THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

SAGARDIGHI THERMAL POWER PROJECT

1 x 660 MW UNIT NO. 5, PHASE – III

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

DOCUMENT NO:- PE-TS-XXX-600-C001

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
POWER SECTOR, PPEI BUILDING
HRDI COMPLEX, PLOT NO. 25
SECTOR 16A, NOIDA
U.P. -201301

PREAMBLE

This Document /specification has been subdivided into following sections:

Section-C: This section indicates the technical requirements specific to the contract not covered in the section-D.

Section-D: This section comprises of technical specification.

Note: In case of any conflict between section–C and section-D, Section C of the specification prevails.

SECTION – C

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW Unit No. 5, PHASE – III

EPC BID DOCUMENT

DOCUMENT NO. 12A05-SPC-G-001

VOLUME: II-G/1

GENERAL SPECIFICATIONS AND DESIGN CRITERIA
FOR
CIVIL AND STRUCTURAL WORKS

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SEPTEMBER, 2017

VOLUME: II-G/1

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR CIVIL AND STRUCTURAL WORK

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GENERAL

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SECTION - I

GENERAL

1.00.00 INTRODUCTION

Volume: II-G/1 of this specification cover site survey, soil investigation, site development works, design and construction of Civil & Structural works. The scope of works covers complete Civil & Structural Works including supply of all materials, labour, tools and plants as required for successful execution of the turnkey package.

This section-I of Volume: II-G/1 lists Codes and Standards to be adopted and the principal structures of the plant, and briefly describes the basic concept, requirements and features pertinent to each. Documents to be submitted have also been brought out in this section along with the procedure to be followed for the same.

In case of any contradiction between any part of the Bid Document with the other, requirement of most stringent one shall be applicable.

2.00.00 CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions as appropriate.

The latest editions/revisions of following codes and standards along with addendums/amendments, if any, shall be followed:

2.01.00 General

a) Internationally accepted design Codes and Standards which are equivalent or more stringent than corresponding Indian Standards.

b) National Building Code of India.

c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.

d) IS-1200 : Method of measurement of Building and Civil Engineering Works.

e) IS-1256 : Code of Practice for Building Byelaws.

2.01.01 Earthwork

a) IS-1498 : Classification and identification of soils for General Engineering purposes.

b) IS-3764 : Safety Code for excavation work.

c) IS-7293 : Safety Code for working with construction machinery.

2.01.02 Concrete

IS-269 : Ordinary and low heat Portland cement.

IS-383 : Coarse and fine aggregate from natural sources for concrete.

IS-432 : Mild Steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.

IS-455 : Portland Slag Cement.

IS-456 : Code of Practice for Plain and reinforced concrete.

IS-460 : Test Sieves (all parts).

IS-516 : Methods of test for strength of concrete.

IS-1199 : Methods of sampling& analysis of concrete.

IS-1566 : Hard drawn steel wire fabric for concrete Reinforcement.

IS-1786 : High strength deformed steel bars and wires for concrete reinforcement.

IS-1834 : Hot applied sealing compounds for joints in concrete.

IS-2386 : Methods of test for aggregates for concrete (all parts).

IS-2502 : Code of practice for bending and fixing of bars for concrete reinforcement.

IS-3370 : Code of practice for concrete structures for storage of liquids (all parts).

IS-3414 : Code of practice for design and installation of joints in buildings.

IS-4948 : Welded steel wire fabrics for general use.

IS-6452 : High Alumina Cement for Structural use.

IS-7320 : Concrete slump test apparatus.

IS-7861 : Code of practice for extreme weather concreting (all parts).

IS-8041 : Rapid Hardening Portland cement.

IS-8112 : High Strength Ordinary Portland Cement

IS-10262 : Recommended guidelines for concrete mix design.

IS-13920 : Ductile detailing of RCC structure subjected to seismic loads

SP- 34 : Handbook on concrete reinforcement and detailing

IS- 216 : Indian Standard Specification for Coal Tar Pitch

IS- 226 : Indian Standard Specification for Structural Steel [Standard quality]

IS-1139 : Indian Standard Specification for Hot Rolled Mild Steel and Medium Tensile Steel and High Yield Strength Steel Deformed Bars for concrete Reinforcement

IS-1200 : Indian Standard Specification for Method of measurement Cement Concrete Works. Part-II

IS-1200 : Indian Standard Specification for Method of measurement Part-V Formwork.

IS-1609 : Code of Practice for Laying Damp proof Treatment using Bitumen felts

IS-1791: Indian Standard Specification for Batch Type Concrete Mixers

IS-2210 : Indian Standard Specification FOR Design of Reinforced Concrete Shell Structures and Folded Plates

IS-2505 : Indian Standard Specification for Concrete Vibrators, Immersion Type

IS-2506 : Indian Standard Specification for Screed Board Concrete Vibrators

IS-2514 : Indian Standard Specification for Concrete Vibrating Tables

IS-2722 : Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS- 2751 : Code of Practice for Welding of Mild Steel Bars used for reinforced concrete construction

IS- 2770 : Indian Standard Specification for Method of Testing Bond in Reinforced Concrete.

IS- 3025 : Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS- 3201 : Indian Standard Specification for Design and construction of Precast Concrete Trusses

IS- 3370 : Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

IS- 3550 : Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS- 3558 :	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS- 3590 :	Indian Standard Specification for Load Bearing Light Weight Concrete Blocks
IS- 3696 :	Safety Code for Scaffolding and Ladders
IS- 3812 :	Indian Standard Specification for Fly Ash for use as Admixture for Concrete.
IS- 4031 :	Indian Standard Specification for Method of Tests for Hydraulic Cement
IS- 4082 :	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site.
IS- 4634 :	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes.
IS- 4656 :	Indian Standard Specification for Form Vibrators for Concrete
IS- 4925 :	Indian Standard Specification for Concrete Batching and Mixing Plant
IS- 4926 :	Indian Standard Specification for Ready Mixed Concrete
IS- 4990 :	Indian Standard Specification for Plywood for Concrete Shuttering work
IS- 4995 : (Part-I&II)	Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
IS- 5512 :	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
IS- 5513 :	Indian Standard Specification for Vicat Apparatus
IS- 5515 :	Indian Standard Specification for Compaction Factor Apparatus
IS- 5751 :	Indian Standard Specification for Precast Concrete Coping Blocks
IS- 5816 :	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
IS- 5891 :	Indian Standard Specification for Hand Operated Concrete Mixers
IS- 6909 :	Indian Standard Specification for Super sulphated Cement

IS- 6923 : Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators

IS- 6925 : Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures

IS- 7242 : Indian Standard Specification for Concrete Spreaders

IS- 7246 : Indian Standard Specification for Table Vibrators for Consolidating Concrete

IS- 7251 : Indian Standard Specification for Concrete Finishers

IS- 7969 : Safety Code for Storage and Handling of Building Materials

IS- 8142 : Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance

IS- 8989 : Safety Code for erection of Concrete Framed Structures

IS- 9013 : Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated-cured Concrete Test Specimens

IS- 9077 : Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction

IS – 9103 : Indian Standard Specification for Admixtures for concrete.

IS- 1489 : Part-1 : 1991 - Specification for Portland pozzolana cement Fly ash based.

2.01.03 Foundations

a) IS-1904 : Code of practice for structural safety of buildings : Shallow foundations.

b) IS-2950 : Code of practice for design and construction of raft foundations.

c) IS-2974 : Code of practice for design and construction of Machine foundations (all parts).

d) IS-2911 : Code of practice for design and construction of pile foundation.

e) IS-9716 : Lateral dynamic load test on pile

f) IS-6313 (Part-1 & 2) : Code of Practice for anti-termite measures and treatment.

2.01.04 Loading

a) IS-875 : Code of practice for Structural safety of buildings - loading standards.

b) : Bridge Rules of Government of India, Ministry of Railways (Railway Board).

2.01.05 Masonry

a) IS-712 : Building limes.

b) IS-1077 : Common Burnt Clay Building Bricks.

c) IS-1127 : Recommendations for dimensions and workmanship of natural building stones for masonry work.

d) IS-1528 : Methods of sampling and physical tests for refractory materials.

e) IS-1597 : Code of practice for construction of stone masonry (all parts).

f) IS-2212 : Code of practice for brickwork.

g) IS-2116 : Sand for masonry mortars

h) IS-2185 : Concrete masonry units.
(all parts - Hollow and Solid concrete blocks).

i) IS-2250 : Code of practice for preparation and use of masonry mortars.

j) IS-2572 : Code of practice for construction of hollow concrete block masonry.

k) IS-2691 : Burnt clay facing bricks.

l) IS-3414 : Code of practice for design and installation of joints in buildings.

m) IS-3495 : Methods of tests of burnt clay building bricks.

n) IS-4441 : Code of practice for use of Silicate type chemical resistant mortars.

o) IS-4860 : Acid Resistant Bricks.

2.01.06 Doors, Windows and Ventilators

a) IS-399 : Classification of commercial timbers and their zonal distribution.

b) IS-883 : Code of practice for design of structural timber in building.

c) IS-1003 : Timber panelled and glazed shutters (all parts).

d) IS-1038 : Steel doors, windows and ventilators.

e) IS-1081 : Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

f) IS-1361 : Steel windows for industrial buildings.

g) IS-2835 : Transparent sheet glass for glazing and framing purposes.

h) IS-1948 : Aluminium doors windows and ventilators.

i) IS-1949 : Aluminium windows for industrial building.

j) IS-2191 : Wooden flush door shutters (Cellular and hollow core type).

k) IS-2202 : Wooden flush door shutters (solid core type).

l) IS-3103 : Code of practice for Industrial ventilation.

m) IS-3548 : Code of practice for glazing in buildings.

n) IS-3614 : Fire check doors.

o) IS-4021 : Timber door, windows and ventilator frames.

p) IS-4351 : Steel door frames.

q) IS-6248 : Metal rolling shutters and rolling grills.

2.01.07 Roof and Flooring

a) IS-2204 : Code of practice for construction of reinforced concrete shell roof.

b) IS-3201 : Criteria for the design and construction of precast concrete trusses.

c) IS-2210 : Criteria for Design of R.C. shell structures and folded plates.

d) IS-809 : Rubber flooring materials for general purposes.

e) IS-1195 : Bitumen mastic for flooring.

f) IS-1196 : Code of practice for laying bitumen mastic flooring.

g) IS-1198 : Code of practice for laying, fixing and maintenance of linoleum floors.

h) IS-1237 : Cement concrete flooring tiles.

i) IS-1443 : Code of practice for laying and finishing of cement concrete flooring tiles.

j) IS-2114 : Code of practice for laying in situ terrazzo floor finish.

k) IS-2571 : Code of practice for laying in situ cement concrete flooring.

l) IS-5491 : Code of practice for laying in situ granolithic concrete floor topping.

m) IS-5766 : Code of practice for laying burnt clay brick flooring.

n) IS-1197 : Code of practice for laying of rubber floors.

o) IS-2441 : Code of practice for fixing ceiling coverings.

2.01.08 Waterproofing

a) IS-1322 : Bitumen felts for waterproofing and damp proofing.

b) IS-1346 : Code of practice for waterproofing of roofs with bitumen felts.

c) IS-1609 : Code of practice for laying damp proof treatment using bituminous felts.

d) IS-3036 : Code of practice for laying lime concrete for a waterproofed roof finish.

e) IS-3037 : Bitumen mastic for use in waterproofing of roofs.

f) IS-3067 : Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings.

g) IS-3384 : Bitumen primer for use in water proofing and damp proofing.

h) IS-4365 : Code of practice for application of bitumen mastic for waterproofing of roofs.

2.01.09 Soil Engineering

a) IS-1498 : Classification and identification of soils for general engineering purposes.

b)	IS-1892	:	Code of practice for sub-surface investigation for foundations.
c)	IS-2131	:	Method for standard penetration test for soils.
d)	IS-2720	:	Methods of test for soils (all parts).
e)	IS-10379	:	Field Control of moisture and compaction of soil for embankment and subgrade.

2.01.10 Water Supply, Drainage and Sewerage

a)	IS-404	:	Lead pipes
b)	IS-458	:	Concrete pipes
c)	IS-651	:	Salt glazed stoneware pipes and fittings.
d)	IS-771	:	Glazed fire-clay sanitary appliances (all parts).
e)	IS-774	:	Flushing cisterns for water closets and urinals other than plastic cisterns.
f)	IS-783	:	Code of pratice for laying of concrete pipes.
g)	IS-1172	:	Code of basic requirements for water supply, drainage and sanitation.
h)	IS-1626	:	Asbestos cement building pipes, gutters and fittings (all parts).
i)	IS-1742	:	Code of practice for building drainage.
j)	IS-2064	:	Code of practice for selection, installation and maintenance of sanitary appliances.
k)	IS-2065	:	Code of practice for water supply in buildings.
l)	IS-2470	:	Code of practice for installation of septic tanks (all parts).
m)	IS-3114	:	Code of practice for laying of Cast Iron pipes.
n)	IS-4127	:	Code of practice for laying of glazed stoneware pipes.
o)	IS-12251	:	Code of practice for Drainage of Building Basement.
p)	IS-1200 [Part XVI]	:	Method of measurement : Laying of water and sewer lines including appurtenant items.
q)	IS-1536	:	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.

r) IS-1537 : Vertically cast iron pressure pipe for water, gas and sewage.

s) IS-3486 : Cast iron spigot and socket drain pipes .

t) IS-5329 : Code of practice for sanitary pipe work above ground for buildings.

u) IS-3076 : Low density polyethylene pipes for potable water supplies.

v) IS-1538 : Cast iron fittings for pressure pipes for water, gas and sewage.

w) IS-1230 : Cast iron rainwater pipes and fittings.

x) IS-1729 : Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.

y) IS-784 : Prestressed concrete pipes.

z) IS-1726 : Cast iron manhole covers and frames.

aa) IS-5961 : Cast iron grating for drainage purposes.

bb) IS-5219 : "P" and "S" traps. [Part-I]

cc) IS-772 : General requirements for enamelled cast iron sanitary appliances.

dd) IS-775 : Cast iron brackets and supports for wash basins and sinks.

ee) IS-777 : Glazed earthernware wall tiles.

ff) IS-2548 : Plastic water closet seats and covers (all parts).

gg) IS-2527 : Code of practice for fixing rainwater gutters and downpipes for roof drainage.

2.01.11 Paving and Roadworks

a) IS-73 : Paving bitumen

b) IS-702 : Industrial Bitumen

c) IS-1201 : Method of testing tar and bituminous materials. thru' 1220

d) IRC-15 : Standard Spec. and code of practice for construction of concrete roads

e) IRC-58 : Guidelines for the design of plain jointed rigid pavement for highways

2.01.12 Earthquake Resistant Design

a) IS-1893 (Part 1, 2, 4) : Criteria for earthquake resistant design of structures.

b) IS-4326 : Code of practice for earthquake resistant design and construction of buildings.

2.01.13 NOT USED.

2.01.14 Structural Steelwork

a) IS-800 : Code of practice for general construction in steel.

b) IS-802 : Code of practice for use of structural steel in Overhead Transmission Line.

Part-I : Load and permissible stresses.

Part-II: Fabrication, Galvanizing, Inspection and Packing.

c) IS-806 : Code of practice for use of steel tubes in general building construction.

d) IS-808 : Rolled steel beams, channels and angle sections.

e) IS-813 : Scheme of symbols for welding.

f) IS-814 : Covered electrodes for manual metal arc welding of carbon and carbon manganese steel.

g) IS-816 : Code of practice for use of metal arc welding for general construction in mild steel.

h) IS-817 : Code of practice for training and testing of metal arc welders.

i) IS-818 : Code of practice for safety and health requirements in electric and gas welding and cutting operation.

j) IS-819 : Code of practice for Resistance spot welding for light assemblies in Mild Steel.

k) IS-919 : Recommendations for limits and fits for engineering.

l) IS-1024 : Code of practice for use of welding in Bridges and Structures subjected to Dynamic loading.

m) IS-1161 : Steel tubes for structural purposes.

n) IS-1182 : Recommended practice for Radiographic Examination of Fusion Welded Butt joints in steel plates.

o)	IS-1200 :	Method of measurement of steelwork and ironwork. [Part-VIII]
p)	IS-1239 :	Mild steel tubes, tubular and other wrought steel fittings (all parts).
q)	IS-1363 :	Black hexagonal bolts, nuts and locknuts (dia.6 to 39 mm) and black hexagon screws (dia.6 to 24 mm). [all parts]
r)	IS-1364 :	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
s)	IS-1365 :	Slotted counter sunk head screws (dia range 1.6 to 20 mm).
t)	IS-1367 :	Technical supply conditions for threaded steel fasteners.
u)	IS-1443 :	Code of practice for laying and finising of cement concrete flooring tiles.
v)	IS-1608 :	Method for tensile testing of steel products.
w)	IS-1730 :	Dimensions for steel plate, sheet and strip for structural and general engineering purpose.
x)	IS-1731 :	Dimensions for steel flats for structural and general engineering purposes.
y)	IS-1852 :	Rolling and cutting tolerances for hot rolled steel products.
z)	IS-1977 :	Structural steel (Ordinary quality)
aa)	IS-2016 :	Plain Washers
bb)	IS-2062 :	Steel for General structural purposes.
cc)	IS-2074 :	Ready mixed paint, air drying, red oxide zinc-chrome, priming.
dd)	IS-2633 :	Methods of testing uniformity of coating of zinc coated articles.
ee)	IS-3613 :	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels.
ff)	IS-3664 :	Code of practice for Ultrasonic Pulse echo testing by contact and immersions methods.
gg)	IS-3757 :	High strength structural bolts.

hh) IS-4000 : High strength bolts in steel structures.

ii) IS-4759 : Hot dip zinc coatings on structural steel and other allied products.

jj) IS-5334 : Code of practice for Magnetic Particle Flaw detection of welds.

kk) IS-7215 : Tolerances for fabrication of steel structures.

ll) IS-7280 : Base-wire electrodes for sub-merged arc welding of structural steels.

mm) IS-7318 : Approval test for welders when welding [Part-I] procedure approval is not required.

nn) IS-8500 : Structural steel - microalloyed (medium and high strength qualities).

oo) IS-9595 : Recommendation for metal arc welding of carbon and carbon manganese steels.

pp) AWS D.1.1 : Structural Welding Code.

2.01.15 Painting

a) IS-348 : Specification for French Polish.

b) IS-427 : Specification for Distemper, dry colour as required.

c) IS-428 : Specification for Distemper, oil emulsion, colour as required.

d) IS-1477 : Code of practice for painting offerrous metal [I & II] in buildings.

e) IS-2338 : Code of practice for finishing of wood and [I & II] wood based materials.

f) IS-2339 : Specification for Aluminium Paints for general purposes in dual containers.

g) IS-2395 : Code of practice for painting concrete, masonry and plaster surface.

h) IS-2932 : Specification for enamel, synthetic, exterior -

a) undercoating, b) finishing.

i) IS-2933 : Specification for enamel, exterior -
a) undercoating, b) finishing.

j) IS-5410 : Specification for cement paint.

2.01.16 a) Indian Road Congress (IRC) Bridge Codes

b) Indian Railway Standard Bridge Rules

2.01.17 Environmental Protection

Charter on Corporate Responsibility for Environmental Protection (CREP) published in Gazette of India dated 27.08.2003.

2.01.18 CEA guide lines for Civil works for Power Plants of 500 MW and above shall also be followed.

3.00.00 SCOPE OF CIVIL WORKS

The scope of civil work comprises all necessary investigations, survey, foundations, building, superstructures and infrastructure required for the complete operating power station.

The work under this Section consists of all Civil and Structural works, but not limited to items mentioned below.

- Topographical Survey
- Area Grading, leveling & dressing (finished grade levels shall be as mentioned elsewhere in this Section)
- Geo-Technical investigation
- Demolition of existing structures / facilities, if any, and site clearance
- Piling work.
- Main plant Roads and Culverts within the Battery limit of this Specification and as shown in the Plot Plan.
- Boundary walls in buildings, if required from statutory point of view
- Provide a connection of at least 3m wide at operating floor level between existing Unit 3&4(2X 500MW) and new Unit#5 (1X660MW).
- Roads along ash pipe line corridor from plant boundary to ash pond including all structures and foundation necessary for canal / drain and pipe crossings, if applicable.
- Storm Drainage network within the battery limit of the Main Plant area and terminating the same to arterial Road side drains or existing drains of Stage-II as practicable.

Major building and facilities

- Power House Building sub structure and super structure with E.O.T crane.

- Foundation for TG and auxiliaries
- Vibration isolation system: Steel spring / viscous dampers for Steam Turbine Generator (STG), Condenser, Boiler Feed Pumps, ID, FD, PA fans and Coal mills.
- Transformer yard including transformer foundations, Fire walls, Rail track (embedded in concrete), transformer oil collection drain pit with sump pump and intermediate pits as required.
- Electrical Grounding mat for all equipment foundations.
- Mill building including bunker and bunker stainless steel lining.
- Civil work & foundations for all electrical auxiliaries in main plant package.
- Boiler & Boiler Auxiliary foundations and super structure.
- ESP foundations and super structure.
- BFP, mill, fan (PA, FD, ID, SA) foundations.
- Cable Racks, Pipe racks, Pipe & Cable racks trenches, duct-banks etc.
- Main plant paving including plinth protection & surrounding drains of all buildings.
- 400 KV Switchyard structures & foundations, Extension of switchyard control building in line with existing Control room building, switchyard maintenance building
- CW & ACW Pump House (CW pumps are concrete volute type) including Fire water pump house, common fire- fighting control room (for PH-II & PH-III), Electrical Annex Building & forebay basin
- CW RCC Channel / Duct from Cooling Tower to CW/ACW Pump House
- CW treatment cum chlorination building structure & foundation
- Self Cleaning Strainer Shed
- Ash handling and disposal system
- Coal handling plant structures and foundations as required
- Mill reject storage bins or silos (Capacity mentioned elsewhere in this specification)
- Vacuum Pump-cum-AHP compressor house
- CPU Regeneration Building.
- FGD Control Building and other buildings / structures as required.

- Condensate Storage Tank foundation.
- ESP Control Building
- Wagon Tippler Complex
- Crusher House
- Crusher House Substation
- CHP utility building
- DG building
- Transfer Points (TPs) for CHP
- WT Control Building and Substation
- Ash Silo Electrical Building
- Expansion of LT Swgr Room (Phase-II) for accommodating new set of battery requirement for Phase-I, II and III.
- Extension of CST Pump House.
- Other auxiliary buildings / structures as required.
- All other civil items not covered above but required for completion and proper functioning of the plant (Unit 5, Phase-III) shall form part of the scope.

Above list of Plant & Non Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work. In case the equipment parameters considered by bidders for Phase-III differs from that of Phase-II, separate buildings may be required to accommodate such equipment and its stand-by units.

The scope shall also include all necessary civil work (mainly civil fdn.) pertaining to erection of stator/ any other equipment (if reqd.).

The civil, structural and Architectural works pertaining to above facilities include supply of all materials, design, engineering and construction of all sub and super structures, erection and installation of equipment and providing finishes including flooring, paving, Side cladding with sheeting/brick masonry, walls, plastering, painting, false ceiling, doors & windows, plumbing, roof treatment, etc. complete in all respect to render the premises functional to the satisfaction of the Owner.

The scope shall also include setting up by the successful bidder a complete testing laboratory in the field to carry out all relevant tests required for the civil works for the project.

Slope protection work shall be done with stone pitching & grouting with cement morter (1:4). RCC retaining wall shall be provided as per requirement.

Entire BTG area is graded at a level of R.L. 34.2M.

Water will be supplied by the Owner at two points within the plant battery limit and the Bidder shall arrange distribution of the same beyond the above point.

A list of Civil Field Quality Assurance Laboratory Apparatus is enclosed in Annexure-I of this Section.

The Bidder shall visit the site and assess the involvement of demolition and site clearance, if required, within the plant area to construct the project & accordingly the cost is to be considered in his offer.

The work shall have to be carried out both below and above the ground level. The work shall be executed accordance to the relevant Indian Standard Code, and in its absence, the work shall be executed according to the best prevailing local Public Work Department (PWD) practices or to the recommendations of relevant American and British Standards or to the instructions of the Owner's Engineer. This shall prevail in respect of civil works for which no specification has been prescribed in this section.

The work shall be carried out according to the design / drawings to be developed by the successful bidder and approved by the Owner / Owner's authorised Consultant. For all building, structures, foundations, etc., necessary terraced layout and details are to be developed by the successful bidder keeping in view the statutory & functional requirement of the plant & facilities and providing enough space & access for operation, use and maintenance.

The land will be given to the successful bidder by the Owner as is where basis. All site investigations, surveys, grading and levelling and other additional works shall be carried out by the successful bidder if necessary.

Setting–up of grid pillers with respect to phase-II general grid, the layout and levels of all structures shall be made by the successful bidder at his own cost from the general grid of the plot and the nearest GSI bench mark or other acceptable bench mark of Govt. Dept. The successful bidder shall be solely responsible for the correctness of the layout and levels.

All necessary statutory clearances shall be obtained by the Bidder prior to execution of work under scope of this specification.

All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to by the successful bidder.

4.00.00 MAIN PLANT STRUCTURES / COMPONENTS

The description of some of the major structures/utilities covered under the Package are given below:

1.0 Power House Building

i) Turbine Hall

The turbine building is an enclosed insulated, weather- tight steel framed structure which houses the turbine generator and related equipment including the feed water heaters. The building consists of an operating floor, mezzanine floors and a ground floor. The roof is supported by steel trusses. The structure is braced in the direction of the crane travel but provided with rigid joints at roof level and framing at other floor levels with the electrical and mill bays in the transverse direction.

One E.O.T Crane (capacity shall be as specified elsewhere in this specification) will operate in the Turbine Hall for handling all parts of boiler feed pumps and turbine generator including generator stators. The generator stators will be erected with the help of the E.O.T. cranes. For rigging and positioning of the condensers, building frame shall not be of any hindrance and temporary openings in the building walls and wall supporting structures shall be maintained till completion of the rigging and positioning of the condensers.

Within the building, the concrete pedestal for supporting the turbine generator will be completely isolated from the building floors for vibration control. The foundation for Turbogenerator and Boiler Feed Pumps/motors shall rest on suitable vibration isolation system consisting of springs and viscodampers (supplied by M/s GERB, Germany or equivalent). The fundamental frequency shall be at least ± 30% away from operating frequency. Resonance at other possible frequencies (half and twice operating speed) shall also be checked. The concrete operating floor will be designed for construction and maintenance loadings of TG. Hatchways with removable chequered plates or grating floor covers will provide access to equipment on lower floor and will be within turbine hall crane access. The intermediate floors will be of concrete with hatchways as necessary.

Windows, doors, exterior walls, internal finish and external finish shall be as laid down in Vol: II-G/2 of this specification.

The roof shall be flat with a gentle slope of about 1 in 100 towards the transformer yard. The roofing will be done by cast-in- situ RCC slab over metal decking supported by steel purlins which are spanning between two adjacent roof trusses. The roof will be insulated by providing 75 mm thick foam concrete. The roof will be provided with membrane water proofing as per architectural specification for making the roof waterproofed. Roof finishes will be as per architectural specification mentioned in Vol: II-G/2 of this specification.

Lighting, ventilation will be provided as described in other sections of this specification.

ii) Electrical and Deaerator Bay

This bay is continuous with the turbine building on the boiler side. This bay houses the electrical switchgears, deaerator heaters, control panels

and provides space for major pipe lines and electrical cables.

All floors with hatchways as required & roof will be of cast-in- situ concrete and the sides will be claded with 250 mm thick brick masonary. Deareator floor shall be properly sloped for draining water to nearby catch pits or drains.

Stairs and platforms shall be provided as required for maximum utility and safety.

Provision of Visitor Lounge/ Gallery in Control Room to be kept.

Connecting Passage, enclosure with control room of Phase – II to be provided.

2.0 Mill Building

This building houses coal pulverisers, coal bunkers, tripper conveyors, vibro feeders, ducts and piping.

Features of Raw Coal Bunkers

o Shape of Bunker	:	Cylindrical
o Bunker capacity (cumulative)	:	Minimum 14 hours storage capacity considering BMCR operation with worst coal.
o Valley angle of Hopper	:	65 Deg. (minimum).
o Gap between hopper outlet and coal feeder inlet	:	3 M (min.)
o Hopper Liner	:	6 mm thick austenitic 316L plates all over fitted without allowing any projections in coal flow path.
o Density of Coal	:	800 Kg/cum (For volume calculation) 1200 Kg/cum (For weight calculation)

All floors will be concrete with hatchways as required. Ground floor slab will have drainage trenches covered with grating.

Building roof will be of Cast-in-situ concrete and the sides will be cladded with 250 mm thick brick masonry.

Stairs and platforms shall be provided as required for maximum utility and safety.

3.0 Flue Gas Draught System Structures

Flue gas draught system structures include De-NOx system, electrostatic precipitators, ID fans, Flue Gas Desulphurisation (FGD) plant, ductwork and chimney. The equipment structures are outdoor construction type supported by exposed steel structures consisting of beams, columns and bracings.

The precipitators will be elevated to allow a good arrangement of gas ducts from the air heaters and to facilitate removal of fly ash in the event of equipment breakdown. Precipitator control room (ESP Control Building) will be housed in a masonry building with R.C. column and beam framing.

At the paved ground level, drainage trenches covered with grating at intervals shall be provided for final discharge into the drainage system/sump pit.

Ducts and precipitators will be covered with thermal insulation.

3.1 NOT USED

4.0 Main and Aux Cooling water system

Miscellaneous Yard Buildings will be all concrete construction, excepting for buildings of more than 12M span where steel roof truss/girders will be provided to support the concrete roof over concrete columns. Gable and side cladding will be constructed with brick masonry.

The following miscellaneous plant buildings/structures will be required under this Main Plant Package :

4.1 CW Pump house and fore bay

The CW /ACW Pump house shall be adjacent to Forebay / feed pool suitably designed based on Hydraulic Institute to ensure efficient pump operation and provided with stop log gates and screen to isolate individual pump sump for maintenance. CW sump shall be of water tight RCC construction. The pumps shall be mounted on RCC floor slab. The superstructure of the building shall have RCC/ Steel framing with RCC roof slab laid over metal decking and brick masonry side cladding. The provision of sludge pit in the forebay base slab shall be provided for periodic sludge removal. The building shall have EOT crane for maintenance and handling of pumps and gates.

4.2 Chlorination building

Adjacent to pump house, chlorination building with RCC/ steel framing superstructure will be located to house chlorine toner and or chlorine / chemical dosing pump and auxiliaries. The side cladding and other finishes shall comply with Architectural specification.

4.3 CW Tunnels/ duct

The underground tunnels / piping from CW pump house to cooling tower basin for circulating cooling water to condenser shall be of watertight RCC construction. The layout and depth of tunnels shall be made suitably so that plant drainage network shall not be affected.

5.0 Switchyard structures and foundations

Substation structures comprise of all towers, gantries, lighting towers, lightning towers/masts, chain link fencing with gates, equipment supports and other structure - all of galvanized steel and with bolted type joints. Foundations for above structures will be reinforced cement concrete. Cable trenches with precast RCC covers of removable type, sump pits, oil pits, cable tray supports, grounding etc. will be constructed in Switchyard areas. Foundations for jacking transformers, oil drainage piping etc. will also be provided. Baffle walls shall be arranged based on layout of transformers and statutory requirement. Additional protection for buried cables need be provided under road/railway track in form of RCC/galvanised iron pipes/RCC box culvert.

Lighting towers shall be provided with a structural steel ladder from its base up to the top of tower. The ladder shall be provided with protection guards in the form of rings. Platforms with protection hand-railing shall be provided at suitable heights for mounting of lighting fixtures. Road inside the switchyard area shall be of 4m (one lane)wide ,water bound Macadam with bituminous topping on prepared sub –grade alongwith 1.0 m wide shoulder on either side.

6.0 Pipe/Cable Trestles and Foundations

No cable/pipe trench is envisaged in the plant area. All cables & pipes in outdoor area shall run above ground over steel trestles or other supporting structures for easy inspection & maintenance except in Transformer Yard area, GIS Substation area and some other localized area where the same can run in R.C.C. trenches. In case overground routing is not feasible due to site constraints, the pipe/cable to be routed through duct-banks.

A minimum clearance (clear head room) of 8.0m shall be kept for all overground pipe/cable trestles for all road/rail crossings. In other areas the clear height shall be 3.0m (minimum) from ground/grade level except in pipe corridor between main plant and plant water system which shall be 5.0m (minimum) from ground/grade level. All trestles shall be provided with continuous walkway of minimum 600mm width with handrail and toe-guards all along the length of the trestle along with approach ladder near roads, passageways etc.

Before and after the rail/road crossing, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8.0m) etc. up to the pipe/cable rack trestles.

Four-legged trestles & foundations are to be provided for supporting the pipe/cables at suitable intervals. Four legged trestles are to be provided mainly at intercepting location of branch pipe rack (maximum distance 100 m) Crossover, operating platform & necessary trussed resisting arrangement at pipe bend shall be provided as required.

7.0 Surface Treatment

Boiler Area

The entire area beneath the Boilers, Precipitator Hoppers, around FD and ID fans upto the stack (From Transformer yard to outer edge of plinth protection of chimney) will be paved with reinforced cement concrete with and sloped to drains. Immediately adjacent to these areas water bound macadam roads with bituminous topping will be provided as required for access to equipment.

Transformer Areas and Switchyard

Oil cooled equipment, such as transformers, will be located within concrete basins filled with gravel. The individual basins will be connected by pipeline to a separate chamber/oil pit for collection and further reclamation of oil through oil water separators, if necessary.

Drains will be adequate to remove full discharge from deluge system used for fire control. Transformer Yard will be paved with reinforced cement concrete. Switchyard area shall be filled with 150 mm thick layer of 20 mm to 40 mm size gravel over a layer of 100 mm thick lean concrete (M10).

Oil Storage Areas

Oil storage area, with dykes to contain oil spills in accordance with Govt. Acts and Regulation on the oil pollution prevention shall be constructed.

8.0 Ash Handling and disposal system

The civil and structural works related to the ash handling system are as follows. For detailed specification of ash handling system Volume-II-H2 shall be referred to.

8.1 Ash slurry pipe trenches/ pedestals

Ash slurry pipes shall be pipes shall be routed in the plant in such a way to cause least disturbance with plant drainage networks. Generally over ground RCC pipe sleepers/pedestals shall be provided for conveying pipes. For road / rail /nallah crossings, RCC box culverts/ trenches with pipe supports inside shall be provided. Drainage provision inside trench shall be provided.

8.2 Fly Ash silo

Fly ash silo shall be of circular RCC structures supported on RCC pedestals on Pile foundation. The bottom height shall be decided based on truck unloading. The silo shall be provided with access ladder to roof.

9.0 Coal Handling Plant

The various structures in the coal handling plant are described below. For detailed specifications of coal handling system, Volume II– H1 shall be referred to.

9.1 Over Ground Transfer Points (TPs)

Over ground TPs shall have RCC foundations and pedestals at (+) 500 mm above ground level. The super structure for TPs shall be of steel framed structure with adequate bracing arrangement. The ground floor and all intermediate floors shall be of RCC and will be finished with IPS and metallic hardener having proper slopes for drainage. The roofs shall be of flat RCC slab with water proof treatment and drainage slope. The cladding shall be of 230 mm thick brick work or of coated steel sheet.

TPs shall be provided with independent steel staircase with steps of MS grating from ground of highest operating floor level. The clear width of the stair shall be minimum 1.0 M. The tread shall be at least 250 mm and riser shall be uniform throughout the height and shall not exceed 190 mm. However the codal regulations shall also be complied with. Continuous handrails shall be provided for the staircases.

Drive units shall be directly supported on floor beams from suitable structural steel stools and not on concrete floors. All transfer houses shall be provided with adequate no windows and doors. The window area shall not be less than 10 percent of total wall area. Maintenance platform inside /outside of transfer house may have chequered plate floors with horizontal floor bracing.

Transfer points / crusher house with metal sheeting as cladding shall have 1.0 m high 230 mm brick enclosure from finished ground floor around the building. Brick wall shall be inside face of sheeting with a lapping of 150 mm.

Adequate floor washing arrangement shall be made for all TPS.

Provision of floor dust collection and removal by chute shall be made.

TP at BTG area i.e TPs between boiler and chimney area must be on pile foundation.

9.2 Overground Galleries and Trestles

On grade and over ground galleries shall be of enclosed type for adequate weather protection. The walkways for on-grade galleries shall be raised and they shall be made of concrete with skid proof finish or with metal bar grating. Overhead conveyor galleries shall be structural steel consisting of two girders braced at top and bottom and supported on trestles.

Walkway portion of over ground conveyor galleries shall be of chequered plate with antiskid bar or expanded metal grating. The maximum span of standard gallery shall be 30 m. The galleries for double stream conveyors shall have one central walkway and two side walkways and single stream conveyors shall have two side walkways. Hand railings shall be provided as required. At crossing points for roads, buildings and railway lines and other important locations seal plate of minimum 3 mm thickness shall be provided. The over ground conveyor galleries shall be designed for adequate ventilation and natural lighting.

Conveyor gallery having slopes greater than 8 degree, stepped walkways of tread 250 mm of chequered plates with nosing and toe guard shall be provided all along the conveyor. 10mm dia Tor anti-skid steel bars shall be provided @ 500 mm for inclined walkways below 8 degrees.

Suitable floor washing arrangement shall be made in the conveyor gallery with down comers.

In between transfer house / buildings four legged trestles shall be place at a maximum interval of 100 m. The arrangement shall be such as to ensure that force in the longitudinal direction of conveyor gallery of length not more than 100 m will be transferred to four legged trestle. Two legged trestles at regular interval may be placed between four legged trestles. The end supports resting on the four legged trestles can have either ends hinged or one hinged and the other on slide type. Slide type support shall be with PTFE bearing to allow both rotation and movement.

End of conveyor gallery which will be supported over transfer points, shall be so detailed that only vertical reaction is transferred from gallery and no horizontal force in longitudinal direction is transferred from gallery to transfer points and vice–versa.

All RC trestle pedestals should be raised to (+) 1.0 m above FGL.

Trestles shall be of structural steel braced adequately and provided at suitable locations. Location of trestles shall be decided carefully so that there is no interference with underground and over ground structures, tunnels, trenches, drains, etc. The minimum clearance over road and railway crossing should be 8.0 meters.

9.3 Drainage of CHP area

Suitable drainage arrangement shall be provided for all under-ground structures and tunnels with sump pumps. Coal stockyards and surrounding areas also shall have suitable surface drainage facilities.

9.4 Wagon Tippler Complex

a) One (1) Rotaside Wagon Tippler complete with all accessories including driving accessories, rack & pinion, wagon tippler table complete with rails, rail fixture, integrated weigh bridge, cradle, sustaining beam, clamping arrangement etc. as required for safe, reliable and trouble free operation. The height of the roof shall be decided based on the provision for H.T. electrical overhead wire for Electric Loco and the clearance required for Wagon Tippler during unloading.

b) One (1) Side Arm Charger with the Wagon Tippler complete with the carriage, coupling for disengaging the front wagon, drive, drive pinion, chain, necessary rail, rail fixtures, cable for the travel of the machines, limit switches, brakes, necessary stops with buffer etc. as required for safe, reliable and trouble free operation of the plant.

c) One (1) local control room with wagon tippler for controlling the operation of Wagon Tippler in conjunction with side arm charger.

d) Steel Grating (heavy duty) of 300 mm square openings over wagon tippler hopper. The grating shall be fabricated from structural flats and round bars of suitable sections and complete with all necessary fixtures. The gratings shall be suitable to pass coal of size 300mm and below. The grating design shall be adequate for manual/mechanized hammering for breaking oversize coal lumps.

e) One (1) set of Apron Feeder below the Wagon Tippler Hopper complete with dribble feeder, skirt, flow control arrangement, drives and supports for evacuating ROM Coal at the rate of 1650 / 1500 TPH (Designed / Rated) from Wagon Tippler Hopper.

f) One (1) R.C.C. Wagon Tippler Hoppers of 375 M3 capacity minimum along with accessories. 16 mm thick TISCRAL / Equivalent liner on all internal walls of the hopper and other areas inside the hopper coming in contact with coal.

Wagon tippler pit shall be of RCC construction. This structure shall be designed as a water retaining structure with limited crack width of 0.1mm. Proper provision shall be made while constructing to provide structural water proofing after the concreting of the pit is complete. Sump shall be provided to collect and pump out water which enters through coal/tunnels etc. RCC access shaft accommodating staircase as well as monorail for handling of machinery shall be provided. Control and switchgear room shall be of RCC framed construction with brick cladding. Control room shall be provided with fixed glazing in aluminium framework on front side. Steel glazed windows with 6 mm

thick wired glass shall be provided for other walls. RCC staircase shall be provided for access to the control room.

Hoppers shall be of RCC construction. The pit shall accommodate the hoppers along with feeder and conveyors below. The hopper pit shall be of RCC construction and designed as water retaining structure. During construction proper provision shall be made to make the pit completely water proof. For Reclaim hopper sloping surfaces 5mm thick stainless steel liner of SS 409M shall be provided. For Wagon tippler sloping surface including grizzly supported RCC beams & all other surfaces where coal is to strike 16mm thick TISCRAL / equivalent plate shall be provided. Suitable sump shall be provided in the pit to effect surface water drainage. RCC access shaft shall be provided with staircase to the bottom of the pit. Monorail for taking machinery into the pit shall be provided in the access shaft projecting through two leaf steel sliding door. Plinth level of the pit shall be kept at least 500 mm above graded level with RCC sloped paving all round to enable bulldozer movement. Shed above hopper pit shall be of structural steel construction.

Wagon tippler shed shall be steel framed structure with rigid framing in the transverse direction and bracing in the longitudinal direction. Roofing shall be of colour coated galvanised sheet of minimum thickness 0.8 mm and side cladding shall be of similar sheet but with 0.6 mm thickness above 3 metres high brick wall. Roof shall be given a minimum slope of 1 vertical : 4 horizontal. Rain water gutters of matching colour shall be provided to convey the rain water through Pipes as specified elsewhere. RCC drains shall be given on either side along with plinth protection all round.

9.5 Crusher House

Crusher house shall be of steel structure of framed / braced design. Floors and roofs shall be RCC over structural steel beam. Side cladding shall be as specified elsewhere above wall (height as specified elsewhere) on ground floor. Roof shall be given adequate slope for drainage. Roof shall be given with proper water proofing, for description mentioned elsewhere in this specification. Proper arrangement shall be provided to convey the rain water through gutter of matching colour and down comers as specified elsewhere. Adequate windows shall be provided with steel glazed side hung windows using wired glass. Wherever monorails are projecting outside for lifting of equipment, steel sliding doors shall be provided. Main entrance doors shall be rolling shutter adequately sized to carry equipment inside. Other doors shall be of flush welded steel construction. Ramps shall be provided in front of main door. Grade slab as well as intermediate floors shall be of RCC. Intermediate floor shall be supported on steel beams. Crusher shall be mounted on the floor framing using Vibration Isolator system. Handrail shall be provided around all big openings and kerb plates shall be provided around all small openings.

Two staircases shall be provided one inside and one outside, both of structural steel. Rack and pinion elevator shall be provided. Machine room of elevator floor and roof shall be of RCC. Side cladding of M/C room shall be of colour coated sandwiched cladding system. An RCC kerb wall of 300 mm shall be given around the floor. M/C room shall be given adequate slope for drainage purposes. Roof shall be given with proper water proofing, for description mentioned elsewhere in this specification with down comers as specified elsewhere. Main door to M/C room shall be of steel of flush welded construction. Adequate ventilation shall be given using steel glazed window. Toilet shall be provided in the Crusher house.

Foundation of the building columns shall be of RCC. Foundation design criteria are given elsewhere. All the foundations shall be connected together by tie / plinth beams. Top of the pedestals for the columns shall be above finished ground floor level as specified elsewhere.

10.0 Area Grading

Site leveling and grading for the plant area within this phase shall be within scope of this contract. Work shall have to be carried out as per grading layout plan approved by the Owner/ Owner's Engineer. All existing drains/channels in the plant and other areas associated with the plant shall be suitably diverted before taking up any construction. These diversions shall be so designed as to ensure effective disposal of water without any accumulation or flooding in adjoining areas.

11.0 Roads

All plant service roads will be 8M (for double lane) or 4M (for single lane) wide, water bound macadam with bituminous topping on prepared sub grade, providing access to all truck sized building doors and all structures requiring maintenance by vehicles. Water bound macadam with bituminous topping will be provided at areas requiring parking facilities. Bituminous topping of all plant roads and parking areas shall be done after completion of plant construction & maintenance of road till such time shall be in scope of successful bidder.

All Roads shall be designed in accordance with the provision of the latest edition of the relevant I.R.C. codes of practice.

The subgrade shall be prepared with well compacted selected soil/earth. Subbase shall be 300 thick (consolidated thickness) grannular subbase with crushed stone (grading-1), morum and sand. The wearing coarse shall be 75 mm thick bituminous macadam binder course with 20 mm open graded premix carpet with seal coat on top, laid on 225 mm (compacted thickness) water bound macadam course.

12 0 Miscellaneous plant building

The following plant buildings / facilities are generally required for plant operation.

- Condensate Storage Tank Foundation.
- ESP Control Room and intermediate surge hopper.
- RCC Fly Ash Silo.
- Switchyard.
- FAE tower
- Cable Rack, Pipe rack, Cable & Pipe Rack & Trenches.
- C.W. Chlorination Plant Building.
- FGD Control Building and other buildings / structures as required.
- CPU Regeneration Building.
- Vacuum-Cum-AHP Compressor house.
- Wagon Tippler Complex
- Crusher House
- DG Building
- WT Control Building
- CHP utility building
- Expansion of LT Swgr Room (Phase-II) for accommodating new set of battery requirement for Phase-I, II and III.
- Extension of CST Pump House.
- Ash Silo Electrical Building
- Pipe rack, Cable rack, Pipe & Cable Rack, Trenches
- Junction Towers (TPs)

The buildings are RCC / steel framed building with brick / colour coated metal sheeting as side cladding. Architectural requirements shall be as per Vol:II-G/2.

Other non-plant buildings / facilities not specifically mentioned above or in Vol-II:G/2, but required for operation of the plant shall be constructed by the Bidder.

The EPC Bidder may add extra facilities / buildings as may be required for operation of plant subject to prior approval of Owner / Consultant.

13.0 Auxiliary and Non-plant Building

Auxiliary and non-plant buildings those are required for the plant to be prepared.

Above list of Plant & Non Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work. In case the equipment parameters considered by bidders for Phase-III differs from that of Phase-II, separate buildings may be required to accommodate such equipment and its stand-by units.

14.0 Drainage System

Drains shall be designed as a network covering the plant area within the battery-limit of this specification. This plant area drainage has to be terminated up to surrounding Road side drains constructed by other agency. Attempts will be made to convert construction drains into main drain as far as practicable.

Auxiliary/Branch drains shall cover individual grades to terrains; collect storm water and other non-contaminated discharge from plant buildings and then be connected to Main drain/existing phase I drain at suitable locations as practicable. The invert of the in-plant peripheral drains shall be kept such that water can be discharged by gravity to the drain under all condition. RCC pipe culverts/box culverts will carry drainage under intercepting roads and railway tracks. Effluent drains shall completely be separated from storm water drain. Effluent drain within the main plant battery limit will not be the scope of this contract. Suitably designed underground storm water RCC piping on the basis of design loads specified elsewhere in this specification shall be limited to required areas where surface drainage ways are not desirable or practicable from other functional point of view. Class of RCC pipes shall be decided by Bidder as per design requirement. For pipe drains, concrete pipes of minimum grade – Class NP2 will be used. However, for road concrete pipes of Class NP3 will be used and for rail crossing, railway norms shall be followed. R.C.C. Manholes will be provided at maximum 30m intervals along the length, at connection points and every change of alignment, gradient or diameter of pipeline. The drains shall generally be of open type RCC rectangular construction. R.C.C. drains shall be covered with perforated R.C.C. pre-cast slab (M-25) of minimum 50mm thickness with provision of openable galvanized steel grating covers at every 4.0m intervals. Similarly, all drains along the periphery of buildings shall also have perforated R.C.C. pre-cast slab (M-25) of minimum 50mm thickness

with provision of openable galvanized steel grating covers at every 4.0m intervals. Design of such drain covers shall be done considering loading as specified elsewhere. In areas where vehicular loads would come, pre-cast RCC covers/box culverts of suitable thickness without perforations and designed for the vehicular loads shall be provided.

The drainage system shall be designed for precipitation intensity of 60 mm per hour (maximum hourly intensity of rainfall). Run-off coefficient for open ground area (unpaved) shall be minimum 0.80 and for paved area and other covered surface including roads the same shall be considered as 1.0.

Surface drains will normally have a slope of 1 IN 1000 along longitudinal direction and RCC pipes to have such slopes such as to have effective discharge. RCC or masonry structures will be provided at drops/falls to prevent scouring. Drops/falls shall be provided on both sides of box/pipe culverts. Minimum self-cleansing velocity should be adopted as 0.7m/sec but the velocity of flow should not be more than 2.4 m/sec for concrete drain, however, it is recommended to maintain the maximum velocity within 1.2 m/sec.

15.0 Pavements

- Boiler Area

  The entire area encompassing both the units from Power House to Chimney will be paved with reinforced cement concrete with and sloped to drains. Immediately adjacent to these areas water bound macadam roads with bituminous topping will be provided as required for access to equipment.

- Transformer Areas and Switchyard

  Oil cooled equipment, such as transformers, will be located within concrete basins filled with gravel. The individual basins will be connected by pipeline to a separate chamber/oil pit for collection and further reclamation of oil through oil water separators, if necessary.

  Drains will be adequate to remove full discharge from deluge system used for fire control. Transformer Yard will be paved with reinforced cement concrete. Switchyard area shall be filled with 150 mm thick layer of 20 mm to 40 mm size gravel over a layer of 100 mm thick lean concrete (M10).

16.0 Waste water Treatment and Drainage system

The description of some of the major structures/components covered under the Waste Water System Package is given below :

Coal pile area run-off will be led to settling pond. Earthen settling pond with two (2) compartments will be provided. Top of earthen dyke shall be 500mm above surrounding finished grade level to restrict ingress of

storm water from adjacent areas. Capacity of pond shall be determined on the basis of inlet drain invert. The side slopes and bottom will be protected with PCC blocks of minimum 75mm thickness with suitable underbed having interstices filled with cement-sand mortar. At the downstream of pond RCC overflow weir and sump shall be provided. Design and detailing of pond shall be as per good engineering practice so as to satisfy functional requirement as specified in Section-IIH of this specification. Necessary sluice gates with hoisting arrangement shall be provided in inlet drain (battery limit for drain shall be as shown in tender drawings) carrying coal pile area run-off so that one settling pond can be operative while the other one under excavation.

The Power House and Boiler area service water waste shall be collected in a RCC underground oily waste retention pit. Necessary pumps and supporting floor/maintenance area shall be provided. This effluent will finally be treated in CPI. Foundation for CPI shall be designed as per IS:456.

Oil storage and handling area run-off will be collected to a conventional baffled oil water separator (battery limit shall be as shown in tender drawings). This oil water separator will be an underground RCC structure having RCC baffle wall and overflow sump for collecting water at outlet end. An oil collection pit shall be provided on sidewall of oil water separator. This structure shall be designed as uncracked section as per IS:3370. The structure shall project at least 300mm above finished grade level. Handrail shall also be provided around the pit. The overflow sump shall be covered at top over which pumps will be installed.

RCC sump for collecting boiler blow down and ESP area floor washing shall be under scope of other package. However, civil work for outlet of this effluent shall be under scope of this package.

Effluent from plant sanitary sewage shall be treated in Up-flow filter and finally discharged to soak pits. Outlet of septic tanks shall be the inlet of Civil Work for Effluent Treatment Work under this package. Design and construction of Up-flow filter and soak pit along with other necessary civil work shall be under scope of this package.

There will be a Guard Pond (effluent monitoring pond and equalization basin) sized for holding wastewater more than 24 hours before final discharge to storm water drainage system. The guard pond (earthen) shall have adequate capacity as per design requirement with 750 mm free board. Top of earthen dyke shall be 500mm above finished grade level. The pond shall be of such construction as to prevent pollution of ground water by seepage of any wastewater having side slopes and bottom lined with minimum 1.0mm HDPE for minimizing seepage loss. Over the LDPE lining, PCC blocks of minimum 75mm thickness having interstices filled with cement-sand mortar shall be provided. Filter media shall be suitably designed & provided below liner.

All other civil works including drains / MS pipe with fitting / RCC pipes / pipe racks including foundations etc. for successful completion and operation of waste water treatment plant shall as mentioned elsewhere in this specification.

17.0 Sanitary Sewerage System

The scope of foul water from toilet shall include layout and laying of sewers up to the septic tank, up-flow filter with soak pit for individual building for sewerage system together with all fittings and fixture and inclusive of ancillary works such as connections, installation of man-hole and inspection chambers. Sanitary outlet can be discharged to surface drain after treatment.

18.0 Construction Facilities for early works

The Bidder shall develop and construct all necessary facilities like Batching plant, Chilling plant, Construction store, Fabrication yard and Raw material storage area and Canteen for site personnel at no extra cost to the Owner. The associated roads and drains connecting these facilities shall also be constructed by the Bidder. The Bidder shall visit the site and locate suitable areas for these facilities.

5.00.00 DOCUMENT SUBMISSION

Design and Construction documents pertaining to all Civil, Structural and Architectural works that will be required to be submitted to Owner/ Owner's Consultant/Review Consultant for their approval have been brought out under following clauses. Approval of these documents by the Owner/Consultant shall not relieve the successful bidder of his responsibility for any errors and fulfillment of Contract requirements.

5.01.00 Design Document

Design Document shall comprise Mechanical/Electrical assignment Drawings, design data, design assumptions & references, detailed structural analysis (including computer output, if any) & design calculations and design drawings.

Design calculations and drawings shall be submitted and reviewed only after approval of corresponding Mechanical/Electrical/System general arrangement drawings. The contractor shall submit approved GA drawings along with three (3) copies of design documents (except design drawings), four (4) copies of design drawings for comments/approval of the Owner/Consultants. On final approval of the drawing and design, Contractor shall submit eight (8) copies of the drawing with one soft copy in CD each to the Owner and consultant for distribution.

5.02.00 Construction Document

Based on approved design drawing, detailed drawings for construction will be prepared by the successful bidder. For reinforced concrete structures and foundations detailed bar bending schedules in approved format shall

accompany each detailed drawing. For structural steel work the successful bidder will prepare detailed fabrication drawing along with bill of materials.

Six (6) copies each of selected or all detailed drawings/ fabrication drawings as decided by Engineer for all structures along with bar bending schedule/bill of materials need be furnished to Owner/Consultants for their review and approval.

Upon approval, eight (8) copies of each drawing along with one soft copy in CD shall be submitted to the Owner and Consultant for their distribution. Procedures for submission and approval of Construction Documents other than stated above have been mentioned elsewhere in this specification.

5.03.00 As Built Drawings

"As-built" drawings shall be prepared by the Contractor after completion of construction / erection incorporating all the changes, if any, done on Engineer's instruction/approval. In case of any discrepancy in the number of prints and CD to be submitted for Design, Construction documents and As-Built drawings mentioned elsewhere in the specification, stipulations made here shall prevail.

6.00.00 LAYOUT

Before starting the work, the successful bidder shall carry out the setting out of foundation and structures and provide levels, with reference to general existing grid and benchmark. If the successful bidder uses the grid, benchmark and reference pillar made by other Contractors, he shall coordinate with the Contractor and shall satisfy himself of the accuracy of the reference marks. If he is required to set out the foundation afresh, he shall do so independently with reference to the one existing grid and benchmark, which has been followed by other agency at the instruction of the Engineer. In case any discrepancy is found, it shall be immediately brought to the notice of the Engineer for any rectification / modification necessary. No complaint shall be entertained at a later stage. The successful bidder shall accurately set out the position for holding down bolts and inserts.

If required, in the option of the Engineer, he shall construct and maintain pillars for grid, references and benchmarks and maintain them till the completion of the construction. He shall also help the Engineer with instruments, materials and labours for checking the detailed layouts and levels. The successful bidder shall be solely responsible for the correctness of the layout and levels, and Engineer's approval shall not be deemed to imply any warranty in carrying out the works correctly. The Tenderers shall take into account the cost of these in quoting their price.

7.00.00 WORKSMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those, which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge lining and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt

assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye- laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the successful bidder shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the successful bidder shall have, with no additional cost to the Owner, the services of the supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

8.00.00 TEMPORARY WORK

All scaffoldings, staging, temporary bracing and other necessary temporary work required for proper execution of the Contract shall be provided by the successful bidder at his own cost and inclusive of all materials, labour, supervision and other facilities.

The layout and details of such Temporary work shall have the prior approval of the Engineer, but the successful bidder shall be responsible for proper strength and safety of the same. All Temporary work shall be so constructed as not to interfere with any permanent work or with the work by other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or with the work of other agencies, such removal and re-erection, if required, shall be carried out by the successful bidder at the direction of the Engineer without any delay and any extra cost on this account shall be borne by the successful bidder.

9.00.00 INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

Modification in layout of foundation/structure during detail engineering stage may be necessary to avoid fouling with those under other's scope. Necessary changes on this account will be made without any extra cost to Owner.

10.00.00 SEQUENCE OF WORK AND PROGRESS REPORT

The sequence in which the works are to be carried out shall be as approved by the Engineer in accordance with the construction method accepted by the Engineer and to be followed by the successful bidder. A programme of work is to be submitted for the Engineer's review and approval and this has to be periodically updated and modified as per actual progress to enable timely completion.

The successful bidder shall regularly submit to the Engineer progress reports for periods of working as specified by the Engineer showing up to date progress on all-important items of work.

11.00.00 CIVIL FOUNDATION OF THE FUTURE EQUIPMENT ALREADY DONE

A few civil foundations have already been constructed for future equipments. Such existing foundation details including bolts, inserts etc to be studied in detail before procurement of specific equipments for respective purposes so that the same can safely be placed over the existing foundations complying all technical compatibility. In case this is not at all possible, new foundations need to be constructed after complete demolition of existing foundations.

ANNEXURE-I

LIST OF CIVIL FIELD QUALITY ASSURANCE LABORATORY APPARATUS

SL #	DESCRIPTION	QUANTITY
1	Cube moulds - 150 mm (ISI marked)	144
2	Cube moulds - 70.6 mm	18
3	Cube moulds - 50 mm	9
4	Cylindrical moulds - 300 long 150 dia	18
5	Beam mould – 700X150X150	18
6	Cube testing machine with two dial gauge and brick plate attachment	1
7	Digital thermometer - 200°C	6
8	Electrical oven	1
9	IS sieve set – 75 µ, 150 µ, 300 µ, 600 µ, 1.18 mm, 2.36 mm, 4.75 mm, 6.3 mm, 10 mm, 12.5 mm, 16 mm, 20 mm, 22.4 mm, 25 mm, 31.5 mm, 40 mm, 50 mm, 53 mm, 63 mm, 80 mm, 90 mm, 120 mm, 125 mm, pan (24 nos. per set)	1 Set
10	Measuring cylinder (glass) 50 ml, 200 ml, 500 ml	2 each
11	Physical balance Digital 10 kg capacity L.C. – 1 gm	1
12	Platform balance – Digital: 200 kg capacity	1
13	Pycnometer	2
14	Slump cone with tamping rod	8
15	Specific gravity bottle – 50 ml	2
16	Air entrainment meter capacity – 0.005 cum	2
17	Casegrande apparatus	1
18	Core cutter with collar and rammer	16
19	English type trowel	12
20	Hygrometer with thermometer	1
21	Impact testing machine	1
22	Le-Chatelier apparatus with water bath	1
23	Measuring cylinder (plastic) 50 ml, 100 ml, 200 ml, 500 ml	1
24	Modified Proctor test apparatus	1
25	Length gauge	1
26	Penetrometer for mortar test	1
27	Moisture meter	1
28	pH meter	1
29	Sand replacement method apparatus	2
30	Screw gauge	2
31	Spatula	8
32	Standard Proctor test apparatus	1
33	Standard sand grade 1, 2, 3	500 kg each
34	Stop watch - Digital	1
35	Thermometer ordinary 50°C	10
36	Thickness gauge apparatus	1
37	Vernier calipers - Digital	1
38	Vicat apparatus	2
39	Weigh Boxes	4
40	Cylindrical measures: - capacity 0.01 cum, Dia (I) – 250 mm, Height – 280 mm, (I) with tamping rod as per IS 1199.	1

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SECTION-II

SPECIFIC DESIGN CRITERIA - CIVIL

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SECTION - II

SPECIFIC DESIGN CRITERIA - CIVIL

1.00.00 INTRODUCTION

This section outlines the followings:

a) A brief description of Soil Characteristics.

b) Design considerations for Reinforced Concrete Structures.

c) Design considerations for Foundations.

d) Roads.

2.00.00 SOIL CHARACTERISTICS

Previous Soil investigation Report for the adjacent units (3 & 4) may be referred for preliminary information. However, detail soil investigation, as required, to be carried out for foundation design of various facilities.

Soil characteristics and parameters to be adopted in final design, the successful bidder is required to do detail geotechnical investigation work as part of the contract to verify/generate data so required.

It should be noted that nothing extra whatsoever on account of variation between soil data annexed in this specification and that found by detailed geotechnical investigation to be carried out by bidder shall be payable.

3.00.00 LOADS

All structures and portions thereof shall conform to the latest revision of relevant Indian Standard specifications and also to the various other technical requirements. Any structure, which carries Indian Railway Loading or is situated in the vicinity of Railway Lines, the design has to conform to the Indian Railway Standard Specifications and approval must be obtained from Railway Authority including the clearance etc. All structures shall be designed to sustain within the stress limitation as specified in the Code, all dead loads plus assigned live, equipment, wind, seismic or other design loads.

a) **Dead Loads**

Dead load shall include the weight of all structural components and architectural appurtenances incorporated in the structures plus hung loads and any other permanent, externally applied load. This should also include equipment dead load. The content of tanks, silo, bins and hoppers shall be measured at full capacity for this purpose. Hung loads

and the contents of tanks, silo, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilizing loads for uplift.

The following unit weight of material shall be considered for computation of loads. Loads given in IS:875 (part-I) shall be made use of for material not listed below.

Materials		Unit weight
Plan cement concrete	:	24.0 kN/cum
Reinforced cement concrete	:	25.0 kN /cum
Structural steel	:	78.5 kN /cum
Brick work	:	19.0 kN /cum
Cement plaster	:	21.0 kN /cum
Floor Finish	:	24.0 kN /cum
Coal	:	12.0 kN /cum
Fly Ash	:	16.0 kN /cum
Bottom Ash	:	16.0 kN /cum

b) **Live Loads**

Live loads in different areas shall include dust loads, minor equipment loads, cable trays, small pipe racks/hangers, operation/maintenance loads etc. The loads considered shall not be less than those specified in IS: 875 (Part II).

The loads listed hereunder are minimum loads for the areas involved. Special use areas shall be investigated and loading revised upward as necessary.

Hung loads shall be based on minimum loading equivalents of 1.0 kN/Sq.m for piping and 0.5 kN/Sq.m for electrical, ventilation and air conditioning. Loadings resulting from concentrations of facilities in specific areas shall be substituted where listed base loading is excluded.

i) **All Buildings**

a) Roofs :

Inaccessible roof (Flat)	:	1.5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof where equipments are placed	:	5 kN/Sq.m + hung loads, if any + 0.5 kN/Sq.m (dust load).
Accessible roof without equipments	:	1.5 kN/Sq.m + hung loads,

if any + 0.5 kN/Sq.m (dust load).

Inclined roof : As per IS : 875 (Part 2).

b) Stairs & Platforms : 5.0 kN/Sq.m

c) Corridors : 5.0 kN/Sq.m

d) Removable gratings, chequered plates, walkways etc. : 5.0 kN/Sq.m

e) Office, Laboratory, Conference rooms and other non-plant areas etc. : 5.0 kN/Sq.m

ii) **Power House Building**

a) Ground Floor

Unloading Bay : 50 kN/Sq.m

Other areas : 25 kN/Sq.m

b) Mezzanine Floor : 15 kN/Sq.m plus hung loads.

c) Operating Floor

Equipment Lay-down Area : 35 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher

Rotor Removal Area : 50 kN/Sq.m plus hung loads or actual load furnished by equipment supplier whichever is higher

: Rotor removal area beams shall also be checked for half the rotor load at the center of the beam

Other Areas in Turbine Hall : 25 kN/Sq.m plus hung loads

All other Areas in Operating Floor except Turbine Hall : 15 kN/Sq.m plus hung loads

d) Cable Spreader Floor : 7.5 kN/Sq.m plus hung loads

e)	All other floors	:	10 kN/Sq.m plus hung loads
f)	Due to anchoring of conductors on any "A" row column	:	2 x 20 = 40 kN (Twin ACSR Moose Conductor) and 10 kN (Sheilding Wires) OR actual load furnished by equipment supplier, whichever is higher

iii) Mill Building

a)	Ground Floor	:	25 kN/Sq.m
b)	Feeder Floor	:	15 kN/Sq.m + hung loads + 0.5 kN/Sq.m (dust load).
c)	Tripper Floor	:	15 kN/Sq.m + hung loads + 0.5 KN/Sq.m (dust load).

iv) Auxiliary Buildings

a)	Ground Floor	:	10 kN/Sq.m
b)	Cable Spreader Floor	:	7.5 kN/Sq.m
c)	Pump House Operating Floor	:	15 kN/Sq.m / As supplied by pump manufacturer, whichever is higher
d)	Office Floor	:	5 kN/Sq.m
e)	Switchgear room	:	15 kN/Sq.m
f)	All other Floors	:	10 kN/Sq.m

v) Non Plant Buildings

a)	Floors with equipment:		10 kN/Sq.m
b)	All other floors	:	5 kN/Sq.m

vi) Coal handling structures :

1)	Flat accessible roofs	:	1.5 kn/sq.m + 1 KN/sq.m dust load.
2)	Flat accessible roofs	:	0.75 kn/sq.m + 1 KN/sq.m dust load

3) Inclined roof	:	In accordance with IS 875 For live load + 0.25 KN/sq.m For dust load.
4) All TPS and Crusher house floors	:	7.5 KN/sq.m
5) Switch gear and MCC floor	:	10 KN/sq.m
6) Walkways of Gallery	:	3 kn/sq.m or a concentrated load of 2 KN at center + dust load of 1 KN/sq.m
7) Wagon Tippler:		

Grizzly over the Wagon tippler hopper shall be designed for JCB/Hydraulic excavator loads. Also hopper and grizzly shall be designed for loads transmitted by coal heap equivalent to 5m.

Coal density shall be considered as 1200 kg /cum for design of wagon tippler hopper.

Wagon tippler structure shall be analysed for the worst load combination. However it shall be analysed for the following load combination also.

1. Combination-1

i. Hopper full
ii. Equipment load
iii. Maximum load from railway track
iv. Earth pressure without surcharge and sub soil water pressure
v. Maximum load from steel column for shed
vi. Maximum load from paddle feeder support
vii. Maximum load from coal tray

2. Combination-2

i. Hopper full
ii. Equipment load
iii. Maximum load from railway track
iv. Earth pressure with surcharge and subsoil water pressure
v. Maximum load from steel column for shed
vi. Maximum load from paddle feeder support
vii. Maximum load from coal tray

vii) Underground Structures/Trenches/pits

Minimum surcharge shall be 20 kN/Sq.m. For structures in vicinity of roads and heavy vehicular movement surcharge shall be considered as applicable as per loading specified elsewhere in this specification.

Trenches/pits inside building shall be designed for a surcharge equal to Live Load intensity of Ground Floor or 15 kN/Sq.m whichever is greater. In Boiler area and other outdoor areas within Power Block, the minimum surcharge shall be 20 kN/Sqm.

viii) Covers for Trenches / Channels

Self-weight of top slab and a uniformly distributed load of 4.0 kN/Sqm on each panel or one 0.75 kN central point load, whichever is critical, shall considered. At road crossings, the covers shall be designed for vehicular movements as per IRC standards

ix) Roads

Design of roads shall be in accordance with Indian Road Congress standard IRC 37.

x) Road Culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches

Road culverts and its allied structures including R.C.C. Pipe Crossings & Road Crossing of Trenches shall be designed for Class `AA' loading (wheeled and tracked both) and to be checked for Class `A' loading as per IRC standards.

xi) Railway Supporting Structures, Rail Culverts

Railway supporting structures and rail culverts shall be designed as per Railway Bridge Rules.

Reduction in Live load as per provision of IS:875 shall not be permitted.

The areas covered with equipment shall be designed on the basis of weight of equipment (flooded/operating) in addition to an uniform live load of 5.0 kN/Sqm or specifically defined live load whichever is greater.

Foundations and fixing arrangements for items of equipment, which generates vibration, will be designed to prevent transfer of such vibrations to the adjoining structures.

For loads caused by moving equipment over the floor for installation, consideration shall be given to the shoring of beams and floor, from floors below.

c) Equipment Loads

i) Loadings (both static and dynamic) of major equipments, including boiler, turbine-generator, boiler feed pumps, feed water heaters, de-aerator, PA, FD & ID fans, Coal Mill obtained from the manufacturer's certified drawings of the specified

equipment to be furnished. Where design of structures supporting minor equipment other than those included above has to proceed, the loadings will be estimated from similar jobs or catalog data.

ii) All equipment, tank and piping design loadings will include Hydraulic Testing loads.

iii) Air and gas duct loadings will include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads as applicable.

iv) Crane girders and supporting columns will be designed for vertical and horizontal forces (including impact forces) as developed from the crane weights and wheel loads. Unless otherwise specified, the vertical and horizontal loadings will conform to the applicable sections of the IS specifications.

v) Weight of equipments, ducts, tanks, pipes, conduits etc. supported by structure shall include maximum possible loading conditions i.e. flooded material contents and associated impacts, test loadings, anchorage and constraint effects.

vi) All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the plant.

Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analyzed for both conditions of loading and shall be designed for most critical condition.

vii) Jet forces resulting from guillotine type pipe ruptures shall be considered in the design, if it is of high magnitude. Jet force to be considered shall be equal to the product of the pipe cross section and the internal design pressure applied on an area equal to the pipe cross section.

viii) Lay down areas in the Turbine Hall shall be investigated for concentrated loads resulting from equipment components to be stored during erection and maintenance operation. Where live load allowance is inadequate to permit storing of such equipment components, the design live load shall be increased to permit such use or the area shall be restricted by identifying lay down areas for specific components, each area to be identified by permanent marking.

d) Wind Loading

Wind loading will be in accordance with Indian Standard Code IS:875

(Part 3, Latest Revision) for a basic wind speed of 47 m/sec. upto a height of 10 metres above mean ground level. Terrain Category-2 shall be considered for all structures.

Risk coefficient (k1) shall be considered as 1.07 for all structures.

Notwithstanding the design wind forces calculated based on above parameters, the structures shall not be designed with a wind pressure less than 1.5 Kn/ sq.m.

e) Seismic Loading

The lateral forces will be established in accordance with the recommendations of IS:1893 (Latest Version only). The site falls in Zone-III as identified in the map in IS:1893. Importance factor shall be taken as per latest versions of IS:1893 parts.

Response spectrum method shall be used for seismic analysis as per IS : 1893 for tall and irregular buildings / structures like Boiler structures, Power House building, Mill building, TG foundation, ESP structure, Stack, all Transfer points, Ash Silo etc.

f) Temperature Loads

The structures shall be designed to withstand stresses due to fifty (50) percent of the total temperature variation. The total temperature variation for temperature loading should be taken as two thirds (2/3) of the average annual variation in temperature. The average maximum annual variation for this purpose will be taken as the difference between the mean daily minimum temperature during the coldest month of the year and mean daily maximum temperature during the hottest month of the year.

Mean Daily minimum ambient temperature during coldest month of the year = 5° C

Mean Daily maximum ambient temperature during hottest month of the year = 50° C

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provision shall be made for the effects produced as per provision in the relevant IS codes.

g) Steam Piping Load

Minimum intensity of steam piping load shall be 6.0 kN/Sqm for the areas at different levels through which steam piping is routed. However, the bidder shall check the loading as per static/dynamic analysis for steam piping or load data supplied by piping vendor and the worst loading shall be considered in design. Horizontal anchor loads, if any,

shall also have to be considered in design.

h) Earth Pressure Load

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house and underground liquid storage tanks earth pressure at rest shall be considered with coefficient of earth pressure at rest shall not be less than 0.50.

In addition to earth pressure and ground water pressure, etc., surcharge load shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure. Intensity of Surcharge Load shall be as described elsewhere in this specification.

i) Crane, Monorail & Elevator Loads

Crane girders and supporting columns shall be designed for vertical and horizontal forces (including impact forces) as per crane vender's data. All lifting beams and monorails shall have their design loads increased for impact factor as mentioned hereinafter.

Impact Factor

Loads for cranes, hoists and elevators shall be taken as per IS:875. The minimum impact factor to be used in design shall be as follows:

Crane loads

a) For vertical force, an impact factor of 25% of the maximum crane wheel load

b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail

c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.
Monorail loads

a) Impact factor of 10% of lifted load of hoist for monorail and support design

b) Impact factor of 25% of the lifted load for electrical pulley and support design

Elevator

A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.

j) Construction Loads

The integrity of the structures shall be maintained without use of temporary framing struts or ties and bracing so far as possible. However, construction or crane access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented by bidder to ensure stability and integrity of the structures during any periods involving use of temporary bracing systems.

k) Other Loads

Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance load, creep and shrinkage shall also be considered in design of all structures.

All Power House columns adjacent to first row of Boiler columns shall be designed for an additional load of 500 kN to account for piping/cable rack loads.

All structures situated in the vicinity of railway lines shall be designed conforming to the Indian Railway Standard Specification.

l) Thrust Load

Thrust blocks will be designed against the thrust load from pipe lines considering the test pressure in the pipe lines.

m) Ash Silo

The following densities shall be considered for design of ash silo / buffer hopper / bottom ash extraction hopper etc.

a) For volume calculation of bottom ash silo : 6.5 kN/cum

b) For volume calculation of fly ash silo : 7.5 kN/cum

c) For load calculation of both types of silos : 16.0 kN/cum

The ash silo shall be designed generally as per the criteria laid down in IS:4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3 rd portion. Special attention shall be given in assessing the effect of hot temperature of ash on the wall. Temperature of ash shall be considered in design.

3.01.00 Stability of Structures

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like underground tanks, pits

trenches, basements, etc. Minimum factor of safety of 1.25 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken into consideration.

All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS:456 and other relevant IS Codes, subject to the following minimum values.

a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.

b) Factor of safety against sliding shall be 1.5 minimum.

c) Factor of safety against uplift due to hydrostatic forces shall be 1.25 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

Ground water table shall be considered at Plant Finished Grade Level for design of foundations and all underground structures.

3.02.00 Load Combinations

While designing consideration shall be given to the following load combinations:

i) DL + LL

ii) DL + LL + PL + Equip $\pm$ TL

iii) DL + LL + PL + Equip + Cb + CtLA$\pm$ CS $\pm$ TL

iv) DL + LL + PL + Equip + Cb + CtLB$\pm$ CS $\pm$ TL

v) 0.9DL $\pm$ EL (for DL only) $\pm$ TL

vi) 0.9DL $\pm$ WL1 $\pm$ TL

vii) 0.9DL $\pm$ WL2 $\pm$ TL

viii) DL + *LL + PL + Equip + Cb + Ct ± EL ± TL
(* Appropriate portion of LL which is considered for working out EL shall only be taken)

ix) DL + LL + PL + Equip + Cb + CtL1 ± (CS1+WL1) ± TL

x) DL + LL + PL + Equip + Cb + CtL1 ± (CS1+WL2) ± TL

Where the above loads are :

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe Load

Equip = Equipment loads

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load from left to right

WL2 = Wind load from right to left

EL = Earthquake load

TL = Temperature load

Appropriate impact factor shall be considered as per IS:875 (Part 2) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS:875 (Part 3). All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination number (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components.

Appropriate allowable increase in permissible stresses as per IS codes, may be taken only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind, no increase in permissible stresses will be permitted.

Applicable load factors to be used for design of RCC structures by Limit State Method as per IS:456.

Load Combinations for Underground Structures

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub-structure of pump house, channels, sumps, tanks, reservoirs, trenches and other under-ground structures.

Only liquid pressure from inside and no earth pressure and ground water pressure, and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).

Earth pressure, surcharge pressure and ground water pressure from outside and no water pressure from inside.

Base slab of the pump house shall be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water table. Intermediate dividing piers of pump sumps and partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety as per IS:3370 against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

3.03.00 Design Concepts

Wind and seismic forces shall not be considered to act simultaneously.

For the design of main plant structures during seismic condition, the Deaerator Feed Water Tank shall be considered full up to operating level. However, for other load combinations, Deaerator Feed Water Tank in flooded condition shall be considered.

`Lifted Load' of crane shall not be considered during seismic condition.

For design of all underground structures/foundations, ground water table shall be considered at the Finished Ground Level.

If R.C.C. floors and roofs except those cast over metal decking are assumed to act as diaphragm transmitting lateral loads to braced bays then main beams/girders shall be provided with shear connectors. However, whenever large/more number of cutouts is provided in the floor slab, horizontal floor

bracings shall be provided below slab to transfer horizontal force to columns without considering diaphragm action from slab. Shear connectors shall also be provided over beams having R.C.C. slab on one side and opening /chequered plate / grating on other side.

For R.C.C. roofs cast over metal decking, horizontal bracings must be provided below slab to transfer horizontal force to columns.

In Turbine Bay, horizontal wind girders between A-row and B-row columns must be provided below Mezzanine and Operating floor at gable ends to transmit wind load from gable columns.

PTFE bearing shall be provided where horizontal loads not to be transferred.

For calculation of seismic load, equipment load shall be considered as Dead Load.

Ultrasonic pulse velocity tests shall be carried out for the top decks of all machine foundations viz. TG substructures, BFP Foundation, ID fan, FD fan, PA fan and Mill foundations to ascertain the homogeneity & integrity of concrete.

Whenever any structure under this contract will carry or receive additional load from the work of any other contract, the structures under this contract shall be provided with sufficient margin to carry the above load (like Mill Bay structure, Trestles etc.) details of which shall be finalized during detail engineering.

Gratings / chequered plates shall not be considered as restraining members for compression flange of beams/girders. Diaphragm action shall also be not considered in design. Adequate horizontal bracings to be provided.

4.00.00 DESIGN OF REINFORCED CONCRETE STRUCTURES

a) Reinforced Concrete Structures shall be designed in accordance with the requirements of IS-456 & IS-875 subject to the minimum Grades as specified in this specification for all possible combination of loads, e.g. dead load, live load, crane loads, wind or seismic loads, soil loads and surcharge loads.

The following minimum grades of concrete as per IS-456 shall generally be used.

Sl. No.	Class	Grade of conc.	Min. cement content Kg/Cum	Max. free water cement ratio
1.	i) Plain cement concrete used for screeds and backfill	M10	-	-
	ii) Lean concrete	M10	-	-
2.	Paving in main plant area/Grade Slab	M20	300	0.55
3.	i) Reinforced concrete for super structure and foundation	M25	300	0.5
	ii) Reinforced concrete for water retaining structure	M25	300	0.5
4.	Pre-cast concrete	M25	300	0.5
5.	Reinforced concrete for foundation of TG, Mill & Fan foundations	M30	320	0.45
6.	TG top deck	M35	340	0.45
7.	Piles	M25	400	0.5

b) Reinforcing bars will be TMT bars of grade Fe500 conforming to IS-1786 and Mild Steel bars conforming to IS : 432 (Grade I) of main producer such as "SAIL" or "TATA STEEL" or "RINL" or vendor approved by WBPDCL.

c) For equipment (supported on VIS) foundations including top deck, Coal Mill foundation, Ordinary Portland Cement (grade 43) shall be used. For all other concrete work included in the scope of this specification shall be either with Ordinary Portland cement or Portland Slag Cement Or Portland Prozzolana cement.

d) The design of R.C. Structures shall be carried out by limit state or working stress method as per the provisions of IS-456.

e) Concrete tanks/water retaining structures will be designed in accordance with the recommendation of IS-3370.

f) Grouting material :

Grouting shall be done with Conbextra GPX-2 of `Fosroc' or or 'SIKA' or equivalent for Equipment foundations and Conbextra GP-1 or equivalent for

all structural column bases. For pipe-supports grouting shall be done with 1:1:2 cement-sand - 6mm down stone chips.

g) RCC silos shall be designed as per IS:4995 (part 1 & 2).

h) For reinforcement detailing IS:5525 and SP:34 shall be followed.

i) The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.

j) Liquid Retaining Structures

RCC water retaining structure like storage tanks, reservoirs etc., shall be leak proof and designed as uncracked section in accordance with IS:3370 (part I to IV) by working stress method.

Substructure of pump houses shall be designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses as per IS:3370 (Part I to IV) by working stress method for concrete face away from water/liquid. For faces in contact with water/liquid the structure shall be designed as uncracked section in accordance with IS:3370 (part I to IV) by working stress method.

All water retaining / storage structures shall be designed assuming liquid up to the height of wall irrespective of provision of any over flow arrangement. Pressure release valve may be used in fore bay and 50% release in water uplift pressure through pressure release valves may be considered in design. Properly designed filtering medium below total area of base slab is to be provided as per approved design.

In all liquid retaining structures leak-tightness shall be ensured and guaranteed. To achieve the same, methodology in design and construction in the way of providing PVC water bars at construction/expansion joints and/or injection grouting, usage of admixture in concrete or any such method should be adopted.

All underground water retaining/conveying system structures shall have plasticiser cum waterproofing cement additives conforming to IS:9103 of ‘SIKA’, ‘FOSROC’ make. In addition, limits on permeability as given in IS:2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS:702 @ 1.7 kg/sqm (minimum) for water / damp proofing. Storm water drains shall not be provided with bituminous paint and weep holes also shall not be provided in storm water drains.

5.00.00 FOUNDATION DESIGN

The design of foundation shall be carried out by Limit State or working stress method as per the provisions of IS-456 : 2000 and on the basis of the soil investigation Report done by the Bidder.

Structural concrete for foundation work shall be M-25, unless a higher grade is specified elsewhere in this specification.

5.01.00 Foundations (For Main Plant Structures)

Foundations for the main plant structures are those for Power House building columns, Boiler House columns, Mill and Bunker bay columns, ESP columns, etc. Top of RCC foundation for the steel columns shall generally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below the finished floor level. Foundation levels of some columns will have to be suitably lowered to accommodate underground services, pits, trenches, etc.

Common foundation should be provided for columns both side of the expansion joint and shall be designed for loading on both columns.

Foundations for Buildings and structures shall be designed to resist forces and moments, caused by vertical loads and by wind or seismic loads, based on static and dynamic analysis done for those structures. The foundation sections shall be sized and reinforced adequately for moments and shear stresses.

5.02.00 Heavy and rotating Equipment Foundations

Loadings (both static and dynamic) of major equipments such as turbine-generator, boiler feed pumps, P.A., FD & ID fans, Coal Mill etc. shall be obtained from the manufacturer's certified drawings of the specified equipment. Where design of structures supporting minor equipment other than those included above must proceed but the exact load data is not available, the loadings will be estimated from similar jobs or catalog data. The foundations for Turbo generator, Boiler Feed Pumps, PA fans, FD fans and ID fans and Mill shall rest on suitable vibration isolation system consisting of springs and damper (M/s. GERB). However, Coal Pulverisers shall be supported on conventional block foundations.

Technical Specification for Vibration Isolation System is attached in Annexure-I of this Section.

For static and dynamic analysis of machine foundation following data will be furnished by the equipment manufacturer.

a) Loading diagram showing static and dynamic loads and points of application of loads.

b) Operating speed of m/c; Critical speed of m/c.

c) Weight of rotating parts; maximum eccentricity of rotating mass from the geometric axis of rotation.

d) Location of C.G. of machines in all three axes.

e) Mass Moment of Inertia.

f) Allowable amplitude/velocity of vibration at machine bearing points.

g) Temperatures in various areas during operation.

Design of foundations for major equipments shall be done in accordance with relevant parts of IS-2974. Unbalanced loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more shall be used for calculating dynamic response. The dynamic analysis will consist of free vibration analysis and forced vibration analysis. While designing following aspects shall also be taken care of.

i) The turbine generator, pulverizer and large fan foundations will be isolated from adjacent structures for vibration control.

ii) The turbine generator pedestals will be designed to meet the manufacturer's deflection criteria and other recommendations.

iii) Natural frequencies of structures and components shall be away from the running speed of equipment by at least 20% generally but for important ones it shall be away by at least 30%. However, frequency separation criteria and amplitude criteria as laid down in IS:2974 and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall also be satisfied. A fatigue factor of 2.0 shall be considered for dynamic forces / due to normal unbalance. For design of foundation of large fans etc. provision shall be kept in the foundation for addition of mass/area for retuning of the foundations, if required at a later date.

All block foundations resting on soil shall be designed using the elastic half space theory or Barkan’s theory. The mass of the RCC block shall not be less than three times mass of the machine and the CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%.

For the foundations supporting minor equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structures, floors, etc. suitable vibration isolation shall be provided by means of springs, neoprene pads, etc. and such vibration isolation system (VIS) shall be designed suitably.

Analysis and design of the Steam Turbine-Generator (STG) foundation shall be

carried out in accordance with relevant codes IS: 2974 Part-3 and IS: 456 and/or manufacturer's requirements. The loads to be considered for static analysis and design shall consist of dead weight of the machine and foundation, machine power torque, condenser loads under normal operating condition, Equivalent static load due to machine unbalance, thermal elongation forces, forces due to one sided operation of the condenser, forces due to condensate pump failure, vacuum loads, forces due to piping, frictional forces at machine sole plate level for turbine, generator and condenser, temperature distribution under operating condition, failure loads of turbine (blade unbalance/loss of blade/bowed rotor), failure loads of generator (short circuit loads), seismic loads due to generator, turbine and condenser and erection loads.

In case of machines supported on VIS with springs and viscous dampers it shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block which support the machine. The spring units shall conform to DIN 2089 and DIN 2096.

For all equipment foundations supported on VIS system, the stiffness of the supporting substructure shall be at least ten (10) times that of spring elements as per DIN 4024.

While performing dynamic analysis of TG and BFP foundation, effect of soil contributing to dynamic properties shall be considered.

Tension in piles shall not be allowed for any combination of loads.

Crusher Foundation

Detailed dynamic analysis shall be done for the top deck together with springs and dampers and the natural frequencies and amplitudes of vibration shall be determined. A mathematical model of the top deck shall be formulated with three – dimensional beam / plate finite elements for the purpose of analysis with the spring idealized with vertical and horizontal stiffnesses. The mass of the machine together with that of the top deck shall be considered for the analysis.

Natural frequencies up to at least 10% above the operating speed shall be determined and three frequencies shall be checked against the design criteria. Forced response dynamic analysis shall be carried out of for the operating condition unbalance forces using a sinusoldal forcing function. Unbalance forces as given by this specification shall be used for his purpose.

Isolation Efficiency

The vibration isolation system shall be designed for about 90% isolation efficiency.

De-coupling

A ratio of the least 10 (ten) shall be ensured between the stiffness of the supporting structure and the stiffness of the spring system in the vertical direction to achieve de-coupling between the two (the stiffness of the spring system being lower). This ensures that dynamic analysis of the supporting structure need not be carried out.

Frequency Criteria

The frequency criterion has already been laid down implicitly Foundation isolation efficiency criteria and de-coupling required.
The bending mode frequency of the top deck shall be at least 20% above the operating speed.

Unbalance Forces

Unbalance forces arising out of all the following cases shall be considered for checking the design and amplitudes.

Balance quality grade Q 40 as per VDI 2060 – 1966.

One hammer broken condition. The missing hammer shall be assumed to be closest to the crusher non – drive end of the crusher.
Three hammers broken condition. All the three hammers broken shall be assumed to be from the same suspension bar and located at the non – drive end of the crusher.

Amplitude Criteria

The calculated amplitudes (mean to peak values) shall not exceed following limits under the specified conditions.

Operating speed of 750 RPM.

150 microns for an unbalance force arising out of balance quality grade Q 40 as per VDI 2060 – 1966.

300 microns in case of a one hammer broken condition.

Amplitudes need not be checked for a three hammer broken condition.

Operating speed of 450 RPM.

200 microns for an imbalance force arising out of balance quality grade Q-40 as per VDI – 2060 – 1966.

400 microns in case of a one hammers broken condition.

Amplitude need not be checked for a three hammer broken condition.

For intermediate operating speed between 450 to 750 RPM the amplitude limits can be linearly interpolated.

The amplitude limits mentioned above are in both vertical and horizontal directions. The amplitude shall be calculated at critical points on the top surface of the R.C.C. deck. The amplitudes shall be checked for the most unfavourable superposition of modes in any direction. However, phase difference between the maximum amplitude occurring in different directions due to the rotating vector may be considered while superimposing the modes.

Transient Resonance

Transient resonance, which may occur during the start – up or coasting down condition of the crusher, shall be checked and the amplitudes in such a condition should not exceed one – and – half times those at operating speed for each design condition.

Strength Criteria

The following criteria shall apply for the design of top deck :
Dead loads, live loads, Seismic loads and dynamic loads shall be considered for the design. The most unfavourable combination shall considered for design.

Seismic loads shall be assumed to act together with dynamic loads for a one-millimeter eccentricity in the rotor. However, seismic loads and dynamic loads arising out of hammer breakage need not be considered together.
Fatigue shall be considered while designing for dynamic forces. A fatigue factor of 2.0 shall be used on all dynamic forces to arrive at the equivalent static force for the purpose of design.
Working stress method shall be used for the design of R.C.C. deck. In survival condition, 10% overstressing may be permitted.
The R.C.C. top deck shall be at least of M25 grade of concrete as per IS : 456.

Fatigue need not be considered for the three hammer broken condition.
For calculating unbalance forces, the heaviest hammer (plain or toothed) shall be considered.

The static deflection of the crusher supporting beams at the points of spring attachments shall not exceed the value specified by the manufacturer.

Loss of contact of foundations at founding level shall not be allowed for any combination of loads.

5.03.00 Switchyard Foundations

Foundations shall be designed for the worst combinations of dead loads, live loads, forces due to wind/seismic, other relevant loading from service

conditions, forces and moments caused by broken wire condition and loadings, due to thermal effects wherever applicable. The design of foundations and all R.C.C. trenches shall be carried out in accordance with the latest relevant IS codes and specifications.

Factor of safety in the design of foundations shall be 2.2 for normal and broken wire conditions and 1.65 for short circuit conditions. Design of foundation shall be carried out as per IS:4091.

Loss of contact of foundations at founding level shall not be allowed for any combination of loads.

5.04.00 Open Foundations

In case open foundations are adopted, the following shall be adhered to:

a) Minimum width of foundation shall be 1.0 m.

b) Minimum depth of foundation shall be 1.0 m below NGL.

c) It shall be ensured that all foundations of a particular structure/ buildings/facility shall rest on one bearing stratum, i.e. either overburden or rock.

d) Wherever the intended bearing structure is weathered rock but the actual stratum encountered during foundation excavation consists of both overburden soil and weathered rock at founding level, under such cases either the foundation shall be lowered completely into the weathered rock or the overburden soil upto the weathered rock level shall be removed and built up through PCC up to designed foundation level.

e) The net allowable bearing pressure values to be adopted for design upon Owner's approval shall correspond to total permissible settlement as mentioned under para "permissible settlement of foundations" or the permissible settlement from functional requirement, which ever is more stringent.

f) Permissible settlement of foundations: The total permissible settlement and differential settlement shall be governed by IS: 1904 and IS: 13063 and from functional requirements, whichever is more stringent. However, total settlement shall be restricted to the following :

i) All facilities in Main Plant area, ducts, Equipment foundation - 25 mm

ii) All foundations in switchyard, control room Building including, isolated/strip continuous/ Raft foundation - 40 mm

iii) Other footings of width upto 6m - 40 mm

iv) Other footings of width greater than 6.0 m (raft) - 75 mm

v) Footings on rock - 12 mm

In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced / reviewed accordingly in consultation with Owner.

5.04.00 Pile Foundations

In case piles are adopted, following shall be adhered to:

a) The pile foundation shall be of RCC, Cast-in-situ bored, precast/cast-in-situ driven pile as per IS: 2911. Bored piles shall be installed by using rotary hydraulic rig. Three-stage flushing of pile bore shall be ensured, by airlift technique or any other internationally accepted method duly approved by the Owner.

b) The minimum diameter of pile shall be 450mm for cast-in-situ and 300mm for precast piles. The uplift and lateral load capacity shall be established by field test.

c) Only straight shaft piles shall be used. Minimum cast length of pile above cut-off level shall be 1.0 m.

d) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter like (SPT & SCPT value, set criteria etc.), reinforcement for job as well as test piles, etc.) for Owner's approval.

e) The piling work shall be carried out in accordance with IS: 2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Bidder for Owner's approval.

f) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under:

Vertical
Lateral
Uplift } Minimum of 3 Nos. in each mode.

The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test the method of loading shall be cyclic as per IS: 2911 (relevant part).

g) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under:

i) Vertical-1.0 % of the total number of piles provided.
ii) Lateral -1.0 % of the total number of piles provided.

The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. The Owner shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS: 2911 (Part-4).

In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Bidder shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required, without additional cost to the Owner.

h) Testing of piles and interpretation of pile load test results shall be carried out as per IS: 2911 (Part-4). Bidder shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory/ institute prior to their use. Additional measurement for pile movement shall also be done.

i) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the piles for routine load test and not intended to replace the use of static load testing.

5.06.00 Other Requirements

i) In case of high ground water table, for excavations comprehensive dewatering arrangement shall be required. Scheme for dewatering and design with all computations and back-up data of dewatering and sheet pilling shall be submitted for Owner's information.

ii) The founding level for trenches/channels shall be decided as per functional requirement. The bottom of excavation shall be properly compacted prior to casting of bottom slab of trenches/channels.

iii) Excavation for open foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil at founding level during excavation, the same shall be removed and compensated by PCC of Grade M15. The foundation pits shall be maintained dry during the complete construction period by means of suitable dewatering systems.

iv) Backfilling, around foundations and bottom of pipes, thrust blocks, etc. shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils.

v) Excess/surplus excavated material shall be disposed off by the Bidder as per the instructions of the Owner upto a lead of about 5 km.

vi) CBR tests for flexible pavement design shall be carried out by Bidder after earth filling has been completed, if applicable.

vii) The storage tanks shall rest on flexible tank pad resting on an open/shallow foundation or pile foundation. The tank pad shall be made of two layers. The first layer shall be thoroughly compacted fill of gravel, coarse sand or other suitable material topped with minimum 75mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (80 / 100 bitumen or equivalent 8 to 10% by volume), rolled and compacted. The second layer shall be with minimum 25 thick premix carpet with 12 mm and down broken stone chips and 80/100 grade hot bitumen. The tank pad shall be laid by an expert agency having wide experience in execution of similar works. The tank pad shall be made up from founding level to the required level by controlled compaction in layers of 200 mm to achieve a relative density of 85% using suitable compaction equipment approved by the Owner. In addition to the above, in case of an open/shallow foundation, a ring wall shall be provided adjacent to the tank wall for retaining the fill below tank. The foundation system shall be designed as per the provisions of IS: 803. The tank shall have a flexible bottom plate, which shall establish complete bearing with the foundation fill.

After the tanks have been erected, hydro testing shall be done.

6.00.00 GENERAL REQUIREMENTS

6.01.00 Minimum Thickness of Structural Elements

The following minimum thickness shall be followed :

Pile caps	900 mm
Suspended floor / slab / walkways / canopy slabs, etc	150 mm
Ground floor slab (non-suspended)	150 mm
Water Retaining slabs / walls	200 mm
Cable / pipe trenches / underground pits / Launder walls and base slab	125 mm
All footings (including raft foundations)	300 mm
Parapets	125 mm

Sunshades at edge	75 mm
Pre-cast louvers / fins	50 mm
Pre-cast trench cover slabs / floor slabs / louvers	75 mm
Paving	150 mm
Basement walls and base slab	200 mm
Silo / bin walls	150 mm
Underground reservoir	
Below ground	200 mm
Above ground	150 mm

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig 1 or table 16a of IS 456 or specified above, whichever is higher.

6.02.00 Minimum Heights For Pedestals/Encasements of Steel Columns

Pedestals to Steel Columns for building structures

In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following.

a) Open area : 300 mm above paved level

b) Covered area : 300 mm above FFL

Stair and ladder pedestal shall be kept 200 mm above the finished floor level.

Pedestals to Steel Columns for Equipment structure :

a) Equipment in open area : as required (300mm min)

b) Equipment in covered area : as required (150 mm min)

c) Structures and equipment supplied by vendor : as per vendor's data subject to minimum as specified above

6.03.00 Ground floor slab-on-grade

Ground floor slab-on-grade shall be minimum M-25 grade RCC construction laid over minimum 75mm thick lean concrete. Minimum 250mm thick graded stone (63mm down size) soling with interstices filled with sand and compacted mechanically, shall be provided as sub-base below lean concrete. The sub-base shall be laid over rammed and well-compacted earth fill or hydraulically compacted sand fill as specified elsewhere in this specification unless the thickness required from design consideration is more.

The ground floor slab shall be of minimum 150 mm thick with double layer reinforcement of 8 dia at the rate of 200 c/c both ways.

6.04.00 Stairs, Platforms, Handrails

All internal stairs, platforms and walkways shall either be of RCC or minimum 6mm thick chequered plate construction. All outdoor stairs, platforms and walkways shall either be of RCC or minimum 40mm thick grating.

All handrails and posts shall be of 32NB medium duty Galvanised M.S. pipes as per IS:1239 (Part I) and for stainless steel handrail as specified elsewhere

in this specification.

7.00.00 ROADS

Geometric design of road shall be done in accordance with Indian Road Congress Standard IRC-37. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally roads shall have much flatter gradient. Transverse camber of 1 in 40 shall be provided.

A detailed CBR test, shall be carried out as per the procedure outlined in IS-2720 (Part-XVI). CBR test shall be carried out in remoulded soil samples under soaked condition.

All roads shall have minimum 1.5m wide shoulder on either side of carriageway. Shoulders shall have sufficient load bearing capacity to support loaded trucks. A flatter slope of 1 in 80 shall be provided on shoulders.

Pipe, slab culverts, or RCC box culverts, as suitable, shall be provided at road crossings for drainage, LP pipes, Ash pipes, cable trenches etc. Level crossings shall be provided where a Railway siding line crosses the road. All culverts shall be designed for IRC class "AA" loading and checked for class A loading.

8.00.00 DRAINAGE

Open RCC rectangular drains shall be provided for storm water. The thickness of sides & bottom shall be minimum 100 mm or as per design considerations whichever is higher. RCC culverts shall be provided for road and rail crossing. Drains shall be provided on both sides of the roads.

Inside surface of the drain will have smooth neat cement finish over with screed concrete. Invert of the drain shall be decided in such a way that the water can easily be discharged to the recommended nearest outfall outside the plant boundary. The minimum slope of the drain shall be 1:1000 longitudinally to take care of the silting problems. It is recommended to maintain the maximum velocity within 1.2 m/sec.

9.00.00 TRANSFORMER TRACK & JACKING PAD

Lay out of transformer track and jacking pads shall be as shown in appropriate drawing.

Transformer track shall be designed as beam on elastic foundation. For this appropriate soil investigation / test shall be carried out to establish design parameters. Grade of concrete, reinforcement etc shall be as specified earlier.

10.00.00 MISCELLANEOUS DESIGN / CONSTRUCTION CRITERIA

1) All masonry walls from ground floor shall be placed on reinforced concrete grade beams. However, light internal partitions may be placed on ground floor slab. Minimum embedment of the grade beam below grade level shall be 300 mm.

2) The steel column base plate along with stiffening gusset plates shall not be protruded above floor level.

3) The steel columns below ground floors and up to minimum 100mm above finished floor level shall be encased in concrete.

4) Ramps for building entrance shall be cast in situ RCC slab and the slope of ramps shall not be more than 1 (vertical) to 6 (horizontal).

5) Minimum 75 mm thick lean concrete M-7.5 shall be provided below all underground structure, trenches etc., to provide a base for construction.

6) All buildings shall have RCC/steel framed super structure. All walls shall be non-load bearing infilled panel walls.

7) Duct banks consisting of PVC/GI conduits for cables shall be provided with reinforced concrete encasing of M20 grade. The minimum depth of top of duct bank from grade level shall be 500mm.

8) Angles 50 x 50 x 6 mm (min.) with lugs shall be provided for edge protection all round of cut-outs/opening in floors, edge of drains

supporting grating covers, edges of RCC cable/pipe trenches, manholes supporting covers, supporting edges of pre-cast covers and any other places where breakage of corners of concrete is expected.

9) Trenches located outside building shall project at least 100mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be sloped suitably for draining out the collected water into the sump pit. The pre-cast covers shall be of minimum M-20 grade and shall not weight more than 65 kg. Lifting hooks shall be provided in the pre-cast covers. The minimum drainage slope along line shall be 1 in 500.

10) For open drains concrete lining of minimum M20 grade on sides & bottom shall be provided. The thickness of lining shall be minimum 100mm or as per design consideration whichever is higher.

11) Raw water reservoir shall be imperviously lined using HDPE/Geotextile liner and covered with pre-cast concrete tiles/brick work.

12) All underground concrete structure such as basement, sumps water-retaining structure shall be designed for water tightness.

13) All underground concrete structure like basements, sumps, water retaining structure etc., shall have plasticizer cum water-proofing cement additive conforming to IS-9103. In addition limit on permeability as given in IS-2645 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coats of bituminous painting for water/damp proofing. In case of water leakage in the above structures, injection method shall be applied for repairing the leakage.

14) All joints, including construction and expansion joints for the water retaining structure and others below subsoil water level shall be made water tight by using PVC ribbed water stops with central bulb. The minimum thickness of PVC water stops shall be 6 mm and minimum width shall be 230mm.

15) All mild steel parts used in the water retaining structures shall have anticorrosive epoxy based paint or equivalent.

16) Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors, switchyard area etc., as per IS-6313 and other relevant standards.

17) Concrete hume pipes for under ground service shall of class NP3/NP2 as per IS-458.

18) For all buildings suitable arrangements for draining out of water collected from equipments, blowdowns, leakages, floor washing, fire-fighting etc., shall be provided for each floor.

19) All walls and slabs shall have two layers of reinforcement for section having thickness 150 mm and above.

20) All gratings shall have bearing bars 32mm x 5mm spaced at 30mm with cross bars at 100 mm on centers. Stairs treads made of grating shall be provided with non-skid abrasive nosing.

21) Unless stated specifically elsewhere in this specification, the clear height of roof/beam from finished floor shall not be less than 4.5 M for plant building and 3.5 M for non-plant building.

22) Unless stated elsewhere specifically in this specification, the finished floor level of any building shall be at least 300 MM from finished grade level.

23) For RCC buildings of more than 15M span steel roof truss/girders will be provided to support the concrete roof on permanently colour coated (on exposed face) galvanized M.S. troughed metal decking over concrete columns. Gable and side cladding will be constructed with brick masonry.

24) Sealing of joints shall be done by two part polysulphide sealant and shall be from approved manufacturer conforming to IS: 12118. Material shall consist of polysulphide polymer and a curing agent.

If any similar design criteria mentioned elsewhere in this specification contradict the above, the stringent of the criteria shall be adopted for design.

ANNEXURE – I

VIBRATION ISOLATION SPRING FOUNDATIONS

1.0 General Requirement

Steel helical springs and viscous dampers shall be provided for equipments requiring foundations with vibration isolation system by the supplier with requisite experience and proven track record of similar installation in power plants of Unit capacity not less than 500 MW.

“Complete Vibration Isolation System with Steel Helical Springs and Viscous Dampers shall be provided for the foundations of Turbo-generator, Boiler Feed Pump, ID, Fan, FD Fan and PA Fan.”

2.0 Material (Design & Supply)

2.1 Steel helical springs and viscous dampers shall consist of

i) Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads etc.

ii) Frames for pre-stressing of spring elements.

iii) Suitable hydraulic jack system including electric pumps, high-pressure tubes etc. required for the erection, alignment etc. of the spring units. One set of extra hydraulic jacks and hand operated pumps shall also be provided.

iv) Any other items which may be required for the pre-stressing, erection, release of pre-stress, alignment and commissioning of the steel helical springs.

2.2. The objective of designing the supporting arrangement for any rotating equipment shall be so that the vibration level is maintained as minimum as possible under all operating conditions. Accordingly, respective rotating equipment shall be supported on RCC deck slab which in turn shall rest on vibration isolation unit consisting of steel helical springs and viscous dampers, which in turn shall be supported on RCC supporting structure. The above design shall form part of this specification.

2.3. The spring units shall have definite stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 30% of vertical stiffness. The stiffness shall be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 to 5 Hz.

2.4. The damper units or spring-cum-damper units shall be of viscous type offering velocity proportional damping. The damper units shall be suitable for temperatures ranging from 0 to 50 deg. C. The damping resistance of individual damper units shall be such that the designed damping is provided using reasonable number of units. Damper shall have damping resistance ranging from 40 kN sec/m to 750 kN sec/m.

2.5. The sizes of the spring units, damper units and spring-cum-damper units shall be such that groups of such units can be accommodated on column heads in case of elevated foundations and on pedestals/walls in case of foundations at ground level.

2.6. The steel helical springs and viscous dampers shall be designed for ensuring “fit and forget” guarantee.

3.0. Manufacturing & Testing

3.1. Complete manufacturing and testing of the steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub-vendor/supplier. For this purpose, the successful bidder/sub vendor shall submit the detail program for approval of engineer and take up the manufacturing/testing after approval of such program. The program shall

include :

i) Manufacturing schedule and quality check exercised during manufacturing.

ii) Detail of test to be carried out at the manufacturing shop with their schedule.

iii) Special requirements, if any, regarding concreting of top deck.

iv) Complete step-by-step procedure covering the installation and commissioning of the spring system.

v) Manuals for erection, commissioning, testing and maintenance of the steel helical springs and viscous dampers.

vi) A checklist for confirming the readiness of the civil fronts for erection of steel helical springs and viscous dampers.

vii) Checklist for equipment required at each stage of erection.

viii) Bill of materials (data sheet) of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.

ix) Bill of materials (data sheet) for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc. with their rating and numbers.

x) Any other details which may be necessary to facilitate design and construction of the foundations/structures.

3.2 The springs shall conform to codes DIN 2089 and DIN 2096. The quality assurance and inspection procedures shall be finalized on the basis of the above codes and the quality plans be drawn accordingly.

4.0 Erection, Commissioning and Supervision

4.1 Complete erection and commissioning of the steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre stress in spring elements, making final adjustments and alignments etc. all shall be done a specialist supervisor of supplier/sub vendor trained for this purpose.

4.2 The scope of work shall be deemed to include all activities, which may not have been explicitly mentioned but are reasonably implied for the successful commissioning of steel helical springs and viscous dampers.

4.3. The successful bidder shall guarantee the performance of the steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as “Guarantee Period”.

5.0. Realignment of Spring System

If any realignment of the steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of Commercial Operation of the machine, the same shall be done by the successful bidder as and when asked for at no extra cost of the Owner.

6.0. Acceptance Criteria

Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096. Following acceptance criteria shall be followed :

i) General workmanship is being good and as recommended by the manufacturer are approved by the Engineer.

ii) Tolerances are within the specified limit

iii) Material test certificate (MTC) is in compliance with the applicable codes/standards.

iv) Bought out material is from the approved manufacturer/vendor

v) Bought out material is matching with the approved sample

7.0. Codes and Standards

Latest revision of following codes shall be used for the design of the spring supported foundations :

IS: 456 Code of practice for plain and reinforced concrete.

IS: 2974 Code of practice for design and construction of machine foundations.

IS: 1893 Criteria for earthquake resistant design of structures

DIN: 4024 Machine foundations; Flexible supporting structures for machine with rotating masses

DIN: 2089 Helical compression springs out of round wire and rod : calculation & design

DIN: 2096 Helical compression springs out of round wire and rod : quality

requirements for hot formed compression springs.

VDI: 2056 Criteria for assessing mechanical vibrations of machine.

VDI: 2060 Criteria for assessing the state of balance of rotating rigid bodies.

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SECTION-III

SPECIFIC DESIGN CRITERIA - STRUCTURAL

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SECTION - III

SPECIFIC DESIGN CRITERIA - STRUCTURAL

1.00.00 STRUCTURAL STEEL DESIGN

a) Structural steel design will be carried out as per the National Building Code with specific consultation to IS-800 unless noted otherwise. Design of structures in electrical substation will be as per IS-802.

b) Lateral forces along the length of the building will be resisted by bracings in horizontal and vertical frames. The transverse lateral load will be resisted by stiff jointed frame action. Additional bracing or moment connection will be used to assure stability of the structures.

c) Structural steel shall conform to Grade A of IS:2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness and welded construction, steel conforming to Grade B (Killed and normalised) of IS:2062 shall be used except for crane girders where Grade C (Killed and normalized) (IS:2062) steel shall be used. All structural steel plates and sections shall be either of “SAIL” or “TATA STEEL” or “RINL” or “JINDAL” make or vendor approved by WBPDCL.

d) Shop connections will be all welded and field connections will generally be bolted unless specified otherwise. Field bolts, wherever provided shall be high tensile of 20 mm dia. or of higher diameter and of property class 8.8 as per IS-1367 for all major connections. The bolted joints shall be designed for friction type connection and the H.T. bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams etc. will be done by 16 mm dia. M.S. black bolts (minimum 4.6 grade) conforming to IS-1363 unless specified otherwise.

e) Welding shall be in accordance with the recommendations of IS-816 - Code of Practice for use of metal arc welding for general construction in mild steel and IS-9595 - Recommendation for Metal Arc Welding of Carbon and Carbon Manganese Steels. Built-up members will be fabricated using submerged arc welding procedure unless manual arc welding is specifically required. All butt welds in plate girders and columns will be full penetration. All butt welds will be radiographically or ultrasonically tested as per relevant IS codes and standard practice. The bare wire electrodes for submerged arc welding shall be as follows:

Filler wire : AWS-A-5.17-EH14
Flux will be agglomerated type of classification
AWS-A-5.17-F7A2EH14

f) All structural steel members for GIS substation shall be hot dip galvanised in accordance with IS-4759. The fasteners shall also be galvanised in terms of IS-5358. Galvanizing of steel structure shall be done after all fabrication work is completed. Zinc coating over galvanized surface of structural members and threaded fasteners shall not be less than 610 gm/sqm and 375 gm/sqm of surface area respectively. However, fasteners may be tapped or re-run after galvanizing. Threads of bolts and nuts shall be capable of developing the full strength of the bolt. The spring washers shall be electro-galvanized as per IS-1573. All galvanizing shall be uniform and of standard quality and shall withstand tests in accordance with IS-2633.

g) Shop primer paint will be single coat of red oxide zinc- chromate primer conform to IS-2074. The surface preparation will be done in accordance with IS : 1477 (Part I & II) – Code of Practice for Finishing of Ferrous Metals in Buildings. Second coat of primer shall be applied after erection and final alignment of the erected structures. Two or more coats of synthetic enamel paint conforming to IS:2932 of approved shade and quality shall also be applied after erection. Total Dry film thickness of the finished paint shall not be less than 110 microns.

h) All welding electrodes shall be of Low Hydrogen type conforming to IS:814 and shall be EB5426H3JX type. All electrodes, flux, wire etc. shall be of ADOR Welding Ltd., ESAB India Ltd., D & H Secheron Electrodes Pvt. Ltd. , Modi electrodes or equivalent as approved by WBPDCL.

Alternatively, flux coated arc welding (FCAW) conforming to AWS-E70T-5 which is a modified procedure of MIG/CO2 (solid wire) can be used.

If submerged arc welding is used, the bare wire electrodes shall be as follows:

Filler wire	:	AWS-A-5.17-EH14
Flux	:	agglomerated type of classification AWS-A-5.17-F7A2EH14

i) Minimum preheat & inter pass temperatures for welding over 40mm to 63mm (thickness of the thicker part at the point of welding) will be 66°C and for over 63mm, it will be 110°C. However, higher preheat & inter pass temperatures may be required due to joint restraint etc. and will be followed as per approved welding procedure.

j) Minimum tests to be carried out during fabrication and erection of structural steel shall be as follows :

Steel

Ultrasonic Test : Plates above 25mm thick will be subjected to ultrasonic test as per ASTM-A435 or equivalent to check the presence of lamination.

Fillet weld

Dye Penetration Test : 5% of the total length, Dye penetration will be carried out to the root run.

Butt weld

Dye Penetration Test : 10% of the total length, Dye penetration will be carried out to the root run after back gouging

Radiographic Test : Splicing should not be provided in tension flange of Bunker Girders and crane girders. Spot radiography shall be carried out on 100% joints in tension zone and 10% joints in compression zone. Minimum 300mm length will be spot radiographed. When radiograph is not possible ultrasonic test will be carried out after grinding the surface.

Ultrasonic Test : 10% of all other Butt welds except crane girder and bunker girder shall be subject to spot radiographic test and the entire balance butt weld for ultrasonic test.

k) Connections

Connection of vertical bracings with connecting members and diagonal truss members shall be designed for full tensile capacity of the bracings.

Size of fillet weld for flange to web connection for built up column section will be as follows:

Full shear capacity for box section.

80% of full shear capacity or actual shear (if indicated in drawings) or 0.5 times of the web thickness whichever is more for I section. Weld will be double fillet.

All welds will be continuous. The minimum size of fillet weld will be as per relevant IS code.

Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. Design shear force should be more than actual shear.

Moment connections between beam and column will be designed for 100% of moment capacity of the beam section.

All butt welds shall be full penetration butt welds.

Connection of base plate & gusset members with the columns will be done considering that total load gets transferred through weld.

All splicing work shall be of full strength. Shop splicing for all sections other than rolled sections shall be carried out by full penetration butt welds. Shop splicing of all rolled sections shall be carried out using web and flange cover plate.

Following connections will be provided during erection :

Welded Connection

Connection of secondary beam to main beam

Connection of bracing to column

Connection of bracing to longitudinal tie beam

Connection of longitudinal tie beam to column

Connection of spandrel beam to column

Connection of other secondary structures

HSFG Connection (Grade 8.8 bolts)

Splicing of column / transverse frame beam / longitudinal tie beam

Connection of frame beam to column

Connection of Crane Girder to column

Connection between crane girders

Other major connections

Bearing Type Connection (HT bolts Grade 8.8)

All removable type connections

M.S. bolts (Grade 4.6)

Purlins, stairs, wall beams etc.

2.00.00 LOADS

Loads as defined under Clause 3.00.00 Section-II will be applicable.

In addition following should be considered.

a) Elevator Loads

Elevator support systems shall be designed to accommodate the capacity load of the elevator plus the weight of the cab and accessories.

b) Coal and Coal Bunker Loads

Coal Weight : 8.0 kN/Cu.M for storage volume calculation

: 12.0 kN/Cu.M for load calculation

Angle of internal friction = 31 Deg. (as per IS-9178 Part-I)

3.00.00 LOAD COMBINATIONS

While designing consideration shall be given to the following load combinations:

i) DL + LL

ii) DL + LL + PL + Equip ± TL

iii) DL + LL + PL + Equip + Cb + CtLA± CS ± TL

iv) DL + LL + PL + Equip + Cb + CtLB± CS ± TL

v) 0.9DL ± EL (for DL only)

vi) 0.9DL ± WL1 ± TL

vii) 0.9DL ± WL2 ± TL

viii) 0.75 (DL +* LL + PL + Equip + Cb + Ct ± EL ± TL)
(* Appropriate portion of LL which is considered for working out EL shall only be taken)

ix) 0.75 [DL+LL+ PL + Equip + Cb + CtL1 ± (CS1+WL1) ± TL]

x) 0.75 [DL+LL+ PL + Equip + Cb + CtL1 ± (CS1+WL2) ± TL]

Where the above loads are :

DL = Dead load of structures, floors, walls etc.

LL = General live load on floors

PL = Pipe load

Equip = Equipment loads

Cb = Crane Bridge

Ct = Crane trolley positioned at middle of bridge

CtLA = Crane trolley + Load near one row

CtLB = Crane trolley + Load near other row

CtL1 = Crane trolley + Half load lifted at centre of bridge

CS = Crane surge for full load

CS1 = Crane surge for half load lifted

WL1 = Wind load with internal suction of 0.2P, left to right

WL2 = Wind load with internal suction of 0.2P, right to left

EL = Earthquake load

TL = Temperature load

Appropriate allowable increase in permissible stresses as per IS codes, may be taken except where as per above load combinations load factors are used in combinations (vii) to (ix) above.

Appropriate impact factor shall be considered as per IS:875 (Part 2) while calculating crane loads.

In calculating wind loads, appropriate internal thrust / suction shall be considered along with external pressures as per IS:875 (Part 3). All possible load conditions considering external and internal pressures shall be considered in analysis and design for each combination number (vi), (vii), (ix) & (x) above to assess worst effect on whole structure as well as its components.

4.00.00 SWITCHYARD STRUCTURES

Structures shall be provided to carry all conductors, insulators, isolating switches, circuit breakers and other items of switchyard included in the contract. Facilities shall also be provided for the termination of the incoming overhead transmission lines.

All switchyard structures shall be of galvanised steel. The structures shall be designed to ensure that the specified minimum phase, earth and erection clearances are maintained under all conditions. The strength and rigidity of the structures shall be such that the alignment of the apparatus, which they carry, shall not be affected by the static and dynamic loads the structures are subjected to.

Towers and gantries shall be designed for both normal and broken wire conditions as per latest IS:802 [Part-1]. The sequence of applying tension during stringing shall also be taken care of in the design of structures.

Wind pressure on towers, gantries, conductors, insulators, strings and other similar structures shall be worked out considering IS:802 [Part-1] latest edition.

Switchyard structures shall be designed to withstand the worst combination of dead loads, service loads, wind induced loads or seismic loads, thermal stresses, and any other special loads like short circuit force etc. Permissible stresses for various steel towers shall be guided by latest IS:802 [Part-1] stipulations.

When calculated deflections, under all permanent loads of any part of a structure, exceeds 6 mm or 1/220 of the span, whichever is less, a reverse camber equal to 1.5 times the calculated deflection shall be built into the unloaded structure.

Switchyard structures shall be designed for the worst combination of loads. The factor of safety for design of members shall be considered as 2 for normal and broken wire conditions and 1.5 for combined short circuit and broken wire conditions. Short circuit forces and wind forces shall not be considered simultaneously.

5.00.00 PIPE AND CABLE RACK STRUCTURES

The pipe and cable rack structures shall accommodate the pipes/cables with proper access and adequate working space for erection and maintenance. These shall be designed to carry safely all the loads acting on them (DL, LL, WL, EQL, forces from pipe lines etc.). The structures shall be adequately rigid to carry the forces from the pipelines at anchor points without undue deflection so that the pipelines are really anchored at the anchor points.

It is envisaged that pipe/cable rack under this Main Plant Package will have to accommodate some additional pipes and cables (such as Plant Water System etc.), which are not in the scope of the Main Plant Package successful bidder. The bidder shall in his offer keep reasonable margin for accommodating such

additional pipes/cables in the rack structure, details of which will be furnished to him during the detailed engineering stage.

6.00.00 OTHER SPECIFIC REQUIREMENTS

All steel framed structures shall be either “rigid frame” or “simple space frames” or a combination of two.

Lateral forces shall be resisted by stiff jointed moment connections in rigid frame design. The column bases shall generally be fixed to concrete foundation pedestal by providing moment resistant base detail.

Simple space frame design utilizes single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. The most of plant steel buildings such as Main Power House, Mill Building etc. shall be designed as simple space frame structures.

The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction.

Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However wherever large cut outs (area more than 1.0 m^2) are provided in the floor slabs horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support in the form of shear connector and horizontal bracing shall be provided as required.

Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimise vibration, avoid resonance and maintain alignment and level.

Chequered plates shall conform to IS:3502.

All indoor gratings shall be electro-forged type and outdoor gratings shall be welded type. Minimum thickness of grating shall be 40mm for indoor installation and 32mm for outdoor installation. The opening size shall not be more than 30mm x 100mm. The minimum thickness of the main bearing bar shall be 4mm. All gratings shall be hot dip galvanized @ 610 gm/sqm.

Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange will not be permitted. Bearing edges of crane girders shall be

machined.

The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

Permissible stresses for different members shall be allowed to exceed up to 33.33% only under normal loads along with wind and seismic conditions. However, members which are designed primarily to resist wind such as bracing members, no increase in permissible stresses will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only under wind and seismic conditions.

Permissible Deflections

The permissible deflections of various steel members under normal loading conditions shall be as specified below. For calculation of deflections in structures and individual members dynamic effects shall not be considered, unless specified otherwise. Also, no increase in deflection limits shall be allowed when wind or seismic load are acting concurrent with normal loading conditions.

Vertical Deflection

a)	For beams supporting dynamic equipment	:	Span / 500
b)	For beams supporting floors / masonry	:	Span / 325
c)	For beams supporting pipes (pipe racks)	:	Span / 400
d)	For roofing and cladding components	:	Span / 250
e)	For gratings and chequered plates	:	Span / 250 subject to a maximum of 6 mm

For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:

a)	For manually operated cranes & monorails		:	Span / 500
b)	For electric overhead cranes			
	i)	up to 50 t capacity	:	Span / 750
	ii)	over 50 t capacity	:	Span / 1000

Horizontal deflections

The permissible horizontal deflections shall be as per following unless specified otherwise:

a)	Single storey building (without crane load)	:	Height / 325
b)	Multistoried building (without crane load)	:	Height / 500
c)	Pipe rack columns	:	Height / 200
d)	Open Structures	:	Height / 200
e)	Crane gantry girder due to surge	:	Span / 2000 limited to maximum of 15 mm
f)	Building main columns at crane rail level due to action of crane surge load only	:	Height / 2500 limited to maximum of 10 mm
g)	Open gantry columns at crane rail level due to action of crane surge load only	:	Height / 4000 limited to maximum of 10 mm

Provisions of IS:800 and relevant IS Code shall be followed for limiting deflections of structural elements not listed above.

Minimum Thickness of steel elements

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment (Exposed to open air i.e., to Rain; Contact with Soil, Coal, ash, Contact with drained liquid or contaminated water, acid/alkali etc.) shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

a)	Trusses, purlins, girts and bracing	:	6 mm
b)	Columns and beams	:	8 mm
c)	Gussets	:	8 mm
d)	Stiffeners	:	8 mm
e)	Base plates	:	10 mm & above
f)	Chequered plates	:	6 mm o/p & above
g)	Grating flats	:	5 mm

f) Minimum thickness of structural members other than gratings and chequered plate directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

Minimum Sizes of steel elements

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.

Slenderness and Depth Ratio

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS:800.

The following limiting ratios of depth to span shall be considered as a general guide.

a)	Truss	1 / 10
b)	Rolled beams and girders for Ordinary floors and rafters	1 / 24
c)	Supporting floor beams for vibrating Machinery / equipment	1 / 15
d)	Roof purlins and girts	1 / 45
e)	Gable columns	1 / 30

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW UNIT NO. 5, PHASE – III

EPC BID DOCUMENT

DOCUMENT NO. 12A05-SPC-G-001

VOLUME: II-G/2

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORKS

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SEPTEMBER, 2017

VOLUME: II-G/2

GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORKS

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GENERAL SPECIFICATION AND DESIGN CRITERIA FOR ARCHITECTURAL WORKS

1.00.00 SCOPE OF ARCHITECTURAL WORKS INCLUDING SANITARY AND PLUMBING

1.01.00 Scope

The architectural services shall cover finishing work of power house and all auxiliary buildings, Non-plant buildings included under the specification starting from brick work, partition walls, roof protection, finishing of walls, floors and Bidder ceilings, false ceiling, cladding, as required potable water system, service water, Plumbing and sanitation etc. as required for functional requirement. The bidder offer shall cover the complete requirements as per the best prevailing practices keeping in view the statutory and functional requirements of plants & facilities and providing enough space & access for operation, use & maintenance and to complete satisfaction of the owner.

Plant buildings under this scope of work:

- Power House Building including Electrical Bay, Switch Gear Room & Control Room
- Mill Building
- ESP Control Building
- FGD Control Building
- CW & ACW Pump House & Electrical Building
- CW Chemical Treatment Building
- CW Chlorination Building
- CPU Regeneration Building
- Vacuum Pump cum Compressor House

Above list of Plant Buildings is not exhaustive. Buildings necessary for the smooth operation of the plant shall be within this scope of work. In case the equipment parameters considered by bidders for Phase-III differs from that of Phase-II, separate buildings may be required to accommodate such equipment and its stand-by units.

1.02.00 Prequalifying criteria for Architectural works

a) The bidder should have registered architect(s), registered under Council of Architecture (COA), as his employee. An attested copy of COA of the lead Architect should be submitted as a part of Pre-qualification document. The lead Architect should have experience of rendering architectural services one complete 500 MW or above project and this includes BTG, BOP and Non-plant buildings.

b) The bidder may form consortium with an architectural firm. In that case MOU between the bidder and the architectural firm is to be produced. The COA registration certificate of the lead architect of the firm is to be submitted. The architectural firm should have experience of rendering architectural services for BTG, BOP & Non-plant buildings of one completed 500 MW or above TPP or STTP project.

c) In case of foreign collaboration/consortium registration certificate of the lead architect of that country, duly approved and attested by the Consulate of that country is to be produced as per-qualifying document. Successful completion certificate of one 500 MW TPP or STTP by the architectural firm is to be submitted.

d) The bidder shall obtain the approval from WBPDCL for the agency for Architectural services.

2.00.00 DESIGN REQUIREMENTS

2.01.00 Architectural Concepts

a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform & local climate & due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes & skyline.

b) Main plant building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses.

SGTPP 1X660 MW Unit No.5, Phase-III is the extension of SGTPP 2X500 MW Unit No.3&4 phase II. **The Facia of the two power house building must be same from aesthetic point of view**.

The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehendible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.

The bidder must visit the site and have a feel of the overall environment, so that a harmonious as well as integrated architectural concept of the proposed phase of development is achieved.

c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters may be judiciously imbibed. The building shall be designed initiating an

architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man & form.

d) Overall colour scheme of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts and other service elements.

e) Overall emphasis shall be on developing an eco- friendly architecture, merging with the nature with its own sustainable energy management systems.

The scheme shall be conceptually finalized in totality including that of equipment so that the proper co-ordination with other agencies can be taken up at appropriate time.

2.02.00 **Architectural Design**

a) Natural light shall be used to the maximum extent especially in the form of north light/skylight. For adequate light and ventilation, National Building Code recommendation shall be followed. **However all windows shall have minimum 1.0m sill height and bottom of lintel height shall be 2.5m from finished floor level. Minimum door height shall be 2.5m.**

b) Entrance canopies, sunshade (projections, recesses) over openable windows and door openings on exterior facades shall be provided.

c) All the buildings shall be architecturally designed to meet the National Building Code.

d) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect Statutory requirement and any clearances from local authority may be required to be met with, wherever essential. The Architect Consultant shall be of national/ international repute having experience in similar kind of works. The consultant shall evolve the design philosophy and shall present it in the form of presentation drawings, prospective views, 3-D Models & detail drawings. **All architectural drawings shall be prepared under responsibility of an Architect. The Architect should be registered under Council of Architecture. The registration certificate of the architect should be produced by the bidder during bid submission.**

e) A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the multidisciplinary engineering activities involving power plant technology and architectural & civil engineering for a smooth control hierarchy and man machine interface.

f) At the inception of the detail engineering the bidder should submit the architectural concept of the overall plant with 3D views & colour scheme of Plant & Non-plant buildings for selection of the owner. The selected concept shall the vernacular of the project to bring harmony all over the plant site.

2.03.00 **Plant Buildings**

2.03.01 **Powerhouse Building**

Powerhouse shall be of structural steel framed with RCC floor and Brick Wall and insulated metal cladding construction. Operating floor being the heart centre of Powerhouse shall be designed as a very impressive floor having high quality finish, material and appropriate ambience.

External facade shall be with full brick thick wall up to approximately 3.0m high, plastered and painted. From 3.0m-upto roof external façade shall be clad with factory fabricated Rockwool / PU insulated metal cladding on A Row & Gable ends, on C Row and any other external exposed surfaces, single skin metal sheet cladding over brick work shall be installed where brick work is technically required. Fire Wall facing towards Transformer yard, shall be minimum 6.0M high and 1 ½ brick thick wall or 250mm thick RCC wall as per Fire Prevention regulation. Single skin metal cladding similar to the Top sheet of Insulated Metal Cladding used for other part of the facia shall be applied over the Fire wall to match the overall elevation treatment.

Sufficient natural light and ventilation has to be ensured for every part of the building unless prevented due to technical reasons. Operating floor may have large glazed area made with Structural glazing system. At Crane girder level windows on A Row, B Row and gable ends shall be provided. Sufficient natural light is to be ensured at TG Hall floor.

Rain-water pipes or sanitary pipes shall not be visible from outside. Provision of pipe ducts shall be made to ensure pipe routing.

Minimum one number Down comer shall be provided at each grid column.
All cable spreader floors shall have proper slopes and provision of fire emulsifying system for drainage.

Steel columns within fire hazardous areas like electrical room, Main control room and switch gear room shall be encased with brick work or concrete. All steel columns shall have 150mm high concrete base to ensure proper floor finishing work and to protect the column base.

Minimum 2.1m high headroom clearance has to be maintained at every part of the building.

Vertical Head room clearance shall be maintained as per industry factories Act.

Sufficient headroom shall be provided in cable galleries.

Where false ceiling is to be provided, provision of human access has to be made to maintain the HVAC, Electrical and other service lines above false ceiling. If the height between false ceiling and bottom of beam is more than 2.1M then steel grid system (1.2M X 1.2M span) with catwalk to be provided to support the false ceiling system and human access respectively.

Minimum 1.5M wide passage is to be marked on the floor as safety exit route. Such passages shall lead to Fire-escape staircases or fire-safe zones. Doors of fire-hazardous rooms or areas shall open towards safety exit passage. All external doors shall open towards outside. Fire escape staircases shall be located as per fire-code and TAC.

2.03.02 **Mill & Bunker Building**

This shall be of steel framed structure having single skin metal cladding to clad Tripper floor only. The colour and pattern of the sheeting should match the overall ambiance of Power Island. Sufficient natural light and ventilation should be provided for tripper floor. Provision of roof access through stair should be made.

2.03.03 **Other Plant Buildings**

Structures of Other plant buildings shall be as per description stated elsewhere in this Civil/Structural Specification. Architectural concepts of structures shall offer its own identity and will be aesthetically blended to give pleasing appearance maintaining harmony of the plant complex. Functional needs of each building shall be maintained.

3.00.00 ARCHITECTURAL REQUIREMENTS

3.01.00 Roof Insulation and Ventilation

The roof of buildings which are recommended by HVAC department for over deck insulation shall be insulated with rigid insulating board.

Extractor fans will be provided over roof of turbine hall for ventilation. For ventilation requirements relevant section of the specification shall be referred.

3.02.00 Roof Waterproofing

Roof water proofing treatment shall be as follows:

a) For roofs having structural slope

Spray applied an average 40 mm thick two component Hydro flouro-carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m3 as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102.

Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

b) For roofs having no structural slope

Spray applied an average 40 mm thick two component Hydro flouro-carbon (CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m3 as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a brush/roller in 2 coats. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 75mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

For other plant and non-Plant buildings Two component PUR foam minimum 50 mm thick as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane layer. Over the finished surface APP Bitumen membrane as specified shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar under bed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with

polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

3.03.00 **Partition Wall**

All intermediate walls shall be full brick thick wall in 1:6 cement sand mortar. Half brick thick wall in 1:4 cement: sand mortar with 2 nos. 6 mm dia rod in every fourth layer shall be provided. For long walls intermediate RCC pillars and RCC horizontal tie shall be provided or shall be provided with structural steel member at minimum 2.5 m clear height with MS inserts/lugs for anchoring in brick work shall be provided. Similarly MS lugs shall be provided on the structural member at spacing 500/600 mm on vertical face for proper anchorage for brickwork, lugs embedded in concrete and suitable vertical structural member at maximum 5m c/c. Full glazed partition in anodized aluminium frame shall be provided for operator's cubicles for clear view of the operating equipment and in Control room area.

Internal Dry Partition wall made of Gypsum board / Cement particle board / Calcium silicate board is to be used where light weight construction is required. Board thickness shall be minimum 12.0mm. Partition may be single ply or double ply construction. Boards are to be fixed on metal studs as per manufacturer's details and specifications. Provisions for glazing and glazed doors, cable conduit, etc. are to be made as necessary. Gypsum board partition shall be finished

3.04.00 **Plastering**

Exterior & rough side of interior brick wall	20mm thick minimum sand faced plaster with 1:6 cement-sand mortar in two layers. Where external finish will require rich plastering for special finish plaster shall be of 1:4/1:3.
Interior wall	12 mm thick with 1:6 cement-sand mortar
Ceiling	6 mm thick with 1:4 cement-sand mortar shall be provided to all exposed ceilings.

3.05.00 **False Ceiling**

Aluminium pre-painted/Powder coated false ceiling, similar or equal to LUXALON of Hunter Douglas/ARMSTRONG with either lineal panel system or aluminium tile/plank system for control rooms and other important areas, with suspension system as per manufacturer's details shall be used.

Areas like office space or where specified Mineral Fibre Based Acoustic Ceiling Board either Armstrong or similar to Armstrong, in aluminium snap grid suspension system as per manufacturer's specification shall be provided. As an alternative Moisture & Fire Resistant Gypsum Board false

ceiling system of Saint Gobain Gyproc India Ltd or similar manufacturer may be used.

Unimportant areas Calcium Silicate Board/Tiles false ceiling shall be of HILUX or AEROLITE or Fibre Cement Board of EVEREST Industries Ltd shall be used.

The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be as per specification mentioned elsewhere in the specification.

3.06.00 **Special Finish**

a) The main entrance of powerhouse, control room and other important areas shall have high quality finish to floors, walls, ceilings etc.

b) Main stairs and landing shall be equally treated.

3.07.00 **Doors**

a) Generally factory made hollow metal (steel) flush doors with pressed steel frame shall be provided for plant and utility areas.

b) Factory made Solid core wooden flush doors in teak wood frame shall be used in interior office areas. Aluminium doors shall be provided in at entrances and important areas.

c) Rolling steel shutters shall be used where frequent use is not envisaged and large openings are required. Operation shall be manual/mechanical/ electrical depending on the size of opening.

d) Special areas like control rooms and other special area shall be provided with minimum 15 micron pre-coated i.e. colour anodized aluminium glazed partitions with air lock facilities having two sets of doors and preferably double door systems.

e) Minimum 2 hour Fire rated doors with panic bar shall be provided in cable spreader rooms and other areas having fire hazard and also to all fire exists as per TAC requirement.

f) Doors shall be provided at appropriate location to prevent dust ingress from outside.

g) Wooden panel doors shall be provided for toilet entrance and toilet internal doors shall be solid core PVC.

h) Weather stripping shall be provided to all outside doors as well as air conditioned areas and all other doors where dust-free environment is required.

3.08.00 **Windows & Ventilators**

In Powerhouse building, full glazed windows and ventilators in minimum 15 micron anodized aluminium window frame shall be provided with 4 to 6 mm thick (depending on the size of panel) clear float glass and 6 mm thick clear wired/laminated glass where required from safety point of view. For operating floor of Power House, structural glazing may be considered as an important façade element. All windows and ventilators shall meet the requirement of industrial windows and Ventilators.

In other areas aluminium windows with 4 mm thick clear float glass shall be provided suitably in panels not exceeding 1200 mm wide. The window area shall be so decided as to allow adequate natural ventilation and light.

***Note**: Glass thickness and member sizes of Aluminium Glazed doors and windows shall be designed by the manufacturer and to be submitted for approval by the Bidder before execution.*

3.09.00 **Landscaping**

Generally the natural contour shall be retained except where modifications needed for drainage or other technical reasons. Rockeries, appropriate trees, shrubs, ground cover, lawns along with landscape furniture, sculptures, fountains, decorating/ornamental fencing, electric lights & fittings, etc. shall be provided to create a visually pleasant environment. Special landscaping shall be made around main entrances of powerhouse and other important buildings. Irrigation facilities shall be provided for all green areas.

The plant area shall be covered under Landscaping. Minimum 33% or as per recommendation of MoEF (whichever is higher), of plant area shall be kept as Green Belt. Some of the plantation area shall be fenced suitably as per the choice\advise of the Owner. Trees for formation of green belt of minimum width 100 M for segregation of CHP area from the raw water reservoir will be chosen to match with prevailing landscape in the adjacent areas. Names of some of avenue trees are given for selection, which are “Arjun, Ashoke, Elengi, Amaltus, Gulmohur, Mohua, Sirish, Margose, and White Ceden” and of other species suitable to the local environment. Special landscaping shall be made around main entrance of Power House, Service Building, Main Gate Complex. The area shall be covered by shrubs and seasonal flowers. Plantation for green belt shall commence immediately after the mobilisation of the Bidder at site, so that trees are sufficiently grown at the time of commissioning. The plants shall be maintained for a minimum period of one year after planting, and dead plants, if any shall be replaced. The Bidder shall also lay and commission the irrigation scheme for the landscaped areas which shall include supplying and installing pumps to draw water from the sewage and effluent treatment plant and pump into the system at required head, supplying and laying buried GI pipes of adequate capacity with associated fittings and control valves and sprinklers of approved design for distribution and sprinkling of water to various disposal points. A nursery has to be set up in the area to cater to the need of plantation. Some beatification work like decorative landscaping, rockeries, fountain, and lily pond shall be provided at locations to be suggested.

The Bidder shall furnish detail drawing schedule for landscaping prepared by experts in the respective discipline. The work shall be taken up duly after approval of the Owner.

Arboriculture and avenue plantation all along roads suitable to environment shall be provided.

3.10.00 **Facilities in Buildings**

Adequate toilet and drinking water facilities shall be provided for personnel working in each building. Each building shall have toilet facilities both for Gents and Ladies. Number of toilet fixtures shall be adequate for the occupancy as per National Building Code.

However minimum 1 Water Closet with cistern, 1 washbasin with mirror, towel rail, soap case, 1 urinal shall be provided in each toilet.

Each floor shall have drinking water facility connected through potable water with water cooler.

Provisions should be kept for barrier free environment for physically challenged persons like ramps in 1 in 12 slope, lifts, toilets, etc.

3.11.00 **Potable Water System and Service water Plumbing**

This system for various buildings shall be connected to the drinking water and service water systems, the scheme for which is indicated elsewhere in this specification.

Water outlets shall be provided for an instantaneous flow rate of approximately 7 Cu.M/Hr. (25 GPM).

System will satisfy state and local plumbing codes. Following I.S. Codes for the system shall be followed:

a) IS-2065: Code of Practice for water supply in buildings.

b) IS-1172: Code of basic requirements for water supply, drainage and sanitation.

c) IS-1200: (Pt. XVI) Laying of water and sewer lines including appurtenant items.

d) IS-1239 Specification for mild steel tubes and mild steel tubular and other wrought steel pipe fittings. (10 mm to 15 mm nominal diameter).

e) IS-3589: Specification for electrically welded steel pipes for water, gas and sewage (220 mm to 2000 mm nominal diameter).

Potable water shall be supplied to basins, water coolers, showers and other plumbing fixtures. Soil and waste piping shall drain through traps to the yard sanitary sewer system.

Service water shall be supplied to water closets, urinals, sinks, and other plumbing fixtures.

3.12.00 **Roof Drainage Systems**

The system shall be provided for removal of water from roof surface to avoid damage to the roof structure of all buildings and shall consist of the following:

a) Roof Drain Heads with dome strainer

b) Rain Water Down comers

c) Gully pits

IS-1742 code of practice for building drainage shall be followed for this purpose.

a) Adequate numbers of rainwater drains heads shall be provided for all roof areas as per standard norms for roof area.

b) System will be designed to handle rainfall at a rate as specified elsewhere in this specification and in accordance with stipulations of IS-1742.

c) Any roof more than 8.0 metres above grade shall have access from within the building for cleaning of roof drains.

d) Runoff gradient should not be less than 1 in 100.

e) Roof drains will conduct water to storm sewers. No rain water pipes shall be exposed to outside view. Minimum 150 mm dia. Medium duty G.I pipe of TATA, Jindal or equivalent approved make shall be used.

f) Roof drains will conduct water to storm sewers. No rain water pipes shall be exposed to outside view.

3.13.00 **Glazing & Glazed Partition**

a) Glazing in Control room between A.C. and non-A.C. areas shall be insulating glass consisting of two 6 mm thick toughened float glass sheet hermetically sealed and separated by 12 mm gap for thermal insulation. Clear glass shall be provided where clear view is required. In other areas tinted glass may be provided.

b) 4 mm thick ground glass shall be provided for toilets.

c) Glazing between two A.C. areas shall be with 6 mm thick clear float glass.

d) All glazing shall be in aluminium frame having 15-micron colour anodization.

e) 6mm thick. Wired / laminated glass shall be used for windows / ventilators at higher level for safety.

f) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.

g) For glazed aluminium door, 8.0mm thick clear float glass with or without etching is to be provided.

3.14.00 **Sealant**

Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 shall be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 or polystyrene filler board of HD100 of Supreme or equivalent shall be used as joint filler. All joints around exterior doors, windows, and expansion joints, etc. shall be sealed for proper water- lightness.

3.15.00 **Damp Proof Course**

40 mm thick 1:1.5:3 concrete with 2% waterproofing admixture or as per manufacturer's recommendation to be provided.

3.16.00 **Plinth Protection**

Minimum 1000 mm wide concrete plinth protection having thickness of 150mm with PCC M20 and over 150 mm soling, along building periphery shall be provided with surface drain of required size and slope, to suit storm water quantity, shall be connected to station main drainage system.

3.17.00 **Miscellaneous Metal Railing**

a. For main stair & lobby of Powerhouse building up to operating floor main landing and one half landing above operating floor level, around large openings at operating floor, main stair of Service building, Administrative building shall have 40mm diameter stainless steel railing with minimum 3mm thick SS posts & decorative minimum 3mm thick seamlessly joined SS handrails. Stainless steel pipe handrail in shall be of grade SS-304 and of approved design to meet the functional requirement as well as very good aesthetic appearance. Other hand railings of Power house building shall be MS Galvanised hand railing with 40 mm NB (medium) main post and 32 mm NB (medium) as horizontal rails. With toe guard shall be provided.

b. For any other RCC stairs of non-plant buildings 20mm square MS bar post with suitable MS Bar/flat (20 – 25 kg/Sq.m) and PVC handrails are to be provided. However design pattern shall be approved by the Owner.

c. For plant & non-plant buildings, unless otherwise indicated in the specification the post and handrails of stairs, railings, etc. Shall be of 32 mm dia NB medium class G.I. pipes as per IS-1239-part (I).

3.18.00 **Painting**

Exterior Masonry Surface	:	Buildings shall be finished with waterproof External Quality Acrylic Emulsion Paint similar to “Apex Ultima”, “Weathergurd”/ “Weathershield” over plaster. Granular textured paint may also be combined along with External Quality Acrylic Emulsion Paint to form suitable pattern on building façade. Aluminium composite panels (ACP) may be used to accentuate certain portion of the façade or certain element of the façade as the case may be.
Exterior Steel Work	:	Two primer coats steel work Zinc silicate 50 microns each. Two finish coats High built epoxy finish of 90 microns each coat.
All Woodwork	:	Synthetic paint over a coat of primer.
All Internal Steel Work	:	Epoxy Paint over approved primer
Steel in contact with acid /alkali	:	Acid/Alkali/Chemical resistant paint
Interior Office Spaces Control Rooms, All A.C. Areas And as mentioned in the annexure	:	Acrylic emulsion paint over 3 mm thick white cement putty punning.
Other Areas	:	Acrylic distemper over plastered surface as indicated in annexure for finish schedule in this document.
Fire Door	:	Post Office red shade shall be provided.

3.19.00 **Miscellaneous Work**

a) Counter tops in kitchen, Washbasin, pantry & similar areas shall be polished granite over RCC slab or Kota stone top.

b) Pavements, walkways, etc. Shall be 50/ mm or of standard thickness thick anti-skid interlocking concrete pavers

c) M.S. grill shall be generally anodized aluminium grill shall be provided. But in specific cases, M.S. grills shall be used as per approved design for security purpose made of 25 mm X 6mm M.S. Flats / 12mm – 20mm M.S. square bar of approved design shall be provided to suit security requirements.

d) R.C.C. stair railing shall be with 20 mm square M.S. Bar balustrades with suitable M.S. flats & anodized aluminium / PVC handrails shall be provided. Stainless steel pipe railing in specific areas shall be used.

e) For RCC main stair and landing of powerhouse building shall be of Kota stone and white marble strip combination, RCC stair of Service Building & Administrative building shall be of white marble/combination of Baroda green and pink marble with all edges and nosing moulded.

f) Anti-termite treatment shall be given to columns pits, foundations, and trenches, below floor as per IS: 6313.

g) Suitable arrangement of floor drain with trap shall be provided in floor where spillage of water may occur.

h) RCC staircase shall be provided in main entrance of Turbine building, Facility building and other important buildings. Turbine hall staircase shall be provided with Structural steel work

i) Access Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non-combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel. The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate – PVC / Conductive PVC on a semi –automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment. **Location and area of such access flooring shall be as per electrical requirement and Electrical GA Drawings.**

j) Doors, windows and rolling shutter in all buildings shall have sun- shade either recessed in the wall or projected out. Projection of sunshade shall be 750 mm for door and 450 mm for windows. Where doors and windows are side by side, 750 wide continuous sunshades shall be provided. For recessed type shed minimum 450 mm offset shall be provided.

3.20.00 Chain Link Fencing

Chain link fencing for areas as per safety requirement shall be provided. This shall be as per Civil/Structural specification.

3.21.00 **Temporary Fencing**

The construction of Temporary Fencing shall be done as mentioned below:

a) RCC post and its foundation shall be at 3.0m interval.

b) Fence shall be installed along lines shown on approved drawings.

c) Post size shall be 150sqr at bottom and 100sqr at top.

d) Total height of the posts shall be 2400mm from grade level.

e) Strainer posts shall be provided at sharp changes in grade, at comers at change of direction and where directed, and at every 30.0m interval.

f) All comer post will have two stay posts and every tenth post will have a transverse stay post.

g) Barbed wires shall run post to post and to be fixed to the posts by tightening hooks.

h) Diagonals and vertical per span with barbed wire shall be provided. In general CPWD specification is to be followed.

3.22.00 **Watch Towers**

Not applicable under this scope of work.

3.23.00 **Sanitary Drainage System**

a) Diameter of Soil Pipe and Waster Pipe shall not be less than 100 mm.

b) Drainage pipes shall be UPVC Type-B pipes as per IS: 13592-1992 (amended to 1995) or Cast Iron pipes as per IS: 1537 & IS: 3486 within the building.

c) IS: 1742-Code of Practice for building drainage & IS: 5329 -Code of Practice for sanitary pipe work above ground for buildings should be followed.

d) If not specified the minimum gradients of soil and drainage pipe line shall be as follows:

I. 100 mm nominal dia : 1 in 35

II. 150 mm nominal dia : 1 in 65

III. 230 mm nominal dia : 1 in 120

IV. 300 mm nominal dia : 1 in 200

e) Each floor drain should have ‘P’ or ‘S’ trap connection as required.

f) Pipe to pipe should be connected in 45^0 or 135^0 both vertically and horizontally.

g) For cleaning purpose during maintenance, Floor Cleanout and Wall Cleanout should be provided for horizontal run and vertical run of the pipes.

h) In no case soil pipe shall be connected to waste pipe.

i) In vertical stack proper venting system with anti-siphonage vent pipes should be provided for all Water Closets.

j) CI pipes shall be joined by lead caulking and UPVC pipes shall be joined by thermoplastic joint as per manufacturer's detail.

k) Soil & Waste pipes shall be taken out of the building separately and shall be connected to separate Inspection chambers. From inspection chamber further connection shall be made to either septic tank or STP line as per plant drainage scheme.

4.00.00 INTERIOR FINISH SCHEDULE FOR POWER HOUSE BUILDING (Refer ANNEXURE - I)

5.00.00 INTERIOR FINISH SCHEDULE FOR AUXILIARY BUILDINGS (Refer ANNEXURE - II)

6.00.00 INTERIOR FINISH SCHEDULE FOR NON PLANT BUILDINGS (Refer ANNEXURE - III)

6.01.00 Architectural Specification of Control Room & Annexure Room

The control room of the Turbine Building is located at Operating Floor level. It is the nerve centre of the plant having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience. To accentuate the Front portion of the UCB control room façade a suitable combination of Aluminium composite panel (ACP)/granular textured paint may be used. Please also note that the finish of the visitor's lounge/gallery in the control room enclosure will be same as that of control room.

The room will be fully air-conditioned and have access from T G hall side through Air locks to reduce the noise level as well as heat load. Each Air- lock space shall have two numbers of double leaf glazed sensor operated sliding aluminium doors. The wall facing the turbine hall shall be fully glazed aluminium partition wall with hermetically sealed insulating glass panels. Control room shall have an internal acoustic partition wall along the entire length of the room, facing operating desks. This partition shall be integrated with Digital Display Boards at different locations and have monolithic fabric finishes with high acoustical properties. It will have fully vitrified tiled floor, linear metal ceiling with A.C and lighting fixtures and wall with acrylic emulsion paint. The control room shall have very high quality furniture of approved make similar to Godrej/ Featherlight. The control desk of laminated and moulded finish of approved colour and texture, appropriate to accommodate/ house control panels, monitors shall be equipped with all functional requirements. Operator's chairs shall be swivel type on casters and have

cushioned seat and back of approved material and colour. Necessary arrangement for sealing expansion joints on floor, wall and ceiling has to be ensured. Brief technical specifications of different items to be used for the control room are as follows.

a) Flooring: Non-skid, full body vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles of 1st quality dual charged similar to MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd, KAJARIA of minimum size minimum 600 mm x 600 mm x 10mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer's specification. Total thickness of the flooring shall be 50mm thick including the thickness of the tiles, under bed.

b) Skirting: Walls of UCB control room from floor level up to false ceiling level shall be provided with vitrified tiles of 1st quality, full body vitrified, 10 mm thick nonporous, homogenous, abrasion resistant cover base of matching colour, internal and external corner strip similar to "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd, KAJARIA and fixed to the wall strictly as per manufacturer's specification.

c) Wall finish: Columns, bracings or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make or composite panelling of approved pattern up to the RCC ceiling level. The colour and design composition of ACP cladding or composite panelling is to be submitted for approval of the authority before taking up the work.

d) False ceiling: The bottom level of false ceiling shall be kept 3500mm above floor level and as applicable. Combination of Gypsum plaster board and Aluminium lineal (LUXALON or similar approved) or plank/panel false ceiling system of approved pattern having state of the art facilities and requires a highly sophisticated hi-tech expression and ambience in order to enhance the aesthetic appearance of the control room. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. Under-deck insulation with 50 mm thick resin bonded rigid mineral wool / polystyrene block with protective aluminium foil lining shall be provide on the ceiling, on the walls and beams above false ceiling level.

e) Air lock doors: Double acting glazed aluminium door with minimum 15 micron colour anodized finish with 3mm thick shall be used having glazing thickness 6mm of clear float glass of approved brand .The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. The aluminium sections shall be similar to HYDRO-Domal System.

f) The doors shall be complete with weather seal, gaskets, floor spring, doorstopper, door locks, push/pull bars of similar finish and all necessary hardware. The aluminium sections shall be similar to HYDRO-Domal System.

g) Glazed partition wall: The glazed partition wall shall be made of aluminium sections having same finish that of aluminium doors with double-glazed insulating glass panels. This partition height shall be from top of floor finish to the bottom of the false ceiling. Insulating glass shall consist of 2 nos. 8 mm thick toughened plain glass separated by an air gap of 12mm thick, hermetically sealed, moisture resistant and of approved manufacturer. The partitions shall be weather proof complete with gaskets, clips, hardware, etc. The aluminium sections shall be similar to HYDRO-Domal System.

h) Internal partition wall of control room: The internal partition wall along the entire length of the room, facing operating desk shall consist of Digital Display Boards at different locations, integrated with wall panels of Anutone Acoustic Ltd or equivalent laid flush with the display board and two nos. of matching doors on either sides for access to the rear side for maintenance. This special purpose partition shall be as manufactured by Anutone Acoustic Ltd or equivalent and shall have rigid frame work consisting of G.I. Studs of adequate size @ 600 mm c/c and floor, ceiling and intermediate channels to provide a strong wall system capable of supporting wall hung C.C.T.V. at designated locations. The framing system shall be integrated with independent floor supported structural framework of digital display board so as to cover the entire exposed surface around the board with partition panels. The entire wall shall have Class I fire rating as per BS code. The partition shall not transmit any load to false ceiling. The entire partition wall shall have concealed framing system and have monolithic fabric finish of approved colour or composition of two different colours as per approved design to entire exposed surfaces including door panels on control room side.

3D views with different colour and pattern showing flooring wall panelling and false ceiling is to be submitted for owner's selection.

7.00.00 DESIGN DATA FOR ARCHITECTURAL WORKS

1	Brick works – internal and external:	230 mm thick fly ash brick wall with 1:6 Cement- Sand mortar. All Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise.
2	Half brick thick wall:	1:4 cement: Sand mortar with 2 nos. 6 mm dia M.S. rod in every fourth layer.
3	One third brick wall:	1:3 cement: sand mortar with 2 nos. 6 mm dia M.S. rod at every alternate layer.
4.	Damp proof course:	40mm thick 1:1.5:3 Concrete with a 2% admixture of water proofing compound or as per manufacturer's recommendation.
5.	Plaster:	

	Exterior & rough side:	20 mm thick with 1:4 cement- sand of interior brick wall mortar in two layers except where special finish provided.
	Interior:	12 mm thick with 1:4 cement-sand mortar
	Ceiling:	6 mm thick with 1:3 cement-sand mortar
6.	White Cement Putty Punning:	3 mm thick punning to be provided to all areas receiving acrylic emulsion or Acrylic Distemper paint.

7. Cladding for Power house :

Providing and fixing of double skin insulated wall cladding system comprising of colour coated profiled external sheet manufactured out of similar or equal to 0.45 mm BMT COLORBOND® XRW or equivalent steel- High tensile with min 550 MPa yield strength, metallic hot-dipped coated with Al-Zn alloy (55% Aluminium, 43.5% Zinc, 1.5% Si) as per AS1397 / IS15961 - ZINCALUME® AZ150 (min. 150 g/m2 total on both sides) with Super Durable Polyester COLORBOND® steel XRW quality paint system of approved color, suitable for exterior application conforming to AS/NZS 2728 type-4 / IS15965 class 3.. Profile sheet of nominal.1015 mm effective cover width and nominal 28 mm deep ribs with subtle square fluting in the five pans at nominal 203 mm centre-to-centre. The end rib shall be designed for anti-capillary action, to avoid any seepage of water through the lateral overlap. The sheet shall have a total coating thickness of 35 microns, super durable polyester COLORBOND® XRW or equivalent with Thermatch™ solar reflectance technology quality paint system of 20 microns on exposed surface and 5 micron reverse polyester coat on back surface over 5 micron primer coat on both surfaces. The paint system would have stable resin & inorganic pigments for paint durability and is lead free for water harvesting. The steel sheet shall be fastened with nominal 40 µm zinc coated or nominal 25 µm Zinc-Tin alloy coated, Hex head, self-drilling screw as per AS 3566-2002 Class 3 fasteners with EPDM washer and also as per the requirement considering the profile shape and design load.The inner sheeting shall be 0.50mm/0.6mm TCT of SMP coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength. The colour coating shall comprise of 25 microns finish coat over a 10-micron primer coat on the exposed side and a back coat of 10 microns over a primer coat of 5 micron on the reverse side. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Sub- girts of size 50mm x 50mm x 50mm manufactured out of 16G GI (1.6mm GI) 'Z' shape would be fixed the inner sheeting on face side at runner locations and outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the sub-girts. The clips shall be concealed and no fasteners are to penetrate the external sheeting. An insulation of 50mm thick Rockwool Insulation of

density 48KG/M3 conforming to IS: 8183 shall be provided and fixed to the inner sheet and between the two sheets as per specification. If the insulation is made of polyurethane foam then the core in between the outer profiled sheet and the inner sheet will be formed out of polyurethane foam in 30mm thickness having a density of 40-45 kg/cum. The foam shall be in filled in between the outer and the inner sheet using a highly dedicated foaming machine and the entire process of forming the panel will be carried out at factory Panels may be prefabricated factory made panels or in-situ type. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

Note: For single skin wall cladding/ roofing, specification for outer sheet as mentioned above is to be followed. Flashings shall be of same material that of sheeting.

The work is to be executed by the in-house/authorised applicator of the manufacturer, under the supervision of the authorised representative of the manufacturer.

Approved Manufacturer: LLOYD Insulations (India) Ltd. TATA Blue Scope Steel, or similar approved.

8. False Ceiling : Aluminium pre-painted false ceiling, either lineal panel system or aluminium tile/plank system.

a) PANELS

Panels to be manufactured from pre-painted, stove enamelled, alloy EN-AW-5050 or equivalent (according to EN 1396 and ECCA).

Panels are to be coupled in longitudinal direction by means of panel splices. Optionally the flange with 3 x 7 ventilation holes can be used to achieve a ventilated ceiling.

b) SUSPENSION

Rows of 0.5 Fe/0.95 Aluminium roll formed carriers shall be installed about 1200mm center on center by means of adjustable suspensions about a distance of 1200mm, center on center. Carriers will be joined by means of carrier splices. Carriers provided with prongs to hold panels in a standard module of 100mm.

c) PERIMETER PROFILES

- Clip-on U-profile, 28.6x12.5 x20 mm, made of 0.35 thick aluminium
- Wall L-profile, 29.2x19.4 mm, made of 0.5 mm thick aluminium
- Wall L-profile, 45x18.5 mm, made of 0,8 mm thick steel or aluminium
- Wall W-profile, 45x21x21x18.5 mm, made of 0.8 mm thick steel or aluminium

d) PERFORATIONS

Manufacturer shall supply panels with following perforation specifications:

- ∅ 1.0 mm, Δ 2 mm with 23% open area
- ∅ 2.0 mm, Δ 5 mm with 16%open area

Perforated panels to have a nominal plain border along the longitudinal panel direction to assure a maximum flatness and product stability:

- 84C panel, 1 mm perforated to have a plain border of 7 mm
- 84C panel, 2 mm perforated to have a plain border of 6 mm

e) ACOUSTICS

Manufacturer shall supply acoustic non-woven tissue, thickness 0.2 mm factory applied inside the panels. Alternatively the installer can place individual PE wrapped mineral wool pads.

f) COATING

The coating will consist of a tough and durable polyester finish in nominal thickness of 20 microns, applied in a continuous coil-coating process ensuring uniform coating and absolute adhesion.

g) INSTALLATION

All materials shall be installed by the approved applicator/erector of the manufacturer under supervision of the authorized representative of the manufacturer.

Approved make: LUXALON by Hunter Douglas, Armstrong, INTERARCH or similar approved.

Alternatively in other air-conditioned areas 12.5 mm Gypsum board/Mineral fibreboard /Calcium Silicate Board / Fibre Cement Board ceiling with aluminium grid will be used.

Approved make: Saint Gobain Gyproc India Ltd, Armstrong, AMF, Everest, HILUX , Aerolite or similar approved.

9. Floor finish:

a. Generally finish to utility areas shall be 40 mm thick heavy-duty patent stone with metallic hardener on concrete slab.

The heavy-duty overlay shall be ready-to-use, metallic aggregates based powder after application of epoxy based bonding agent of two components, solvent less epoxy resin based equal or similar to BASF's MASTERTOP 230i. It shall be formulated to meet the requirement of ASTM C881 Type 2, Grade 2, and Class B &C. The Bonding agent shall exhibit minimum open time of 6 hours and shall exceed the tensile

strength of concrete in terms of its adhesive bond strength. The Floor topping product shall be high strength with compressive strength of 80 MPa at 28 days; flexural strength exceeding 8 MPa at 28 days. The product shall be capable of resisting metal crawler chassis and shall have abrasive wear less than 0.15 mg/cycle on H22 wheel, ASTM C501 test method. The product shall have adhesive bond strength in excess of 1.5 MPa when tested as per ASTM D4541. Curing of the layer to be done with non-degrading membrane forming curing & sealing compound shall be equal or similar to MASTERKURE 181, acrylic resin based formulation. The product shall comply with ASTM C 309 Class B. The product shall exhibit water loss not more than 0.55 kg/m2 in 72 hours when tested as per ASTM C156. The product shall form non-degrading abrasion resistance film which shall also exhibit capability as primer for subsequent protective coatings or bituminous overlays.

Approved make: BASF, FOSROC, SIKA, STP or similar

b. For T.G. Hall (operating floor) Granite / Kota stone flooring finish will be as follows :

Minimum 18~20 mm thick polished Granite/ Kota stone slab or 600x600 mm tiles to be used over minimum 30 mm thick under-bed. Stones shall be hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. Per. Sq.m. water sprinkled on to it and finished by buffing with felt or Hessian bobs.

c. For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

Approved Make: ENDURA of Jhonson, Chemstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. Or similar approved.

Paints- ICI, ASIAN Paints, Berger or similar approved.

d. For battery room finished with Epoxy Flooring (where required)

On the prepared substrate, one coat of a solvent free, resin based dispersion, Primer shall be applied. Density of the primer is around 1kg/lt and the mixing ratio of two components, Comp. A and B:: 1:2.5 by weight.

Over the primed surface, epoxy modified cementitious self levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three component Comp.A: Comp.B: Comp.C: 1:2.5:17 by weight, compressive strength at 30ºC approx. 45N/mm² after 28days, the mortar density is around 2.2 kg/lt.

Priming should be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components, only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A: comp. B: 3:1 (by weight). The mixed density is 1.5kg/lt at 27°C. The system shall be allowed for curing for 3 days.

Approved Make: Sika India (P) Ltd., BASF, FOSROC, STP or similar.

e. All areas of toilet, including W.C and urinal shall have vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

Approved Make: Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved.

f. Access Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non-combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate - PVC/ Conductive PVC on a semi –automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment

Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of 65mm to a maximum of 600 mm from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of levelling and accurately align panels for a maximum ± 25 mm in the vertical direction. Pedestals shall support an axial load without

permanent deflection and an ultimate load as laid out in System Performance requirement. The Pedestal head assembly shall consist of a 90 x 90 mm x 4.00 mm embossed head mechanically riveted to a 100mm long 20mm dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-vibrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 25.00 mm OD pipe of thickness 2.00 mm mechanically locked on a press for perpendicularity and then welded to a base plate of 125 x 125 x 2.50 mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, and rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x570 mm length.

Approved make of Tile: Unitile® USF 1500 or similar approved.

g. Floor/staircase and the areas prone to slippage due to oil spillage etc. Shall be provided with non-skid floor finish.

h. 750 mm wide, minimum, R.C. paving as plinth protection, shall be provided around all buildings with surface drain of required size.

i. Risers and treads of concrete staircase of powerhouse shall be of white marble slab and in all other stairs; same shall be of Kota stone finish. 20/25 mm thick Kota stone finish excepting main stair riser and treads shall be of marble. All areas shall have 150 mm high skirting unless indicated otherwise in the specification.

j. For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of Suntex Insulatic Pvt Ltd or similar shall be applied.

10. Doors and Windows:

a. Hollow metal door at all levels shall be installed from ISO 9001-2000 certified Manufacturer. All hollow metal general doors with or without vision panel. Pressed Galvanised steel Single /Double leaf to required sizes which consist of frame, shutter, infill and finish as detailed below and conforming to IS 277.

Door frame shall be Single rebate profile of size 100 x 57 mm made out of 1.20 mm thick galvanised steel sheet (18 gauge). Frames should be Mitered and field assembled with self tabs. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished

plastered masonry wall opening. Once frame installed should be grouted with cement slurry if recommended on the clear masonry opening.

Door leaf should be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 0.8mm (22 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors should be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be as per joinery details with a screw on glass beading on the inside. The glass should be 5 mm clear toughened glass. Louvers when recommended should be site proof and shall be flush fixed on the external surface.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware.

Approved make: Shakti Met Dor, NCLSeccolor, Godrej, Gandhi Automation Pvt Ltd, or similar.

Approved Harrware: DORMA, Guardian

b. Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel confirming to IS 277 with the following specification shall be used. Recommended fire door shall have doors tested at CBRI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision litters /panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory.

Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60 mm (16 gauge) minimum thick galvanized steel sheet. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2 mm (18 gauge)

minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule.

Approved Make: Shakti Met Dor, Godrej, Navair, Promat, Gandhi Entrance Automation Pvt. Ltd, or equivalent.

Hardware list: Hinge, Door closer, Panic Bar with external trim, Mortise lock & latch with lever handle for without panic bar door.

Approved Hardware: DORMA, Guardian

c. Main Entrance of Control Room, Control Equipment Room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing with sensor operated sliding type for main entrance for main control room, service building, administrative building and double swing type for control equipment room, etc. Doors of control room, control equipment room, computer room, etc. Shall be full glazed pre-coated minimum 3mm thick aluminium i.e. coloured anodized aluminium. Full glazed aluminium partition with airlock shall be provided along (B) row of Turbine hall operating floor where clear view is desired. Glazing between air-conditioned areas shall be single glass whereas that between air-conditioned and non-air-conditioned area shall be with hermetically sealed insulating glass.

Approved Make: Domal Systems of HYDRO, Hidalco, DORMA, or equivalent.

d. Doors of W.C. and shower shall be wooden panel door.

e. All windows and ventilators for prestigious buildings like power house, service building canteen, fire station, administrative building etc. Shall be glazed aluminium windows conforming to IS:1949 & IS: 1948.

Approved Make: Domal Systems of HYDRO, Hindalco, DORMA or equivalent.

f. Pre-coated (polyester painted) steel windows and ventilators may be used for auxiliary plant buildings.

Approved make: Ncl Altek & Seccolor Ltd.

g. Alternatively steel reinforced UPVC windows may be used for some non-plant building if agreed by the Owner.

Approved make: "Fenesta" by DSC Ltd. DURAPLAST

Approved Hardware for doors shall be of HAFELE, DORMA or similar approved.

11. Rolling Shutters:

Rolling shutters as per IS: 6248 with suitable operating arrangement (manual, mechanical and/or electric) according to size shall be provided in buildings to facilitate handling and transportation of equipment. The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanised steel lath section of 18swg tested mild steel strips at 75mm rolling centres, locked with galvanised malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3mm thick galvanised steel plate and security riveted with stiffening angles.

Approved Make: DiTEC-Gandhi Entrance Automation Pvt .Ltd, Shakti Met Dor or similar approved.

12. Glazing:

a. Glazing for windows in general shall be minimum 6 mm clear float glass and as mentioned elsewhere in this document.

b. Glazing in Control room between A/C & non-A/C area shall be with double glazed insulating glass consisting of 2 nos. 6 mm clear toughened float glass with 12 mm air gap in between, hermetically sealed.

c. Minimum 6.0 mm thick toughened float glass as specified below shall be provided in doors, partitions, windows of Power house building, Service Building, Administrative Building, etc.

d. 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type outer float glass and 6mm thick plain inner float glass with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system. Quality of glass is given below.

e. 6mm thick Glass quality shall be toughened hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 82%, Visible light Reflectance- 10% & inside – 11%, Total Solar Energy Transmittance – 66% Reflectance–10% UV transmission – 49%, Solar Heat Gain Coefficient – 0.70

Shading Coefficient – 0.81 ,U – Factor Air 2.77 W/m2k , Sound Insulation – 31db outer lite.

f. 6 mm thick toughened Blue low E hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 35%, Reflectance 13%outside & inside – 30 %, Total Solar Energy Transmittance – 19%, Reflection – 9%, UV – 9 %, Solar Heat Gain Coefficient – 0.29 Shading Coefficient – 0.33,U –Factor Air – 1.9 W/m2k, Sound Insulation – 33db outer lite (# 2 surface) Glass with a combination of 6 mm thick toughen Optifloat clear 6mm glass inner lite (# 3 Surface) Now the two sheets of glass will be separated by an aluminium spacer leaving an air gap of 12.7 mm thick and sealed with the weather proof sealant.

Approved make : AIS of Asahi India Glass Ltd., Pilkington Glass India Pvt. Ltd. Saint Gobain or approved equivalent.

13. Roof waterproofing :

a) Roof water proofing treatment shall be as follows:

- For roofs with structural slope:

- Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Spray applied an average 40 mm thick two component Hydro flouro-carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m3 as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

- All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

For roofs having no structural slope:

- Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Spray applied an average 40 mm thick two component Hydro flouro carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m3 as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 75mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibres (RECRON or equivalent) and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.

- All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

- For other plant and non Plant buildings rigid insulating board (expanded / extruded polystyrene block) as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane

layer. Over the finished surface APP Bitumen membrane as specified below shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar underbed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

a. APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P, Dr. FIXIT TORCHSHIELD P4160 or similar approved shall be manufactured from a rich mixture of bitumen and selected polymers blended together to obtain excellent heat resistant, flexibility, UV resistance. Modified bitumen then coated onto a dimensionally stable carrier to obtain excellent tensile strength, tear and puncture resistance.

b. APP membrane shall conform to Conforms to: UEAtc,ASTM D146, DIN52123, ASTM D36, ASTM D5, UEAtc, ASTMD 5147, ASTM D4799.

c. Technical Data
   - Chemical Base : APP modified Bituminous Polyester
   - Thickness : 4mm
   - Unit weight : 4.40 kg/m^2(According to UEAtc)

d. Mechanical / Physical Properties
   - Tensile Strength (L/T) N/SCM - 800/600 (According to UEAtc,ASTM D146)
   - Elongation at break (L/T) - 40/50 - (According to UEAtc,ASTM D146)
   - Resistance to water pressure - No leakage - (According to DIN52123)
   - Carrier (Polyster) weight- 180 g/m^2
   - Softening Point - 145 oC - (According to ASTM D36)

e. Concrete, mortar surfaces must be clean, free from grease, oil, and loosely adhering particles. Steel and iron surfaces must be free from scale, rust, grease and oil. All surfaces must be as true as possible.

f. Bituminous primer is to be applied to a clean, smooth and dry surface by brush, roller or spray. The material is to be Unrolled and align and re rolled correctly before torching. Overlaps should be minimum 100 mm. Gas burner is to be used to heat the substrate and thermo fusible film on the underside on lower face of membrane. When the thermo- fusible film melts after torching, the membrane is ready to stick. The membrane should be Rolled forward and press firmly against the substrate to bond. Both the overlaps shall be heated and the round tipped trowel shall be used for heating the same to smoothen and press into seam.

g. All angles and abutments should be sealed with extra care to ensure full bondage. The edges should be sealed well into the grooves.

- **For vertical surfaces (Parapet)**

Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls(2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Approved make of elastomeric membrane/: Dr. Fixit, SIKA India Pvt. Ltd, LLOYD, STP Ltd., BASF, FOSROC or similar approved.

Approved make of APP Bitumen membrane: SIKA, STP, Dr. FIXIT or similar approved.

Note: Waterproofing materials should be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person. Performance Guarantee should be given by the manufacture to the owner after completion of the roof waterproofing work.

b) For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100. The top surface of finished roof shall be such as to allow quick drainage of rainwater.

c) The Bidder shall give guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water proofing treatment work. The guarantee shall be for materials and workmanship for twenty (20) years. The mode of execution of the guarantee shall have to be acceptable to the owner.

d) Heavy duty HDPE pipes conforming to relevant BIS Code shall be provided to drain off rainwater from the roof. The numbers and size of down comers shall be governed by IS: 1742 and IS: 2527.

14. Painting:

a) External masonry surfaces of all buildings shall be finished with External Quality Acrylic Emulsion paint similar to "Apex Ultima", "Weathergurd" / "Weathershield" over plaster. Granular textured paint may also be combined along with External Quality Emulsion paint to form suitable pattern on building façade.

b) Acrylic plastic emulsion paint of AkzoNobel/Asian Paints/ Berger or any other reputed make approved by APGENCO shall be provided in control room, control equipment room, computer room, UPS room, all office areas and all air-conditioned areas including entrance lobby.

c) All other areas shall be provided with Acrylic Distemper paint.

d) Internal surface of walls in rooms for pumps, machineries and maintenance shall be painted with washable synthetic enamel paint of dark shade up to a height of 1.5 m above floor level.

e) Battery room and all other areas coming in contact with acid/alkali or other corrosive liquid shall be painted with acid/alkali resistant paint. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado as specified elsewhere in this section. Ceiling shall also be painted with Acid & Alkali resistant paint.

f) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall have minimum 110 micron DFT. Anti corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, nontoxic graft Co-polymer coating of Meta Chem Paints & Adhesive Pvt. Ltd or similar approved.

g) All woodwork shall be painted with two coats of synthetic enamel paint over a coat of approved primer. DFT shall conform to IS specification.

h) All fire exits shall be painted in Post Office red.

i) Epoxy paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.

j) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.

k) Paints shall be of reputed brand of reputed manufacturer like AkzoNobel/Berger/Asian Paints, Nerolac. For granular textured coating Vineratex, Heritage or equivalent shall be used.

15. Aluminium Composite Panels

1. Material:

Total thickness of the panel – 4mmThickness of the aluminium skin – 0.5mm, Tensile strength of aluminium skin –120N/mm2 minimum, Density of PE core – 920 – 980 Kg/m^3 (Non toxic grade Polyethylene) Coating – PVDF Adhesive film – DUPONT, USA Coating thickness (front foil) – 24µ - 30µ in PVDF including primer.15µ - 18µ in polyester coating. Coating thickness (back foil) – 4µ - 7µ polyester coating.

2. Colour – as indicated in the drawing.

3. Fixing arrangement – aluminium composite sheets shall be folded inwardly on four edges (without cutting the outer skin) to from Aluminium Composite Panels (ACP) and shall be riveted to the aluminium extruded section like angel or channel. There shall be at least one rivet at the both ends of the folded edge and other rivets shall be200mm c/c per panel edge/fold. Aluminium angles shall form a frame around the panel and shall be fixed to the steel sub-frame by self tapping screws with EPDM shim to prevent by-metallic reaction. The gap/groove between two adjacent panels shall be filled with Silicon sealant of approved make (GE or similar make) to prevent water seepage.

4. The supply fabrication and erection of ACP is inclusive of steel sub-base frame work if necessary as per site condition. The Bidder shall take site measurement and produce working drawings for approval of engineer before erection of ACP.

5. Name of system provider- Eurobond, Alu Bond, or similar.

16. **Poly Carbonate Sheet:**

a) 2 mm thick Compact Polycarbonate sheet, transparent or smoke tinted, of Lexan Polycarbonate or MAKROLON Polycarbonate sheet or similar approved.

b) Framing shall be specially designed aluminium sections, colour anodised, with EPDM Gasket as per system provider's details. Framing shall be fixed to the steel structure as per site measurement, drawings and – Engineer in Charge.

c) Sealing of joints shall be done with Silicon sealant.

d) Minimum Density required for Multiwall Polycarbonate and Compact sheets:-

- 6 mm Multiwall Sheets: - 1.3 kg/m^2
- 8 mm Multiwall Sheets: - 1.5 kg/m^2
- 10 mm Multiwall Sheets: - 1.7 kg/m^2
- 16 mm Multiwall Sheets:- 2.8 kg/m^2
- Compact Sheets: - 1.2 kg/m^2/mm

e) The offer should be backed by warranty of 10 years against yellowing due to weathering and five years against breakage as manufacturing defect.

f) The sheets should have the minimum co-extruded UV coating of min 45 Micron

g) The fixing should be done Aluminium Clamping profile (top and bottom) min 60mm wide profile with EPDM gasket by using self-driving and self-tapping screws.

h) The sheet should be produced and supplied Preferably by local manufacturer

i) The sheet should pass the ISI 14443 specification for Multiwall system.

Approved make: BAYER India, GE or similar

17. Stairs:

a) All stairs shall have not more than 13 risers in one flight but in case of fire escape stairs, 15 risers may be allowed instead of 13 risers. Height of risers and width of treads shall be180 mm (maximum) and 250 mm (minimum) respectively for fire escape stairs and 166mm (maximum) & 250mm (minimum) for general staircases. Minimum width of stairs shall be1000mm for fire escape stairs and 1200 mm for general stairs. In general rises shall be 150 mm.

b) Aluminium angle nosing shall be provided for edge protection of RCC stairs. Moulded marble nosing shall be provided for the main stairs finished with marble slab / Kota slab finishes.

c) 40ø NB stainless steel pipe handrail for stair in T.G. Hall area and 32ø NB medium class G.I pipe Handrail for stairs in other areas, minimum 1.0 metre high, shall be provided around all floor/roof openings, projections/balconies, walkways platforms, concrete and steel stairs.1200mm high railing may be provided for external fire escape stairs. Handrail shall be two rail systems with the top rail 1000mm / 1200mm above the walkway/ platform/ floor surface and the intermediate rail 500mm below the top rail. Guardrail post spacing will be proportional to the length of the protected horizontal opening but will not exceed 1500mm c/c to posts. Stainless steel class shall be 304 grades.

18. Draining out water from floors

In all buildings, suitable floor drainage system to drain out water collected from equipment, blow downs, leakages, floor washings, fire fighting etc., shall be provided in each floor.

19. Fencing :

Minimum 3.0 metre high fencing above toe wall shall be provided around switch yard, trans-former yard, building transformer area, fuel oil area, Dry ash storage silo area & other areas where fencing is necessary

due to statutory requirements. Fencing shall comprise 2.4 metre high PVC quoted galvanized chain link fencing of minimum 8 gauges (including PVC coating) of mesh size 75 mm and galvanized concertina for switch yard/transformer yard. Galvanized barbed wires of a height of 0.6 metres shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauges. Steel entry gate matching construction shall be provided for all fenced areas. Top of the toe wall shall be minimum 200 mm above the formation level.

20. Water Supply and Sanitation:

a) RCC roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building.

b) Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply.

c) Extra heavy cast iron pipes with lead joints or UPVC pipes with thermoplastic joints shall be used for sanitary work below ground.

d) UPVC pipes with proper sealing shall be used for sanitary work above ground level.

e) Each toilet shall contain following best quality fittings/porcelain fixtures in adequate numbers as per National Building Code. In toilets primarily meant for workers an additional squatting type WC shall be provided. Minimum one exclusive toilet facilities for handicapped shall be provided in each floor.

- Water closet – Indian & European type.
- Large flat back urinal with porcelain divider.
- Shower set.
- Wash basin – Counter-top wash basin to be provided in office areas selectively as per Owner's desire.
- Sink – Stainless steel sink with integrated drain-board to be provided in janitor's closets, kitchen, pantry areas of "FRANKE" or similar approved make.
- Metal storage cabinets, under- counter as well as overhead, shall be provided in janitor's room, kitchen, pantry and similar areas as per requirement of Owner.
- Minimum 600 mm long porcelain tray.
- Minimum 500 mm long stainless steel towel rail.
- Stainless steel liquid soap holder.
- Recessed porcelain soap tray in shower area.

- Stainless steel toilet paper roll holder.
- Robe hooks
- 450x750 mm high square edge 6 mm thick float glass mirror of adequate width to match toilet layout and interior décor.
- Septic tanks with up-flow filter including all accessories and extra heavy cast iron soil lines shall be provided.
- Effluent from septic tank shall pass through chlorination chamber to bring down BOD level to acceptable limit before discharging to nearest drain or to STP Main line.
- Drinking fountains in adequate numbers.

The exact number of fittings and fixtures, brand, colour etc. shall, however be finalized during detail engineering stage and same shall be of Owner's choice and Approval.

Note Toilets in Power House Operating Floor, Operating floor of service shall have coloured fixtures including counter-top wash basins with wide mirror, European type water closet with flush valve, sensor operated urinal, exclusive shower set etc. Other toilets in general shall have white porcelain fixtures, low down cisterns, sensor operated urinals etc. Toilets for handicapped persons shall have adequate grab bars, barrier-free access and appropriate fittings and fixtures.

Approved Make of toilet fixtures: KOHLER, Hindware, Parryware, Nycer, Cera.

Approved make of toilet fittings: KOHLER, Jaquar, ESCO, ESS ESS,

21. Under-Deck & Over-Deck Insulation

- ♦ Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- ♦ Density of Material shall be between 40 to 60 Kg/m3
- ♦ Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C
- ♦ The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.

- Material should be FM (Factory Mutual), USA approved.

- Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.

Under-deck Insulation thickness shall be minimum 26mm for Kizen Project. Under-deck insulation shall be provided for all AC areas having roof exposed to sun.

Approved manufacturer- Armaflex, Kflex

For thermal over-deck insulation on the terrace BASF's PERIPOR board or similar shall be used. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications;

Colour: Orange
Thickness: 50 mm
Compressive strength: 200-220 kN/m^2
Thermal Conductivity (K): 0.034 W/mK
Thermal Transmittance (U): 0.5-0.6 W/m^2 °C
Water Absorption (% vol): <0.1% (by total immersion)
Actual area covered would be used for measurement.

22. Sealant:

1. Polysulphide Elastomeric joint sealant shall be, two-component, high performance polysulfide formulation equal or similar to **MASTERFLEX 700i** of BASF having weathering resistance to ultraviolet ray property. The product shall exhibit **shore 'A' hardness of 25** and have **movement accommodation factor of 25%**. The sealant must comply with the performance specifications as laid in **BS:4254 and ASTM C 920**. All the joints must be primed using compatible primer for the substrate from the equal or similar to MASTERFLEX PRIMER range of BASF. Sealant application shall be carried out, strictly in accordance with Manufacturer's recommendations.

2. Polyurethane based single component joint sealant materials based upon polyurethane resins shall be similar or equal to **Masterflex 472/474 of BASF**. They have been formulated with different modulus of elasticity 0.25-0.45 N/mm^2 and Shore 'A' hardness of 15-30 which makes them suitable for slightly different applications. The product shall exhibit elongation at break 600% and recovery of 80%.

23. **Expansion joints may be as per following locations:**

a) Floor to Floor Joints at all internal locations

b) Roof to Roof Joints

c) Floor to Wall joints at internal locations

d) Roof to Wall Joints

e) Wall to Wall joints in exterior locations

During construction of RCC slab, beam, column the expansion gap shall be maintained by using polystyrene filler board of HD100 of Supreme or equivalent.

During finishing stage expansion gaps shall be finished with the either elastomeric EPDM profile or elastomeric extruded poly vinyl chloride fitted in extruded aluminium sections with aluminium joint cover to form an integral system as manufactured by Three R Construction solutions Pvt Ltd. or an approved equivalent.

Expansion gap between metal cladding shall be finished with metal saddle of same material having 'U' or 'W' shape and shall be covered with metal cladding –fixed at one end and fixed with slotted hole on other end or as per manufacturer's detail.
Externally the expansion joint sealing system shall form a continuum vertical and horizontal sealing system to make the building envelop water tight.

24. Approved make of other items:

a) Expansion Joint Control: 3R Construction Solutions Pvt Ltd or similar

b) Silicón Sealant: Dow Corning India Pvt. Ltd, McCoy Silicones Ltd. Or similar

c) Insulation: TWIGA - for glass wool insulation, LLOYD,
Mineral Rock Fibers Ltd. - for mineral fibre wool insulation.
LLOYD - for Rockwool insulation
For extruded polystyrene foam insulation, "Insuboard" by The Supreme Industries Ltd, BASF, or similar approved.
For PU Insulation by BAYER India or similar approved.

d) Toilet Partition: Merino-Besco, Shakti Hormann or equivalent.

e) Anchor fastener/Bolt: RIPPLE, HILTI or similar approved.

25. Statutory rules :

a) Design shall be complied with all applicable statutory rules pertaining to Factories Act as applicable for the State, Rules of Tariff Advisory Committee (TAC), and Water Act for pollution control etc.

b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 500 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane

cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

c) Provision for fireproof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. Shall be made according to the recommendation of Loss Prevention Association of India / Tariff Advisory Committee.

d) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

ANNEXURE - I

DESCRIPTION OF TG BUILDING

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
Interior Finish Schedule For Power house Building							
1	T.G. Hall Area,	Overall 50mm thick flooring shall be finished with 18 mm thick polished Granite stone slab/tiles for unloading areas and walkways shall be demarcated with 75 mm wide and 18 mm thick Granite stone (black) on both sides of Granite stone finished walkways.	Acrylic emulsion paint over white cement putty on masonry surfaces wherever necessary and all other wall surface shall be with Acrylic Distemper, Polished Granite slab minimum 20 mm thick wall cladding on (B) row wall (outer) upto false ceiling level/upto Roof slab for Control Room facade. There shall be minimum joints between granite slabs. The quality including colour texture etc. Of granite shall be approved by the owner. Above false ceiling of control room & Annexure room there shall be exposed plastered masonry surfaces. A row and gable end shall have double skin metal cladding system.	T.G. Hall – anti-corrosive paint to metal deck and all metal works. Acrylic Distemper on exposed plastered ceiling (without false ceiling). Aluminium lineal pattern false ceiling for false ceiling areas.	Hollow metal flush door in general and 2Hr Fire Check door for fire escape stairs and electrical rooms. Important areas shall have Glazed aluminium door. For main entrance to Main control room shall be sensor operated glazed sliding door.	Aluminium glazed window. Main glazed partition for Main control room shall be insulated double glazed as per specification. A Row shall have structural glazing with low E glass blue tinted toughened glass on outer face and clear toughened float low E glass on inner face as per specification.	
2	Switchgear Room, MCC Room,	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty vitrified tiles flooring. Overall thickness shall be 40mm.	Acrylic Distemper	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	
3	Control Rooms, Control Equipment Room, Computer Rooms, etc. Other than Main Control Room.	Non-skid, fully vitrified, 10 mm thick non-porous, homogenous, abrasion resistant, floor tiles similar to “MARBONITE”, “FERRASTONE” of “BOSS Profile Ltd”, “RESTILE”, ENDURA” of H & R Jonson (India) Pvt. Ltd, “Kajaria” of minimum size minimum 600 mm x 600 mm x 9~10 mm of approved colour and shall be laid over concrete floor with laying compound strictly as per manufacturer’s specification. Total thickness of the flooring shall be 40mm thick including the thickness of the tiles and under bed.	Brick masonry walls, columns, or any other element within the room as the case may be shall be clad with polyester coated 3mm thick Aluminium Composite Panels (Aluminium thickness minimum 0.2mm) of approved make upto the false ceiling level. The colour and design composition of ACP cladding to be submitted for approval of the authority before erection.	Lineal pre-coated aluminium alloy ceiling stove enamelled on both sides similar to ‘Luxalon’ or “INTERARCH” in combination with Gypsum board to form patternincluding suspension system as per manufacturers details. The false ceiling work shall take care of all illumination, fire detection & fighting, HVAC and all other service requirement. False ceiling shall be provided with 25 mm thick insulation of resin bonded mineral wool conforming to IS: 8183. Wherever under-deck insulation is required the insulation shall be Closed Cell Elastomeric Nitrile Rubber.	Aluminium glazed door	-Do-	

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
4	All office areas, Conference Room and other important areas.	10/11 mm thick non-skid fully vitrified tiles of minimum size 600 mm x 600 mm similar to "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd, "Kajaria" (overall 40 mm thick) laid in pattern with different colour of tiles.	Acrylic emulsion paint over white cement putty.	Acoustic mineral fibre board ceiling on aluminium grid system. Acrylic emulsion paint over white cement putty in areas without false ceiling.	Aluminium glazed door single or double leaf with 8mm thick toughened, tinted & etched float quality glass as per owner's choice with floor spring, mortise lock & latch and all accessories.	Aluminium glazed window with minimum 4mm thick clear float glass of specific values as mentioned in the specification with all accessories. Windows shall be partially open able and partially closed type having shutter size not more than 750Wx1500H mm.	
5	Access floor where required	Minimum 600 mm high false floor with adjustable metal supporting system and fire resistant cement in-fill epoxy coated metal floor panels finished with Vitrified tiles flooring and matching skirting.	–	–			
6	Stairs & Lobby	Kota stone slab in general.	Acrylic Distemper Paint	Acrylic Distemper Paint	Hollow metal flush fire door	-Do-	
7	Main Stair & Landing	Granite slab or Aranga White marble slab/makarana pink / Jaishalmir Yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner.	Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty.	Aluminium glazed door/ fire door	-Do-	
8	Lift lobby	Granite slab or Aranga White marble slab/makarana pink / Jaishalmir yellow and Baroda green combination 25 mm thick (min.) with larger possible size to be approved by the owner.	Granite slab cladding	Aluminium lineal pattern false ceiling	Aluminium glazed door/ fire door	-Do-	
9	Battery Room & Battery Charger Room, UPS Room	Minimum 20 mm thick acid and alkali resistant vitrified tiles "ENDURA" or similar, set in and jointed with epoxy mortar (overall 40 mm thick) along with 2100 mm high dado of same tile.	Acid/Alkali resistant paint.	Acid/Alkali resistant paint.	Hollow metal flush fire door	-Do-	
10	Chemical Feed Station	Minimum 20 mm thick acid and alkali resistant vitrified tiles "ENDURA" or similar, or Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 40 mm thick) along with 2100 mm high dado of same tile having 20mm thickness.	Chemical resistant paint.	Chemical resistant paint.	Hollow metal flush fire door with chemical resistant paint finish	-Do-	
11	AHU Rooms, Air Washer Rooms, Cable Spreader Rooms & all other service areas	50 mm thick heavy-duty cement concrete floor with metallic hardener.	Acrylic Distemper Paint	Acrylic Distemper Paint	Hollow metal flush fire door. For AHU Room and Air Washer rooms airtight doors are to be provided.	-Do-	
12	Toilet and other wet areas	Minimum 10 mm thick non-skid vitrified tile, of make "MARBONITE", "FERRASTONE" of "BOSS Profile Ltd", "RESTILE", ENDURA" of H & R Jonson (India) Pvt. Ltd, of minimum	Acrylic emulsion paint over white cement putty.	Acrylic emulsion paint over white cement putty. Aluminium false ceiling where required.	Main entry to toilet or wet areas shall be wooden panel door in hard wood frame and doors for WCs shall be PVC door frame	Aluminium glazed window/ ventilator	

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
		size 400 mm x 400 mm (overall 40 mm thick) with glazed ceramic tile of same make dado topped with 50 mm wide matching moulded ceramic trims. Dado height shall be 100 mm higher than lintel level starting from finish floor level.			&shutter.		
13	Oil Spillage area	Non-skid self-leveling epoxy over IPS (overall 40 mm thick)	Epoxy paint.	Epoxy paint.	Hollow metal flush door / fire door	-Do-	
14	Electrical Switchgear Room, MCC Room, etc	Electric insulated flexible PVC sheet as per IS: 15625-2006 to be laid over heavy duty vitrified tiles flooring. Overall thickness shall be 40mm.	Acrylic Distemper	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	
15	All other general areas except operating floor	Overall 50 mm thick heavy-duty concrete floor (IPS) with metallic hardener or 40mm thick steelcrete tiles finish.	Acrylic Distemper	Acrylic Distemper	Hollow metal flush door / fire door	-Do-	

ANNEXURE - II

DESCRIPTION OF AUXILIARY PLANT BUILDINGS

Interior Finish Schedule For Plant Buildings

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
1	Mill Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Metal cladding	Synthetic enamel paint	Hollow metal flush door / fire door	Steel glazed window / ventilator	
2	ESP Control Building	10 mm thick non-skid fully vitrified tiles of make “MARBONITE”, “FERRASTONE” of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room. Other areas 50mm thick heavy duty IPS flooring with metallic hardener. MCC & Switchgear rooms shall have flexible electric insulated PVC synthetic sheet finish over IPS.	Acrylic emulsion paint over white cement putty for control room. Other areas Acrylic Distemper paint.	Pre-coated aluminium linear ceiling ‘Luxalon” or “INTERARCH” in air-conditioned areas. Acrylic Distemper paint in other areas.	Hollow metal flush fire door/ Aluminium glazed door	Steel glazed window / ventilator	
3	FGD Control Building	10 mm thick non-skid fully vitrified tiles of make “MARBONITE”, “FERRASTONE” of minimum size 600 mm x 600 mm (overall 40 mm thick) laid in pattern for Control room. Other areas 50mm thick heavy duty IPS flooring with metallic hardener. MCC & Switchgear rooms shall have flexible electric insulated PVC synthetic sheet finish over IPS.	Acrylic emulsion paint over white cement putty for control room. Other areas Acrylic Distemper paint.	Pre-coated aluminium linear ceiling ‘Luxalon” or “INTERARCH” in air-conditioned areas. Acrylic Distemper paint in other areas.	Hollow metal flush fire door/ Aluminium glazed door	Steel glazed window / ventilator	
4	CW, ACW Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Acrylic Distemper Paint	Acrylic Distemper Paint	Hollow metal flush door / fire door	Steel glazed window / ventilator	
5	CPU Regeneration Building	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Acrylic Distemper Paint	Acrylic Distemper	Hollow metal flush door / fire door	Steel glazed window / ventilator	
6	Vacuum Pump House	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting	Acrylic Distemper Paint	Acrylic Distemper	Hollow metal flush door / fire door	Steel glazed window / ventilator	
7	CW Chemical Treatment Building	Minimum 20 mm thick acid and alkali resistant vitrified tile “ENDURA”or Minimum 37mm thick Acid /Alkali resistant brick, set in and jointed with epoxy mortar (overall 50 mm thick) along with 2100 mm high dado of same tile having 20mm thickness. Where required, other areas with 50mm thick heavy duty flooring with metallic hardener.	Chemical resistant paint in acid & alkali prone area and rest with Acrylic Distemper paint.	Chemical resistant paint for acid & alkali resistant area and other areas with Acrylic Distemper paint.	Hollow metal flush door / fire door	Aluminum glazed window / ventilator.	
8	Transfer Points	50 mm thick heavy duty cement concrete floor with metallic hardener and matching skirting.	Metal cladding	Painted exposed structure	Hollow metal flush door / fire door	Steel glazed window / ventilator	

ANNEXURE - III

DESCRIPTION OF NON-PLANT BUILDINGS

Interior Finsih Schedule For Non Plant Buildings

	BUILDING /AREA	FLOORING/SKIRTING/ DADO	WALL	CEILING	DOOR	WINDOW	REMARKS
1	Watch Tower	NOT APPLICABLE					
2	Car & Scooter parking shed and Cycle parking shed						

THE WEST BENGAL POWER DEVELOPMENT CORPORATION LIMITED

SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW UNIT NO. 5, PHASE – III

EPC BID DOCUMENT

DOCUMENT NO. 12A05-SPC-G-001

VOLUME: II-G3

TECHNICAL SPECIFICATIONS
FOR
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

DEVELOPMENT CONSULTANTS PRIVATE LIMITED
CONSULTING ENGINEERS
BLOCK DG-4, SECTOR-II, SALT LAKE CITY
KOLKATA- 700 091, INDIA

SEPTEMBER 2017

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TECHNICAL SPECIFICATION

LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

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SECTION - I

LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

1.00.00 SCOPE

This specification is intended to cover topographical surveys and preparation of plans (maps) showing all permanent features including buildings, large trees, pucca & kutchha nullas, ditches, (with or without water), nearby roads / approaches, railway track, culverts, overhead transmission & communication lines, ridges, boundary wall, fencing, demarcation line etc. of the project area as well as sectional views of the drains, ditches, creek, culverts and similar items (with all dimensions and invert levels). Carrying of the Bench Mark (existing reference BM outside the project area) to project site by levelling, establishing bench marks and grids in the field, spot level survey at specified intervals and on change points, contouring, constructing and fixing of bench mark pillars & grid pillars in the field, clearing of jungles & debris and cutting of trees (to the minimum extent as required for the work and as per instruction of the Owner) etc. shall also form a part of the scope of work. In addition, the true north, magnetic north and the angle between the grid lines (established at site) and the true north or magnetic north shall be indicated in all drawings.

It may also be necessary to interconnect the existing grid lines (with measured angles and distances) and level references as well as a few permanent buildings and permanent roads adjacent / near the specified project site area during the proposed survey work and thus incorporate the same in the survey plans / maps.

The Plot Plan gives location of the project and an indication of the project area to be surveyed. These drawings are preliminary and do not cover the entire scope of work. These may be modified, survey area increased / decreased, and any new drawing may be given before award of the Work or during execution of the work (keeping sufficient time for field survey work and plotting).

Permanent features and levels of a few existing items as given in the above drawings shall not be used as reference without verification by actual survey with precision instruments by the successful bidder and plotted in his maps / drawings accordingly.

The grid pillars and B.M. pillars shall be maintained and checked frequently to ensure the correctness of the value of the pillar till the completion of the job and handing them over to the Owner. It shall be responsibility of the successful bidder to check the pillars jointly with Owner / Engineer at the time of final handing over of the work to the Owner.

The tenderers should visit the project site, at his own cost, before quoting rates for this tender. No extra claim (in terms of extension of time or revision in rates, etc.) shall be entertained at a later date on the ground of insufficient

knowledge about the site or for lack of clarifications on this specification.

2.00.00 GENERAL

2.01.00 Work to be provided for by the successful bidder

2.01.01 Work to be provided by the successful bidder, unless specified otherwise, shall include but not be limited to the following:

a) Furnish necessary instruments and all other tools and materials including pegs, marking plates for reference grid and bench mark pillars, construction materials for pillars, labour & skilled surveyors, supervision by competent engineers, services, necessary transport, full insurance and all other incidental items as may be necessary for on-time and successful completion of the surveying and mapping work.

b) Furnish original field & level books, notes taken on special features and field drawings with readings & relevant features plotted.

c) Preparation, thorough checking & cross checking in the field and submission of completed survey plans / maps and drawings in specified scale incorporating sectional views and details as included under Section - 1.0.

d) Construction and installation of reference grids and bench mark pillars at specified locations.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the successful bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Information to be Submitted by the Tenderer.

2.03.01 With Tender

The tenderer shall indicate in his tender the number of different surveying instruments (with make and year of manufacture), skilled & experienced surveyors, and competent engineers that will be deployed at the site for this work. His experience during last five years in similar survey work shall be detailed in the tenderer's offer which shall also include his present commitments.

2.03.02 After Award

The successful bidder shall inform and satisfy the Engineer regarding deployment of personnel engaged by him for quality work under an agreed time-frame for completion of the work under this Contract.

He shall also prepare, discuss with Owner / Engineer and submit an agreed work programme within seven (7) days of award of the Work and during which period he shall also mobilize his instruments, tools, personnel at the project site.

The survey documents shall be submitted to the Owner / Engineer by the successful bidder progressively during execution of the Work in order to enable him to review the work and, if necessary, cross-check at site along with successful bidder's surveyor and engineer and point out the deficiencies / discrepancies, if any, therein. However, the successful bidder shall be still responsible for the correctness of the entire work and shall resurvey and replot any portion of the Work which may be found to be defective later on. During such checking / cross-checking as well as supervision during execution of the entire work, the successful bidder shall extend all facilities including proper instruments, tools, other materials, surveyors & labour, etc. to the Owner / Engineer.

The successful bidder shall engage qualified engineers, surveyors, drafting persons, etc. for executing the work under this Contract.

3.00.00 INSTRUMENTS AND CONSTRUCTION MATERIALS

3.01.00 Instruments

The entire field surveying shall be done with the combination of transit / optic The odolites (which can read upto 20 seconds or less), Prismatic Compass, Precision Levelling Instruments with well-graduated & accurate staff, Chain, Measuring Steel Tapes and Plane Table Survey by Clenometer with the help of Clenograph Scale, ranging rods, etc.

Theodolite should be optically centred and the levels should be tilting type. Measuring tapes shall be used with calibrated tension. The calibration charts for the instruments shall be submitted before the start of the Work.

High quality surveying instruments (particularly, theodolites & levels) of reputed manufacturers shall be deployed for accurate and dependable survey work. Electronic instruments, if available with the successful bidder, will be preferred.

3.02.00 Construction Materials for Reference Grid and Bench Mark Pillars

Concrete for pillars shall be of mix 1:2:4 (one cement : two coarse sand : four 20 mm down stone aggregates). All the component materials shall be of best & acceptable quality and conforming to the provisions of the latest version of the Indian Standards.

Steel plates for engraving B.M. value and referece grids shall be of mild steel,

conforming to IS : 2062.

4.00.00 EXECUTION

4.01.00 Permanent Adjustments

All permanent adjustments of the instruments shall be made before starting the work, to the satisfaction of the Owner / Engineer.

4.02.00 Contour Intervals and Scale of Drawings

4.02.01 Contour Intervals

For contouring, spot levels shall be taken at 10 m horizontal intervals or less in both directions to establish the contours at 300 mm intervals for nearly flat terrains and at 0.5 m to 1.0 m intervals for undulating hilly terrains, as per schedule of items and direction of the Owner / Engineer.

4.02.02 Scale of Drawings

Depending upon the area to be covered, survey maps shall be prepared in the scale of 1 : 500 or 1 : 1000, as indicated in Schedule of Items, and all permanent features (as indicated under Section - 1.0), grid pillars, bench mark pillars, reference grid and bench mark pillars, contours (as specified in 4.2.1 above) etc. shall be plotted.

Sectional views of the drains, ditches, culverts, roads, etc., however, can be prepared in a scale suitable for furnishing all pertinent dimensions, levels and information, and in a separate drawing sheet.

4.03.00 Submission of Drawings and Documents

The following documents shall submitted to the Owner / Engineer :

4.03.01 Original field and level books and notes taken on special features, plus a photo-copy each of the above documents.

4.03.02 Field drawings with readings and relevant features and sectional views plotted - three (3) copies for review by Owner / Engineer. (One copy will be returned to the successful bidder with comments, if any).

4.03.03 Original and one (1) copy of the above field drawings (item 4.3.2 above) after field verification of the comments and incorporating the corrected features.

4.03.04 Original tracing and four (4) prints of the final survey maps and drawings showing other details, all prepared in ink and in clear legible form. Format of and title block on the drawing / map shall be as per direction of Owner / Engineer.

4.04.00 Time of Completion

Time shall be deemed to be the essence of the Contract. The entire survey work including submission of the final survey maps and drawings as well as other documents (ref. : 4.3 above) shall be completed within a period of ..... weeks / months in the following manner :

a)	Mobilisation and firming up time schedule and survey groups...	:	1 week
b)	Completion of field survey work and submission of three (3) copies of the field drawings and a photo-copy of the field & level books and the field notes, etc. (Items 4.3.1 & 4.3.2 above).	:	weeks
c)	Submission of the final survey maps & drawings and other documents (item 4.3.1, 4.3.3 & 4.3.4 above).	:	weeks

Construction and installation of grid and bench marks pillars, however, are to be subsequently completed within weeks of the clearance from Owner / Engineer.

If the Owner / Engineer feels that the progress of the work is not satisfactory, he shall notify the successful bidder to take necessary measures to complete the Work on time. If the successful bidder fails to comply with the Owner's directive or fails to complete the Work on time, Owner will be at liberty to get the Work done by any other agency and forfeit the amount related to unfinished works and the Earnest Money / Security Deposit of the successful bidder.

4.05.00 Security Rules and Statutory Regulations

The successful bidder shall strictly follow at site all security rules and regulations enforced by Owner from time to time regarding movement of materials, equipment / instrument, personnel to and from site, issue of identity cards, badges, control of entry and all similar matters.

The bidder, his employees and agents shall not disclose any information or drawings prepared by him or furnished to him by the Owner / Engineer.

He shall also follow all safety rules and regulations and shall take sufficient measures to adhere to the same.

The bidder shall conform in all respects with the provisions of any statute, ordinance law, rules, regulations, by-laws of Central, State, Local or other duly constituted Authority. The bidder shall give all notices and fees to be given or

paid.

In respect of labour, the bidder shall comply with all rules framed by the Government for the protection of health, wages, welfare and safety of the workers. The successful bidder shall be responsible for effective insurance under the Indian Workman's Compensation Act., Third Party Liability Insurance, etc. in accordance with the Indian Law and Regulation at his own cost.

In fine, the successful bidder shall keep the Owner and Engineer indemnified against all penalties and liabilities of every kind.

5.00.00 TECHNICAL SPECIFICATIONS

5.01.00 Establishing of Bench Marks

At least two permanent bench marks at each site at approved locations shall be established from the existing bench marks. While carrying the bench mark, levels shall be established on permanent objects as directed by the Engineer. Levelling survey shall be done in the forward and reverse direction and the closing error should not be more than $\pm$ 05 mm.

5.02.00 Establishing of Grid Pillars

Permanent grid pillars shall be established in either direction at every 100 m intervals or as directed. *One reference pillar and one reference grid direction shall be provided by the Owner. For carrying reference pillars, additional station points shall be established for traversing or triangulation as directed by the Engineer. The closing error for any closed traverse shall not exceed the specified limits as per clause 5.6. The maximum tolerance for any grid location shall be $\pm$ 1 mm. Generally for all angular measurements, transit of theodolite shall be done. Measurement shall be verified by cross-checking the diagonal angle as directed by the Engineer. For observing bearing from magnetic north, care should be taken that no magnetic substance to influence the bearing reading is there. The magnetic north should also be periodically verified.

Reference shall be taken from the existing permanent objects identifying from the Cadestal map for establishing the new grid line and shall be related to true north line where grids do not exist.

5.03.00 Reference Grid Pillars and Bench Marks

All reference grid pillars and permanent bench marks shall be 900 mm x 200 mm x 200 mm cement-concrete pillars with 150 mm projecting above ground. 150 mm square x 12 mm thick steel plates (with two L-shaped 20 cm long M.S. lugs welded to the plate) or 6 mm thick aluminium plates with bolts shall be embedded or bolted on top of the pillars. Grid points & lines shall be accurately punched on the plates as also the numerical values of grid lines and levels. Grid lines and levels as required shall be painted.

5.04.00 Topographical Surveying and Mapping

Positions, both in plan and elevation, of all natural and artificial features of the area in question (including permanent objects) are to be established and subsequently delineating them on survey maps by means of conventional symbols (preferably those of Survey of India maps). Necessary levelling work of the project area shall be combined with methods of establishing horizontal location so that location and sketching of contours for the area can be done at specified intervals and in specified scales on maps. Rock outcrops, springs / falls (if any) and other unusual ground formations / conditions shall be noted and locations plotted on the maps.

The field work shall be done in the following steps :-

a) Establishing horizontal and vertical controls and locating reference grids and bench marks in the area.

b) Levelling and plotting contours.

c) Surveying and locating the natural, artificial and permanent features in details as described earlier.

d) Taking of longitudinal and cross-sections of the corridors for pipe line and road / rail and drains, ditches, waterbodies, culverts, etc.

All survey work shall be related with true north and true north shall be established at site beforehand.

5.05.00 Traversing and Ground Controls

Triangulation or Traversing or a combination of the two methods shall be adopted for the purpose of establishing horizontal controls, in order to determine the exact relationships between various existing points / features on ground, so that surveys required under the present scope of work and in future may be correlated and tied together.

Before commencement of work, the plan showing base lines and the grid lines and their spacings shall be got approved by the Owner / Engineer at site. First, a traverse covering the entire survey area shall be established with reference to a permanent object / reference grid pillar already existing at Site (as instructed by the Owner / Engineer).

The closing error in traverse (primary / secondary) shall not exceed one in three thousand in terms of length or, L $\sqrt{N}$ second (total) in angular measurement, whichever is less. (Where, L = the least count of the instrument and N = the number of stations).

5.06.00 Contouring

Spot level surveying at specified intervals shall be adopted for contouring the area, so that accurate contouring can be done. At places of sharp curvature or abrupt changes in direction and elevation, points selected shall be close to represent the actual ground configuration.

Levelling operation shall always start on a control station / nearby bench mark and end on the same.

5.07.00 Route Survey

Route Survey shall be conducted along a narrow strip / belt of the terrain selected after field reconnaissance or as directed by Owner / Engineer at Site. Topographical survey for existing storm drainage lines as well as for routing pipe lines, transportation and communication lines, etc. shall be conducted. Longitudinal profiles as well as cross-sections shall be taken at 50 m intervals or less in nearly flat / undulating terrains and at 20 m intervals in hilly terrains, as per direction of the owner / Engineer. All cross-sections shall be with reference to centre line of corridor showing levels at every 2 - 5 metre intervals and all breaks in the profile. The width of strip / corridor shall be as specified in the drawing or as directed by Owner / Engineer.

6.00.00 RATES

The rates for the items of land survey and establishing reference grids and bench mark pillars shall include the cost of materials consumed in this work or incidental to it, the cost of instruments, tools and plants, labour, supervision, transport, installation, taxes, insurance, royalties and revenue expenses, security and safety measures, approaches, power, fuel, services, preliminary and enabling works, camps, stores, water, etc. and overheads & profits complete. In case no specific item is provided in the schedule to cover any particular item of work, it is implied that the bidder will include the cost of executing such work in the rates quoted for connected items in the schedule.

7.00.00 METHOD OF MEASUREMENT

Unless specified otherwise in the schedule of items, the measurement of items shall be done as follows :

7.01.00 Carrying and Establishment of Bench Mark (B.M.)

Carrying of the bench mark from nearby available permanent B.M. to site (at boundary point) shall be measured in running kilometre along the route of survey passing over all kinds of ground conditions which includes levelling, establishing bench marks, complete as per specification. Supply and installation of B.M. pillars shall be measured separately.

7.02.00 Topographic Survey

Areas of topographic survey shall be measured in Hectare which includes surveying and plotting of topographic features, physical features of all objects, areas of shallow water bodies, pucca & kuchcha nallas, ditches, nearby roads / approaches, railway tracks, culverts, overhead transmission & communication lines and supports, ridges, etc., levelling and establishing grid lines complete as per specification. Supply and installation of grid pillars shall be measured separately.

7.03.00 Route Survey

Area of route survey shall be measured in Hectare for the specified corridor width of land which includes surveying and plotting of topographic features, physical features of all objects, pucca & kutcha nallas, ditches (with or without water), roads / approaches, railway tracks, overhead transmission & communication lines, and supports, ridges, etc., levelling and establishing grid lines complete as per specification. Supply and installation of grid pillars shall be measured seperately.

7.04.00 Bench Mark Pillars and Grid Pillars

Pillars shall be measured in number as per specification and schedule of items.

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TECHNICAL SPECIFICATION

GEOTECHNICAL INVESTIGATION

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SECTION - II

GEOTECHNICAL INVESTIGATION

1.00.00 SCOPE

This specification covers the complete soil exploration work including carrying out field tests and laboratory tests to evaluate static as well as dynamic parameters of soil/rock and preparation of detailed report including the recommendations regarding founding level, type of foundation for different kinds of structures/machines and methods of deep excavation.

2.00.00 GENERAL

The successful bidder shall perform all work under the purview of this specification along with all incidental and related work including setting out, staging, approach to test locations, successful bidder's office, stores and protection of adjacent buildings, structures or services / facilities. No separate payments shall be made on such accounts. The tenderer should therefore take into account all such relevant items while quoting his unit rates against the schedule of items.

2.01.00 Work to be provided for the successful bidder

The work to be provided by the successful bidder, unless specified otherwise shall include but not be limited to the following.

a) Furnish necessary plant and equipment, tools and tackles, instruments, necessary power, fuel, water, labour, supervisions by qualified and experienced engineers and supervisors specialised in the type of investigation, transport of materials, men and equipment etc., services, full insurance and all other incidental items as may be necessary for entire and successful completion of the work as per tender terms, drawings, specifications and instruction of the owner / engineer.

b) Locate in the field and in layout drawing all boreholes and other field investigation items.

c) Furnish progressively and periodically field bore logs, investigation observations, test results with relevant data and features in triplicate.

d) Prepare and submit draft (in duplicate) and final (after incorporating comments, if any) sub soil investigation report as per specification, schedule of items and instructions of the owner / his engineer.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the successful bidder unless specifically mentioned elsewhere in the contract.

2.03.00 Location and Levels

Location of all boreholes and field test points and levels of the existing ground at such locations shall be established by the successful bidder at his own cost from two reference grids and one bench mark given by the owner/ his engineer and these shall be subsequently plotted in the layout plan, bore logs and other relevant field test data sheets / tables to be incorporated in the report by the successful bidder.

Making bench mark pillar (s) and reference line pillers (whatever are required for the work) and maintaining them upto the completion of the work shall be the responsibility of the successful bidder at no extra cost by the owner.

2.04.00 Codes and Standards

The following is the general list of IS Codes to be used for the soil investigation work and preparation of report. In all cases latest revision along with amendments, if any, shall be referred to.

IS:1498	-	Classification and identification of soils for General Engineering purposes.
IS:1888	-	Method of load tests on soils
IS:1892	-	Subsurface investigation for foundation
IS:1904	-	Structural safety of buildings : shallow foundations
IS:2131	-	Method for standard penetration test for soils
IS:2132	-	Code of Practice for thin walled tube sampling of soils
IS:2720	-	Methods of tests for soils
IS:2809	-	Glossary of terms and symbols relating to Soil Engineering.
IS:2810	-	Glossary of terms relating to soil dynamics
IS:3025	-	Methods of sampling and testing for water used in industry
IS:3043	-	Code of Practice for earthing
IS:4078	-	Indexing and storage of drill cores

IS:4434	-	Code of Practice for insitu vane shear test for soils
IS:4453	-	Code of Practice for exploration by pits, trenches, drifts and shafts
IS:4464	-	Presentation of drilling information and core description in foundation investigation
IS:4968 (Part-II)	-	Dynamic Cone Penetration Test.
IS:4968 (Part-III)	-	Static Cone Penetration Test.
IS:5249	-	Method of test for determination of dynamic properties of soil.
IS:5313	-	Guide for core drilling observations
IS:5529 (Part I)	-	In situ permeability tests - tests in over-burden
IS:5529 (Part II)	-	In situ permeability tests - tests in bed rock
IS:6403	-	Determination of allowable bearing pressure on shallow foundations.
IS:6926	-	Diamond core drilling for site investigation for river valley projects.
IS:6935	-	Method of determination of water level in boreholes
IS:7746	-	In situ shear test on rock
IS:8009	-	Calculation of settlement of foundations -
(Part-I)		Shallow foundations subjected to symmetrical static vertical loads
(Part-II)		Deep foundations subjected to symmetrical static vertical loading.
IS:8763	-	Guide for undisturbed sampling of sands
IS:8764	-	Method for determination of point load strength index of rocks
IS:9143	-	Method for the determination of unconfined compressive strength of rock materials

IS:9179	-	Method for preparation of rock specimen for laboratory testing
IS:9214	-	Method of determination of modulus of subgrade reaction (k-value) of soils in field
IS:9221	-	Method for determination of modulus of elasticity and poisson's ratio of rock materials in uniaxial compression.
IS:9259	-	Liquid limit apparatus for soils
IS:9640	-	Specification for split spoon sampler
IS:10108	-	Sampling of soils by thin wall samples with stationary piston
IS:10589	-	Equipment for subsurface sounding of soils
IS:10837	-	Specification of moulds for determination of relative density and its accessories
IS:11229	-	Specification for shear box testing of soils
IS:11315 (Part II)	-	Description of discontinuities in rock mass - core recovery and rock quality

3.00.00 SOIL EXPLORATION

3.01.00 Test Boring

Test Boring through different layers of soil shall be carried out by the successful bidder at the locations marked in the drg. no. and/or at such other locations as directed by the Engineer in a manner described below.

Various methods of boring as described in IS:1892 may be adopted. The tenderer shall furnish in his tender the complete details of the equipment and the method he proposes to follow. Minimum diameter of boring shall be 150 mm.

During the boring operations if rock strata is not encountered, the boring shall be continued upto 30 m depth for two bore holes and upto 20m depth for the remaining boreholes unless stated otherwise. Incase rock strata is encountered within the above depths, boring operations shall be discontinued and drilling operation as enumerated in clause 4.0 below shall be resorted to. If the present formation level is above the natural ground with filled-up soil, the depth of boring mentioned above shall exclude such filled-up soil.

The bidder shall describe in detail the equipment and method of boring he proposes to use. In the absence of dry boring equipment, wash boring at the discretion of the Engineer may be allowed, but the particular way of cleaning the casing by washing has to be approved by the Engineer. However, if the engineer, at any time, feels that the washing process is disturbing the samples to be taken, he may stop the work and the successful bidder shall have no claim whatsoever on this score. If the successful bidder can, however, improve the method to the satisfaction of the Engineer, he may be allowed to resume the wash boring work.

When boring cannot be advanced due to presence of hard material, it should be checked whether there is continuous strata of hard material below before resorting to drilling methods. If only a local boulder is present it should be chopped using suitable chopping bits and the detris removed and normal boring continued.

Ground water level for each bore hole shall be checked during boring operation and shall be recorded in bore log. Sub-soil water samples shall also be collected from each borehole and recorded.

Where possible, completed boreholes shall be capped and a G.I. pipe inserted in order to preserve them for future ground water level observation. The successful bidder shall use his own materials for this and the unit rate quoted shall be inclusive of the same. These bore holes after completion of observation shall

be handed over to the owner in such condition as to enable future observation of ground water possible. The other boreholes not used for observation shall be backfilled by the successful bidder using sand fill as and when directed by the Engineer.

3.02.00 Stabilization of Boreholes

Boreholes shall is stabilized, whenever required, against caving of the sides of the drill hole and heaving of the bottom of the hole. especially in cases where the hole is carried below the ground water level, by use of drive pipe or casing or by means of drilling fluids (water or mixtures of water and colloidal, gel forming thixotropic clays such as betonite), grouting (in rack) or other suitable methods.

3.03.00 Open Trial Pits

The location of open trial pits shall be as shown in drg. no. .... and/or at such other locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall be upto a depth of 3.5m below natural ground level or not below the ground water table or as directed by the Engineer. In no case, the depth shall be extended over 5m. The size of pits shall be 3.0m x 3.0m or as directed by the Engineer. Samples of undisturbed soil shall be obtained preferably at every 1.5m or where a change in strata is noticed.

The successful bidder shall provide a suitable access to the bottom of the pits. Sampling in trial pits shall be done as directed by the engineer.

The successful bidder shall be paid at contract unit price for each trial pit which will include all costs for earthwork in excavation with necessary side slope and backfilling and shoring/ sheeting for side protection, if required. If the pits exceed over 3.5m in depth, the successful bidder shall be paid at unit price for the extra depths of excavation.

After completion of the test, sampling and visual examination, the pit shall be suitably backfilled as directed by the engineer. Unless otherwise specified, excavated soil shall be used for this purpose.

3.04.00 Boring in River Bed

For carrying out boring in river bed, the barge / boat should be properly anchored so that there is no movement of the platform due to waves which can cause demage to the drill rods and casing.

3.05.00 Rock Drilling

During boring operation, once rock strata is encountered, the normal method of boring operation as described under clause 3.01.00 earlier shall have to be stopped and drilling operation will be resorted to for determining depth and nature of rock strata, in a manner as described below.

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock. The tenderer shall indicate in his tender the type of coring bit he proposes to use. The behaviour of rock mass is governed more significantly by the nature of fractures in the rock then by the type and hardness of the material composing the rock itself. Hence, good drilling technique should be adopted to obtain an intact sample truly representative of the in-situ material and for achieving highest percentage of recovery possible. Variations in the speed of rotation, the downward pressure on the core barrel, the pressure at which the drilling fluid is introduced into the hole and the length of hole drilled (run length) prior to removal of the core are major items which must be controlled by the driller. In general, coring should be initiated with short runs both because the upper portions of rock masses are commonly highly fractured and also because the elevations at which core losses occur can be more accurately determined. If conditions indicate that it is possible, the length of the runs may be determined by the length of the core barrel.

In zones which are highly fractured or where the barrel continuously becomes blocked it is essential that short runs be used even though this means removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure should be resorted to when rod vibration or chatter occurs. The pressure under which the drilling fluid should be introduced into the hole will be the minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimise the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube

core barrels should be used. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each bore-hole the successful bidder shall record the rate of sinking of drill rods, ground water table elevations, if any, nature, type and sequence of rock drilled. From the recovered cores the successful bidder shall determine nature of fractures and degree of weathering of rock for each bore hole. The successful bidder shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each bore hole. The successful bidder shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stages of core advance and for all the bore-holes. Rock quality designation is defined as the ratio of cumulative lengths of intact pieces of core greater than 10 cm to the length of core advance.

The successful bidderr shall furnish all the information mentioned above fully verified and signed by the Engineer at site and submit them in triplicate to the Engineer.

The drilling operation shall be terminated when more than 75% of the core recovery is possible. If core recovery is lower and the nature of rock is weathered, drilling must be continued upto 30m for two bore holes and 20m for the remaining boreholes below the natural ground level.

In addition to the above mentioned points the successful bidder shall also take into consideration the provisions of the latest revisions of the following Codes of Practice :

a) IS:6926 - Code of practice for diamond core drilling for site investigation for river valley projects (optional).

b) IS:4078 - Code of Practice for indexing and storage of drill cores.

c) IS:4464 - Code of Practice for presentation of drilling information and core description in foundation investigation.

3.06.00 Adits and Test shafts

An exploratory adit is a horizontal or near horizontal excavation made by mining methods in rock. The term "test shaft" is used to refer to a vertical excavation, generally in rock and to very deep test pits. These are used for in-situ examination of the nature of the rock and its structural features such as joints, fractures, faults and shear zones. Adits may also be used for insitu tests to determine the modulus of deformation of rock.

3.07.00 Sampling

Bored spoil shall be collected continuously during boring to note any change of strata. Samples of undisturbed soil shall be obtained preferably at every

1.5 m where a change in strata is indicated by the slurry flowing out. In no case shall the depth between successive sampling be more than 3.0 m and a sample shall be obtained on the average for every 2.0 m depth of boring , since it is intended to ascertain the characteristics of the soil at various depths. If, however , there is fair uniformity in the characteristics of the soil for certain depths the engineer may limit the number of samples stipulated above.

3.07.01 Tube Sampling

For obtaining undisturbed samples in its simplest from , an open drive thin wall tube sampler shall be attached to a rod and shall be lowered to the bottom after completely cleaning the borehole bottom by washing. The samplers to be used should have area ratio less than 13 percent and preferably less than 10 percent. The head should have check valve and ports to permit easy escape of drilling fluid or air from the sample tube as the sample enters it.

Sampling will be accomplished by jacking or driving the tube depending on the type of soil to be sampled. Upon completion of the sampling operation the sampler shall be withdrawn from the borehole and the sample of soil carefully taken out. Approximately on inch length of soil is to be removed from each end for identification. If there is any surface water on the sample, this shall be wiped off with soaking paper, all sludge of cuttings from advancement of borehole removed and the sample immediately packed in an airtight, close fitting container marked with respective test bore numbers, elevation at which the sample was taken and other relevant information as per IS:1892. The size of soil test samples shall preferably be 65 mm dia x 200 mm high , but not less than 50 mm dia. x 150 mm high.

Representative / disturbed samples shall also be taken in different strata for visual classification, water content, grain size analysis, Atterberg limits, determination of specific gravity and compaction tests.

3.07.02 Chunk Samples

In cohesive soils, undisturbed samples of regular shapes shall be collected. The samples shall be cut and trimmed to a suitable size (0.3 x 0.3 x 0.3 m). A square area (0.35 x 0.35 m) shall be marked at the centre of the levelled surface at the bottom of the pit. Without disturbing the soil inside the marked area, the soil around this marking shall be carefully removed upto a depth of 0.35 m. The four vertical faces of the soil block protruding at the centre shall be trimmed slowly so that its size reduced to 0.3 x 0.3 m. Wax paper cut to suitable size shall be wrapped uniformly and covered with two layers of thin cloth over all the 5 exposed surfaces of the soil block and sealed properly using molten wax. A firmly constructed wooden box of size 0.35m x 0.35m (internal dimensions) with the top and bottom open shall be placed around the soil block and held in such a manner that its top edge protrudes just above the surface of the block. The space between the soil block and the box shall be filled uniformly and tightly with moist saw dust. The top surface shall also be covered with saw dust before nailing the wooden lid to cover the box firmly

taking care that the soil block is not disturbed. The area of contact between the bottom portion of the block and the ground shall be reduced slowly by removing soil in small quantities using small rods, so that the block can be separated from the ground slowly without disturbance. After inverting the wooden box along with the soil block, the bottom portion shall be trimmed and covered with wax paper, cloth and sealed with molten wax. A wooden lid shall be nailed to the box after providing proper saw dust cushion below it. An arrow mark shall be made on the vertical face of the wooden box to indicate the top surface along with the coordinates and depth of sampling.

3.07.03 Sampling in rock

Sampling in rock shall be accomplished during the drilling process by employing double tube core barrels for continuous core recovery. The drilling procedure to be followed should be the one which brings about the highest percent recovery and the exact procedure must be determined in the field.

3.08.00 Record of Boring

Detailed chronological record of drilling and sampling operations shall be maintained in the field log and should be submitted to the owner after completion of boring work at site. The final log showing pertinent subsurface information and results of field and laboratory testing should be submitted with the soil report.

The field log should contain at least the following information :

a) Reference information like project number, title and location, exploration number and location by coordinates, inclination of the boring and if inclined the bearing or azimuth of the dip of the hole, reference level and datum.

b) Personnel information - name of drilling contractor, driller and inspecting engineer.

c) Equipment data - manufacturer's name and model designation.

d) Sampling and coring information :

i) General : Sample type and number, sampler dimension, depth at start and completion of sampling, length of sample, recovery ratio and complete visual description of each sample in "as retrieved" state.

ii) Drive samplers : weight and height of drop of hammer and number of blows for each 150 mm penetration.

iii) Push samplers : hydraulic pressure and rate of penetration.

iv) Soil or rock coring : average rotational speed, down-ward hydraulic pressure and rate of penetration.

v) Rock coring : Rock quality designation (R Q D)

e) Description of material penetrated but not sampled.

f) Casing information - size, depth at which required, length and depth of bottom of casing; weight and height of drop of hammer and number of blows for each 300 mm of penetration for driven casing, and average rotational speed and downward pressure on casing and average rate of penetration for drilled casing.

g) Seepage pressure test information-depth and duration of test.

h) Groundwater information - depth to water surface recorded daily and continued till water level has stabilized.

I) Artesian pressure information - depth at which encountered, measured head and lime at which each measurement is made.

j) Elevation of top and bottom of hole and top of rock

k) Date and time of all operations and delays with reasons.

l) Miscellaneous information to aid interpretation of sub-surface conditions.

m) Additional pertinent information.

The final log shall be a condensation of the field log refined on the basis of field and laboratory tests. The final log should present a clear, concise and accurate picture of subsurface conditions to be utilized by the engineer.

4.00.00 PENETRATION TESTS

Penetration tests using various types of equipment as specified shall be conducted to measure the resistance of soil to penetration.

4.01.00 Standard Penetration Test

Standard penetration test (SPT) shall be carried out in accordance with IS:2131 at every change in strata or at 1.5 m intervals or as directed by the engineer. The successful bidder shall record the number of blows for each 150 mm penetration of the standard split spoon sampler over a depth of 450 mm. The number of blows for the first 150 mm of penetration shall not be considered in evaluating the penetration resistance. Rammer used for driving the sampler rod shall be 65 kg and drops of 750 mm shall be maintained. Records of the test including depth at which driving is initiated and the number of blows for each 150 mm penetrating shall be shown in the field log, the final log shall indicate the actual SPT value (sum of number of blows for last 300 mm of penetration) at appropriate depths.

4.02.00 Static Cone Penetration Test

The test shall be carried out at locations as shown on the drawing and/or at such other locations as directed by the Engineer. A steel cone with an apex angle of 60 deg. and overall base diameter of 35.7 mm giving a cross-sectional area of 10 Sq.cm shall be pushed through soil strata through a distance in accordance with the design of the equipment and cone resistance is noted. Thereafter the cone and the friction jacket with 36 mm OD are pushed together for a distance depending upon the design of the cone and the friction jacket assembly and combined values of cone and friction resistance noted. The procedure shall be repeated upto the desired depth. Rate of penetration shall be 1 cm/sec. unless otherwise instructed by the Engineer. The test shall be carried out upto a depth of ... m or upto the top of rock layer whichever is earlier.

The driving mechanism shall have a capacity of not less than 10 tonne for the mechanically operated equipment. If approved by the Engineer, manually operated equipment may be used for shallow depths (Not greater than 10 m) in case of soft clay layer.

The successful bidder shall get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the actual test and produce the test certificates to the Engineer.

The test shall be carried out in accordance with IS:4968 (Part-III), latest edition. Cone resistance and frictional resistance shall be separately provided in the report together with a borehole log.

4.03.00 Dynamic Cone Penetration Test

Dynamic cone penetration test shall be conducted to predict stratification, density, bearing capacity etc. of soils. The test shall be conducted by driving a standard size cone attached to the bottom of a string of drill rods. The test shall be conducted upto the specified depth or terminated earlier if the number of blows exceeds 35 for 100 mm penetration when the cone is driven dry and 20 for 100 mm penetration when the cone is penetrated by circulating bentoite, in order to avoid damage to the equipment.

The specification for the equipment and accessories for performing this test, test procedure , field observations and reporting or results shall conform to IS:4968 Part – II, the driving system shall comprise of a 65 kg. drive mass having a free fall of 0.75m. The cone shall be of 62.5 mm diameter provided with vents for continuous flow of bentonite slurry through the cane and rods in order to avoid friction between the rods and soil. The use of bentonite slurry may not be necessary when the investigation required is upto a depth of 6m only. On completion of the test, the results shall be presented as a continuous record of the number of blows required for every 300 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot of blow count for 300 mm penetration vs. depth.

5.00.00 GROUND WATER INVESTIGATION

Groundwater investigation shall comprise determination of groundwater levels and pressures and permeability of subsurface materials. The effect of tidal variations (if applicable for the site) on ground water level shall also be observed by noting the water level in boreholes during high and low tide periods.

5.01.00 Ground water level observation

The successful bidder shall make necessary arrangements to prepare the boreholes for ground water observation. Completed boreholes should be capped and a G.I. pipe inserted in order to preserve them for future ground water observation. These observations will be taken by the successful bidder during the period of investigation. At the end of the site investigation work , these boreholes shall be handed over to the owner in such a condition that further observations can be taken by the owner for a period of at least a year.

Piezometers will have to be installed in boreholes as directed by the owner. A piezometer consisting of either a simple standpipe of PVC tubing with a slotted end and surrounded by granular filter of plastic fabrics shall be used for granular soils or permeable rocks. In impermeable soils, hydraulic piezometer consisting of a porous element connected by twin small-bore plastic tubing to a remote reading station will be used.

5.02.00 In-Situ Permeability Test

In-situ permeability test shall be performed in the boreholes specified and/or at such other locations at specified depths as directed by the Engineer for determination of the permeability co-efficient of the soil. The type of test shall be either pump-in or pump-out test depending on the sub-soil and ground water conditions. Pump-in test shall be conducted whether ground water in the borehole exists or not. Pump-out test with piezometer installations shall be conducted to obtain data for dewatering purposes when ground water is met in the borehole.

The specification for the equipment required for the test and the procedure of testing shall be in accordance with IS:5529, Part-I. The successful bidder shall provide all necessary equipment (diesel operated). When it is required to carry out the permeability test for a particular section of the soil strata above the ground water table, bentonite slurry shall not be used while boring.

5.02.01 Pump - in Test

Pump-in test shall be conducted in the borehole/trial pit by allowing water to percolate into the soil. Choice of the method of testing shall depend on the soil permeability and prevailing ground water level. Only clear water shall be used for conducting the test. Before conducting the test, the bore hole shall be cleaned. Water shall be allowed to percolate through the test section for sufficient period of time to saturate the soil before starting the observation.

a) Constant Head Method (in borehole)

This test shall be conducted in boreholes where soils have a high permeability. Water shall be allowed into the bore hole through a metering system ensuring gravity flow at constant head so as to maintain a steady water level in the bore hole. A reference mark shall be made at a convenient level which can be easily seen in the casing pipe to note down the fluctuations of water level. The fluctuations shall be counteracted by varying the quantity of water flowing into the bore hole. The elevation of water shall be observed at every 5 minute interval. When three consecutive readings show constant level of water surface above test depth, diameter of casing pipe, etc. shall be noted and recorded as per the proforma recommended in IS : 5529, Part-I, Appendix-A.

b) Falling Head Method (in borehole)

This method shall be adopted for soils of low permeability and which can stand without casing. The test section shall be sealed by the bottom of the boreholes and a packer at the top of test section. If the test has to be conducted at an intermediate section of pre-bored hole then, double packers shall be used. Access to the test section through the packer shall be by means of a pipe which shall extend to above the ground level. Water shall be filled into the pipe upto the level marked just below the top of the pipe and water allowed to drain into the test section. The water level in the pipe shall be recorded at regular intervals as mentioned in IS : 5529, Part-I, Appendix-B. The test shall be repeated till constant records of water level are achieved.

c) Percolation test (in trial pit)

Percolation test shall be conducted in the trial pit in areas where effluent is stored / discharged in ground level tanks. The loss of water due to percolation into the soil shall be estimated by the soil absorption capacity. This test shall be conducted in trial pits as per the procedure given in IS : 2470-Part-I, Appendix-A.

5.02.02 Pump - Out Test

This test shall be adopted to determine accurate values of permeability of soil below water table. Observation pipes of 50 mm dia shall be installed at regular intervals along three radial lines extending from the borehole at 120 degrees to each other. Length of these pipes shall depend on the ground level and estimated lowering of the ground water table. The test shall be carried out by pumping out the water to a known depth and recording the water levels in the observation pipes at regular intervals of time till the water level is stabilized. The observations shall be recorded as specified in IS : 5529, Part-I, Appendix-D.

6.00.00 FIELD TESTS

In situ tests shall be performed as desired by the engineer to meassure properties of soil during the field investigation work.

6.01.00 Menard Pressuremeter test

This test shall be carried out as per clause 3.7 of IS:1892 in the bore holes specified and/or at such other locations as directed by the Engineer to the full depth of bore holes, to assess the co-efficient of earth pressure at rest and the stress-strain modulus of soil. The tests shall be carried out at every 3.0 m intervals.

The tenderer shall furnish in his tender the complete details of the equipment and method he proposes to follow.

The successful bidder will submit, for approval of the Engineer detailed arrangement drawings for the tests including the detail of the equipment he proposes to use and satisfy the Engineer about its adequacy. The successful bidder shall also check and confirm whether the equipment he proposes to use will be suitable for carrying out this test in bore holes of size specified under clause 3.01.00 of this section. If not, separate bore holes of suitable diameter shall be made at locations approved by Engineer for conducting this test.

6.02.00 Direct Load Tests on Soils

The direct load tests on soil shall be carried out in the trial pits specified and/or at such other locations as directed by the Engineer. This test is to be carried out at 2.5m/3.5m below the natural ground level as indicated in the above drawing/as directed by the Engineer. The plate sizes to be used shall depend on the nature of the soil, a 45 cm square plate will be used in clayey soil and in sandy soils , three plates of size varying between 30 cm to 75 cm will be used. The test shall be carried out in a manner as to give dependable assessment of bearing capacities of the soils at particular level. The results of the test shall also be used for arriving at the modulus of sub-grade reaction and deformation modulus of soil.

The tenderer shall furnish in his tender the complete detail of the equipment and method he proposes to follow.

The excavation and side protection during the test and back- filling after the test shall be carried out by the successful bidder. If ground water table is at a depth higher than the specified test depth, the ground water table shall be lowered and maintained at the test depth for the entire duration of the test. The cost of dewatering shall be borne by the successful bidder.

The successful bidder will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of its being capable of giving accurate data. However, the successful bidder shall have to modify the

arrangement at his own cost if it is ultimately found to be deficient.

The successful bidder must get the dial and pressure gauges calibrated by an approved testing laboratory before commencing the direct load tests at the site and produce the certificates of the tests to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The successful bidder shall bring not less than two dial gauges and one pressure gauge as standby.

In no case settlement observations by means of level and staff shall be accepted.

The tests shall be carried out as described in IS:1888 unless otherwise specifically directed. The application of load may be by gravity or by reaction as detailed out in the above standard.

The test plate shall be preloaded with a load of 700 Kg/ sq.m. retained for a reasonable period and then replaced to take out all slacks of the arrangement. All settlement observations shall start thereafter. Unless the ultimate bearing capacity can be calculated from the available soil data, the successful bidder shall assess ultimate bearing capacity of the soil under test. Increments of the load shall be of about one fifth of the ultimate bearing capacity. The increments shall continue to an extent that allows locating the 'Yield Value of the Soil' as defined in IS:1888 or upto practicable limit of testing.

While releasing the loads, the rebounds are to be observed in a similar manner as the settlement observations.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to start of releasing the load so that the total settlement can be checked by him.

In addition to carrying out plate load tests, undisturbed/disturbed soil samples shall also be collected at regular intervals during excavation.

The payment shall be lumpsum for each test and shall include all costs inclusive of earthwork in excavation upto 3.5m depth below natural ground level, shoring for side protection, if necessary, and back filling after the test. For the depths over 3.5m extra payments shall be made only for earthwork and shoring, if any. If water table is required to be lowered during the test, necessary diesel operated pumping arrangement will have to be provided by the successful bidder himself. All expenses in this connection shall be included in his quoted rates.

6.03.00 Vane Shear Tests

Vane shear test shall be conducted for measuring the strength of soft clay in-situ at all depths from the surface to at least 30m and at locations as specified. The test shall be conducted by pushing into the clay a small four-bladed vane of suitable size (75mm or 100 mm diameter depending upon the soil condition), attached to the end of a rod and then measuring the maximum torque necessary to cause rotation. This torque is a measure of the moment developed by the shear strength of the clay acting over the surface of the cylinder.

The test can be performed at desired depths either inside boreholes or by direct penetration from ground surface. If cuttings at the test depth in the bore hole show any presence of gravel, sand, shells, decomposed wood etc., which are likely to influence the test results, the test at that particular depth may be ommitted with the permission of the engineer.

The specification for the equipment and accessories required for performing this test procedure, field observations and reporting of results shall conform to IS:4434.

6.04.00 Determination of Dry-Density of Soils

In place dry density of soil is required for assessment of bearing capacity of soils analysis for stability of natural slopes and in settlement calculations for estimating overburden pressure at different depths. The following methods depending on the scope of application in different types of soils shall be adopted as directed by the engineer for determination of in-place dry density of soils.

6.04.01 Sand Replacement Method

This method is suitable for fine, medium and coarse grained soils. Small sand pouring cylinder should be used when the soil consists of fine to medium size grains while for soils containing stones where difficulties would be encountered with this method, a large sand pouring cylinder should be used. The sand used for filling shall be clean, uniformly graded natural sand, passing 1.00 mm IS sieve and retained on 600 micron IS sieve. It shall be free from organic matter, oven dried and stored for suitable period to allow its water content to reach equilibrium with atmospheric humidity.

Equipment and accessories, test procedure, observations and reporting of results shall conform to IS:2720 (Part XXVIII)

6.04.02 Core-cutter Method

The specification for this test shall be as per IS:2720 (Part XXIX). The method should be applied for fine grained soil, free from aggregates. Fine grained soils for the purpose of application of this method is defined as soil with not less than 90 percent passing 4.75 mm IS sieve.

6.04.03 Ring and Water Replacement Method

The specification for equipment, test procedure, observation and reporting of results for this test shall conform to IS:2720 (Part XXXIII). The test equipment shall consist of a circular ring placed at the surface of the ground and plastic film inserted in the hole to retain the water. The method should be applied in coarse grained soils including gravels, cobbles, boulders and rock. Density can be determined for either the total material or material smaller than specified or given size.

6.04.04 Rubber balloon Method

The equipment, testing method, observations and reporting of results shall be as per IS:2720 (Part XXXIV). This method should be applied for firmly bonded soils, it is unsuitable for very soft soils which will deform under slight pressure or in which the volume of the hole cannot be maintained at a constant value.

6.05.00 In-situ Block Shear / Wedge Shear Test

The test shall be carried out in a manner as to give a dependable assessment of shear resistance of rock, when at a shallow depth, rock is encountered.

The tenderer shall furnish in his tender the complete detail of the equipment and the method he proposes to follow.

The test shall be carried out in the trial pits marked in drg. no. and/or ..... at such other locations as directed by the Engineer. The interpretation of test data and report shall be as per the provisions of IS:7746. The set up without an arrangement for direct application of normal load as detailed in the above standard shall be followed.

Regarding the approval of detailed arrangement drawings for the test, adequacy of conducted test, dial gauges to be used for the test and recording of observations for the test the provisions as laid down for direct load tests on soils shall hold good.

The payment terms as indicated for clause 3.02.00 above shall hold good for this test.

6.06.00 Test for Measurement of soil Resistivity

For designing the earthing system for the project it is necessary to find out the electric resistivity of the soil at some representative locations of the project site.

Soil resistivity is determined in Ohmmeter by using "WENNER's FOUR ELECTRODE METHOD". The principle of the above method is generally as under :

Four electrodes are driven into the earth along a straight line at equal intervals of 'S'. This distance 'S' can be varied and different readings taken for electrode spacing S = 5, 10, 15, 20 metres etc. to detect the vertical variations of resistivity at a certain location. A current I is passed through the two outer electrodes and the earth. The voltage difference, V, between the two inner electrodes is measured. The current I flowing into the earth produces an electric field proportional to its density and to the resistivity of the soil. The voltage V measured between the inner electrodes is, therefore, proportional to this field. Consequently, the resistivity will be proportional to the ratio of voltage to current.

If the depth of burial of electrodes in the ground is negligible compared to the spacing between the electrodes , then the soil resistivity.

= 2 X 3.14 X S.V / I

Where , Resistivity of soil in Ohm-meter

S = Spacing between electrodes in metre

V = Voltage difference between two inner electrodes in volts.

= Current flowing through two outer electrodes in amp.

Earth testers normally used for the above purpose comprise the current source and meters in a single instrument and directly read the resistance. Such an instrument is known as four terminal meggar. Using such meggar for measurement , above formula becomes

= 2 X 3.14 X S.R.

where R is meggar reading in Ohms.

Depth of burial of electrodes shall not be more than 1/20 or the spacing between the electrodes.

Correction of the test results should be done, if necessary, using the method outlined in IS:3043.

The location and number of the test points are shown in the plant layout. The number shall be increased if the test results obtained in different locations show a significant difference.

7.00.00 TESTS FOR DYNAMIC PROPERTIES

For evaluation of in-situ dynamic and damping properties of soils, Block Vibration Test, Cyclic Plate Load Test and Wave Propagation Test shall be conducted. The triaxial test method using repeated static loading should also be carried out for arriving at the value of the Young's Modulus.

The Tenderer shall furnish in his tender the complete details of the equipment and method of testing he proposes to follow.

The locations at which such tests are to be carried out as indicated and/or at such locations as directed by the Engineer. If the present formation level is above the natural ground level with filled-up soil, the depth of trial pits shall exclude such filled-up soil.

The tests shall be carried out as described in IS:5249 or IS:1888 as applicable. The successful bidder will submit, for approval of the Engineer, a detailed arrangement drawing for the tests and satisfy the Engineer about its adequacy in respect of strength and safety and of it being capable of giving accurate data. However, the successful bidder shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The observations shall be recorded directly in log books, proforma of which has to be approved by the Engineer, who shall also be present to check the data. The Engineer shall be notified well in advance of the detailed programme of the test and shall also be informed prior to the start of releasing the load so that the total settlement can be checked by him.

The payment shall be lumpsum for each test and shall include all costs inclusive of earthwork in excavation, shoring for side protection (if necessary) construction/curing of plain concrete test block, supply and embedment of foundation bolts etc. and backfilling after the test.

7.01.00 Block Vibration Test

Test pits of size 4.5m x 2.75m at the bottom shall have to be made. Then at the bottom of the pit a Plain Cement Concrete block of grade M15 and of size 1.5m x 0.75m x 0.70m shall be constructed. Suitable foundation bolts shall be embedded in the concrete block during casting for fixing the oscillator assembly. The concrete block shall be cured for a minimum of fifteen days and then the following Block Forced/Free vibration Test shall be carried out as per the recommendations of IS:5249 :

a) Vertical Vibration Test

b) Longitudinal Horizontal Vibration Test

c) Free Vertical Vibration Test

d) Horizontal Free Vibration Test.

7.02.00 Wave Propagation Test

The wave propagation test for determination of shear modulus shall be conducted both by exciting the block to steady state vibrations in the vertical direction and by making seismic waves to pass through the ground by impact of hammer and determining the time of travel of these waves between two points at a known distance apart.

7.03.00 Cyclic Plate Load Test

The test shall be carried out in a manner as to give a dependable assessment of load-deformation characteristics within the soil mass.

The provisions of IS:1888 shall be followed for conducting the test. The application of load may be by gravity or by reaction as detailed out in the above Standard.

The successful bidder must get the dial gauges and pressure gauges calibrated by an approved testing laboratory before commencing the test at site and produce the certificates of the test to the Engineer. There shall be adequate number of standby gauges available at the site for quick replacement of faulty gauges. The successful bidder shall bring not less than two dial gauges and one pressure gauge as standby.

The successful bidder shall provide a layer of cement-sand mortar (1:1 mix) below the bearing plate to level-off any uneven parts and interstices on the rock surface. Also to achieve a uniform distribution of pressure over the loaded surface, the successful bidder shall provide a flexible layer in the form of rubber pad over the loaded surface.

For conducting the load test the successful bidder shall apply cyclic loading and unloading, with four or five cycles, increasing in successive of 20% to 25% of full load. While releasing the loads the rebounds to be observed in a similar manner as the settlement observations. The range of cyclic loading shall be decided only after the static net bearing capacity is established by conventional plate load tests.

8.00.00 FIELD DETERMINATION OF CALIFORNIA BEARING RATIO

The test shall be carried out at locations as shown on the drawing or at locations as directed by the Engineer. The test shall be carried out at a depth of 500 mm below the finished ground level.

The successful bidder shall submit, for approval of the Engineer complete detail of the equipment and the method he proposes to use. However, the successful bidder shall have to modify the arrangement at his own cost if it is ultimately found to be deficient.

The surface area to be tested shall be exposed, cleaned of all loose and dried material, levelled and then soaked till saturation with a surcharge weight of 15 kg. After soaking is complete, the test surface shall be drained of all free water and allowed to stand for at least 15 minutes before starting further operations.

The test shall be carried out strictly in accordance with the provisions as laid down is IS:2720 (Part XXXI) latest edition. Surcharge weights of 15 kg including that of the annular weight of 5 kg shall be applied before application of load on the penetration piston. Load shall be applied on the penetration piston such that the penetration is approximately 1.25 mm/min. The load

readings shall be recorded at penetrations of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 and 12.5 mm. The maximum load and penetration shall be recorded if it occurs for a penetration of less than 12.5 mm.

After completion of the test, a sample of soil shall be taken from the point of penetration for moisture content determination. In place density shall also be determined.

From the plot of load penetration curve, after necessary correction, the bearing ratios shall be calculated for penetrations of 2.5 mm and 5 mm. If the bearing ratio at 2.5 mm penetration is greater than that at 5 mm penetration the former shall be taken as the bearing ratio. If bearing ratio at 2.5 mm penetration is less than that at 5 mm penetration, the test shall be repeated and if the ratio at 5 mm penetration is consistently greater than that at 2.5 mm penetration, the ratio at 5 mm penetration shall be taken.

9.00.00 LABORATORY TESTS ON SOIL SAMPLES / ROCK CORES

The successful bidder shall carry out the tests as listed out in the Schedule of Items, and/or as decided by the Engineer, in laboratory. He shall furnish the name/s of laboratories where he proposes to have the tests carried out and have them approved by the Engineer.

The owner shall have the right of access to successful bidder's laboratory and/or any other laboratory where tests have been arranged to be carried out during the progress of this investigation.

Adequate volume of test samples of soil/rock cores shall have to be collected from site and stored, labelled and transported carefully to the approved laboratory for carrying out the tests. The method and procedure of testing to be followed shall be as per the relevant Indian Standard Codes of Practice. The results of the tests shall be submitted to the Engineer in sextuplicate duly signed by the laboratory- in-charge. In tests for rock cores L/D = 1.0 of samples must be maintained.

10.00.00 REPORT ON SUB-SOIL INVESTIGATION

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

10.01.00 General

a) On completion of all the field and laboratory work, the successful bidder shall submit a formal report containing geological information of the region, procedure adopted for investigation, field observations, summarised test data, conclusion and recommendations. The report shall include detailed borelogs, subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the

conclusions drawn etc. Initially, the successful bidder shall submit ----- copies of the report in draft form for the owner's review.

b) The successful bidder's qualified geotechnical engineer shall visit the owner's corporate office for a detailed discussion on the owner's comments on his draft report. During the discussions, it shall be decided as to the modifications that need to be done in the draft report. Thereafter the successful bidder shall incorporate in his report the agreed modifications and after getting the amended draft report approved, ----- copies of the detailed final report shall be submitted alongwith one set of reproducibles of the graphs, tables, etc.

c) The detailed final report based on field observations, in-situ and laboratory tests shall encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigations. The successful bidder shall acquaint himself about the type of structures, foundations loads and other information required from the Engineer.

10.02.00 Data to be furnished

The report shall include the enlisted items but not be limited to them.

a) Purpose and scope of investigation

b) Authorization enabling the successful bidder to carry out the work at the site.

c) Project description including proposed facilities and construction materials required for the works.

d) Description of the site which shall include :

i) Location of the site and existing facilities.

ii) Topography of the site

iii) Drainage Characteristics

e) A plot plan showing the locations and reduced levels of all field tests e.g., boreholes, trial pits, static cone penetration tests, dynamic cone penetration tests, plate load tests etc., properly drawn to scale and dimensioned with reference to the established grid lines.

f) A true cross section of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, various in-situ tests conducted and samples collected at different depths and the rock stratum, if met with.

g) A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how soil/rock strata is varying vertically and horizontally.

h) Geological information

i) Regional geology - geologic province, topographic position of site, processes of formation of subsurface materials at site.

ii) Description of overburden and bedrock at the site (if applicable for the site)

iii) Comments on texture and structure of rock, joints, bedding planes, fissures, weathering condition etc (of applicable for the site)

iv) Effect of geologic features on design.

i) Past observations and historical data, if available, for the area or for other areas with similar profile or for similar structures in the nearby area.

j) Bore hole & trial pit logs on standard proforma showing the depths, extent of various soil strata etc.

k) Plot of SPT (N) value (both uncorrected and corrected) with depth.

l) Procedure of investigations employed - field tests and laboratory investigation.

m) Results of all laboratory test summarised (i) for each sample as well as (ii) for each layer along with all the relevant charts, tables, graphs, figures, supporting calculations, conclusions and photographs of representative rock cores.

n) For all triaxial shear tests stress vs. strain diagrams as well as Mohr's circle envelopes shall be furnished. If back pressure is applied for saturation, the magnitude of the same shall be indicated. The value of modulus of elastricity E shall be furnished for all tests along with relevant calculations.

o) For all consolidation tests, the following curves shall be furnished :
e vs. log p
e vs. p and
compression vs. log t or
Compression vs. square root of t (depending upon the shape of the plot for proper determination of co-efficient of consolidation).

The point showing the initial conditions (e, P) of the soil shall be marked on the curves.

p) The procedure adopted for calculating the compression index from the field curve and settlement of soil strata shall be clearly specified. The time required for 50% and 90% primary consolidation along with secondary settlements, if significant, shall also be calculated.

q) For pressure meter tests, the following curves shall be furnished :

Field pressure meter, creep and air calibration curves indicating Po, Pf and P1.

Corrected pressure meter and creep curves indicating P'o, P'f & P'1.

r) From the pressure meter test results the value of cohesion, angle of internal friction, pressure meter modulus, shear modulus and coefficient of subgrade reaction shall be furnished along with sample calculation. Calculation for allowable bearing pressures and corresponding total settlements, for shallow foundations mentioned below and capacity calculation of piles in various modes shall also be included.

10.03.00 Recommendations

Recommendations shall be given area wise duly considering the type of soil, structure and foundation in the area. The recommendations shall include but not be limited to the following:

a) Type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total settlements permissible for structures and equipment. Minimum depth and width of foundation shall also be recommended. The provision in relevant IS codes indicated in clause 2.04.00 shall be considered.

b) For shallow foundations, the following shall be indicated with comprehensive supporting calculations:

i) Net safe allowable bearing pressure for isolated square and continuous strip footings of different sizes at different founding depths below ground level considering both shear failure and settlement criteria, giving reasons for type of shear failure adopted in the calculation.

ii) Net safe allowable bearing pressure for mat foundations at different founding depths below ground level considering both shear failure and settlement criteria.

iii) Rate and magnitude of settlement expected of the structure.

iv) Modulus of subgrade reaction, modulus of elasticity, deformation modulus from plate load test results alongwith time-settlement and load-settlement curves for the various footing sizes at different founding levels indicated above. The

recommended values shall include the effect of size, shape and depth of foundation.

c) If piling is envisaged, the following shall be indicated with comprehensive supporting calculations:

i) Type of pile and reasons for recommending the same considering soil characteristics.

ii) Suitable founding strata for pile.

iii) Estimated length and diameter of pile for various values of pile capacities. End bearing and frictional resistance shall be indicated separately.

iv) Magnitude of negative skin friction, if any, to be considered in pile design.

d) Recommendations on foundations for special structures like tanks, transformers, sub-station structures, conveyor trestles, silo/stack like structures, etc.

e) Recommendations regarding bases of roads and pavements.

10.04.00 Additional Recommendations

a) Co-efficient of permeability of various sub soil and rock strata based on in-situ permeability tests.

b) Cone resistance, frictional resistance, total resistance, relation between cone resistance and SPT(N) value and settlement analysis for different footing sizes based on CPT/SPT.

c) Electricity resistivity of sub-soil based on electrical resistivity tests including electrode spacing vs cumulative resistivity curve.

d) Evaluation of design parameters for design and analysis based on dynamic parameters of soil like Amplitude vs. Frequency curves, co-efficient of elastic uniform compression and elastic uniform shear of soil, co-efficient of elastic non-uniform compression, co-efficient of elastic non-uniform shear, value of damping co-efficient, elastic and shear modulus of soil and Poisson's ratio of soils.

e) Co-efficient of earth pressure at rest and stress strain modulus of soil from Menard pressuremeter test.

f) Recommendations regarding earth pressure as a function of depth below grade as applied to side walls of underground structures. Values of co-efficient of permeability shall be included in the report.

g) Recommendations regarding method and slope of deep excavations.

h) Recommendations regarding stability of slopes, during excavations, etc.

i) Potential of rock slides and methods of stabilisation of slides for very steep cut.

j) If expansive soil is met with recommendation on removal or retainment of the same under the structures/roads etc. shall be given. In the latter case detailed specification of any special treatment required including specification for materials to be used, construction method, equipment to be deployed etc. shall be furnished.

k) Susceptibility of sub soil strata to liquefaction in the event of earthquake and recommendation on remedial measures, if necessary.

l) Information of special significance like dewatering schemes etc. which may have a bearing on design and construction.

m) Aggressiveness of percolating water through sub-soil/ rock fissures to reinforced concrete foundation/sub- structures and also recommended protective measures, if required.

n) Recommendation for the type of cement to be used and any treatment to the underground concrete structures based on the chemical composition of soil and sub-soil water.

o) Recommendation on suitability of the overburden soil as material of construction of earthen embankments and in back filling of excavated pits / trenches.

p) Recommendation on the use of rock available as construction material.

q) Recommendation on the availability of material for use as aggregates at the site.

r) Recommendation for additional investigation beyond the scope of the present work if the successful bidder considers it necessary.

s) Plates

   i) General plan showing location of site, and areal geology.
   ii) Plan showing existing features, proposed facilities, contours and locations of boring and other investigations.
   iii) Geologic sections and soil profiles.

t) Appendices

   i) Logs of subsurface explorations
   ii) Field test results
   iii) Laboratory test results

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SECTION: III

TECHNICAL SPECIFICATION

AREA GRADING

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SECTION - III

AREA GRADING

1.00.00 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, blasting (if required), hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for sub-grade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful bidder

The work to be provided for by the Successful bidder, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing etc. and all other details as may be required by the Engineer.

c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) If blasting is resorted to, necessary licenses to be procured from the proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Successful bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
IS : 2720 (Part-II)	:	Determination of Moisture Content
IS : 2720 (Part-IV)	:	Grain Size Analysis
IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry
IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative
IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place,
IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils,
IS : 3764	:	Safety Code for Excavation Work
IS : 4081	:	Blasting and related drilling operations
IRC : SP-11	:	Hand book of quality control for construction of roads and runways
IRC : 36	:	Construction of Earth Embankments for Road Work

2.04.00 Conformity with Designs

The Successful bidder shall carry out the work as per the drawings issued to him and/or Successful bidder's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 Materials to be used

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.05.02 Borrow Material

Borrow material required for area filling shall be excavated from approved locations and levels, and shall consist of selected material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail engineering stage.

Necessary arrangement shall be done by the Successful bidder at his own cost for locating and using the borrow areas as the source of supply of filling material.

The depth of borrow pits should be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.06.00 Quality Control

The Successful bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades :
- i) Periodic Surveys
- ii) Establishment of markers, Boards etc.
- iii) Checking levels and slopes of the graded surface.

b) Area filling :
- i) Checking the quality of fill material
- ii) Checking moisture content of the fill.
- iii) Checking the degree of compaction.

2.06.01 Any work which fails to conform to the specifications will be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection will be reviewed in accordance with the site Quality Plan.

2.07.00 Information regarding Site Conditions

Boring and sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawings or otherwise furnished to the Successful bidder shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. The Successful bidder must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution.

3.00.00 EXECUTION

3.01.00 General

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.

The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, railway tracks, cable, pipelines, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the successful bidder. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Engineer. Adequate area lighting shall be provided by the successful bidder, if night work is undertaken.

The Successful bidder shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Engineer. The proposal shall include but not be limited to the following.

a) Mobilisation and demobilisation of plant

b) Proposed plant and equipment, labour resources & supervision.

c) Details of proposed method of clearing and grubbing for each area of cut and fill.

d) Drawings showing the areas for placement of material.

e) Management of excavation and filling works i.e., control of setting out, testing procedures, handling, temporary stockpiles, etc.

f) Temporary works proposals

g) Excavation, filling and compaction by mechanical plant

h) Dealing with surface water

i) Dewatering

j) Disposal of materials

k) Safety precautions, fencing and lighting

l) Calculations as appropriate to support work proposal

3.02.00 Setting Out

The Successful bidder will prepare and submit to the Engineer, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Engineer with modifications and corrections if necessary, the Successful bidder will set out the work from the control points furnished by the Engineer and fix permanent points and markers for future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Successful bidder will proceed with the work. Engineer shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Successful bidder of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Successful bidder's work at any stage, the same shall be remedied by the Successful bidder.

3.03.00 Initial Levels

Initial levels either in a definite grid pattern or as directed by the Engineer will be taken by the Successful bidder jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. These initial levels and cross-sections shall be jointly signed by the Successful bidder and the Engineer before commencement of work.

3.04.00 Clearing and Grubbing etc.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300 mm girth shall be uprooted. Trees above 300mm girth which are required to be cut, shall be got identified by the Engineer and then marked.

Felling of trees shall include taking out roots upto 600 mm below ground level. After the tree is cut and roots taken out, the pot- holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer and then shall be transported to the Owner's store or any other space as directed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed as directed by the Engineer. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.05.00 Classification

Materials involved in earthwork shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Successful bidder :

a) Ordinary and hard soil

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) Soft and Decomposed Rock

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction. The mere fact that the Successful bidder resorts to blasting for his own convenience shall not mean that the rock will be classified as hard rock.

c) Hard Rock

This shall include rocks occurring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork.

3.06.00 Earthwork in Excavation

3.06.01 General

Before commencement of excavation the existing ground surface shall be cleared in accordance with Clause no. 3.4.0.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Successful bidder, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering, disposal, etc.

This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level.

3.06.02 Excavation in Ordinary Soil, Hard Soil & Soft and Decomposed Rock

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation.

On completion, the work will be finally checked and approved by the Engineer. In case where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers, shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Engineer.

3.06.03 Excavation in Hard Rock

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc.

3.06.04 Blasting

3.06.04.1 General

Excavation shall be continued in hard rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Successful bidder shall repair the same to the satisfaction of Engineer. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Unless otherwise stated herein, I.S. Specification IS:4081 "Safety Code for Blasting & Related Drilling Operation" shall be followed.

Specific permission of Engineer will have to be taken by Successful bidder for blasting rock and he shall also obtain a valid Blasting licence from the authorities concerned.

Successful bidder shall obtain necessary licence for storage of explosives, fuses and detonators issued to him from owner's stores or from supplier arranged by him, from the authorities dealing with explosives.

The fees, if any, required for obtaining such licence, shall be borne by Successful bidder. Successful bidder shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Govt. authorities and statutory bodies/regulations.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Successful bidder shall employ a competent experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Successful bidder shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Successful bidder has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges and where directed by Engineer, a trench shall have to be cut by chiselling prior to the blasting operation separating the area under blasting from the existing structures.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M 10. Stepping in rock excavation shall be done by hand trimming.

Successful bidder shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Successful bidder shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and/or Union Government.

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Successful bidder shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superceded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they

shall be allowed to handle the explosives.

3.06.04.2 Material

All materials such as explosives, detonators, fuses tamping materials etc. are proposed to be used in the blasting operations shall have the prior approval of the Engineer.

Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used.

The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. The rate of burning of the fuse shall be uniform and not less than 4 seconds or inch of length with 10% tolerance on either side.

Before use, the fuse shall be inspected and moist damaged or broken ones discarded. The rate of burning of fuses or when they have been in stock for long shall be tested before use.

The detonators used shall be capable of giving an effective blasting of the explosives, moist; and damaged detonators shall be discarded.

3.06.04.3 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules. Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The megazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annex adjoining the magazine provided that their number does not exceed 25,000 and that the annex is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annex and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine.

Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Persons entering the magazine, must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful:

- Not to put their feet on the clean floor unless they have the magazine shoes on.
- Not to allow the magazine shoes to touch the ground outside the clean floor.
- Not to allow any dirty or grit to fall on the clean floor.

Persons with bare feet, shall before entering the magazine dip their feet in water and then step direct from the tub over the barrier (if there be one) on to the clean floor.

A brush broom shall be kept in the lobby of the magazine for cleaning out the magazine, on each occasion if it is opened for the receipt, delivery or inspection of explosives.

No matches or inflammable materials shall be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100 m of a magazine.

No person having article of steel or iron on him shall be allowed to enter the magazine.

Oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on their person.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.06.04.4 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.06.04.5 Use of Explosives

The Successful bidder shall appoint an agent who shall personally superintend the firing and all operations connected therewith.

The successful bidder shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shot holes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit.

Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading

wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully and shall compare the number of blasts planted/fired to the actual number of shorts heard and satisfy himself that all blast have exploded. Withdrawal unexploded charges shall not be permitted.

The unexploded charges shall be flooded with water and the hole shall be marked distinguishable manner. Another hole shall be made by drilling a parallel fresh hole not less than 450 mm from misfired hole and fired in the usual way. The process shall be continued till the original blast is exploded. The engineer shall also be informed by the Successful bidder of all the cases of misfired/unexploded charges, their causes and steps taken. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.06.05 Disposal

The excavated spoils will be disposed off within the specified lead in any or a combination of some of the following manners, as directed by the Engineer :

a) By stacking separately the materials suitable for area filling and materials not suitable.

b) By stacking it temporarily for use in backfilling at a later date.

   i) By either spreading, or

   ii) Spreading and compacting at designated filling areas and/or

disposal areas.

3.06.06 Dewatering

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Successful bidder shall remove by pumping or other means approved by the Engineer, any water inclusive of rain water and subsoil water accumulated in the area. Method of dewatering shall be got approved by the Engineer.

3.06.07 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Successful bidder may need to construct temporary drainage systems to drain surface water from working areas.

3.07.00 Treatment of Slips

The Successful bidder will take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Successful bidder, the same shall be removed by him.

3.08.00 Earthwork in Filling

3.08.01 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated/approved by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Engineer, Successful bidder shall remove the same forthwith from the site at no extra cost of the owner. Surplus fill material shall be deposited/disposed of as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Before commencement of area filling the existing top soil shall be removed upto a minimum depth of 150 mm, or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 250 mm, loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Engineer.

a) Each layer of earth of cohesive in nature shall be compacted to 90% of proctors dry density unless otherwise permitted/directed by the Engineer.

b) Each layer of earth of non-cohesive in nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Engineer. Each shall be compacted with approved machine (mechanical plant) and usually manual compaction shall not be allowed unless specifically permitted by the Engineer. The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six posses of 8/10 tonne roller.

    i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (type pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.

    ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimise the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Engineer and shall conform to the stipulations laid down in IS:4701.

The cohesion less soil to be used for area filling, should be placed in fully saturated condition to obtain the maximum possible density. The saturation moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also

after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the successful bidder's cost as directed by the Engineer. If the required compaction is then not achieved the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification all to the successful bidder's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms. approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.08.02 Filling in Disposal Areas

Excavated materials if not used in area filling, will be disposed of in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Engineer.

All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Engineer.

3.09.00 Compaction Control

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Successful bidder in accordance with these specifications and as directed by the Engineer.

The Successful bidder shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle. He shall also supply all consumable materials such as kerosene, spirit, gas and sample bags as required.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Successful bidder is to obtain the Engineer's approval for the firm to be used. The Successful bidder may undertake this work with the Engineer's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Engineer based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent, otherwise further rolling shall be done at the appropriate locations.

The successful bidder shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Engineer.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Soil Testing

The following tests shall be undertaken by the Successful bidder and results and reports shall be submitted to the Engineer for approval. Test failures are to be immediately notified to the Engineer, otherwise results to be submitted

within 24 hours of testing. Each layer of material shall be tested for compaction.

Each layer is to be tested in a manner that is representative of its full depth. The Engineer may at his discretion instruct the Successful bidder to increase or decrease the frequency of testing.

a) Minimum one test per 500 cu.m. of soil coming out of the borrow pits for determination of natural moisture contents in order to evaluate how far the natural moisture content tallies with the optimum value and whether further addition or reduction of water content would be necessary. Test to be done in accordance with IS : 2720 (Part-II).

b) Minimum two sets of laboratory tests per 8000 cu.m. of soil coming out of the borrow pits for determination of dry density at optimum moisture content. Test to be done in accordance with IS : 2720 (Part-VII, XIV, XXVIII, XXIV) as applicable.

c) Minimum two sets of test per 500 cu.m. of loose fill for determination of moisture content just prior to compaction of area filling. Test to be done in accordance with IS: 2720 (Part-II).

d) For each compacted layer, minimum one test per 2000 sq.m. of compacted area for determination of moisture content and dry density.

e) Minimum two tests per 8000 cu.m. of soil for determination of soil classification. Test to be done in accordance with IS: 2720 (Part-IV).

f) Minimum 10 (ten) density measurements shall be plotted to establish moisture content-dry density relationship.

4.02.00 Acceptance Criteria

4.02.01 Excavation

On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth. Over excavation of the sides will be made good free of cost by the Successful bidder. The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.02 Area-filling

The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved will be as decided by the Engineer. The work of area filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted along with the tender:

i) Equipment, machinery & earthmoving vehicles, available with the Successful bidder and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.1.0 (i) above.

iii) Method of transportation.

5.02.00 After Award

After award of contract the successful tenderer shall submit the following for approval and adoption:

a) Within 15 days of Award of the contract, the Successful bidder shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area-filling quantities will be balanced, minimising temporary stacking of spoils.

It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Successful bidder. The initial programme being submitted by the Successful bidder should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Successful bidder shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Engineer for adoption.

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SECTION: IV

TECHNICAL SPECIFICATION

EARTHWORK IN EXCAVATION AND BACKFILLING

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SECTION - IV

EARTHWORK IN EXCAVATION AND BACKFILLING

1.00.00 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful bidder

The work to be provided for by the Successful bidder, unless specified otherwise, shall include but not be limited to the following:

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) Construction, maintenance and removal after completion of magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.

2.02.00 Work to be provided for by others

No work under this specification will be provided by any agency other than the Successful bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other

standard practice as may be specified by the Engineer shall be followed:-

IS:1200 (Part-I)	Method of Measurement of Building and Civil Engineering work; Part - I Earthwork.
IS:2720 (Part-II)	Determination of Moisture Content
IS:2720 (Part-VII)	Determination of Moisture content / Dry Relation using Light Compaction.
IS:2720 (Part-xiv)	Determination of Density Index (Relative Density) of cohesionless soils.
IS:2720 (Part-xxix)	Determination of Dry Density , in place, by core cutter method.
IS:2720 (Part- xxviii)	Determination of Dry Density of soils, in place, by sand replacement methods.
IS:3764	Safety code for Excavation work.
IS:4081	Blasting and Related Drilling Operations
IS:4701	Earthwork on canals

2.04.00 Conformity with Designs

The Successful bidder is to carry out the work as per the drawings issued to him and/or Successful bidder's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 Materials to be used

2.05.01 General

All materials required for the work shall be of best commercial variety and approved by the Engineer.

2.05.02 Borrow Material

Borrow material required for back-filling shall be excavated from approved locations and levels, and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries, shall be used as fill material.

2.06.00 Quality Control

The Successful bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

a) Lines, Levels and Grades	:	i) Periodic surveys
		ii) Establishment of markers, boards etc.
b) Back-filling	:	i) Checking the quality of fill material
		ii) Checking moisture content of the backfill
		iii) Checking the degree of compaction

2.07.00 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Successful bidder shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Successful bidder must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.00.00 EXECUTION

3.01.00 Setting Out

The Successful bidder will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his Proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Successful bidder will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking.
These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Successful bidder will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Successful bidder of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, in case any errors are noticed in the Successful bidder's work at any stage.

3.02.00 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Successful bidder jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made therefrom, shall be jointly signed by the authorised representative of the successful bidder and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.03.00 Clearing and Grubbing, etc.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300mm girth shall be uprooted. Trees above 300 mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600 mm below ground level or 150 mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250 mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.04.00 Classification

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) Hard Soil

This shall include:

i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;

ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;

iii) soling of roads, paths, etc., and hard core ;

iv) macadam surfaces such as water bound, and bitumen/tar bound;

v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;

vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and

vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) Soft and Decomposed Rock

This shall include:

i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;

ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;

iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and

iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) Hard Rock (requiring blasting)

This shall include:

i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required;

ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.05.00 Excavation for Foundations and Trenches

3.05.01 General

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Successful bidder, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Successful bidder shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Successful bidder shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Successful bidder shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Successful bidder's fault, the excess depth shall be filled up to the required level (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those overcuts which are unavoidable will be made up by ordinary cement concrete 1:2:4. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.05.02 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Successful bidder to carry out the balance work just before the foundation work of the structure can be started.

3.05.03 Excavation in Hard Rock

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres,

steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method.

3.05.04 Blasting

3.05.04.1 General

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Successful bidder shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.05.04.2 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The mezzanine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annex adjoining the magazine provided that their number does not exceed 25,000 and that the annex is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annex and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.05.04.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.05.04.4 Use of Explosives

The Successful bidder shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The successful bidder shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the

shotfirer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shot holes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the successful bidder and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing. When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shot holes and filling the same with light

charge of explosives.

Adequate safety precautions as per building byelaws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.05.05 Disposal

The excavated spoils will be disposed of in any or all the following manners:

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

c) i) By either spreading, Or

ii) spreading and compacting at designated filling areas and / or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

3.05.06 Disposal of Surplus

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner.

3.05.07 Protection

The Engineer shall be notified by the Successful bidder as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Successful bidder shall protect all under-ground services exposed by excavation. The Successful bidder shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

3.05.08 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Successful bidder may need to construct temporary drainage systems to drain surface water from working areas.

3.05.09 Dewatering

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Successful bidder shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (except where such dewatering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

3.05.10 Timber Shoring

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Successful bidder to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.05.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacings, cross strutted with ballies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of

the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.05.10.2 Open Timbering

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.06.00 Treatment of Slips

The Successful bidder will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Successful bidder, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Successful bidder will be cleared and back-filled later by him.

3.07.00 Back-filling

3.07.01 General

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.07.02 Filling and Compaction in Pits and Trenches around Structures

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed

and properly compacted to achieve a dry density of not less that 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.07.03 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.07.04 Filling in Trenches for Water Pipes and Drains

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings .

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling up to a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.07.05 Filling in Disposal Area

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the Successful bidder.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.08.00 Approaches and Fencing

The Successful bidder should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.09.00 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good by the Successful bidder while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.02.00 Back-filling

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part - VII) or a relative density of 75% as per IS-2720 (Part-XIV) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.02.00 After Award

After award of the Contract the successful tenderer shall submit the following for approval and adoption:

a) The Successful bidder shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures.

The programme should show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Successful bidder. The initial programme being submitted by the Successful bidder should have sufficient flexibility to take care of such reasonable variations.

b) The Successful bidder shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

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SECTION-V

TECHNICAL SPECIFICATION
FOR
CEMENT CONCRETE - PLAIN & REINFORCED

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SECTION - V

TECHNICAL SPECIFICATION
FOR
CEMENT CONCRETE - PLAIN & REINFORCED

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS:456.

1.03.00 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful bidder

The work to be provided for by the Successful bidder, unless otherwise specified shall include but not be limited to the following :-

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Except where it is excluded from the Scope of Contract, Successful bidder shall prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval results of tests of various properties of the following :

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Successful bidder may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Successful bidder, jointly and severally.

2.02.00 Work by Others

No work under this specification will be provided by any agency other than the Successful bidder unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information are required with the tender :

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms, if any, with which association is sought for to

execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The following information and data including samples where necessary, shall be submitted by the Successful bidder progressively during the execution of the contract.

a) Programme of Execution and Requirement of Materials

The Successful bidder will submit a Master Programme for completion of the work giving monthwise requirements of materials for the procurement.

This Master Programme may have to be reviewed and updated by the Successful bidder, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Successful bidder before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used, shall be submitted as directed by the Engineer, in sufficient quantities for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Successful bidder of his responsibility of supplying materials of specified qualities :

i) Coarse and fine aggregates

ii) Admixtures

iii) Plywood for Formwork

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other waterproofing materials.

vi) Joint filling compounds

vii) Foundation quality Rubber Pads

c) Design Mix

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval

before it can be used on the works.

d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.1(b) and 3.16.1 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.1 (c).

f) Detailed Drawings for Templates & Temporary Supports for Embedments

As per Clause 2.1 (e).

g) Mill Test Reports for Cement & Reinforcing Steel

h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.4 of this specification.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0 : SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 Conformity with Design

The Successful bidder will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Successful bidder will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Successful bidder to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Successful bidder, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Successful bidder on approved proforma. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Successful bidder as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs

and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.05.02 Cement

Generally cement shall be 33 grade ordinary Portland Cement conforming to IS-269 . In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer :

a) 43 Grade ordinary Portland Cement conforming to IS-8112

b) 53 Grade ordinary Portland Cement conforming to IS-12269

c) Rapid hardening Portland Cement conforming to IS-8041

d) Portland slag cement conforming to IS-455

e) Portland Pozzolona Cement (flyash based) Conforming to IS- 1489 (Part -1)

f) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2)

g) Hydrophobic Cement conforming to IS-8043

h) Low heat Portland Cement conforming to IS : 12600

i) Sulphate Resisting Portland Cement conforming to IS-12330

2.05.03 Aggregates

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

a) Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the successful bidder to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand , one very fine and the other very coarse. In such cases , the two types shall be combined to meet the requirements of a particular zone of IS:383. In all cases , the preferred zone is Zone - II.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading. Crushed stone sand alone may be used only with the approval of the Engineer.

2.05.04 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 will be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-1 of IS:456.

In case of doubt regarding development of strength , the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS- 4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 Admixture

Only admixture of approved quality will be used when directed or permitted by the Engineer . The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards :

IS : 2645 - Integral cement water proofing compound

IS : 9103 - Indian standard specification for Admixtures for Concrete or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075 , Part 1 to 3) and may be one of the following :

a) Accelerating admixtures :

- Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" .

b) Retarding admixtures :

- Modified ligno sulphonate based set retarding concrete admixture like , "Plastiment R".

c) Water reducing admixtures :

- Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament" .

d) Air entraining admixtures :

- Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP " or surface - active agents like "Sika AER".

e) Water proofing admixtures

- Modified ligno-sulphonate based waterproofing admixture like "Plastocrete Super".

However, the Successful bidder shall furnish following technical information about the admixtures (along with the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer :

i) Type of admixture

ii) Mix proportion & mode of application in concrete/mortar

iii) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content , PH value infra red analysis & solid content.)

2.05.06 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and Storage of

materials shall conform to IS:4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Successful bidder to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the Type and different types of cement shall not be intermixed.

2.06.03 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and sizewise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Successful bidder shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same.

The quality control operation shall include but not be limited to the following items of work :

a) Admixture : Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete.

			For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
b)	Aggregate	:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c)	Water	:	Impurities tests.
d)	Cement	:	Tests to satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).
e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f)	Reinforcement	:	Shapes, dimensions, length of plices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Specification (If Successful bidder's supply).
g)	Grades of concrete	:	Usage and mix design, testing of all properties.
h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.
i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
j)	Embedded and Anchorage Items	:	Material, shape, location, setting.
k)	Placing	:	Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
l)	Compaction	:	Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter

and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Beaming plates : Lines, elevations and bedding mortar.

n) Concrete Finishes : Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing : Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirt or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete.

Admixtures may be permitted to be used in accordance with IS:456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Structural concrete shall be of M30 grade and for other part of the work shall be as shown on the drawing as per grade classification of IS-456. In case of liquid retaining structures, IS:3370 will be followed.

3.04.00 Proportioning and Works Control

3.04.01 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456, may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Successful bidder to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations :

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Successful bidder will strictly abide by the same in his design of concrete mix installation. Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, values given in the tables in IS:456, shall be followed.

Various trials shall be given by the successful bidder with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE - I

STRENGTH REQUIREMENT OF CONCRETE

	Specified Characteristic Compressive Grade of concrete strength of 15 cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)
M - 10	10
M - 15	15
M - 20	20
M - 25	25
M - 30	30
M - 35	35
M - 40	40

Note -1: Nominal mix concrete of proportions 1:4:8 or 1:3:6 may be used as lean concrete for simple foundations for masonry walls , below the reinforced concrete foundations and mass filling. These mixes need not be designed.

TABLE - II

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO

(FOR GUIDANCE)

CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/CEMENT/RATIO	RATIO BY WEIGHT OF CEMENT OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
		20 mm size	38 mm size	20 mm size	38 mm size
Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
	0.7	1:10	1:12	01:08.7	01:10.6
Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
	0.7	01:08.0	01:08.5	01:07.4	01:08.0
Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
	0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTE : 1 - Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

NOTE : 2 - It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

NOTE : 3 - The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete

where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per Table-5 of IS : 456.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on -

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS:456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Successful bidder's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, proportions for different grades of concrete is specified in Table-9 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS:456.

3.07.02 Durability Requirement

Table-5 of IS:456 gives the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The successful bidder may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super-plasticizer. However the successful bidder has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below :

TABLE - III

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipment, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C. structures.
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts.
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

(NOTE : Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer)

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS:1199.

3.09.00 Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer :-

Very narrow space	- 12 mm
Reinforced concrete except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Mass concrete in very large structure	- 150 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles :

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 Mixing of Concrete

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS:4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS:1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Bachers conforming to IS:2722 may be used.

Batching plant conforming to IS:4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within + 2% of the quantity of Cement , water or total aggregates being measured and within + 5% of the quantity of any admixture being used . The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical / electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces :

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the successful bidder may have to employ form vibrators conforming to IS:4656. For slabs and other similar structures, the successful bidder will additionally employ screed vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation therefrom shall be set right by the Successful bidder as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/ Instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the location of the joints are not specified, it will be in accordance with the following :

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Successful bidder proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Successful bidder should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following

procedure shall be adopted for treating it :

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, the joint will be left to harden for at least 12 - 24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Successful bidder is able to repair it by approved methods. All concrete work shall be inspected by the Successful bidder immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations :

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the inforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left bycutting out defective concrete.

i) Grouting with a cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.02 Finishing Unformed Surface

A few typical and common cases of treatment of concrete surface are cited below :

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other

allied works are to be built, the Successful bidder shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Successful bidder.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete . This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface.

It is important not to apply the curing compound when standing water is still present on concrete.

The successful bidder shall arrange for the manufacturer's supervision.

The Successful bidder shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case any lapse on the part of the Successful bidder is noticed by the Engineer, he will inform the Successful bidder or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Successful bidder within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS:9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Successful bidder shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Successful bidder to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Successful bidder shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Successful bidder of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Cutting & Bending of Reinforcement

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Successful bidder before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat(not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Successful bidder shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS:1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that any operation of concreting may be

expected to be done at 5ºC atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Successful bidder shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40ºC while placing. Positive temperature control by precooling, postcooling or any other method, if required, will be specified.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20.00 Form Work

3.20.01 General

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The successful bidder shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rekers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Successful bidder wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.
To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will

be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion- resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings , saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Siparol Concentrate" before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer

bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete ; impact from dumping of concrete ; movement of men and construction equipment ; wind action and any other imposed load during construction. The successful bidder shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pouer of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete.

3.20.04 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Before removing any formwork, the Successful bidder must notify the Engineer well in advance to enable him to inspect the concrete if he so desires. The Successful bidder shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed therefrom and have this record checked and countersigned by the Engineer regularly.

The Successful bidder shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE - IV

SCHEDULE OF REMOVAL OF FORM

Part of Structure	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
	Temperature Deg.C				Temperature Deg.C			
	Above 40 Deg.C	40 Deg.- 20 Deg.	20 Deg.-Below 5 Deg.	5 Deg.	Above 40 Deg.	40 Deg.- 20 Deg.	20 Deg.- Below 5 Deg.	5 Deg.
	Days	Days	Days	Days	Days	Days	Days	Days
a) Columns & Walls	2	1	1	Do not remove forms until site cured test speci- men develop at least 50% of the specified 28 days strength	1	1	1	Do not remove forms until site cured test specim- en dev- elop at least 50% of the specif- ied 28 days strength
b) Beam sides	3	2	3		2	1	1	
c) Slabs, 125 mm	10	7	8		7	4	5	
d) Slabs over 125 mm thick and soffit of minor beams	18	14	16		12	8	9	
e) Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40ºC can be reduced to those of the temperature range of 20ºC to 40ºC subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary portland cement and Rapid hardening portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of portland cement at the time of removal of form as mentioned above . This has to be supported by regular tests.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer :

For

a)	Sectional dimension	-	± 5 mm
b)	Plumb	-	1 in 1000 of height
c)	Levels	-	± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer :

a) Ordinary : These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) Plywood : These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in

good condition.

c) Ornamental: These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Successful bidder shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures. The Successful bidder shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Successful bidder, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer. Items to be embedded.

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Lugs or plugs for door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any miscellaneous embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Successful bidder.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at

specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Successful bidder to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Successful bidder to get them tested in an approved laboratory. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality\of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure.

The sealing strips will be non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed

manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Successful bidder is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanised.

Non - metallic sealing strips will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features :

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer :

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75ºC
Ultimate Elongation	:	Not less than 350%

b) P.V.C. Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70ºC
Ultimate Elongation	:	Not less than 275%

3.23.04 Joint Sealing Compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS:1834.

Alternatively, when directed , the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 Isolation Joints

Strong and tough alkathene or PVC sheet about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Successful bidder. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, will be measured and paid separately.

Alternatively non-shink , free flow, cementious grout like "Sikagrout 214/ Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly levelled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured , their type , the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The Successful bidder shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like "Sikatop Seal" fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS:2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Successful bidder before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Successful bidder. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods :

Method 1 : A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against

which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days :

Compressive strength	-	55 to 60 N /Sq. mm
Flexural Strength	-	25 to 30 N /Sq. mm.
Tensile strength	-	15 N Sq. mm (approx)
Bonding strength to concrete	-	3 N / Sq. mm (approx)
Bonding strength to steel	-	20 N / Sq. mm (approx)

The whole operation shall be done as per manufacturer's specification. The successful bidder shall provide manufacturer's supervision.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %

The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water

resistant concrete admixture shall be used to provide a waterproof concrete around 410 Kg/ Cm.m a melamine based super plasiticizer will be preferable.

a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Successful bidder shall have the services of the manufacturer's supervisor to supervise the work, if desired by the Engineer.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "Noleak CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Successful bidder shall have the work supervised by the manufacturer's supervisor. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer.

3.26.05 Protective Coating on Inside Surface

Two coats or cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/ floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Successful bidder.

The Successful bidder shall execute this work in direct collaboration with one of the well known specialised approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls are required, these will be paid extra under suitable items in the contract. A 20 (twenty) years' guarantee for satisfactory performances shall be given by the Successful bidder as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Successful bidder even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films : Application in Walls or base of Structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder :

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6

ii) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for

subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.

v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.

vii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

ix) Protecting with a layer of 75 mm plain cement concrete M-100, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Engineer, by using bitumen emulsion protective coating of approved manufacturer.

3.28.00 Waterproofing by Pressure /Chemical Grouting

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non- shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Successful bidder shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Successful bidder shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Successful bidder is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Successful bidder will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Successful bidder. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The Successful bidder shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS:2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS:3550 will be carried out by the Successful bidder at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS:3025 & IS:456.

4.05.00 Admixture

4.05.01 Air Entraining Agents (A.E.A)

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Successful bidder by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Engineer, the Successful bidder will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Successful bidder.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS:516 and IS:1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS:516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS:456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS:1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the Successful bidder every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 15 of IS:456.
Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Successful bidder. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 16 of IS:456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to Clause 16 of IS:456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS:456.

5.04.00 Load Test

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS:456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of

the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Successful bidder. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS:456.

The entire cost of load testing shall be borne by the Successful bidder. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good by the Successful bidder to the satisfaction of the Engineer.

6.00.00 LIST OF I.S. CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed :-

IS : 73	-	Indian Standard Specification for Paving Bitumen
IS : 216	-	Indian Standard Specification for Coal Tar Pitch
IS : 269	-	Indian Standard Specification for 33 grade Ordinary Portland Cement
IS : 383	-	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS : 432	-	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 & 2
IS : 455	-	Indian Standard Specification for Portland Slag Cement
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS : 457	-	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for

Dams and other Massive Structures

IS : 516 - Indian Standard Specification for Methods of Test for Strength of Concrete

IS : 737 - Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose. IS : 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS : 1200 - Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.

IS : 1200 - Indian Standard Specification for Method of (Part-V) Measurement of Formwork

IS : 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS : 1489 - Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2

IS : 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS : 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS : 1786 - Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement

IS : 1791 - Indian Standard Specification for Batch Type Concrete Mixers

IS : 1834 - Indian standard specification for hot applied sealing compound for joint in concrete.

IS : 2062 - Steel for general structural purpose.

IS : 2185 - Indian Standard Specification for Hollow and solid / solid light wt. Cement Concrete Blocks - Part - 1 & 2

IS : 2210 - Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates

IS : 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS : 2430 - Indian standard specification for method of sampling of Aggregate for concrete.

IS : 2502	-	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS : 2505	-	Indian Standard Specification for Concrete Vibrators Immersion Type
IS : 2506	-	Indian Standard Specification for Screed Board Concrete Vibrators
IS : 2514	-	Indian Standard Specification for Concrete Vibrating Tables
IS : 2645	-	Integral Cement water proofing compound
IS : 2722	-	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
IS : 2770	-	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1 : Pull out Test
IS : 3025	-	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - art - 1 to 37
IS : 3201	-	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.
IS : 3370	-	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4
IS : 3384	-	Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing
IS : 3414	-	Code of practice for Design and Installation of joints in Buildings
IS : 3550	-	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
IS : 3558	-	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS : 3696	-	Safety Code for Part-1 : Scaffolding and Part 2: Ladders
IS : 3812	-	Indian Standard Specification for Fly Ash for Use as Pozzolone & Admixture

IS : 4031	-	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14
IS : 4082	-	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
IS : 4090	-	Indian Standard Specification for Design of Reinforced Concrete Archs
IS : 4634	-	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers
IS : 4656	-	Indian Standard Specification for Form Vibrators for Concrete
IS : 4925	-	Indian Standard Specification for Concrete Batching and Mixing Plant
IS : 4926	-	Indian Standard Specification for Ready Mixed Concrete
IS : 4990	-	Indian Standard Specification for Plywood for Concrete Shuttering work
IS : 4991	-	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground
IS : 4995	-	Indian Standard Specification for Design (Part-I of Reinforced Concrete Bins for the Storage & II) of Granular and Powdery Materials
IS : 5512	-	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
IS : 5513	-	Indian Standard Specification for Vicat Apparatus
IS : 5515	-	Indian Standard Specification for Compaction Factor Apparatus
IS : 5751	-	Indian Standard Specification for Precast Concrete Coping Blocks
IS : 5816	-	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
IS : 5891	-	Indian Standard Specification for Hand Operated Concrete Mixers
IS : 6452	-	Indian Standard Specification for High Alumina Cement for Structural Use
IS : 6909	-	Indian Standard Specification for Supersulphated Cement

IS : 6923	-	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators
IS : 6925	-	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures
IS : 7242	-	Indian Standard Specification for Concrete Spreaders
IS : 7246	-	Indian Standard Specification for Table Vibrators for Consolidating Concrete
IS : 7251	-	Indian Standard Specification for Concrete Finishers
IS : 7320	-	Indian Standard Specification for Concrete Slump Test Apparatus
IS : 7861	-	Indian Standard Specification for (Part-I Recommended Practice for hot and cold & II) Weather Concreting
IS : 7969	-	Safety Code for Storage and Handling of Building Materials
IS : 8041	-	Indian Standard Specification for Rapid Hardening Portland cement
IS : 8043	-	Indian standard specification for hydrophobic cement
IS : 8112	-	Indian Standard Specification for 43 grade Ordinary Portland Cement
IS : 8142	-	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
IS : 8989	-	Safety Code for Erection of Concrete Framed Structures
IS : 9013	-	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
IS : 9077	-	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
IS : 9103	-	Indian Standard Specification for Admixtures for Concrete.
IS : 9417	-	Recommendation for welding cold worked bars for reinforced concrete construction
IS : 10262	-	Recommended Guideline for concrete Mix Design

IS : 12269	-	Indian standard specification for 53 grade ordinary portland cement
IS : 12330	-	Indian standard specification for sulphate resting portland cement
IS : 12600	-	Indian standard specification for low heat portland cement

VOLUME: II-G/3

SECTION: VI

TECHNICAL SPECIFICATION

NOT USED

VOLUME: II-G/3

SECTION: VII

TECHNICAL SPECIFICATION

NOT USED

VOLUME: II-G/3

SECTION-VIII

TECHNICAL SPECIFICATION
FOR
BORED CAST IN SITU CONCRETE PILE

CONTENT

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SECTION - VIII

TECHNICAL SPECIFICATION FOR BORED CAST IN SITU CONCRETE PILE

1.00.00 SCOPE

This specification deals with the requirements regarding materials, workmanship and installation of bored cast- in-situ reinforced concrete piles and all related items of work like sand filling in the holes after casting the piles, testing the load bearing capacity of individual piles and group of piles, etc. The relevant clauses of the "Technical Specification for Concrete Work", appearing elsewhere in this document, fall within the scope of this specification.

IS:2911 (Part-I/Sec-2) shall form a part of this specification and shall be complied with unless they are at variance with the specification where the latter shall prevail.

2.00.00 GENERAL

2.01.00 Work to be provided by the successful bidder

The work to be provided for by the successful bidder, unless otherwise specified, shall include but not be limited to the following :

a) Furnish all labour,supervision, services, materials, equipment and accessories, tools, plants transportation including consumables and temporary works required for the supply and installation of piles of desired capacity.

b) Mark the proposed sequence of installation on six (6) copies of identification plan. The identification plan will be prepared by the successful bidder as per the basic plan furnished by the Engineer, if so desired by him.

c) Furnish full details of the proposed piling equipment, accessories, temporary works and method of pile construction for approval of the engineer.

d) Submit detailed daily report of boring and pile casting incorporating information as required by the Engineer.

e) Carryout load tests to the satisfaction of the engineer including casting and dismantling of test caps if necessary and submit the test results in approved proforma.

f) Make necessary earthwork and approaches for movement of pile installation equipment.

g) Provide all necessary work mentioned under "Technical Specification for Cement Concrete (Plain and Reinforced)", as may be applicable.

2.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the successful bidder unless specified elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification shall, unless specfied otherwise, conform to the latest revisions and/or replacements/amendments of the following or any other Indian Standard Specifications and Code of Practice.

IS : 269	-	Indian Standard Specifications for 33 Grade Ordinary Portland Cement.
IS : 383	-	Indian Standard Specifications for Natural Sources for Concrete.
IS : 432	-	Indian Standard Specification for (Part - I)Mild Steel & Medium Tensile Steel Bars and Hard drawn Steel Wire for Concrete Reinforcement : Part I Mild Steel and Medium Tensile Steel Bars.
IS : 455	-	Indian Standard Specifications for Portland Slag Cement.
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete.
IS : 516	-	Indian Standard Specifications for Methods of Test for Strength of Concrete.
IS : 1199	-	Indian Standard Specifications for Methods of Sampling and Analysis of Concrete.
IS : 1786	-	Indian Standard Specifications for high strength deformed steel bars and wires for concrete reinforcement.
IS : 2062	-	Steel for General Structural Purposes
IS : 2386	-	Indian Standard Specification for Methods of Test for Aggregates for Concrete Part - I to VIII.
IS : 2502	-	Code of Practice for Bending & Fixing of Bars for Concrete Reinforcement.
IS : 2722	-	Indian Standard Specifications for Portable Swing Weight Batches for Concrete (Single and Double Bucket Type).
IS : 2751	-	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction.

IS : 2911 - Code of Practice for Design and Cons-truction of Pile Foundations - Bored Cast-in-situ piles. (Part-I/Sec.2)

IS : 2911 - Code of Practice for Design and (Part - IV)Construction of Pile Foundations - Load Test on Piles.

IS : 4926 - Indian Standard Specifications for Ready Mixed Concrete.

IS : 9716 - Guide for Lateral Dynamic Load Test on Piles.

2.04.00 Conformity with design

The successful bidder will prepare check lists in approved proforma which will be called "Pile Installation Cards". At each important stage of the work as decided by the engineer, the work will be checked and approved by the engineer for correctness and conformity with the design, specification and drawings, before allowing the next phase of work to commence. The intermediate checks and approvals by the engineer will not, however, absolve the successful bidder from his total responsibility to execute the work as per the specification and drawings and to remove and/or rectify all work which is defective or inaccurate.

2.05.00 Materials

2.05.01 General

All materials whether incorporated in the works or used temporarily as aids or for executing enabling works will be of best approved quality conforming to the latest Indian Standard specification.

2.05.02 Casing

Casing in boreholes where used, should be manufactured out of best quality mild steel with proper treatment, the composition and thickness of the materials being of special importance where they are likely to be in contact with harmful chemicals and organic materials causing deterioration in service. Casing to be left in place like in offshore piling should also receive similar consideration in selection. They shall have sufficient strength and rigidity to permit their being driven and not to be distorted by soil pressure or driving of adjacent tubes. They shall be sufficiently water-tight to exclude water during placing of concrete.

2.05.03 Concrete

Concrete type M-15/M-20 grade shall be used for piles as indicated in drawings. Materials and method of manufacture for cement concrete shall in general be in accordance with IS : 456. The concrete cube strength on 15 cm. cubes at 28 days shall satisfy the acceptance criteria as per IS : 456. Concrete cubes will be cast as per instruction of the Engineer. These will be cast and cured by the Successful bidder at site for testing. The concrete shall be of such consistency as to give a slump of 100 to 150 mm. Cement used for the

concrete shall be Portland Blast Furnace Slag or 33 Grade ordinary Portland cement conforming to IS:455 & IS:269 respectively. The minimum cement content should be 350 kg/m3 and 385 kg/m3 for M-15 & M-20 grade concrete respectively based on subsoil condition requirement besides that required from strength and other considerations.

2.05.04 Reinforcement

Reinforcement shall be mild steel bars conforming to IS: 432. If instead of mild steel, Tor steel bars are used, they shall conform to IS : 1786.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the engineer shall not be used, failing which, the engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the successful bidder's dues. The relevant clauses pertaining to storage of material under "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply.

2.06.02 Casing

Mild steel casing will be painted outside with two coats of anticorrosive paint or smeared with protective layer of grease and kept stored in weather proof sheds, off the ground, on sturdy racks in such a manner as to enable quick and easy in spectrum. Epoxy painting on outside surface shall be provided if so specified in the drawing.

2.07.00 Quality Control

The successful bidder shall establish and maintain quality control for different items of work and materials as may be directed by the engineer to assure compliance with contract requirements and maintain and submit to the engineer records of the same. The quality control requirements stipulated under the "Technical Specification for Cement Concrete (Plain and Reinforced)" will apply wherever relevant. In addition, the requirement will include but not be limited to the following.

a)	Location and plumb	:	Control survey for accuracy in plan and check for verticality.
b)	Driving of casing	:	Correction of weight of hammer, length of fall, number of strokes per minute and rate of penetration.
c)	Boring	:	Boring method to suit soil profile.
d)	Casting of piles	:	Check inside casing, reinforcement cage, concrete mix, placing, consolidation and

curing.

e) Inspection of pile

f) Load tests

2.07.01 Any work which fails to conform to the specification will be subject to the issue of a `non-conformance report' in line with the quality control procedures to be implemented at site. Corrective or remedial action, design modification or product rejection will be reviewed in accordance with site quality plan.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS : 2911 (Part - I/ Sec.2) and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification might not have covered all the aspects to the full satisfaction of the engineer.

3.01.00 General

The tenderer shall furnish complete information about the type of piles offered with sketches of pile sections showing reinforcement, method of boring, details and availability of equipment and accessories formula or data curve on which the tenderer bases the load carrying capacity of piles as well as the criteria for determining suitable and sufficient founding of individual piles and any other relevant details.

The tenderer will be supplied with bore hole logs or any other data indicating the nature of the soil expected to be encountered. The information furnished to the successful bidder shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. Piles should be founded on suitable continuous hard strata. In case the successful bidder is required to drive piles to greater or shallower depths than that is envisaged, the rates will be adjusted as per relevant items in the schedule of items and no other extra claims will be entertained. The tenderer should, in his own interest, investigate the site thoroughly and take additional bores if he feels it necessary to assess the type of boring equipment to be used and the depth to suitable founding strata.

3.02.00 Design of Pile

The successful bidder shall satisfy the engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the engineer desires, sufficient test piles shall be installed to prove the adequacy of the pile, at the places indicated by the engineer and a load test shall be performed on each pile.

The Successful bidder shall satisfy the Engineer as to the boring procedure and equipment which he proposes to use for the particular conditions of the site. If the Engineer desires, sufficient test piles shall be driven to prove the adequacy of the pile, at the places indicated by the Engineer, and a load test shall be performed on each pile.

Piles have to be reinforced throughout their length. Main longitudinal reinforcement in the length of the piles as well as links or spirals shall be provided as shown in the drawings. Longitudinal bars shall preferably be in one length. Reinforced cage shall be handled and installed carefully without damaging its shape. All other requirements of reinforcement bars i.e., qualilty, workmanship, etc. shall be as specified for reinforced concrete work in Technical Specification for Concrete work.

The average basic length of the piles shown in the drawing/schedule of items is tentative and is to be assumed from cut-off level to the tip of the pile, but the final length will be decided by the Successful bidder with approval of the Engineer on the basis of boring resistance actually observed at site at the particular location. It will be the responsibility of the Successful bidder to prove by subsequent load tests/pull-out tests that the adopted length of the pile shall carry the safe loads, in compression and tension with the resulting deflections being within permissible limits. To ensure this, the length of the pile actually installed will be subject to change if considered necessary from the abovementioned basic length and payment shall be made to the Successful bidder on the basis of the actual lengths of pile installed at the rates quoted by the Successful bidder for deviation in length above or below the stipulated basic length.

If the load test is satisfactory and the Engineer accepts the type of the pile as suitable, payment shall be made for the pile. If the piles by reasons of defective workmanship or failure of one or more load tests, are found to be unsatisfactory, the cost of the test piles shall be borne by the Successful bidder.

3.03.00 Identification of Piles

A plan in triplicate, showing clearly the designation of all piles by an identifying system shall be filed with the engineer before installation of piles is started if so desired by the engineer.

3.04.00 Sequence of Piling

Individual piles and pile groups shall be constructed in such a sequence that the adjacent piles already installed are not disturbed, nor their carrying capacity reduced by subsequent boring/driving operation. The Successful bidder shall submit the sequence order and programme chart to the Engineer and get his confirmation before starting the work.

3.05.00 Boring

3.05.01 With Casing

Boring equipment and accessories shall generally conform to IS:2911 - relevant section. Boring may be done by either rotary or percussion equipment or grabbing equip- ment using reversed or direct mud circulation method. In case of unstable soils the boring tools used should be such that suction effects are minimised. Stabilisation of the sides of bore hole shall be done by use of casing. The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm.

The casing should be used from the ground level and shall be kept ahead of boring in case where there is danger of caving-in due to subsoil water entering into the bore hole or where the soil is loose. While boring below subsoil water level, precaution shall be taken so that no boiling of the bottom of the hole occurs due to difference in hydrostatic head.

Boring shall proceed by alternatively driving the casing and extracting the bored material with the boring tools. While boring in soft material liable to cavitation boring tools shall not be operated at a level below the toe of the casing. Care shall be taken to ensure that the volume of water added to the bore shall be not more than the minimum necessary for the operation of the boring tools. The casing shall be driven down through the soft material to penetrate a hard stratum not subjected to cavitation and shall be sealed in this material as far as possible. Thereafter the boring shall be continued by means of the boring tools until the approved bearing layer is reached.

Criteria for approval of the bearing layer will be agreed between the Engineer and the Successful bidder based on visual inspection of recognisable samples, recovered from the pile bore in the upper levels of the compact layer. The approved samples shall consist of sound material shall be consistent in quality for a depth of 300 mm in the pile bore. A sample of this material shall be supplied by the Successful bidder to the Engineer duly labelled for maintaining records of the founding strata.

The piles shall be installed with due consideration for safety of adjacent structures by a method which leaves their strength unimpaired and which develops and retains the required bearing resistance.

Where the soil is such that driving of a pile causes previously installed piles to heave, load test shall be conducted at the expense of the Successful bidder on such pro- portion of the heaved piles which shall be ordered by the Engineer.

3.05.02 With Drilling Fluid

Alternate to the boring with casing, stabilisation of the sides of bore hole can be effected by the use of drilling fluids.

In such cases the drilling fluid must be used at least from the level of subsoil water, as the hole, should then be always kept almost full with the fluid. The density and composition of the fluid shall be such as to suit the requirements of ground conditions and to maintain the fine materials from the boring in suspension. At the last stage of boring or in inter- mediate hard layers chisel or a chopper may be used. The rate for piling work should be inclusive of any chiselling, chopping of hard strata, clearing of bottom of pile borehole etc. complete as per specifications and necessary penetration test as may be required to prove the soundness of the founding strata. A five per cent bentonite suspension would be generally suitable and its quality shall conform to specification given in Appendix 'A' of IS : 2911 (Part-I/Sec.2).

3.06.00 Spacing of Piles

In general, all piles shall have a minimum spacing on centres of 3 d (where 'd' is the diameter of the pile) unless shown otherwise in the drawings.

3.07.00 Placing of Reinforcement

Reinforcement as required shall be made into stiff cages sufficiently wired or welded to withstand handling without any damage or distortion. Reinforcement shall be placed immediately after cleaning and inspection of the bottom of bore holes. The reinforcement should be supp- orted away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct positioning during concreting of reinforcement in the piles without any distortion.

Nominal lap between reinforcement cages shall be 60 cm and the main reinforcing steel shall project for a length sufficient to develop bond (45 times the diameter of reinforcing bar) above the level of the underside of the pile cap.

The concrete cover to main reinforcement shall not be less than 5 cm and suitable spacer blocks shall be provided at intervals not exceeding 2 metres and wired to the main reinforcement.

3.08.00 Concreting

Immediately before concreting the bottom of the hole shall be cleaned very carefully. The cleaning of the hole shall be ensured by careful operation by air lifting process unless otherwise allowed by the Engineer. To lift the spoil at founding level before concreting, borehole shall be agitated by jetting with fresh drilling mud with relatively higher pressure than that used during boring or air through tremie pipe. While boring by use of drilling mud, the specific gravity of the mud suspension in the vicinity of the bottom of the borehole shall be determined by suitable slurry sampler in a first few piles and at suitable interval of the piles and recorded. Consistency of the drilled mud suspension shall be controlled throughout the boring as well as concreting operation in order to keep the hole stabilised and to avoid concrete mixed up with the thicker suspension of the mud.

Concreting of boreholes shall start as soon as possible after the completion of boring. If a borehole, be left unconcreted for more than two hours, it shall be cleaned thoroughly as directed by the Engineer before concreting. Concrete shall be so placed as to fill the entire volume of the tube or bore without the formation of voids caused by faulty consolidation or entrapped air. Great care shall be taken to ensure that the fluid alluvial soil does not penetrate between batches of the concrete. Concreting under water shall be done in one operation. Concrete shall be placed by means of a tremie pipe. It shall, however, be ensured that concrete ente- ring the tremie pipe does not get mixed up with the slurry and 1/4 kg of granulated vermiculite shall be poured in the tremie pipe before pouring concrete as directed by the Engineer.

3.08.01 Tremie Method of Concreting

The tremie pipes and funnel shall be filled and lifted just 15 cm above bottom before releasing the concrete column to facilitate flushing out the bottom. The concrete levels in the tremie shall be checked every few centimetres in order to note the difference, if any, between the theoritical quantity that should have been placed and actual quantity that has gone in. This is to locate the position

of over cut during boring.

In addition to the normal precautions to be taken in tremie concreting as per relevant section of IS:2911 the following specifications shall be particularly applicable for the use of tremie concrete in pipes :

a) The concrete shall be coherent, rich in cement (not less than 400 kg/m3) and of slump not less than 100 mm.

b) The hopper and tremie shall be closed system embedded in the placed concrete, through which water cannot pass.

c) The tremie shall be large enough with due regard to the size of the aggregate. For 20 mm aggregate the tremie pipe shall be of diameter not less than 200 mm, aggregates more than 20 mm shall not be used.

d) The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it or with a steel plate of adequate charge to prevent mixing to concrete and water. However, the plug shall not be left in the concrete as a lump.

e) The tremie pipe shall always penetrate well into the concrete with an adequate margin if safety against withdrawal of the pipe is required while discharging the concrete.

f) The pile shall be concreted wholly by tremie and the method of deposition shall not be changed part way up the pile, to prevent the laittance from being entrapped within the pile.

g) All tremie tubes shall be scrupulously cleaned after use.

Normally concreting of the piles shall be uninterrupted. In exceptional cases interruption of concreting may be allowed but it will be resumed within 1 or 2 hours. The tremie shall not be taken out of the concrete, instead it shall be raised and lowered slowly, from time to time to prevent the concrete around the tremie from setting. Concreting should be resumed by introducing a little richer concrete with a higher slump for taking care of the partly set concrete in the bore.

If the concreting cannot be resumed before final setting of concrete already placed, the pile so cast may be rejected.

In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be reintroduced in the following manner to prevent impregnation of laittance or scum lying on the top of the concrete already deposited in the bore.

The tremie shall be gently lowered on to the old concrete with very little penetration initially. A ver- miculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing laitance/scum. The tremie will be pushed further in steps making fresh concrete sweep away laitance/scum in its way. When tremie is buried by about 60 to 100

cm, concreting may be resumed.

3.08.02 Concreting in Cased Holes

In case of cased holes, after the required founding level is encountered, the bottom shall be sealed with concrete and the reinforcement cage shall be lowered. If the borehole is dry, concrete shall be deposited by direct pour from the top followed by gradual withdrawal of casings. If water is present in the borehole, it shall be bailed out by bailer.

If it is difficult to dewater by the bailer, concrete shall be placed under water by means of a placer. After the head of water has been neutralised by the head of the concrete, excess water shall be bailed out and concrete shall then be deposited by direct pouring from the top, as is done, if the borehole is dry.

Extraction of casing shall be done in such a way that no necking or shearing of the concrete in the shaft takes place.

During the extraction of casing, slumping of concrete shall be observed and when required, additional quantity of concrete shall be poured so that the pile is formed above the cut-off level as per the requirements indicated below.

3.08.03 Cut-off Level

The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.

Where cut-off level is less than 1.5 m below the working level concrete shall be cast to a minimum of 500 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile as directed by the Engineer. When concrete is placed by tremie method, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above cut-off level shall be determined and allowed in Works.

3.09.00 Steel Pipe or Casing tube

This item shall be fabricated with mild steel plates conforming to IS : 2062 and/or steel tubes for structural purpose conforming to IS : 1161 & IS : 1239 as shown on drawings and/or described in the schedule of items.

Fabrication work and welding of steel shall be done in accordance with IS : 800 and IS : 9595. Welding of pipes shall be done by experienced and good welder who have been qualified by tests in accorance with IS : 817.

3.10.00 Trimming of Pile Heads

Completed piles shall be trimmed to the cut-off levels shown on the drawings or

until sound concrete is found to the satisfaction of the Engineer. In the event of trimming being carried below the cut-off level, the pile shall be made upto the correct cut-off level, with concrete of the same quality as used in the piles at the Successful bidder's expense. Reinforcement shall be exposed for the full bond length appropriate to the diameter of the bar and projected in the pile cap. The minimum distance of keying of pile into pile cap shall be 75 mm unless noted otherwise. All concrete and cement shall be removed from the bars, which shall also be wire-brushed to remove any loose, rust, dirt and scale.

Manual chipping shall be permitted after three (3) days of pile casting. Pneumatic chipping, if permitted by the Engineer, shall not be started before seven (7) days. In case Portland Pozzolana cement is used, chipping shall only be started as directed by the Engineer.

3.11.00 Lengthening of Piles

Where it is necessary to increase the length of any pile after it has been driven, the head of the pile shall be cut-off to expose the reinforcement for a full bond length of the bars to lap with the new bars. The exposed surface of the concrete shall be hacked to form a key, brushed to remove loose material and covered with 25 mm thick cement mortar (1:2 mix) immediately before the new concrete is placed.

3.12.00 Removal of Spoil

The Successful bidder shall be responsible for the prompt removal from the site of all spoil due to the boring to places indicated by the Engineer. The cost of such disposal shall be deemed to have been included in the cost of piling.

3.13.00 Back-Filling of Abandoned Borings

The Successful bidder shall backfill all the abandoned borings between the concrete pile and the surface level after setting of concrete of the piles, by sand or by other materials as directed by the Engineer.

All permanently abandoned boreholes generally shall be backfilled with selected materials and for a depth of 5 M below cut-off level with plain concrete of mix 1:4:8 so that resistance to lateral forces on neighbouring piles are developed.

3.14.00 Record for Installation of Piles

The Engineer and the Successful bidder shall maintain separate registers, signed jointly by both the parties, giving the following information for each pile or any other proforma as agreed between Engineer and Successful bidder. These data shall be submitted to the Engineer, in triplicate, on completion of installation of each pile.

a) Date of completion, pile number & sequence of installation of piles in a group.

b) Bored depth, concreted depth, empty boring and nature of stratum at founding level.

c) Pile diameter,details of reinforcement and details of mild steel liner where provided along with stiffener.

d) Volume of concrete poured, time taken, cement bag consumption, slump of concrete and RL of top of concrete.

e) Time taken for penetration of every 15 cm during last 2 M depth before founding level.

f) Method of cleaning bottom of hole at founding level before concreting.

g) Records of additional borings or other subsurface information obtained during the process of boring.

h) Any other relevant important information.

Any sudden change in the rate of boring which cannot be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile shall be promptly reported to the engineer and adequate corrective measures shall be taken free of any charge as decided by the engineer.

The data for pile load test (load, displacement, time, etc.) are to be recorded sequentially for the test under consideration in a suitable proforma as agreed between Engineer and Successful bidder. These data along with the load-displacement curve shall be submitted to the Engineer, in triplicate, on completion of each load test.

3.15.00 Defective Piles

Any pile which is shown to be defective under load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

If an individual pile should fail to meet the requirements specified in Clause 16.00.00 above such piles may be deemed to be defective and the Engineer may order such investigation to be made as he considers appropriate.

When any pile is found defective, the Successful bidder shall perform at his own expense one or more of the following remedial measures as directed by the Engineer.

i) Replacement of defective piles.

ii) Providing additional piles.

iii) Alteration in design of pile caps.

3.16.00 Idle Period

The phasing of construction and movement of plant shall be done as desired by the engineer. The phasing may involve some extra movement of the plant or

some idle period, but the successful bidder will not be entitled to any claim due to this reason.

3.17.00 Test Pile

The successful bidder may have to construct test piles, if desired by the engineer, before he starts systematic piling operation at locations indicated. For this purpose, the pile construction process shall be the same as in usual piling process to be followed on this job. Load test on such piles shall be as per the provisions under "Procedure for Initial Load Test" in IS : 2911 (Part - IV) or as directed by the engineer.

3.18.00 Offshore Piles

Offshore piles, subjected to high horizontal forces and having large unsupported height above the bed level are to be installed under structures to be constructed on river/sea bed. Installation shall be done with the help of floating rig/crane from the river or by cantilever method from land using moving gantry or similar other equipment. Temporary filling of the area for movement of the piling rig will, however, be allowed to the extent that such filling does not encroach on the flow of the river and also no hindrance is caused to adjoining work. The cost of building such temporary gangway/filling, embedment and removal of the same shall be included in the cost for relevant items related to installation of offshore Piles in the schedule of items.

The piles adopted are in general large diameter bored piles with mild steel liner retained for a height as indicated in the related drawings. The liner shall be of 6 mm mild steel plates fabricated to true shape and be provided with protective surface treatment. The concreting shall be done by tremie method as described earlier and according to the other stipulation as described in the Technical Specification.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

The successful bidder shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in the contract. Whenever directed, the successful bidder shall get the specimens tested in a laboratory approved by the engineer and submit to the engineer test results in triplicate within three (3) days of completion of the test.

4.02.00 Components of RCC

The testing and acceptance criteria for components of reinforced cement concrete shall be as stipulated in the relevant clauses of the Technical Specification for Cement Concrete (Plain and Reinforced).

4.03.00 Components of Steel

Testing and acceptance criteria for the component of steel pipe material and fabrication work shall be as stipulated in relevant clauses of IS : 800 and IS :

9595.

4.04.00 Load Tests

4.04.01 General

Initial tests and/or routine tests as indicated in the schedule of items or as directed by the engineer shall be carried out on single pile or pile groups to ascertain the capacities of the piles and their behaviour.

Any or all of the tests described below shall be carried out as indicated in the schedule of items and as directed by the engineer. The tests shall be performed as per requirements of the relevant Indian Standards and as supplemented herein.

4.04.02 Vertical Load Test [as per IS : 2911 (Part-IV)]

Load tests shall be carried out on single piles to check the bearing capacity or the quality of piles in the manner specified below :

From among the completed piles the Engineer at his discretion shall select piles for the purpose of testing.

At least 1% of the piles driven shall be tested to an overload of 50% above the working load of the pile and 0.1% of the piles driven shall be tested to an over load of 100% above the working load of the pile.

Load shall be applied in increments of about one-fifth of the design load till the design load is reached and thereafter in increment of 10 tonnes till the test load is reached.

Each increment of load shall be maintained for minimum of half an hour upto design load and thereafter for one hour till the test load is reached. Test load shall be maintained for 24 hours.

For each increment of load, readings of settlement at every ten minutes shall be taken. The next increment of load shall be applied only when the difference in settlement of readings between the last two readings does not exceed 0.02 mm. On application of test load, readings shall be taken at every hour.

Unloading will be done in following decrements of load :

i) Test load to design load

ii) Design load to 50% of design load

iii) 50% of design load to 25% of design load

iv) 25% of design load to complete unloading

Each decreased load shall be kept for a minimum of half an hour and readings of rebound taken every ten minutes. The next decrement shall be applied only when the difference in readings between the last two readings is less than 0.02

mm.

The observation and recording of settlement and rebound shall be done simultaneously by the Successful bidder and the Engineer's representative. Three copies of all the readings for the test shall be supplied by the Successful bidder to the Engineer-in-charge. Actual proforma for recording the results shall be proposed by the Successful bidder and approved by the Engineer-in-charge before the start of the load test.

The pile shall be deemed to be acceptable if the gross settlement at the test load of one and a half times the designed load does not exceed 0.01" per tonne of test load or 1/2" (12 mm) whichever is less.

In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such piles failed and the Successful bidder shall carry out load tests on these piles in the same way as the load tests on the original piles at his own cost. This procedure will be repeated in the case of each failure of pile under/during load test.

The Successful bidder shall arrange at his own expense sufficient amount of knowledge for loading well in advance of the commencement of the load test.

Detailed proposal together with a sketch for the load test arrangement shall be furnished by the Successful bidder to the Engineer-in-charge for checking and approval.

The pile head shall be chipped off to natural horizontal plane till sound concrete is met. The projecting reinforcement shall be cut-off or bent suitably and the top finished smooth and level. A bearing plate with a hole at the centre shall be placed on the head of the pile for the jacks to rest.

Jacks used in any particular load test should be of the same capacity and their number shall be limited to two only. They should preferably be connected and operated by one pump. The Successful bidder shall submit certificates certifying the correctness of the calibrations of the pressure gauges and jacks before use. All jacks should be fitted with locking devices. Settlement and rebound shall be recorded by minimum two (2) deflectometers of 0.01 mm sensitivity and also by other independent means of direct measurement. Deflectometers shall be supported independently and in such a way as to be not affected by the settlement of the piles.

4.04.03 Lateral Load Test

The test shall be carried out by introducing hydraulic jack with gauge between two piles under test or the reaction shall be suitably obtained otherwise. When the test is conducted by jack located between two piles, the full load imposed by the jack shall be taken as the lateral resistance of each pile.

Load shall be applied in increments of about one-fifth of the design load. The next increment shall be applied after the rate of displacement is nearer to 0.1 mm per 30 minutes. Displacement shall be read by using at least two (2) deflectometer of 0.01 mm sensitivity spaced by 30 cm and kept horizontally one above the other or by any means as per IS-2911 (Part-4) or as approved by the

Engineer. The safe lateral load on pile shall be taken as the least of the followings :

a) Fifty percent (50%) of the final load at which displacement increases to 12 mm.

b) Final load at which the total displacement corresponds to 5 mm.

4.04.04 Pull-out Test

The test shall be carried out to an overload of fifty percent (50%) of the estimated safe load or a displacement of 12 mm total whichever is earlier.

Uplift force may preferably be applied by means of hydraulic jack(s) with gauge using a suitable pull-out set up as per IS-2911 (Part-4) or as approved by the Engineer.

The pull-out load increments and consequent displacement readings shall be same as in the case of Vertical Load Test.

The safe load shall be taken as the least of the followings :

a) Two-thirds of the total load at which the load-displacement is 12 mm.

b) Half the load at which the load-displacement curve shows a clear break (downward trend).

4.05.00 Non-destructive Dynamic Test on Working Piles

4.05.01 "Low Strain" Method for Integrity Investigation of Concrete Piles :

The method of testing shall conform to ASTM D 4945.

All equipments e.g., small impact device 16 lbs. nylon tipped hand held hammer, accelerometer, pile integrity tester & pile driving analyser shall be arranged by the Successful bidder. Analysis shall be carried out byexponential amplification of the signal with time and the average velocity curve obtained by numerically integrating the acceleration record to be submitted. From analysis of the results any defect like necking, honey-combing, segregation or weakness in concrete, when detected shall be reported in detail.

4.05.02 "High Strain" Method for Determining of Pile Capacity

The method of testing shall conform to ASTM D 4945. All equipment including piezoelectric transducers, strain gauges, pile driving analyser, two track oscilloscope for displaying data and analog tape recorders for recording data shall be arranged by the successful bidder. For every hammer below, the analyser shall determie the following data :

i) Pile bearing capacity
ii) Transferred energy

iii) Maximum compression force

iv) Maximum tension force

v) Maximum impact velocity

vi) Maximum acceleration

vii) Maximum displacement

which are to be properly recorded and analysed and submitted in a detailed report form.

4.06.00 Acceptance Criteria

The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification to the satisfaction of the Engineer and the standards stated hereinafter.

a) The head of the pile shall be within 75 mm of the specified position on the drawings.

b) The pile shall not be out of plumb by more than two percent.

c) The toe of the pile shall be at the approved bearing level in each case.

d) The total volume of concrete shall not be less than 20% and not more than 50% greater than the calculated volume. The calculated volume for this purpose shall be the cross-sectional area inside the casing multiplied by the length of the shaft. The concrete shall show the specified strength as indicated by the cube test results.

e) The results of the load tests incl. non- destructive dynamic test carried out in accordance with the contract and with the specifications shall be satisfactory.

f) In case of single pile the positional tolerance shall not be more than 50 mm.

4.07.00 Lateral Dynamic Load Test on Piles

Two types of tests, namely, free and forced vibration lateral tests shall be carried out to observe response of soil-pile system under horizontal dynamic loads and for the evaluation of soil-pile stiffness, soil modulus, natural frequency, time period and damping characteristics of soil-pile system.

A minimum of three representative piles of same type in almost similar soil conditions shall be tested. Two adjacent piles shall be subjected first to free vibrations and then to forced vibrations, the third pile shall only be tested under forced vibrations.

The equipment and accessories for the test, setting up and test procedure and recording of observations shall be as described in relevant sections of IS : 9716

(Guide for Lateral Dynamic Load Test on Piles). The tests shall normally be carried out without sustained vertical load other than that of the oscillator assembly. However, sustained weight can be used to increase dynamic force to obtain resonance or nearly resonance condition.

From analysis of test data, the following parameters shall be determined :

i) Frequency of vibrations

ii) Amplitude of vibrations

iii) Imparted dynamic force

iv) Natural frequency

v) Damping coefficient

vi) Soil-pile stiffness

vii) Coefficient of horizontal soil modulus variation

5.00.00 INFORMATION TO BE SUBMITTED

5.00.01 With Tender

The tenderer should submit the following information alog with his tender.

5.01.01 Design Data

The successful bidder will submit full details of the method of construction, design data and drawings for the type of piles he wishes to adopt.

5.01.02 Programme of Construction

The successful bidder will also submit the details of the construction equipment that he will employ. A proposed construction programme, matching with the capacity of the equipment and taking into consideration the various idle and non production periods on account of shifting of equipment, testing and possible delays due to modifications of design should be drawn up and submitted along with the tender, keeping in view the completion dates stipulated in the tender.

5.02.00 After Award

After award of the contract, the successful tenderer is to submit the following details :

5.02.01 Execution Plan

Within 15 days of receiving the letter of intent the successful bidder will submit six (6) copies of drawings showing the sequence of piling. The drawings will be prepared on the basis of a master plan giving identification number of the piles, which will be furnished by the engineer.

5.02.02 Detailed Construction Programme

Within thirty (30) days of award of the contract, a detailed construction programme for completion of the work is to be submitted. This master programme will be reviewed and updated every month or at more frequent intervals as directed by the engineer, incorporating the various factors that have caused or are likely to cause changes in the programme.

5.02.03 Requirement of Materials, Tools and Plants and Equipment

In accordance with the master programme, a detailed material, tools and plants and equipment requirement schedule, particularly for those items which the owner is to supply or is to help in procurement as per the terms and conditions of contract is to be submitted within thirty (30) days of award of the contract.

5.02.04 Test Results

The test data and results for the various items like welding of pipes, ingredients of RCC, concrete cubes and cylinders, driving of the shell, static load tests on single piles and pile groups and dynamic tests on working pile will be submitted regularly and as and when directed by the engineer.

6.00.00 RATES

The rates for the items of installation of cast-in-situ bored piles shall include the cost of mateials consumed in this work or incidental to it as well as testing of materials, the cost of plants and equipment, labour, supervision, transport, taxes, insurance, royalties and revenue expenses, security and safety measures, approaches, power, fuel, lubricants, services, preliminary and enabling works, camps, stores, etc. and overheads & profits complete. The rate shall include the entire cost of boring, supplying and installing concrete including the cost of extra concrete above cut-off level and subsequently dismantling and removing the same and providing steel casing wherever required. In case no specific item is provided in the schedule to cover any particular item of work, it is implied that the successful bidder will include the cost of executing such work in the rates quoted for connected items in the schedule.

7.00.00 METHOD OF MEASUREMENT

7.01.00 Piles

Unless specified otherwise in the schedule of items piles shall be measured in number and payment shall be done for the number of piles of a specific size and with a specified length measured from the toe of piles upto the pile cut-off level.

For any addition or reduction over the above specified lengths, the extra/rebate in rates for specific sizes shall be measured in length units.

7.02.00 Permanent Steel Casing
The weight of M.S.plate for use as casing shall be measured for payment.

7.03.00 Reinforcement

Length of reinforcing steel measured or calculated from drawings, whichever is less, including laps will be multiplied by standard unit weights to arrive at the quantity to be paid for.

7.04.00 Filling in boreholes

The theoretical volume of the selected material required to fill the borehole between the concrete pile and surface level or the actual quantity of such material provided, whichever is less, shall be measured for payment.

7.05.00 Load Tests

For load tests, measurement shall be taken for vertical, lateral load or pull-out tests on single piles or pile group and dynamic test on working piles as per specification and schedule of items on each occasion of test.

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SECTION: IX

TECHNICAL SPECIFICATION

FABRICATION OF STRUCTURAL STEEL WORK

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SECTION - IX

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply of all raw steel materials, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Successful bidder

The work to be provided for by the Successful bidder, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following:

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on successful bidder's design drawings approved by the Owner / Consultants.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and connections developed by the successful bidder along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the successful bidder shall be in adequate quantity to avoid delay in erection.

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural

steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the successful bidder, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:-

List of I.S. Codes - Relevant to Fabrication of Structural Steel Work

IS Codes	Description
IS: 800 -	Code of practice for general construction in steel.
IS: 801 -	Code of practice for use of cold formed light gauge steel structural members in general building construction.
IS: 806 -	Code of practice for use of steel tubes in general building construction.
IS: 808 -	Dimensions for rolled steel beams, channels and angle sections.
IS: 812 -	Glossary of terms relating to welding & cutting of metals.
IS: 813 -	Scheme of symbols for welding.
IS: 814 -	Covered electrodes for metal arc welding of carbon and carbon manganese steel.
IS: 815 -	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
IS: 816 -	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 817 -	Code of practice for training & testing metal arc welders.
IS: 818 -	Code of practice for safety and health requirements in electric

and gas welding and cutting operations.

IS: 819 - Code of practice for resistance spot welding for light assemblies in mild steel.

IS: 822 - Code of practice for inspection of welds.

IS: 919 - (Part - 1&2) Recommendations for limits and fits for engineering.

IS: 1161 - Steel Tubes for structural purposes.

IS: 1182 - Recommended practice for Radiographic Examination of fushion welded butt joints in steel plates.

IS: 1200 - (Part - 8) Method of measurement of steel work and iron work

IS: 1239 - (Part - 1&2) Mild steel tubes, tubulars and other wrought steel fittings

IS: 1363 - (Part - 1 to 3) Hexagon head bolts, screws and nuts of product grade C.

IS: 1364 - (Part - 1 to 5) Hexagon head bolts, screws and nuts of product grade A & B.

IS: 1365 - Slotted counter sunk head screws (dia. 1.6 to 20 mm)

IS: 1367 - (Part - 1 to 18) Technical supply conditions for threaded steel fasteners.

IS: 1608 - Method for tensile testing of steel products.

IS: 1730 - Dimensions for steel plate, sheet and strip for structural and general engineering purposes.

IS: 1852 - Rolling and cutting tolerances for hot-rolled steel product.

IS: 1977 - Structural steel (Ordinary quality)

IS: 2016 - Plain washer

IS: 2062 - Steel for general structural purposes.

IS: 2629 - Recommended practice for hot-dip galvanising of iron and steel.

IS: 2633 - Method for testing uniformity of coating on zinc coated articles.

IS: 3644 - Code of practice for ultrasonic pulse echo testing by contact

and immersion method.

IS: 3757 - High Strength Structural Bolt

IS: 4000 - High strength bolts in steel structure

IS: 4759 - Specifications for hot-dip zinc coatings on structural steel and other allied products.

IS: 4923 - Hollow steel sections for structural use.

IS: 5334 - Code of practice for magnetic particle flaw detection of weld.

IS: 5369 - General requirements for plain washers and lock washer.

IS: 6005 - Code of practice for phosphating of iron and steel.

IS: 6649 - Specification for hardened and tempered washers for high strength structural bolts and nuts.

IS: 6623 - Specification for high strength structural nuts.

IS: 7215 - Tolerances for fabrication of steel structures.

IS: 7280 - Bare wire electrode for submerged arc welding.

IS: 8500 - Structural steel micro alloyed (medium & high strength quality).

IS: 8629 - Code of practice for protection of iron and (Part - I to III) steel structures from atmospheric corrosion.

IS: 9595 - Recommendation for metal arc welding of carbon manganese steels.

PAINTING

IS: 117 - Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes.

IS: 128 - Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black.

IS: 1477 - Code of practice for painting of ferrous metal (Part - I & II) in building.

IS: 2074 - Ready mixed paint, air-drying red-oxide zinc chrome priming.

IS: 2339 - Specification for aluminium paints for general purposes in dual container.

IS: 2932 - Specification for enamel, synthetic exterior type - I.

IS: 2933 - Specification for enamel, synthetic exterior type - II.

2.04.00 Conformity with Designs

The successful bidder shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates of materials supplied by the successful bidder in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

1) IS: 801 - Cold formed light gauge steel structural member.

2) IS: 806 - Steel tubes in general building construction.

3) IS: 1161 - Steel tubes for structural purpose.

4) IS: 1977 - Structural steel (Ordinary quality) St-42-0

5) IS: 2062 - Steel for general structural purpose

6) IS: 8500 - Structural steel-micro alloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Electrodes

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable:

1) IS: 814 - Covered electrodes for metal arc welding structural steel

2) IS: 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.

3) IS: 7280 - Base wire electrode for submerged arc welding.

2.05.04 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm^2 and a minimum elongation of 23 per cent on a gauge length of 5.6 /A, where 'A' is the cross sectional area of the test specimen: -

1) IS:1367 - Technical supply conditions for threaded fasteners.

2) IS:1608 - Method for tensile testing of steel other than sheet, strip, wire and tube.

b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer.

2.05.05 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

1) IS: 1977 - Structural steel (Ordinary Quality) St-42-0

2) IS: 2062 - Steel for general structural purpose

3) IS: 8500 - Structural steel - micro alloyed (medium & high strength quality)

4) IS: 6623 - High Strength Structural Nuts

5) IS: 6649 - Hardened and tampered washers for high strength structural bolts & nuts.

2.05.06 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimar Paints Ltd., may be necessary.

2.06.00 Storage of Material

2.06.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the successful bidder's yard immediately, failing which, the Engineer shall be at liberty to get the material removed. The Successful bidder shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in successful bidder's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.06.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground sectionwise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.06.03 Electrodes

The electrodes for electric are welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.06.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.06.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.07.00 Quality Control

The Successful bidder shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Successful bidder's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Successful bidder's fabrication shop whether located at Site or elsewhere. The Successful bidder shall co-operate with

the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Successful bidder.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work:

1) Steel: Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

2) Bolts, Nuts: & Washers	Manufacturer's certificate, dimension checks, material testing.
3) Electrodes:	Manufacturer's certificate, thickness and quality of flux coating.
4) Welders:	Qualifying Tests
5) Welding sets:	Performance Tests
6) Welds:	Inspection, X-ray, Ultrasonic tests
7) Paints:	Manufacturer's certificate, physical inspection reports
8) Galvanizing:	Tests in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.08.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

The Successful bidder shall submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall start to submit progressively for approval the shop drawings based on the approved Design Drawings and before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates.

The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the successful bidder's responsibility. The approval of the drawing however shall not relieve the successful bidder of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following: -

a) Assembly drawings giving exact sizes of the sections to be used and

identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolt location etc.

c) Details of all connections with supporting calculations.

d) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion.

Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification --IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Successful bidder shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.01.03 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4 mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.02.00 Bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS:919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.
Holes for bolts shall not be formed by gas cutting process.

3.02.02 Assembly

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.03.02 Preparation of Material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Engineer, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when

produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.06 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 Deg. C. However, if welding is to be undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg. C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03.07 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03.08 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.06.00 Lacing bars

The ends of lacing bars shall be neat and free from burrs.

3.07.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.08.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.09.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10.00 Shop connections

a) All shop connections shall be welded as specified on the Drawings.

b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Successful bidder will have to make the desired changes.

3.11.00 Castings

Steel castings shall be annealed

3.12.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will faciliate the check of interchangeability.

3.13.00 Shop painting

3.13.01 General

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall immediately painted with red oxide zinc chromate primer conforming to IS: 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy resin based zinc rich primer such as Blast Steel EZ1 of Shalimar Paint Limited.

3.13.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.03 Contact surfaces

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14.00 Galvanizing

3.14.01 General

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.
The Successful bidder shall provide such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Successful bidder shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Successful bidder shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Successful bidder shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by the Successful bidder shall conform to the relevant Indian Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.02.03 Testing Criteria for checking Lamination in raw steel plates

All raw steel plate of thickness more than 20 mm supplied by the successful bidder shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Successful bidder. If the plates in the fabricated item is found to be laminated, the component will be rejected.

4.02.04 Welding

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-destructive including X-ray, ultrasonic test or similar. In the event of further tests as may be desired by the Engineer, if the results are found to be unsatisfactory; and if the test shows no defect. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken.

4.02.05 Bolts, nuts and washers

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may

have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards.

4.02.06 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02.07 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Successful bidder's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the Successful bidder's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Successful bidder will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work.

the Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Packing and Shipping

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Successful bidder shall include and provide for in his rates, the freight and other charges for despatching the materials to the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packings shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following: -

a) Name and address of the consignee
b) Name and address of the consignor
c) Gross weight of the package in tonnes and its dimensions
d) Identification marks and/or number of the package
e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially:

a) Name of the Successful bidder
b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Successful bidder When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Successful bidder.

The successful bidder shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Successful bidder shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the progressive bills of the Successful bidder.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information are required to be submitted with the Tender:

a) Progress Schedule

The Successful bidder shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

1) Preparation and approval of shop drawings

2) Procurement of materials

3) Fabrication and shipping of all anchor bolts

4) Fabrication and shipping of main steelwork

5) Fabrication and shipping of steelwork for bunkers. Tanks and/ or silos as applicable.

6) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork

7) Final date of completion of all shipments

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted.

c) Matching Steel

A rough indication of the quantities and details of matching steel sections required to start the work shall be furnished.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the up to date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Results of any test as and when conducted and as required by the Engineer.

d) Manufacturer’s mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

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SECTION: X

TECHNICAL SPECIFICATION

ERECTION OF STRUCTURAL STEEL WORK

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SECTION - X

ERECTION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the successful bidder.

The work to be provided for by the successful bidder, unless otherwise specified in the Contract, shall include but not be limited to the following:-

a) The successful bidder shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The successful bidder shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. any defect observed in the foundation shall be brought to the notice of the Engineer. The successful bidder shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, levelling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures if required by the Contract.

g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following :

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size bolt if required.

iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.

v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.

vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

viii) Carry out tests in accordance with this Specification if directed.

2.02.00 Work by others

No work under this Specification will be provided for by any agency other than the successful bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:-

IS-800 : Code of Practice for general construction in steel

IS-456 : Code of Practice for plain or reinforced concrete

IS-7205 : Safety Code for erection of Structural Steel work

IS-12843 : Tolerance for erection of Steel Structures

2.04.00 Conformity with designs

The successful bidder will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Engineer.

2.05.00 Material

2.05.01 General

The successful bidder will check the quantity, quality and the sizes of the fabricated materials and verify the adequacy of the same in accordance with the Drawings and Specifications. The successful bidder shall make good any deficiency, if detected, either by repair or with fresh material as may be directed by the Engineer.

All consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the successful bidder for erection work and will be deemed to have been included in this rates.

2.05.02 Materials to conform to Indian Standards

All materials required to be supplied by the successful bidder under this Contract shall conform to the relevant Indian Standard Specifications.

2.06.00 Storage of materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency.

2.06.02 Yard

The successful bidder will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which will be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to

permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work. The Tenderer should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the successful bidder as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built.

2.07.00 Quality Control

The successful bidder shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work:-

1) Erection : Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

2) Grouting : Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

3) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

The successful bidder shall salvage, collect and deliver all the packing materials to the Owner.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.01.03 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made.

The responsibility of the successful bidder in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

3.01.04 Temporary floors for buildings

It shall be the responsibility of the successful bidder to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.01.05 Setting out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The successful bidder shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the successful bidder shall set proper screed bars if desired by the Engineer, to maintain proper level.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

Bolts length not exceeding 8 x dia. or 200 mm	Bolt length exceeding 8xdia. or 200 mm	Remarks
1/2 turn	2/3 turn relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation - 30 over or under.	Nut rotation is

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE - II

Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
20	59.94
22	81.63
24	103.73

NOTE :

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.07 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.08 Holes, cutting and fitting

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and/or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the successful bidder shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below :

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like “Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.04.00 Painting after erection

Field painting, if required to be done by the erection successful bidder, shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection successful bidder to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project.

The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.05.00 Stainless Steel Plate Lining in Bunker Hopper

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing.

The stainless steel liner shall be fixed to the Bunker hopper by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16 ISMBOS-311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways. The plug welding shall be ground flush with the lining plate.

3.06.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the successful bidder shall remove all falsework, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.07.00 Safety Measures during Erection

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slingning, welding, gas cutting, etc.) should be taken as per IS : 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good by the successful bidder responsible, to the satisfaction of the Engineer.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2 and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within

the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below :

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
Main columns	a) Shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10M length measured between connection levels, but not more than ±7.0 mm per 30 m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss.	± 9 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between	3 mm

Component		Description	Variation Allowed
		bearing or seating level supposed to be at the same level.	
Trusses	a)	Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or not greater than 10 mm whichever is the least.
	b)	Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least.
Crane Girders & Tracks	a)	Difference in levels of crane rail measured between adjacent columns.	2.0 mm
	b)	Deviation to crane rail gauge	± 3.0 mm
	c)	Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
	d)	Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps		At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

II. For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ± 3.0 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1.0, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2.0 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this Contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

Along with the Tenders the Tenderers will be required to submit the following information :

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure-wise erection schedule proposed to be maintained by the successful bidder to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary Works & Manpower

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection yard

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the successful bidder shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the successful bidder shall submit the following :-

5.02.01 Detailed Programme

The successful bidder shall submit a detailed erection programme for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The successful bidder shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the successful bidder shall also furnish details of fabricated materials in hand at site and the strength of his workers.

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SECTION: XI

TECHNICAL SPECIFICATION

ROADS AND DRAINAGE

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SECTION - XI

ROADS AND DRAINAGE

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, sub-base, water bound macadam, bituminous macadam, wearing course etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be provided for by the successful bidder

The work to be provided for by the successful bidder, unless specified otherwise, shall include but not be limited to the following:

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 Work by others

No work under this Specification will be provided for by any agency other than the successful bidder unless specifically mentioned elsewhere in the Contract.

2.03.00 Codes and Standards

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

2. IRC-19 Standard specifications and Code of Practice for Water Bound

Macadam.

3. IRC:SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

5. IS:2212 Code of Practice for Brickwork.

6. IS:783 Code of Practice for Laying of Concrete Pipes.

7. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 Conformity with Designs

The successful bidder shall carryout the work as per the drawings issued to him and/or successful bidder's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 Materials to be Used

2.05.01 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.06.00 Quality Control

The successful bidder shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter.

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ±40 mm.

i) Longitudinal Profile

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below :

Sub-grade ± 25 mm

Sub-base ± 20 mm

Base course ± 15 mm

Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

ii) Surface Regularity of Subgrade and Pavement Courses

The surface regularity of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table-I.

The longitudinal profile shall be checked with a 3 metre long straight edge, at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

TABLE - I
PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal Profile with 3 metre straight edge					Cross Profile
		Maximum Permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding: mm				Maximum permissible variation from specified profile under camber template mm
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen subgrade	25	30	-	-	-	15
2.	Granular subbase	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing ** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous pene-tration macadam or built-up spray grout	12	-	-	20	-	8

Sl. No.	Type of Construction	Longitudinal Profile with 3 metre straight edge					Cross Profile
		Maximum Permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding: mm				Maximum permissible variation from specified profile under camber template mm
			18	12	10	6	
1	2	3	4	5	6	7	8
6.	Open graded premix carpet, mixseal surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20 ***	6
8.	Semi-dense carpet	10	-	-	-	20 ***	6
9.	Asphaltic Concrete	8	-	-	-	10 ***	4

NOTES :

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance up to 50 percent above these values in this column may be permitted at the discretion of the Engineer. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 EXECUTION

3.01.00 Shoulder Construction

3.01.01 Description

This work shall consist of constructing shoulders on either side of the pavement, in accordance with the requirements of this specification and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

3.01.02 Materials

Shoulder may be of selected earth or granular material conforming to the requirements of embankment construction or granular sub-base construction respectively.

3.01.03 Construction Operations

Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.

In the case of bituminous courses, shouldering operations shall start only after the pavement course has been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement and the area so affected thoroughly cleaned.

During all stages of shoulder construction, the required cross-fall shall be maintained to drain off surface water.

3.02.00 Kerb

3.02.01 Material

Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-15. The blocks shall be 100 mm wide and of suitable length. The depth of blocks unless otherwise mentioned elsewhere, shall be 375 mm considering 225 mm height of footpath from the road level.

3.02.02 Laying

The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.03.00 Sub-base (Granular Sub-base)

3.03.01 Description

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

3.03.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table-II below.

TABLE - II
Grading for Granular Sub-base Materials

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90-100	90-100	90-100
4.75 mm	35-70	40-90	50-100
75 micron	0-20	0-25	0-30
CBR Value (Minimum) : for fraction of material passing 20 mm sieve	30%	25%	20%

Note : The material passing 425 micron sieve for all the three gradings when tested according to IS:2720 (Part V) shall have liquid limit and plasticity index of not more than 25 percent and 6 percent respectively.

3.03.03 Physical Requirements

The fraction of material passing 20 mm sieve shall give a CBR value as specified in Table-II when tested in accordance with IS:2720 (Part XVI) after preparing the samples at maximum dry density and optimum moisture content corresponding to IS:2720 (Part VII) and soaking the same in water for 4 days.

3.03.04 Spreading and Compacting

Immediately prior to the laying of sub-base, the subgrade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.

The sub-base material shall be spread on the subgrade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of the layer after consolidation does not exceed 150 mm.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the centre longitudinally except that on superelevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density for the material determined as per IS:2720 (Part VII). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

3.04.00 Water Bound Macadam Sub-base/Base Course

3.04.01 Description

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonded together with screenings,

binding material, where necessary and water, laid on a prepared subgrade or sub-base, as the case may be, and finished in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the Engineer.

3.04.02 Materials

3.04.02.1 Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table-III.

TABLE - III

Physical Requirements of Coarse Aggregates
for Water Bound Macadam

Sl. No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		ggregate Impact Value	IS:2386 (Part IV) or IS:5640**	40 percent maximum.
2.	Base	a) Loss Angeles Abrasion Value*	IS:2386 (Part IV)	50 percent maximum.
		or		
		Aggregate Impact Value	IS:2386 (Part IV) or IS:5640**	40 percent maximum.
		b) Flakiness Index***	IS:2386 (Part I)	15 percent maximum.

* Aggregate may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water, shall be tested for impact value under conditions in accordance with IS:5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

3.04.02.2 Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

3.04.02.3 Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table-IV, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE - IV
GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size range	Sieve designation	Percent by weight passing the sieve
1.	90 mm to 40 mm	100 mm	100
	80 mm	65-85	
	63 mm	25-60	
	40 mm	0-15	
	20 mm	0-5	
2.	63 mm to 40 mm	80 mm	100
	63 mm	90-100	
	50 mm	35-70	
	40 mm	0-15	
	20 mm	0-5	
3.	50 mm to 20 mm	63 mm	100
	50 mm	95-100	
	40 mm	35-70	
	20 mm	0-10	
	10 mm	0-5	

3.04.02.4 Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the gradings set forth in Table-V Screenings of Type A in Table shall be used with coarse aggregates of

grading 1 in Table IV. Screenings of Type A or B, shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3.

TABLE - V
GRADINGS FOR SCREENINGS

Grading Classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm 10.0 mm 4.75 mm 150 micron	12.5 mm 90-100 10-30 0-8	100
B	10 mm 4.75 mm 150 micron	10 mm 85-100 10-30	100

3.04.02.5 Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value of less than 6 as determined in accordance with IS:2720 (Part V).

Application of binding material may not be necessary, when the screenings used are of crushable type such as moorum or gravel.

3.04.03 Construction Operations

3.04.03.1 Preparation of Base

The subgrade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50 mm x 50 mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1 metre intervals in the latter before laying the coarse aggregate.

3.04.03.2 Inverted Choke

If the water bound macadam is to be laid directly over the sub-grade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared subgrade before application of the coarse aggregates is taken up.

3.04.03.3 Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

3.04.03.4 Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

3.04.03.5 Applications of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be

damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

3.04.03.6 Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

3.04.03.7 Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

3.04.03.8 Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the

macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.05.00 Tack Coat

3.05.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.05.02 Materials

Binder : The binder used for tack coat shall be bitumen of a suitable grade as directed by the Engineer and conforming to IS:73, 217 or 454, as applicable, or any other approved cutback.

3.05.03 Construction Operations

3.05.03.1 Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous material before the application of the binder.

3.05.03.2 Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight-run bitumen shall be 5 kg. per 10 square metre area for an existing bitumen treated surface and 10 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers.

The tack coat shall be applied just ahead of the on-coming bituminous construction.

3.06.00 Bituminous Macadam Binder Course

3.06.01 Description

This work shall consist of construction, in a single course, of 50 mm / 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder, laid immediately after mixing, on a base prepared previously in accordance with the requirements of these Specifications, and in conformity with the lines, grades and cross sections shown on the drawings or directed by the Engineer.

3.06.02 Materials

3.06.02.1 Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS:73.

3.06.02.2 Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, of fairly cubical shape and free of disintegrated pieces, organic and other deleterious matter, and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table-VI.

TABLE - VI
PHYSICAL REQUIREMENTS OF AGGREGATES
FOR BITUMINOUS MACADAM

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion* Value	IS:2386 (Part IV)	35% Maximum
2.	Aggregate Impact Value*	-do-	30% "
3.	Flakiness Index	IS:2386 (Part I)	35% "
4.	Stripping Value	IS:6241	25% "
5.	Water Absorption	IS:2386 (Part III)	2% "

* Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thicknesses shall conform to the grading A or B given in Tables VII & VIII.

TABLE - VII
AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90-100	
40 mm	35-65	100
25 mm	20-40	70-100
20 mm	-	50-80
12.5 mm	5-20	-
4.75 mm	-	10-30
2.36 mm	-	5-20
75 micron	0-5	0-4

TABLE - VIII
AGGREGATE GRADING FOR 50 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90-100	
25 mm	50-80	100
20 mm	-	70-100
12.5 mm	10-30	-
10 mm	-	35-60
4.75 mm	-	15-35
2.36 mm	-	5-20
75 micron	0-5	0-4

3.06.02.3 Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading A and B respectively, except when otherwise directed by the Engineer.

The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

3.06.02.4 Variation in Proportioning of Materials

The successful bidder shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content of $\pm$ 0.3 percent by weight of total mix shall, however, be permissible for individual specimens taken for quality control tests.

3.06.03 Construction Operations

3.06.03.1 Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

3.06.03.2 Preparation of Base

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

3.06.03.3 Tack Coat

A tack coat shall be applied over the base.

3.06.03.4 Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix.

The temperature of binder at the time of mixing shall be in the range 150 Deg.- 165 Deg.C and that of aggregates in the range 125 Deg. - 150 Deg.C, provided that the difference in temperature between the binder and aggregate at no time exceeds 25 Deg.C.

Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly.

The mixture shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

3.06.03.5 Spreading

The mix shall be spread immediately after mixing by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths, where the available plants cannot operate in the opinion of the Engineer, he may permit manual laying of the mix.

The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg.C.

In multilayer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

3.06.03.6 Rolling

After the spreading of mix, rolling shall be done by 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to keep from unduly roughening the pavement surface.

Rolling of the longitudinal joint shall be done immediately behind the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except that on super-elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface or having the mix pick up on the roller wheels. The second or inter mediate rolling shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions, which become apparent shall be corrected by removing or adding fresh material. The rolling shall then be continued till the entire surface has been rolled to compaction, there is no crushing of aggregate and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel-lubricating oil be used for this purpose.

Rolling operations shall be completed in every respect before the temperature of the mix falls below 80 Deg.C.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat before allowing any traffic over it.

3.07.00 Open-Graded Premix Carpet

3.07.01 Description

This work shall consist of laying and compacting an open-graded carpet of 2 cm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to form a wearing course, in accordance with the requirements of these specifications.

3.07.02 Materials

3.07.02.1 Binder

The binder shall be bitumen of a suitable grade, as directed by the Engineer, and satisfying the requirements of IS:73, 217, 454 or other approved cutback as applicable.

3.07.02.2 Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, and vegetable or other deleterious matter. They shall preferably be hydrophobic type.

The aggregates shall satisfy the quality requirements set forth in Table VI except that the Flakiness Index shall be limited to a maximum of 30.

3.07.02.3 Proportioning of Materials

The materials shall be proportioned as per quantities given in Table IX.

TABLE - IX
QUANTITIES OF MATERIALS REQUIRED FOR 10 SQ.M OF ROAD SURFACE FOR 2 CM THICK OPEN-GRADED PREMIX CARPET

Aggregates of Carpet		
a)	Stone chippings - 12 mm size; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
b)	Stone chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
		Total : 0.27 Cu.m
Binder for premixing (quantities in terms of straight run bitumen)		
a)	For 0.18 Cu.m of 12 mm size stone chippings at 52 kg per Cu.m	9.5 kg
b)	For 0.09 Cu.m of 10 mm size stone chippings at 56 kg per Cu.m	5.1 kg
		Total : 14.6 kg

3.07.03 Construction Operation

3.07.03.1 Weather and Seasonal Limitations

Open-graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg.C or below.

3.07.03.2 Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with Table I as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matter with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

3.07.03.3 Tack Coat

A tack coat complying with clause 3.5 shall be applied over the base preparatory to laying of the carpet. Application of tack coat shall, however, not be necessary when the laying of carpet follows soon after the provision of a bituminous course.

3.07.03.4 Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

3.07.03.5 Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall commence with 6 to 8 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally, except that on the super elevated portions it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

3.07.03.6 Seal Coat

A seal coat conforming to clause 3.8 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.08.00 Seal Coat

3.08.01 Description

This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.

Seal coat shall be of either of the two types below, as specified:

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.08.02 Materials

3.08.02.1 Binder

The binder shall be bitumen of a suitable grade as directed by the Engineer and conforming to the requirements of IS:73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be utilised, in terms of straight run bitumen shall be 9.8 kg and 6.8 kg per 10 square metre area for Type A and Type B seal coat respectively.

3.08.02.2 Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 6 mm size defined as 100 percent passing through 10 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic metre per 10 square metre area. The chippings shall satisfy the quality requirements spelled out in Table VI except that the upper limit for flakiness Index shall be 30.

3.08.02.3 Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.08.03 Construction Operations

3.08.03.1 Preparation of Base

The seal cost shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

3.08.03.2 Construction of Type A Seal Coat

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly on the surface, preferably by means of a mechanical gritter, otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the centre except in super elevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

3.08.03.3 Construction of Type B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6-8 tonne smooth wheeled power rollers. Rolling

shall be continued till the pre-mixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.08.04 Opening to Traffic

In the case of Type B Seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. However, as regards Type A seal coat, traffic shall not be permitted until the following day.

3.09.00 Repair of Existing Water Bound Macadam Surface

Pot holes or patches and ruts in water bound macadam base or surface course, which is to be surface treated, shall be repaired by removal of all loose material by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under :

Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides, and then be filled either with i) coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer or ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

The above is only applicable in case of damage to the existing water bound macadam surfaces. In case, however, it is found that there has been damage to the granular sub-base as well, the area of the damaged surface shall be repaired by removal of all loose materials, cut to regular shape with vertical sides and relaid with graded material as per specification of granular sub-base and then surfaced with water bound macadam as per specification for the same.

3.10.00 Road Side Drains

3.10.01 Formation of Drains

The road side drains shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per drawing and as mentioned in the Schedule of Items. Lining of drains may be of bricks or cement concrete blocks of M15 grade concrete as shown on drawing or as directed by the Engineer. If instructed by the Engineer or shown on drawing, drains may be of R.C.C. construction with necessary slopes.

3.11.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable.

3.12.00 Pipe Culverts and Drainage Pipes

3.12.01 Materials

The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS:458- Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tenderer shall specifically mention the particular manufacturer's product he proposes to use. Cement shall be ordinary Portland Cement as per IS:269 - Latest edition.

Aggregates shall be as per IS:383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS:383 - Latest edition.

3.12.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 - Latest edition - and to specification given below :

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the successful bidder without the Owner. Side slips, if there be any, shall be removed by the successful bidder. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose, clods and lumps broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Engineer.

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition - having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earthfilling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS:783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or as instructed by the Engineer.

e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be

properly laid in position and remaining height of block to be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS:783 - latest edition.

3.12.03 Relation with Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.13.00 Manholes and Inspection Chambers

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water-tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.I. or as directed by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

3.14.00 Masonry

3.14.01 Brick Masonry

All bricks shall be of first class (Class A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules of free lime. Bricks shall be soaked in water for at least two hours prior to use and shall be laid truly horizontal and vertical in headers and stretchers with cement mortar consisting of one part of cement and four parts of sand, unless otherwise mentioned in the schedule of Items or directed by the Engineer, in layers not exceeding 1.5 M in height. Each layer shall be allowed at least 24 hours to settle itself before another layer is placed on it and every layer cured with water until the starting of next layer above it.

Materials for mortar such as sand and cement shall be of approved quality. Mortar shall be well mixed, first dry mixed and then by adding water slowly to have a thick workable consistency. Mortar shall be mixed in small batches consistent with the rate of consumption so that no mortar is used after one hour of mixing.

Mortar joints shall be kept uniformly 10 mm thick and all joints should be full of mortar. Brickwork shall be carried up regularly in plumb every course being horizontal. No vertical joints shall come directly over one another.

Joints of the brickwork shall be raked minimum 10 mm deep using raking tool while mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. The brickwork shall be kept moist for 14 days.

All bricks which absorb water more than 20% of their own dry weight after being immersed in water for 24 hours shall be rejected. Brick should be as per IS:1077. Bricks shall have minimum crushing strength of 50 kg/Sq.cm.

3.14.02 Stone Masonry

All stones shall be from approved quarries, hard, tough, durable, compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. A stone shall not absorb more than 5 percent of its weight of water after 24 hours immersion. Samples shall be submitted by the successful bidder and approved samples shall be retained by the Engineer for comparison of bulk supply.

Stone shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall not be less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.14.03 Pointing to Masonry

After raking out of the joints, the brickwork shall be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water, mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean. The pointed surface shall be kept wet for at least three days for curing.

3.15.00 Plaster to Masonry and Concrete

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar - 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall

be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall than be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used. Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS:1661- latest edition.

3.15.01 Finish

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer the plastered surface shall have a neat cement finish. Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat and rubbed smooth with a trowel.

3.16.00 Cement Concrete (Plain and Reinforced)

Shall be as laid down in “Techncial Specification for Cement Concrete (Plain and Reinforced)” Section - III.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the successful bidder as per direction of the Engineer. No extra payment shall be made for such tests.

4.02.00 Masonry and Plastering

Masonry and finish to masonry and concrete shall fully comply with the drawings, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

4.03.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.

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TECHNICAL SPECIFICATION

NOT USED

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SECTION: XIII

TECHNICAL SPECIFICATION

PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

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SECTION - XIII

PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

1.00.00 SCOPE

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

2.00.00 MATERIALS

a) Bricks

Bricks for general masonry work shall conform to IS:1077-1970 and for face brick work shall conform to the specifications in IS:2691-1972.

Bricks for general masonry work shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules or free lime and omit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps boles etc. Compressive strength shall be 50 Kg. / cm^2 minimum for face bricks. Water absorption after 24 hours immersions shall not exceed 15% by weight for common bricks and 12% for face bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks and 3% for face bricks. All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The bricks shall show no efflorence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be upto the specification and defective bricks shall be removed immediately from site at the successful bidder's own cost.

b) Stone

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of

water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the successful bidder and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Lime

Lime shall be stone lime and conform to the specification Building Limes - IS:712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form a putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaked with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) Cement

Cement used shall be ordinarily Portland Cement conforming to Code for ordinary cement in IS:269 and shall be fresh when delivered. The successful bidder shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If the cement is procured by the Owner and issued to the successful bidder, the successful bidder shall satisfy himself at the time of taking delivery that the quality, quantity and freshness of cement are upto the specified standards. No complain later on regarding the cement supplied by the Owner shall be entertained and all rectification work on this account shall be done by the successful bidder at his own expense. If at any time, the Engineer feels that the cement being used by the successful bidder is not upto specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the successful bidder. The successful bidder shall also have no claim for this type of suspension of work.

e) Coarse Aggregates

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified

proportions and strength and of consistency that will work readily into position without segregation.

f) Sand

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrities, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS:383.

g) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discolouration, efflorescence etc.

h) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS:226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS:432 Cold twisted steel bars shall conform to IS:1786. Hexagonal wire netting shall conform to IS:3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanised.

3.00.00 STORAGE AND HANDLING OF MATERIALS

a) Bricks

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimise breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stones

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

c) Lime

Lime shall be stored in weatherproof sheds.

d) Cement

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the successful bidder and shall be removed from the site immediately.

e) Coarse and Fine Aggregates

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) Reinforcement

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

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TECHNICAL SPECIFICATION

ANTI-TERMITE TREATMENT

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SECTION-XIV

ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to prevent the subterranean termites from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites while the building is under construction. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

2.02.00 Safety Precautions

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption though

skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contract with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.03.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (20EC) (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable (20EC) Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable (20EC) Concentrate (IS: 2682 - 1984)	:	1.0
Lindane (20 EC) (IS: 632)	:	1.0

2.03.01 Treatment

To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites shall be done as per IS 6313 (Part III).

2.03.02 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (up to a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be

treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

If there is a concrete or masonry apron around the building, approximately 12mm diameter holes shall be drilled as close as possible to the plinth wall about 300mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to sock the soil below at the rate of 2.25 litres per linear metre.

2.03.03 Treatment of Top Surface of Plinth Filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.03.04 Treatment of Soil Surrounding Pipes, Wastes and Conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.03.05 Treatment of Expansion Joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.03.06 Treatment at Junction of the Wall and the Floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 ACCEPTANCE CRITERIA

The successful bidder shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the owner.

4.00.00 RATES

The rates shall include the cost of labour and all other inputs including concentrated chemical involved in all the operations described above including making holes, channels etc. Rates shall be of complete work per unit length or area as stated in the Schedule.

5.00.00 METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured as per items stated in the BOQ.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work and no extra payment shall be made.

6.00.00 I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981	:	Code of Practice of Anti-Termite Measures in Buildings (pre-constructional)
IS : 632	:	Gamma-BHC (Lindane) emulsifiable Concentrates
IS : 8944 – 1978	:	Chlorpyrifos emulsifiable concentrates
IS : 8963	:	Chlorpyrifos- Technical specifications
IS : 6439 – 1978	:	Heptachlor Emulsifiable
IS : 2682 – 1984	:	Chlordane Emulsifiable
		Pre-constructional chemical treatment measures.

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SECTION: XV

TECHNICAL SPECIFICATION

QUALITY ASSURANCE AND INSPECTION FOR CIVIL AND STRUCTURAL WORKS

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SECTION - XV

QUALITY ASSURANCE AND INSPECTION FOR CIVIL AND STRUCTURAL WORK

1.00.00 INTRODUCTION

1.01.00 This part of the specification covers the sampling, testing and quality assurance requirement (including construction tolerances and acceptance criteria) for all civil and structural works covered in this specification.

1.02.00 This part of the technical specification shall be read in conjunction with other parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

1.03.00 The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part of the technical specifications. The QA and QC activities in all respects as specified in the technical specifications/ drawings / data sheets / quality plans / contract documents shall be carried out at no extra cost to the owner.

1.04.00 The successful bidder shall prepare detailed construction and erection methodology scheme which shall be compatible to the requirements of the desired progress of work execution, quality measures, prior approvals if any and the same shall be got approved by the Engineer. If required, work methodology may be revised/ reviewed at every stage of execution of work at site, to suit the site conditions by the successful bidder at no extra cost to the owner.

2.00.00 QUALITY ASSURANCE PROGRAMME

2.01.00 The successful bidder shall adopt suitable Quality Assurance Programme (QAP) to ensure that the equipments and services under the scope of contract whether manufactured or performed within successful bidder's works or at his sub-contractor's premises or at the OWNER'S site or at any other place of work are in accordance with the specifications. Such QAP shall be outlined by the successful bidder and shall be finally accepted by the OWNER or their authorized representative after discussions before the start of work. The QAP shall be generally in line with IS/ISO Systems.

The successful bidder shall furnish complete QA & QC programme for the work envisaged which may include the following

- Organization structure for the management and implementation of the

proposed quality assurance programme

- Quality System Manual
- Design Control System
- Documentation and Data Control System
- Qualification data / details for Successful bidder's key personnel
- The procedure for purchase of materials, parts, components and selection of subcontractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased, etc.
- System for shop manufacturing and site erection controls including process, fabrication and assembly
- Control of non-conforming items and system for corrective actions and resolution of deviations
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring testing equipment.
- System for Quality Audits
- System for identification and appraisal of inspection status
- System for authorizing release of manufactured product to the OWNER
- System for handling, storage and delivery.
- System for maintenance of records
- Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of work/ equipment/component.

3.00.00 QA AND QC MANPOWER

3.01.00 The successful bidder shall nominate one overall QA coordinator for the contract detailing the name, designation, contact details and address at the time of post bid discussions. All correspondence related to Quality Assurance shall be addressed by the successful bidder's QA coordinator to OWNER. OWNER shall address all correspondence related to Quality issues to the successful bidder's QA coordinator. The successful bidder's QA coordinator shall be responsible for co-ordination of Quality activities between various divisions of the successful bidder and their sub-vendors on one hand & with

OWNER on the other hand.

3.02.00 The successful bidder shall appoint a dedicated, experienced and competent QA&QC in-charge at site, preferably directly reporting to the Project Manager, supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP. An indicative structure of successful bidder's QA&QC manpower required to be deployed at site is enclosed at Annexure-I. Based on the finalized L-2 network and the approved Field Quality plan, the successful bidder shall finalize and submit a deployment schedule of QA&QC personnel along with their details to OWNER for approval/ acceptance and further shall ensure their availability well before the start of the concern activity.

3.03.00 The QA&QC in-charge shall have the organizational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints. The QA&QC setup of the successful bidder shall consist of qualified and experienced Civil, Electrical, Mechanical Engineers and Laboratory assistants with their supporting staff both at their works and site.

3.04.00 The deployment of man power for QA & QC set up shall be affected on the basis of agreed manpower deployment schedule, which shall be prepared by the successful bidder based on the L-2 network and the same shall be submitted to the engineer-in-charge for acceptance.

4.00.00 SAMPLING AND TESTING OF CONSTRUCTION MATERIALS

4.01.00 The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. All samples shall be jointly drawn, signed and sealed wherever required, by the successful bidder and the engineer or his authorized representative.

4.02.00 The successful bidder shall carry out testing in accordance with the relevant IS / standards/codes and in line with the requirements of the technical specifications/quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All testing shall be done in the presence of the engineer or his authorized representative.

4.03.00 Before execution of any civil work the successful bidder shall conduct full-scale suitability tests on various construction and building material such as fine and coarse aggregates, cement, reinforcement, construction chemicals, supplementary cementations materials and construction water to ascertain their suitability for use and the concrete mix designs conducted from reputed institutes such as Jadavpur University, IIEST-Shibpur, NIT-Durgapur etc. as agreed by the engineer. The test samples for such full scale testing shall be jointly sampled and sealed by the engineer and successful bidder, thereafter these shall be sent to the concerned laboratory through the covering letter signed by field quality assurance (FQA) representative of the engineer.

4.04.00 The successful bidder shall timely initiate the action with regard to the evaluation of aggregates and other building material including concrete mix design, so as to ensure completion of these tests before start of civil works at site, thereby not affecting any project work. The test reports and recommendations for suitability of the materials including concrete mix design shall be promptly submitted by the successful bidder to the engineer.

4.05.00 Evaluation of aggregate for potential alkali-aggregate reactivity shall be carried out as per following scope of work

A. Evaluation of Aggregates for Mechanical / Physical Properties

a) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and fiakiness index, as per IS: 2386.

b) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material, soundness, silt content, clay content and organic impurities as per IS: 2386.

c) To prepare evaluation report based on test results of a) and b) above and to advise regarding suitability of fine and coarse aggregates.

B. Evaluation of Aggregates for Potential Alkali-Aggregate Reactivity:

a) To carry out petrographic analysis and accelerated Mortar bar Test on aggregate samples (1N NaOH at 80 deg. Centigrade for 14 days as per ASTM 1260, or the method established/ developed by CSMRS for 22days test).

b) To prepare a report based on test results of a) above and to advise regarding suitability of aggregates to be used and further testing required if any.

5.00.00 LABORATORY AND FIELD TESTING

5.01.00 The field laboratory for QA and QC activities shall be constructed and set-up by the successful bidder in line with the indicative field QA&QC laboratory set-up enclosed at Annexure-II. The Laboratory building shall be constructed and installed with the adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples. The quality plan shall identify the testing equipments/ instrument, which the successful bidder shall deploy and equip the field quality laboratory for meeting the field quality plan requirements. The successful bidder shall furnish a comprehensive list of

testing equipments/ instrument required to meet the planned/scheduled tests for the execution of works for OWNER acceptance/ approval. The successful bidder shall mobilize the requisite laboratory equipment and QA&QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.

5.02.00 All equipments and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the OWNER. The calibration certificates shall specify the fitness of the equipments and instruments within the limit of tolerance for use. Successful bidder shall arrange for calibration of equipments and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to OWNER.

5.03.00 The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute. This includes all IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by OWNER engineer. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to OWNER.

5.04.00 Based on the schedule of work agreed with the engineer-in-charge and the approved FQP, the successful bidder shall prepare a schedule of tests and submit them to the engineer-in-charge and organize to carry out the tests as scheduled /agreed.

6.00.00 PURCHASE AND SERVICE

6.01.00 The major items/ equipments/ components to be manufactured in the shop of the successful bidder i.e. in-house items and those procured from sub-vendors / sub- manufacturer / sub-contractors i.e. bought out items (BOIs) shall be listed out by the successful bidder in their bid proposal.

6.02.00 An indicative list of major bought out items (not exhaustive) and services for civil works is enclosed at Annexure- III, for which the successful bidder shall submit the requisite details / lists of manufacturer's in their bid proposal. The list of manufacturers/ sub-vendors for all the BOEs envisaged in contract including shall be included in the bid proposal by the successful bidder which shall be discussed / reviewed by the OWNER during post bid discussions and the list of proposed manufacturers / sub-vendors for each of the BOIs shall be agreed/ approved. If any item is left out or gets included during detailed engineering, the successful bidder shall propose the manufacturer's / sub-vendor's details for review / approval of OWNER, prior to initiating the procurement of such materials.

6.03.00 Where the manufacturers are placed in details required ("DR") category, the details of the manufacturers / sub-vendors placed in the "DR" category shall be submitted to the OWNER for approval in the prescribed OWNER format within the period agreed at the time of post bid discussions. The successful

bidder's proposal shall include vendor's site facilities, expertise, facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-Contractors proposed. The formats for furnishing above details shall be given to the Successful bidder at post bid discussion stage. Monthly progress reports on sub-contractor detail submission / approval shall be furnished. Such manufacturers / sub-vendors approval shall not relieve the successful bidder from any obligation, duty or responsibility under the contract.

6.04.00 To facilitate advance planning of material testing/ approval of bought out items, well before the start of activity as per L-2 network, representative samples shall be procured by the successful bidder from approved sub-vendors and submitted to the engineer for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate (MTC) is submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. MTC of all bought out items shall essentially contain all the test parameters / characteristics specified in the Technical specifications / standards / codes. In case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to OWNER. Approval of material / sample by the engineer shall not relieve the successful bidder of his responsibility, for their conformance to the specification, as well as the requisite performance and quality of material.

6.05.00 Structural steel supply is in the scope of the successful bidder shall be procured from main steel producers like SAIL, TISCO, RINL, In case of non-availability of some of the sections with main steel producers the successful bidder may propose to procure the sections from the re-rollers of the main steel producers, the name of such re-rollers will have to be cleared by corporate quality assurance of OWNER for which details such as BIS approval, main steel producer's approval, past experience for production of sections of specified material, details of machines plants testing facilities etc., Confirmation that the process control and manufacturing of steel sections by re-rollers shall be same as that of main steel producers, that billets for re-rolling will be sourced from main steel producers only shall be furnished with regards to re-roller.

6.06.00 Even after clearance of re-rollers, induction of billets with identified and correlated Mill test certificates (TC's) in the process of re-rolling, sampling of steel, quality checks thereof and stamping of final product for further identification and correlation with TC's prior to dispatch shall be the responsibility of the successful bidder and these shall be performed in presence of the authorized representative of the main Successful bidder.

6.07.00 Reinforcement steel supply is in the scope of the successful bidder shall be procured from main steel producers like SAIL, TISCO, RINL, In case any size /diameter specified is not available with main steel producers and are proposed to be supplied from the conversion agent of the main steel producer the name of such conversion agent / re-roller shall have to be approved by OWNER for which details such as BIS approval, Main steel producer's

approval, Past experience for production of sections of specified material, details of machines, plants testing facilities etc., and confirmation that the process control and manufacturing of steel sections by re-rollers is the same as that of main steel producers, that billets for re-rolling are sourced from main steel producers only shall be furnished with regards to re-roller.

7.00.00 MANUFACTURING QUALITY PLAN AND FIELD QUALITY PLAN

7.01.00 All materials / components and equipment covered under the scope of work, shall be procured by the successful bidder for the purpose of the contract, after obtaining the written approval of the OWNER, which are to be manufactured at shop/ factory of the vendor/sub vendor shall be covered under a comprehensive quality assurance programme. The successful bidder's purchase specifications and inquiries shall call for Manufacturing Quality Plans (MQP) to be submitted by the sub-contractor/ sub-supplier/ sub-vendor. The MQP called for from the sub-contractor shall detail out for all the components and equipment, various tests / inspection, to be carried out as per the requirements of this specification and standards mentioned therein, quality practices and procedures followed by successful bidder's / sub-contractor's / sub-supplier's quality control organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. Such quality plans of the vendors / sub-vendors shall be submitted to the OWNER for approval for MQP and such approved quality plans shall form a part of the purchase order / contract between the successful bidder and sub-contractor. The quality plans shall be submitted on electronic form e.g. CD or E-mail in addition to hard copy, for review and approval of OWNER. After approval the same shall be submitted in compiled form on CD in addition to hard copy.

7.02.00 The successful bidder shall furnish copies of the reference documents/ plant standards / acceptance norms/ tests and inspection procedure etc., as referred in quality plans. These quality plans and reference documents/standards etc. will be subject to OWNER approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, OWNER shall identify customer hold points (CHP), i.e. test/ checks which shall be carried out in presence of the OWNER engineer or his authorized representative and beyond which the work shall not proceed without consent of OWNER in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to OWNER along with technical justification for approval and dispositioning.

7.03.00 Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the OWNER for reference / record by the successful bidder along with a report of the purchase orders placed so far for the contract.

7.04.00 Well before the start of the work, the successful bidder shall prepare and submit the Field Quality Plans (FQP) and obtain approval of OWNER, which shall detail out for all the works, equipments, services, quality practices and procedures etc in line with the requirement of the technical specifications to be followed by the successful bidder at site. This FQP shall cover for all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site. An Indicative Field Quality Plan for civil works is enclosed at Annexure - IV-A (Indicative FQP for civil works) & Annexure - IV-B (Indicative FQP for structural steel works).

8.00.00 DISPOSITIONING OF NON CONFORMITIES

8.01.00 The non-conformity for the site works on being detected / noted shall be reported by the successful bidder in the standard format of OWNER under the system of dispositioning of non conformity report (NCR) to the engineer. The dispositioning of the NCR relating to equipment, assemblies, materials condition or process during construction / erection shall describe the proposed correction and also include the preventive / corrective action plan for future.

9.00.00 QUALITY AUDIT

9.01.00 OWNER reserves the right to carry out quality audit and quality surveillance of the quality management and control activities, systems and procedures of the successful bidder or their sub-contractor. The successful bidder shall provide all necessary assistance to enable the OWNER carry out such audit and surveillance. The successful bidder shall also take necessary measures, raise NCRs wherever required based on the audit findings / observations.

10.00.00 QA DOCUMENTATION PACKAGE

10.01.00 The successful bidder shall be required to submit the QA documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark. Typical contents of QA documentation pertaining to field activities as per approved MQP, FQP and other agreed manuals / procedures, prior to commissioning of individual system shall generally contain the Quality Plan, Material mill test reports, Non-destructive examination results / reports, Heat Treatment Certificate/Record, Non-conformance Reports, CHP, Certificate of Conformance (COC)and MDCC.

11.00.00 GENERAL QA REQUIREMENTS

11.01.00 The successful bidder shall ensure that the works, BOIs and services under the scope of contract whether manufactured or performed within successful bidder's works or at his subcontractor's premises or at the OWNER'S site or at any other place of work are in accordance with the OWNER technical specification, applicable standards / codes, approved drawings / data sheets / quality plans and BOQ. All the works, BOIs and services shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer.

11.01.01 Storage and Handling of Construction Materials

All materials shall be stacked and stored by the Successful bidder as per IS-4082 and as per the requirements specified in OWNER Technical Specification.

11.01.02 Excavation and Filling Works

The **successful bidder** shall submit a work methodology covering various items of works for alt stages of excavation and filling works. This methodology shall broadly include the quantity wise and classification wise identification of source of excavation and filling, suitability tests as per specification requirements, method of stockpiling, transportation, placement, spreading , compaction, equipment, list of protocols, in-situ tests, third party lab test if required, acceptance checks for final clearance.

For blasting work at site if required, the successful bidder shall associate themselves with the reputed specialized blasting agency such as CMRI, NIRM for trials blasts, design blasts, blasting pattern, monitoring of blast during the blasting operations at site. The successful bidder shall install and operate equipment {such as tri-axial seismograph) for continuous monitoring and control of blast induced vibrations, noise level/ air pressure, dust, silica and noxious gases during all blasting operations in line with the technical specification requirements in association with the specialized blasting agency. The successful bidder shall submit the un-priced copy of the award on the specialized blasting agencies to OWNER, highlighting the scope of services / work awarded to them by successful bidder. The services of such specialized blasting agency shall be available throughout the period in which the blasting work is undertaken at site. The blasting operation shall remain in charge of a responsible, competent, authorized and experienced supervisor (man-in-charge) and thoroughly acquainted workmen, All blasting work shall be done as per approved blasting scheme/ design/ pattern in line with the technical specification requirements and all statutory laws, rules, regulations, relevant standards pertaining to the acquisition, transport, storage, handling along with use of explosives shall be strictly followed by the successful bidder.

Tolerance for finished surface level shall be within 20 mm of the level shown in the drawing. For an unimportant area, tolerance up to +75mm shall be acceptable at the discretion of the engineer. However, these tolerances shall be applicable for localized areas only.

Acceptance criteria shall be

a) When only one set of sample is tested, then all individual samples collected and tested should pass without any deviation

b) For retest of any sample two additional samples shall be collected and tested, and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test then

9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

11.01.03 Masonry and Allied Works

The execution, finishing, testing and acceptance of masonry related works shall be as per the provisions of technical specifications / relevant practices IS code. Local depressions on account of faulty workmanship, broken / chipped edges shall not be acceptable.

All masonry shall be built true and plumb within the tolerances prescribed as below, Care shall be taken to keep the perpends properly aligned. Unless specified otherwise the tolerances in construction of masonry works shall be as below:

Sl. No.	Type of Check	Tolerance
1.	Deviation in verticality in total height of any wall of a building	Shall not exceed ± 12.5mm (more than one storey) + 6mm per 3m height (within a storey)
2.	Deviation from the position shown on the plan of any brickwork	Shall not exceed 12.5mm (more than one storey)
3.	Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment	Shall not exceed 6mm
4.	Deviation of bed joint from horizontal in any length, and it	Shall not exceed 6mm (upto 12m) Shall not exceed 12.5mm total (in any length over 12m)
5.	Deviation from the specified thickness of bed-joints, cross-joints or perpends	Shall not exceed ± 3mm
6.	Finished plastered surface	Deviation not more than 4 mm when checked with a straight edge of 2 m length placed against the surface
7.	The average thickness of plaster	Not be less than the specified thickness
8.	The minimum thickness over any portion of the surface	Not less than the specified thickness by more than 3 mm for

		plaster thickness above 12mm and 1 mm for ceiling plaster

11.01.04 Concrete Works

For concreting works provisions of technical specifications and IS: 456 shall apply. A detailed methodology for concrete works shall be submitted by the successful bidder to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for concrete works shall broadly contain the suitability of source of aggregates, cement, admixture, water and reinforcement steel, etc. The available concrete mix design recommended from a specialist institute, results of trial mix carried out at site, method / control of batching, mixing, transportation, layer wise placement, compaction, fixing / removal of form work, staging, fixing of water stops at appropriate locations along with specials, expansion joints, contraction joints and construction joints, cover blocks and method of curing, methodology of repair of newly placed hardened concrete, testing and sampling of concrete during production and placement and acceptance checks for final clearance.

The equipment, deployment of manpower and machinery shall be arranged by the successful bidder to ensure the continuous rate of placement of specified grade of concrete so as to prevent segregation, bleeding, formation of cold joints, temperature control for concreting in extreme weather conditions and for mass concreting works,

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least seven days from the date of placing concrete in case of ordinary Portland cement, not be less than 10 days for concrete exposed to dry and hot weather conditions, at least 10 days or period may be extended to 14 days where mineral admixtures or blended cements are used. Approved curing compounds may be used in lieu of moist curing with the permission of engineer-in-charge.

Reinforcement steel shall conform to relevant IS codes. Lapping / spacing of reinforcement shall be so staggered that under no circumstances more than 50% of bars at any cross section shall be lapped. Corrosion resistance Steel shall be used for the foundations wherever specified in the technical specification. Sample test for 3% of the number of mechanical bars grips subject to a minimum of three, shall be carried out up to the yield strength of reinforcement of bars.

Test shall be conducted for the water tightness of the liquid retaining structures as per technical specifications, IS 3370 and IS 6494.

All the materials, equipments, processes used in pre cast concrete work shall conform to the requirements for the cast-in-situ concrete.

If fly ash is used in concrete, source of supply shall be checked for suitability as per IS 3812 (Part-I). Routine tests for retention of particles on 45μ sieve and loss on ignition shall be carried out on each lot of fly ash before its use. The storage of fly ash shall be similar to that of cement. Separate Silo for fly ash shall be provided in the batching plant. Validation of Mix design using fly ash shall be carried out by an approved specialist agency, before start of concrete production.

The acceptance criteria of concrete shall be in accordance with clause no,16 of IS 456. However in exceptional circumstances and that too in non-critical areas, the engineer may accept concrete work which is marginally unacceptable as per the criteria laid down in IS 456. For such accepted work, payment shall be made at a reduced rate pro rata to the concrete cube strength obtained, against that stipulated.

All records of concreting, reinforcement, testing of materials, as-built dimensions, the details of the rectification, etc, shall be maintained as given below. Four copies of such record in a bound form shall be submitted to owner for their record and future reference.

a) Testing data/report of aggregates including petrographic examination & potential reactivity of aggregate and repeated temperature cycle tests wherever specified.

b) Mix design details and record of trial mixes carried out at site

c) Testing records of admixture as per IS-9103 / ASTM C494 including third party test reports.

d) Approved scheme for concreting

e) Hourly records of concreting including pour card

f) Protocol indicating the dimensional tolerance and details of inserts

g) Records giving the details of rectification giving the location of grouting, the quantity of grout used at each location, type of grout used

h) Bar bending schedule.

i) Location and details of mechanical anchoring used for reinforcement.

j) Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings

k) Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification

l) Temperature control record of concrete at the time of placement if

applicable.

m) Details of curing, staging and fixing / removal of formwork, checklist for formwork as per Clause 9.9 and Annexure-C of IS 14687 including all machine foundations.

n) Batching Plant shall be calibrated regularly at least once in a 3 months Computerized output shall be taken for each batch of production of concrete. For concreting works of ash pipe pedestals, mixer with weight batcher may be used. Production and supply of concrete from batching plant shall conform to the provisions of IS 4926.

o) Dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances for pre cast members as per OWNER Technical Specification. Load test on Pre cast members (except pre- cast tiles to be laid in the reservoir) shall be carried out @ 2% up to 1000 nos., @1% from more than 1000 nos. precast members of one type. The load test shall be carried out as per the provisions of IS-456

TOLERANCES			
Description of Item/ Structural Element		**Max (mm)**	**Min (mm)**
Cast in Situ Concrete			
1.	Faces of concrete in foundations and structural members against which back fill is placed	+25	-10
2.	Eccentricity of footing as percentage of footing width in the direction of placement	2% but limited to 50mm	
3.	Top surfaces of slabs and of concrete to receive base plates to be grouted	+5	-5
4.	Alignment of beams, lintels, columns, walls, slabs and similar structural elements	+5	-5
5.	Cross sectional dimensions of walls, slabs and similar structural elements	+5	-5
6.	Deviation from specified dimensions of cross-section of columns and beams	+12	-6
7.	Alignment of holding down bolts without sleeves	+1.5	-1.5
8.	Alignment of holding down bolts with sleeves	+5	-5
9.	Level of holding down bolt assemblies	+10	-10
10.	Embedded Parts (in any direction).	+5	-5
11.	Level of embedment for equipment support	+1.5	0
12.	Level of embedment for other embedded parts	+5	-5
13.	Centers of pockets or holes with greatest lateral	+10	-10

TOLERANCES				
Description of Item/ Structural Element			**Max (mm)**	**Min (mm)**
	dimension not exceeding 150mm			
14.	Variation in steps • Riser • Tread		 +1.5 +3.0	 -1.5 -3.0
	Pre- Cast Concrete			
15.	Length:	+/-0.1 percent	+/-5	+ 10
16.	Straightness or Bow	1/750 of the length	+/-5	+/-10
17.	Cross-sectional dimensions	+/- 3 mm or +/- 0.1 percent whichever is greater		
18.	Squareness:	When considering the squareness of the corner the length of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.		
19.	Flatness :	The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.		
Placing of reinforcement and for cover		Clause 12.3.1 and 12.3.2 of IS 456		
Formwork		Clause 9.6 of IS 14687 and 11.1 of IS 456		
Batching		Clause 10.2.2 of IS 456		

11.01.05 Structural Steel Work

For structural steel works provisions of technical specifications and IS: 800 shall apply. A detailed methodology for structural steel works shall be submitted by the successful bidder to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The successful bidder shall submit the welding procedures specification (WPS), heat treatment procedures, NDT procedures etc. at least ninety days before scheduled start of erection work at site. All welding and brazing shall be submitted to the OWNER and carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the OWNER.

All brazers, welders and welding operators employed on any part of the contract either in the successful bidder's / sub-contractor's works or at site or elsewhere shall be qualified as per AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the OWNER.

The records of welding procedure qualification and welder qualification test results shall be furnished to the OWNER for approval. However, where

required by the OWNER, the tests shall be conducted in presence of OWNER / authorized representative.

No welding shall be carried out on cast iron components for repair. All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

All Non-destructive examination shall be performed in accordance with written procedures as per International Standards and as mentioned elsewhere in the technical specification. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. The records of RT (Films) and UT (inspection records or printed reports if possible) shall be documented and produced to OWNER.

Low hydrogen electrode (AWS E-7018) for welding of High/Medium tensile steel, for M.S (IS 2062 Gr. A/Gr. B, IS 8500) sections thickness above 20mm shall be used. Preheating and Post weld heat treatment requirements shall be complied as specified in the technical specification / approved WPS.

The requirements of pre-heating shall be

Thickness of thickest part at the area of welding/heat affected zone	Welding using other than low hydrogen welding electrodes IS-2062	Welding using tow hydrogen welding electrodes or submerged arc welding IS 2062
Upto 20 mm (including)	None	None
Over 20 mm to 40 mm (including)	Not allowed	20°C
Over 40 mm to 63 mm (including)	Not allowed	66°C
Over 63 mm	Not allowed	110°C

The following tests / checks shall be carried out for structural steel works

Sl. No.	Tests / Checks	Quantum / Standard
1.	Physical and chemical properties of material if	As per relevant codes, review of correlated mill test certificates or

Sl. No.	Tests / Checks	Quantum / Standard
	supply in the scope of successful bidder	check testing in absence of MTC
2.	Ultrasonic test on plates above 40mm	As per ASTM A435
3.	Welding procedure & welders qualification test	AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards
	Fillet Weld	
4.	Macro-etch examination on production test coupons for main fillet welds	Minimum one joint per built up beams, columns and crane girder etc.
5.	tension member of crane girder	Dye penetration test on 25% weld length
6.	All other fillet welds	DPT on 5% of weld length with minimum 300mm at each location
	Butt Weld	
7.	DPT	100% after back gouging on ail butt welds except for coal bunker bins 10% after back gouging-For coal bunker bins
8.	Mechanical testing of production test coupons	Minimum one joint per built up beam, column and crane girder.
9.	Radiography test on butt welds (In case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1. Wherever RT is not feasible UT to be carried out with the approval of the engineer)	100% RT on butt welds of tension flange (bottom flange) of crane girders 10% RT weld length of each welder on butt welds, except for crane girders and coal bunker 5% spot RT on butt welds / at inaccessible locations UT on butt welds- For coal bunker bins
10.	Ultrasonic testing on full penetration welds (other than butt welds)	100% UT on the web to flange joint of crane girder 10% UT on other full penetration joints
11.	Control assembly check in shop before erection	1st and further every 10th set of identical structure
12.	Dimensional tolerances	as per IS-7215 and IS-12843

Sl. No.	Tests / Checks	Quantum / Standard
	during fabrication and erection	
13.	Surface Preparation and Paint thickness	SA 2.1/2 , By elcometer random after each coat, each member
	CW Liners site fabrication (Field shop)	
14.	WPS.PQR& welder's Qualification	100%
15.	DPT on root run	100% DPT for pipes upto 1200mm diameter
16.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
17.	UT	Not recommended.
18.	RT	5% RT
19.	DPT on finished butt welds	10% DPT
20.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure whichever is higher.
	CW Liners erection site test	
21.	WPS.PQR& welder's Qualification	100%
22.	DPT on root run	100% DPT for pipes upto 1200mm diameter
23.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
24.	UT	Not recommended.
25.	RT	5% RT
26.	DPT on finished butt welds	10% DPT
27.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure whichever is higher. In cases where hydraulic test is not possible the same may be substituted with 100%RT
28.	Tolerances	As per approved drawings, as per IS : 7215 for fabrication and IS : 12843 for erection of steel structures

11.01.05.1 Stoplog and Trash Racks

Structural design shall be as per IS 5620 and IS 4622 and as per details given in technical specifications. The trash rack to be provided shall be Type-

1 trash rack (removable section rack), conforming to IS: 11388 (latest). Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. Leakage test shall be carried out in the stop logs as per the methodology specified in the technical specification. The leakage measured shall not be more than 5 liters/ minute /meter of length of seal under maximum head. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the successful bidder as per the technical specification requirements. The successful bidder shall submit a manufacturing and field quality plans in OWNER format incorporating all the quality aspects mentioned in the technical specifications.

The lifting beam is to be tested for twice the weight of the heaviest component to be lifted by the beam. IS 13591 shall be referred for measurement of the deflection and acceptance criteria.

11.01.05.2 Coal Tar Anti-Corrosion Tape

Coal tar anti corrosion tape shall conform to the requirements of technical specifications. The Manufacturers test certificate for each lot of supply of the coal tar anti corrosion tape shall contain the softening point, needle penetration, filler content, breaking load in the longitudinal direction, service temperature, direct impact test, cathodic disbanding and solubility, in case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to OWNER.

Tests for Adhesion**,** holiday test and thickness shall be carried out at site**.**

11.01.06 Painting Works

Painting works shall be carried out as per the provisions of technical specifications. A detailed methodology for painting works shall be submitted by the successful bidder to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for painting works shall broadly contain the source of approved brand of paints, shot / sand blasting as specified, minimum acceptable size of shot used for blasting, application of primer, intermediate coat and final coat, experience of applicator, etc. testing of painting work and acceptance checks for final clearance. For PU coating works if specified, material shall be procured from OWNER approved source and the application of the PU coating shall be carried out by an experienced authorized applicator of the material supplier approved by OWNER. A separate quality plan and methodology for PU coating works shall be submitted by the successful bidder for approval of OWNER. Based on the approved quality plan, the tests on material and works shall be got conducted at specialist laboratories like IICT Hyderabad, CECRI Karaikudi.

11.01.07 Sheeting Works

All bought out items shall be procured from the manufacturer's approved by engineer and tested as per relevant IS Codes/ Specification. Raw material of colour coated sheets shall meet the chemical & physical properties as per relevant standards / codes referred in the approved data sheet. It shall be tested for colour match, bare metal thickness, weight of Z/AZ coating, thickness of painting system, reverse impact, T-Bend adhesion, scratch resistance, salt spray test for 1000 Hrs. and any other test / properties as specified in the technical specifications. Colour coated sheets shall be marked with video jet printing at the interval not more than 2m bearing manufacturer's name, date and time of manufacturing. Fasteners shall also be tested for 1000 hrs salt spray test as per the requirement of technical specifications.

Bonded Mineral Wool Insulation shall meet the requirements of thickness, density, thermal Conductivity, all other tests as per the technical specifications and IS-8183.

For sheet installation no gas cut opening shall be allowed at the site, whenever opening is specified these shall be properly cut in the factory and shall be filled with lipping / flashing for true shape / dimension etc. The sheets/ packets shall be stacked neatly clear off the ground at an angle to the ground, over a base pallet to provide drainage. Water / moisture should not be allowed to stagnate on surface, or in between layers. This can damage the coating, and cause corrosion.

11.01.08 Tile Works

The execution, finishing, testing and acceptance of tile works shall be as per the provisions of technical specifications. The material for tile works shall be procured from the OWNER approved brand / source**.** Local depressions on account of faulty workmanship, tiles / natural stones with cracked or broken / chipped edges shall not be acceptable.

The tests shall be carried out on acid resistant bricks / tile- water absorption, compressive strength, resistance to acid, flexural strength, dimensions and all other tests as per IS 4860 and IS 4457, bitumastic ready mixed paint as per IS 158, bitumastic as per IS 9510, potassium silicate, resin type and sulphur type mortars as per IS 4832, part I, II and III, surface preparation for painting as per IS 2395, epoxy painting shall be carried for required coating thickness and dry film thickness.

11.01.09 Fire Proof Doors

Fire Proof doors shall be tested for the requirements mentioned in the Technical Specification. The type test of the doors shall be carried out at CBRI Roorkee for minimum 2 hours fire rating and its Fabrication drawing shall also be approved by CBRI, Roorkee. DFT of paint of Fire Proof Doors and its fittings and fixtures as per BOQ shall be checked. The doors shall be finished

with suitable fire retardant painting system

11.01.10 Water Proofing

The execution, finishing, testing and acceptance of water proofing works shall be as per the provisions of technical specifications. The material for the works shall be procured from the OWNER approved brand / source and the works shall be executed by the authorized applicator of the supplier.

Water proofing shall be tested for water tightness by creating a pond of water minimum 25 mm height on area of 6 m x 6 m, for the period of 48 hrs on fully dried elastomeric membrane surfaces. Minimum 5% area of the roof shall be subjected to water tightness test. Such test necessarily be conducted on vulnerable areas like drain channel / drain head. No dampness shall be visible on the underneath side of roof (i.e. ceiling), parapet and wall junctions etc. which have been subjected for testing. The above testing shall be earned out prior to application of wearing course.

11.01.11 Piling Work

For piling works provisions of technical specifications, approved drawings, BOQs and relevant IS codes / standards shall apply. The piling works shall be executed by the agency meeting the qualifying requirements as specified. A detailed methodology for piling works shall be submitted by the successful bidder to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for piling works shall broadly contain the method of boring, stability of bore hole, termination criteria, tests / checks for termination level, fabrication of cage, cage lowering, concrete batching / mixing, transportation, placing, recording of the time of construction operations, method of conducting initial and routine load tests, testing and sampling of concrete during production and placement and acceptance checks on piles for final clearance.

The equipment, deployment of manpower and machinery shall be arrangement by the successful bidder to prevent the collapse of bore hole and to ensure continuous rate of placement of specified grade of concrete.

The piling works shall be executed as per the technical specifications, approved drawings, relevant codes / standards, FQP and BOQ. In addition to the requirements of technical specifications, the following shall also be ensured while execution of piling works :

a) Time gap between completion of pile boring and start of concreting should be kept to the minimum. However the maximum time gap shall not be more than 6 hours.

b) Muck Debris should be removed from the pile bore by air lift technique(by keeping the tremie & air pipe as close as to bottom of

pile bore) i.e. after completion of boring, after completion of SPT(wherever applicable), after lowering reinforcement cage, but before start of concreting.

c) Density of bentonite slurry shall be checked from the sample taken from the bottom of pile bore (not at 1.0 m above the bottom of the pile bore)

d) Minimum two welding sets shall be kept ready to join the two cages of reinforcement by engaging 3 or more welders. This will ensure the lowering of R/F cage in minimum time.

e) While lowering the R/F cage into the pile bore, two hooks shall always be used to ensure balanced/symmetrical insertion of cage into the pile bore.

f) Concrete cover blocks at the junction of two R/F cage shall be ensured before lowering the second segment.

g) Surge concreting of about 1.0 cum shall be ensured at the start of concreting (i.e. in the first pour), by suddenly allowing to fall through the tremie pipe from the funnel. This will help in displacing left out muck/debris in the pile bore (by the impact).

h) Continuous feeding of concrete shall be ensured by deploying at least two transit concrete mixers (if required to be deployed) and mixing done through concrete batching plant (if deployed). Cold joints in the pile shall be avoided.

i) In a pile group, SPT shall be carried out at termination level in the pile, taken up first.

j) Bentonite slurry circulation to be ensured from start of boring to start of concreting. Flushing of bentonite slurry will only ensure maintaining of density of bentonite slurry uniformly and will not allow bentonite jelly to settle at the bottom, whereas air lift technique with bentonite circulation will ensure removal of muck debris from the bottom of pile bore.

k) Properties of drilling mud shall be checked prior to commencement of the piling work and thereafter, minimum once per week or as found necessary by the engineer. One sample consisting of 3 specimens shall be tested for the above.

l) Low strain pile integrity test on all job piles and test piles shall be conducted as specified in the Technical Specification. This test shall be suitably used to identify the piles for routine tests. High Strain dynamic test shall be done as per the technical specification. The frequency of the test shall be as per the BOQ

m) For Working Piles: Minimum one sample consisting of 6 test cubes shall be made for first ten piles. Out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength. Minimum one sample of 6 test cubes for every 25 nos. of piles shall be tested, out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength

Pile Load Test

Pile load testing shall conform to the requirements of IS-2911 (Part IV) and the technical specification. Initial load tests as specified in the contract documents shall be conducted to assess the safe load carrying capacity of pile before start of work. To verify the load carrying capacity of the working piles, routine load test shall be conducted.

Pile load-testing procedure and the test setup / scheme shall be submitted for approval of OWNER. The successful bidder shall use the test setup having arrangement for anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge for both vertical compression and uplift (tension) Load test (initial) on piles. The cost of reaction system / piles shall deem *to* be included in the cost of test piles

All the gauges and instruments shall be calibrated before the start of the tests on test piles and working piles and the calibration record shall be verified before start of execution of the test.

11.01.12 Water Supply, Drainage & Sanitation

Material used for sanitary and plumbing fittings and fixtures shall conform to and be tested as per the requirements of relevant IS Codes specified in OWNER technical specification.

The obstructions in sewer lines shall be checked by inserting a smooth ball, of diameter 13 mm less than the pipe bore at the high end of the sewer or drain. If absence of any obstructions, such as yarn or mortar projecting through the joints, ball shall roll down the invert of the pipe and emerge at the lower end. The straightness shall be checked by means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of the light may be observed. The mirror will also indicate obstruction in the barrel, if the pipeline is not straight.

The service pipes shall be slowly and carefully charged with water, allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under test / working condition of pressure and flow, when all draw-off taps are closed. The service pipes shall be checked for satisfactory support and protection from damage, corrosion and frost.

11.01.13 Architectural & Misc. Works

Material used for sanitary and plumbing fittings and fixtures, floor finishes and allied work shall conform and tested as per the requirements of relevant IS

Codes specified in OWNER technical specification.

Fabricated item like metal doors, windows, ventilators, louvers, rolling shutters and grills etc. shall be checked for correctness of locations and smoothness of operation and fixtures. All controls and locking devices shall give fault free performance. Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 2.5 mm.

Materials used in glass and glazing shall be procured from source approved by OWNER and shall conform to the requirements of the Technical Specification and IS Codes.

False ceiling panels shall be best quality material in thickness and properties called for in the specification / schedule of items. Material Test Certificate to be submitted before bulk supply.

All bought items covered in the scope of contract shall be procured from sources approved by OWNER and shall conform to the requirements of the technical specifications and referred standards / codes.

11.01.14 Road Work

Quality Assurance and testing requirements for roadwork shall be as per the MOSRTH-Specification (Section 900), IRC specifications or CPWD specifications as specified in the technical specifications and BOQ of the contract.

The testing and sampling shall include the checks on earth work for embankment and subgrade, sub bases and bases and bituminous constructions. The sampling and testing of concrete pavements shall be as per the respective items of earthwork, subgrade / sub-base, concrete, etc.

11.01.15 Fabric Expansion Compensator

Each layer of fabric Compensator shall be checked for thickness, unit weight, tensile strength & elongation, composite layer of the expansion joint shall be tested for temperature withstandability test.

Thermal Insulation shall be checked for thickness, density, thermal conductivity test and all other tests as per IS:8183.

Tests and checks on all other items shall be carried out as per relevant codes.

11.01.16 QA Requirements for Slip form Shuttering

1. The monitoring of the leveling of the yoke and the platform of the slip form shuttering to be done in each shift to avoid tilt during the casting.

2. Manning of each shift shall be done by at least two experienced operators and a foreman particularly in night shift.

3. Suitable removal/ reduction of overhung / excess yoke beam length shall be affected with the decrease in the dimension, as per the approved plan.

4. The laser centering method to be deployed for alignment and Monitoring of centre should be done by laser instruments at least two points. Monitoring/Recording of the same shall be done in each shift of 8 hours

5. Shuttering plates to be used for slip form shall be new and the grade of steel shall conform to the specification requirements.

6. The outage of the alignment of centre shall be prevented by creating a counterbalance for alignment purpose to avoid differential loading, arising out of placement of reinforcement bars at one side or unloading of concrete in a hopper at one side of the platform for slip form shuttering.

11.01.17 QA Requirements for Dyke Work/Impervious Soil Fill/ Other Fill Works

The suitability of the fill materials from each source using laboratory/ field tests shall be determined / ascertained by the successful bidder prior to start of filling work and shall be approved by Engineer. The fill material free from shingle, salts, organic matters, roots sod or any other foreign substances shall be used for filling.

11.01.17.1 Embankment Filling

The fill materials shall be free from debris, wood, vegetable matter and other deleterious matter. Control tests shall be carried out in laboratory from time to time to determine whether the fill produced by methods employed satisfies the requirements of the specifications. Routine field tests shall also be carried out by the Engineer and the work shall be inspected regularly. Field density test should be particularly and specially made in the following areas:

a) Where the degree of compaction is doubtful.

b) Where embankment operations are concentrated i.e. where 2 or more layers are placed one over the other on the same day.

c) To represent every 2000 cum in case of earth and/or 1000 cum in case of ash placed in the embankment.

d) Atleast one test for every full or part shift of compaction operations and

e) Atleast one test for every 250 m length of dyke in each layer. The Engineer shall determine whether the desired results are being

obtained.

QA&QC test for Embankment Filling shall be carried out in line with the Technical Specification, PART-B.

11.01.17.2 Impervious Soil Filling

The suitability of the material from each source shall be determined by laboratory tests and shall be approved by Engineer. QA&QC test for Impervious Soil Filling shall be carried out in line with the Technical Specification, PART-B. The spreading of the next layer shall be carried out only after the underlying layer has been approved by the Engineer or his authorized representative.

11.01.17.3 Sand Blanket and Filter

The material for blanket and sand filters shall consist of clean sound and well graded coarse sand. The materials shall be free from debris, wood, vegetable matter and other deleterious matter. The gradation of sand material shall meet the requirements as specified. QA&QC test for Sand Blanket and Filter shall be carried out in line with the Technical Specification, PART-B.

11.01.17.4 Graded Coarse Aggregate Filter

The coarse aggregate material shall consist of durable well graded broken rock of hard stone variety from the specified quarries and shall be approved prior to being transported to the area of deposition. The materials shall range in the size from 10 mm to 75 mm and shall satisfy the specified filter criteria. QA&QC test for Graded Coarse Aggregate Filter shall be carried out in line with the Technical Specification, PART-B.

11.01.17.5 Rock-Toe, Rip-Rap Works, Rr Masonary

Rock toe shall be formed with rock material consisting of sound, durable and well-graded broken rock obtained from approved quarries and shall be of approved quality. The materials shall range in size from 10 to 45 cm. QA&QC test for rock-toe, rip-rap works hall be carried out in line with the Technical Specification, PART-B.

11.01.17.6 Slope Protection Works

Slope protection works with dry brick packing or ash-cement/ soil-cement mortar ash cement concrete on the slopes, confined within brick masonry panel walls shall be constructed with approved quality of materials. Slope protection works with turfing on downstream slope shall be as per IRC standards. Slope protection works with ash cement concrete on the downstream slopes shall be constructed with approved quality of materials. QA&QC tests for slope protection works shall be carried out in line with the Technical Specification, PART-B.

11.01.17.7 Bentonite Liner

Construction Quality Control (CQC) tests as indicated in Table shall be performed by the Successful bidder's Quality Control Team at regular intervals upon completion of the Soil-Bentonite liner.

QCQ Requirements for Impervious Liner

Parameter	Test Frequency per layer
Moisture Content	1 per 5,000 Cum
Field Density	1 per 5,000 Cum
Falling Head Permeability	1 per 25,000 Cum

All CQC test results shall achieve the required values as established by the engineer. Failure to achieve these values shall require re-working of the impervious mixture in the failed areas.

12.00.00 SHOP TEST EOT CRANES, OTHER CRANES & HOIST

1.0 Hooks

1.1 All tests including proof load test as per relevant IS/BS/DTN shall be carried out.

1.2 MPI/DPT shall be carried out after proof load test.

2.0 Steel casting

2.1 DPT on machined surface shall be carried out.

3.0 Girders, end carriage.crab, gear box and rope drum

3.1 The plates of thickness 25mm and above shall be ultrasonically tested.

3.2 NDT requirements on weldments shall be as follows:

a) BUTT welds in tension : 100% RT and 100% DPT

b) BUTT welds in compression : 10% RT and 100% DPT

c) BUTT welds in rope drum : 100% RT and 100% DPT

d) Fillet welds : random 10% DPT

4.0 Forging (wheel, gears, pinions, axle, hooks & hook trunion)

4.1 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to ultrasonic testing.

4.2 DPT/MPI shall be done after hard facing and machining.

5.0 Wire rope shall be tested as per relevant standard.

6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. Gear box shall be subjected to no-load run test to check for oil leakage, temperature rise, noise and vibration.

7.0 The cranes shall be completely assembled at shop for final testing. All tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. As per IS-3177 shall be carried out at shop.

8.0 All electric hoists shall be tested as per IS-3938 and chain pulley blocks shall be tested as per IS-3832.

13.00.00 CATHODIC PROTECTION

Quality of Cathodic protection system shall be as per given table.

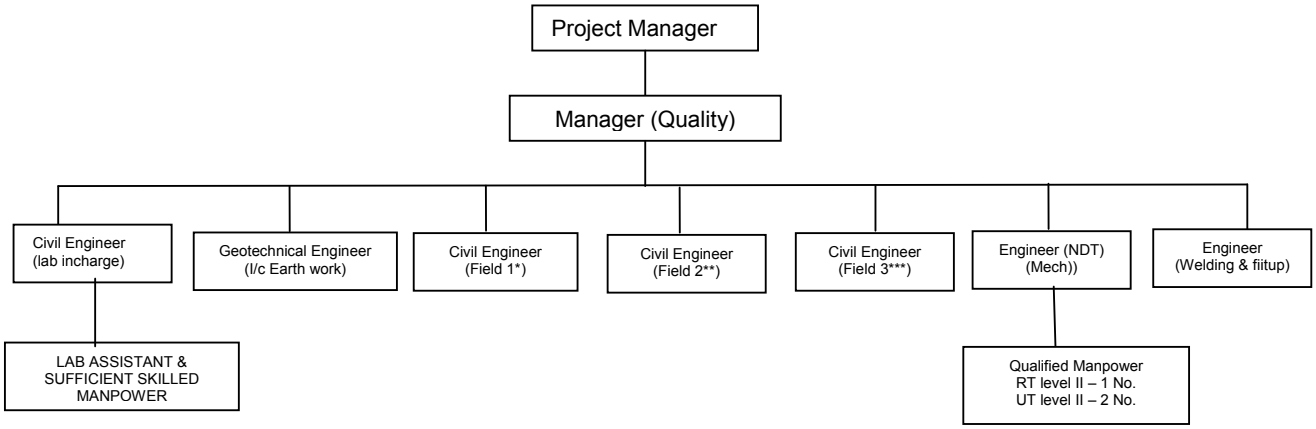
IMPRESSED CURRENT CATHODIC PROTECTION											
Transformer Rectifier Unit											
Attributes Characteristics → / Items / Components / Sub-assembly ↓	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Operational & Functional Checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of TRU as per Owner specification	Efficiency Test on TRU & Transformer	Heat Run Test	Ratio & Polarity Test on TRU	HV & IR Test
Rectifier Transformer (IS : 2026)	Y				Y			Y			Y
Electronic Components	Y				Y						
PCB & Electronic Cards	Y				Y						
Control & Selector Switches (IS : 6875)	Y			Y	Y						
Indicating Meters (IS : 1248)	Y			Y	Y						
Indicating Lamps (IS : 13947)	Y			Y	Y						
Air Break Switches / Fuses (IS : 13947/13703)	Y			Y	Y						
Control Terminal Blocks (IS : 13947)	Y				Y						
Control Transformer (IS : 12021)	Y			Y	Y						
Push Buttons (IS : 4794)	Y			Y	Y						
MCB (IS : 8828)	Y			Y	Y						
PVC insulated Copper control wires (IS : 694)	Y				Y						
Sheet Steel (IS : 513)	Y	Y	Y		Y						
Synthetic Rubber Gaskets	Y	Y			Y						
Annunciator	Y			Y							
Transformer Rectifier Unit	Y					Y	Y	Y	Y	Y	Y

Notes

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to OWNER approval.

ANNEXURE - I

QA & QC ORGANISATION SETUP



NOTE :

1. The above organization setup is minimum however their deployment shall be as per the agreed deployment schedule. The successful bidder shall prepare a manpower deployment schedule in line with the finalized work plan and the same shall be submitted to the engineer-in charge for acceptance/ approval.

2. The successful bidder shall mobilize the QA& QC manpower in line with the finalized manpower deployment schedule and shall ensure their availability well in advance (15 days approx.) of the beginning of the concerned activity/ work.

3. The successful bidder shall further mobilize required number of skilled & supporting staff and additional resources, if any to meet the work schedule.

4. For concrete work 2 Nos. (one for foundation work & one for superstructure)

5. ** For lines and levels -1 No.

6. *** For Finishes and cladding work -1 No

ANNEXURE-II

TYPICAL QA/QC LAB EQUIPMENT

Sl. No.	Equipment	Nos.
1	Vicat Apparatus with deskpot	2
2	Le chatelier flask	2
3	Le chatelier Mould	2
4	Cube Moulds for cement testing	12
5	Vibration Machine	1
6	Length comparator	2
7	Shrinkaqe Bar mould	2
8	Sieve shaker	1
9	Sieves for sand, coarse & fine aqgregate	1 set for each
10	Sieves for coarse aggregate for Road	1 set
11	Proctor testing equipment '	2 sets + 18 cores
12	Slump testing equipment	6 sets
13	Oven	2
14	Physical balance	1
15	Rapid moisture meter	2
16	Thermometer	4
17	Burret	2
18	Measuring cylinders	9
19	Measuring flasks	3
20	Compression testing machine	2 sets of 2000 kN capacity each
21	Cube moulds	30
22	Electronic balance	2 (12 kg capacity), 2 (200 mg capacity)
23	pH balance	As per requirement
24	Radiographic facilities	As per requirement. Party should deploy BARC approved agency for carrying out RT
25	Mechanical weighinq machine	1 (100 kg capacity)
26	Ultrasonic testing machine	As per requirement
27	D.P. Test kit	10
28	Vernier 300 mm. 600 mm	2

Sl. No.	Equipment	Nos.
29	Micrometer (0.25 mm) out side (25.00)	2
30	Radioqraphy film viewer	2
31	Inside Micrometer 25-750 dia	2
32	Digital elcometer for paint thickness	2
33	Baking oven for electrode	3
34	Portable ovens	2
35	Rebar detector to locate the reinforcement before core cuttinq operation	1
36	Concrete coring machine (55mm, 60mm upto 150 mm dia core bit)	1
37	Rebound hammer	1
38	Ultrasonic pulse velocity tester	May be arranged from specialist laboratory.

1. The equipments listed above are indicative and required to be mobilised as minimum requirement, additional equipment if any .required for successful completion of work shall be provided /arranged by the successful bidder.

2. All test reports/ inspection reports have to be computerized and maintained on LAN with an access to the owner

3. Computers - 2 Nos. shall be deployed with Windows operating system and connected to the OWNER server

4. Based on the schedule (L2/L3 Network), Quality control & Quality Assurance work plan shall be finalized by the successful bidder and the same shall be submitted to the engineer-in-charge for acceptance/approval. The Finalized work plan shall be maintained on the computer to be accessed by the owner for database and day to day monitoring.

ANNEXURE-III

INDICATIVE LIST OF BOUGHT OUT ITEMS FOR CIVIL WORKS

Sl. No.	Bought out Item	Proposed Make	Proposed list of Manufacturers
1.	Cement, if procured by Successful bidder		
2.	Structural and Reinforcement Steel, if procured by Successful bidder		
3.	Construction Chemicals- admixtures, waterproofing, accelerators, Epoxy Resin, grouts etc.		
4.	Bitumen, Bitumen Impregnated Fiber Board Joint Filler, Joint Sealing Compound, Bituminous Compound, Joint Sealant		
5.	Colour Coated Sheets		
6.	Paint and Painting System, PU Coating		
7.	Floor Tiles / Flooring/ Acid & Alkali resistant tiles		
8.	Glass and Glazing		
9.	False Ceiling - Glass Reinforced Gypsum System, Mineral Fiber Board System, Pre-painted Coil Coated Steel System		
10.	PVC water stops, hydrophilic strips,		
11.	Particle Boards, Plywood, Fire proof doors		
12.	Roof Water Proofing		
13.	Electro-Forged Gratings		

14.	Anodized Aluminum Sections		
15.	Fittings and fixtures for water supply works		
16.	PVC Pipes and accessories		
17.	Polyethylene water storage tank		
18.	Heavy duty anchor fasteners		
19.	Stop log. Trash Rack, Lifting Beam etc.		
20.	PTFE Bearing		
21.	Flexible Open Bellow Strap		
22.	HDPE Liner		
23.	Cathodic protection system		
24.	Anti weed treatment		
25.	HSFG Bolts		
26.	Any other specific high value and critical bought out Item required, meeting the specification requirements		

Note : The Bidders are required to indicate the list of proposed manufacturers/ sub-vendors for each of the BOI in their Bid proposal, which shall be discussed for finaiization at post bid stage.

LOGO	SUPPLIERS NAME AND ADDRESS:	INDICATIVE FIELD QUALITY PLAN					ANNEXURE- IV A				
		ITEM : CIVIL WORK SUB-SYSTEM : GEOTECH INVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING ETC.		QP NO.: PAGE:	REV. NO.: DATE:	1 0 Page 1 of 18	PROJECT : PACKAGE : CONTRACT NO. MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / Instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
1	GENERAL REQUIREMENTS										
A	Setting up of Field QA&QC" laboratory		As agreed / required	A	Physical	Once prior to start of wort	Tech Specs and Const. Drawings		SR	√	Functioning of laboratory equipment in proper working condition to be verified on monthlv basis
B	Aviaiabilily of requisite laboratory set up and equipment in good working condition well before commencement of concerned activity.		As agreed / required	A	Physical	Once prior to start of work and thereof monthly	Tech Specs and Const. Drawings		SR	√	
C	Submission of QA& QC manpower deployment schedule based on agreed L-2 network.		-	A	Physical	Once prior to start of work	Tech Specs and Const Drawings			√	
D	Availability of QA&QC manpower based on deployment schedule.		-	A	Physical	Once prior to start of work and thereof monthlv	Tech Specs and Const Drawings		SR	√	
E	Sampling for testing of building materials, concrete mix design etc.		As agreed / required	A	Physical	Once per each source	Tech Specs and Const Drawings		SR/TR	√	Test report along with the recommendations from specialist agency to be submitted to the Engineer.
F	Submission of schedule of tests to be done monthly / quaterly and maintenace of the same on a computer connected to LAN for monitoring		-	A	Physical	Once prior to start of work and thereof monthly	Tech Specs and Const Drawings		SR	√	
G	Stacking and storage of construction materials and components at site		As per IS:4082	B	Physical	Random	Tech Specs and Const Drawings and IS: 4082		SR	√	
H	All bought out items to be procured from the approved vendor and on approval of Quality plans by Engineer as per inspection category.		-	B	Verification of TC and/or Testing	100%	Tech. Spec. /BOQ		SR/LB	√	The TC submitted should bear proper identification or correlation with the batch of material supplied and same shall be brought out in the challan/ consignment note.
I	Submission of list of Bought out items and their vendors for each c the bought out item identified for approval within the period agreed in LoA.		-	A	Physical	One time	Tech. Spec./BOQ		SR/LB		To be submitted to CQA for approval with a copy to site .
2	EXCAVATION AND FILLING IN FOUNDATION WORKS										
	Excavations-										
2.1		Nature, type of soil/rock before and during excavations.	As agreed / required	B	Visual	Random in eah shift	Tech Specs and Const Drawings		SR		
2.2		Initial ground level before start of excavations.	As agreed / required	B	Measurement	100%	Tech Specs and Cons! Drawings		SR	√	
2.3		Final shape and Dimensions of excavations.	As agreed / required	B	Measurement	100%	Tech Specs and Const Drawings		SR		
2.4		Final excavation levels	As agreed / required	B	Measuement	100%	Tech Specs and Const Drawings		SR	√	
2.5		Side slope of final excavation	As agreed / required	B	Measurement	Random in eah shift	Tech Specs and Const. Drawings		SR		
2.6		Excavation in Hard Rock- If required									
i)		Receipt, Storage, accountability of Explosive	As agreed / required	B	Physical	Random in each week	Indian Explosive Act 1940/all statutory norms, Tech Specs and Const. Drawings		SR	√	OWNER approved specialist blasting agency such as CMRI, NIRM shall be deployed at site for trial blasts, design blasts, blast vibration monitoring etc. Seismographs shall be deployed at site for monitoring of blast operation vibrations.
ii)		Execution of Blasting Operation	As agreed / required	B	Physical	Random in eah shift	1S:4081, Tech Specs and Const. Drawings		SR	√	
iii)		Submission of Blasting report to E1C	As agreed / required	C	Physical	Each blast	Tech Specs and Const. Drawings			√	

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		ITEM : CIVIL WORK SUB-SYSTEM : GEOTECH INVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING ETC.		QP NO.: REV. NO.: DATE: PAGE:		1 0 Page 2 of 18	PROJECT : PACKAGE : CONTRACT NO. MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / Instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
2.7		Excavation in Hard Rock (Blasting Prohibited)	As agreed / required	B	Physical	100%	As per approved drawing/ scheme, Tech Specs and Const. Drawings		SR	√	
	Fill/Backfill -										
2.8 A	Suitability of borrow fill material - If earth is brouqht from area within the Plant area										
		Suitability	As agreed / required	B	Visual	Randon in each shift	As per technical specifications				
2.8 B	Suitability of borrow fil! material- Applicable in case the earth Is brought from an area, out of the Plant area.										
i		Grain size analysis	Set of Seives, Hydrometer etc.	B	Physical	Once per each type of source or change of source	IS:2720 (Pt.IV), Tech Specs and Const. Drawings		SR/TR	√	The parameters should not be worse than the parameter of the existing soil in plant area
ii		Liquid & plastic limit	Mechanical liquid limit device, grooving tools, Evaporating Disc,Spatula, Palette knives. Balance oven containers etc.	B	Physical	Once per each type of source or change of source	!S:2720 (Pt.IV), Tech Specs and Const Drawings		SR/TR	√	The parameters should not be worse than the parameter of the existing soil in plant area
iii		Shrinkage limit	-do-	B	Physical	Once per each type of source or change of source	18:2720 (Pt.IV), Tech Specs and Const. Drawings		SR/TR	√	The parameters should not be worse than the parameter of the existing soil in plant area
IV		Free Swell Index	Measuring cylinders, etc.	B	Physical	Once per each type of source or change of source	IS:2720 (Pt.XI), Tech Specs and Const-Drawings		SR/TR	√	The parameters should not be worse than the parameter of the existing soil in plant area
V		Chemical Analysis									
a		Organic Matter	Oven , chemical balance, volumetric flasks, burettes, pipettes, conical flasks, set of seives, measunng cylinders etc.	B	Physical	Once per each type of source or change of source	IS;2720 Pt.XXII, Tech Specs and Const. Drawings		SR/TR	√	
b		Calcium carbonate	Reagents and indicators, Burette,flasks,funnels etc,	B	Physical	Once per each type of source or change of source	Part XXIII of IS-2720, Tech Specs and Cons!. Drawings		SR/TR	√	
c		pH value	As agreed / required	B	Physical	Once per each type of source or change of source	Part XXVI of IS-2720, Tech Specs and Const Drawings		SR/TR	√	
d		Total soluble sulphate	As agreed / required	B	Physical	Once per each type of source or change of source	Part XXVII of IS-2720, Tech Specs and Const. Drawings		SR/TR	√	
2.9	Standard proctor Test	Optimum moisture content and max. dry density before fill	As per IS: 2720, Proctor needle apparatus etc.	A	Physical	Once per each type of source or change of source	IS 2720 (Pt.VII). Tech Specs and Const Drawings.		SR/TR	√	
2.10	Moisture content	Moisture content of fill before compaction	As per IS: 2720, bafance, oven etc.	A	Physical	Once per each type of source or change of source	IS 2720 (Pt.II), Tech Specs and Const. Drawings		SR/TR	√	
2.11	Deqree Of Compaction Of Fill / Backfill										
i		Dry density by core cutter method — OR— Dry density in place by sand displacement method	As per IS: 2720/compaction test (core cutter), balance etc.	A	Physical	i) For foundation fill / backfill one for every 10 foundations for each compacted layer.	IS 2720 (Pt. XXIX), Tech Specs and Const Drawings.		SR/TR	√	
						ii) For area filling, one every 1000 SQM area for each compacted layer	IS 2720 (Pt. XXVIII), Tech Specs and Const. Drawings		SR/TR	√	
ii		Relative density (Density Index)	As per IS: 2720, balance oven etc.	A	Physical	—do— (i) & (ii) above	IS 2720 (Pt. XIV), Tech Specs and Const Drawinos		SR/TR	√	
iii		Dry Density by proctor needle penetration	As per IS-2720, proctor nedle apparatus etc.	B	Physical	Random checks to be carried out for each compacted I aver	Tech Specs and Const. Drawings		SR/TR	√	

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		ITEM : CIVIL WORK SUB-SYSTEM : GEOTECH INVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING ETC.		QP NO.: REV. NO.: DATE: PAGE:		1 0 Page 3 of 18	PROJECT : PACKAGE : CONTRACT NO. MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / Instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
3.0	MATERIALS										
	Expert opinion reqarding suitability of construction materials shall be taken from Specialist institute Identified during pre-award)										
3.1	CEMENT										
		Retesting of cement	as per 1S :4031	A	Testing	At Random	As per relevant IS Codes		Test Report	√	Each consignment of cement shall be duly correlated with manufactureres TC, in case the cement is supplied by the contractor one sample from each lot shall be tested for setting time and compressive strength. Acceptance norms shall be as per relevant IS. If cement is stored more than 60 days in godown of contractor same shall be retested for comp. Strength *&* setting time.
3.2	Coarse Aggregate	Moisture content	as per IS : 2386	B	Physical	Once for each stack of 100 Cu.M, or part there of	IS: 456 IS : 383/Tech Spec		SR/LB	√	During monsoon this has to be done every day before start of concreting
ii		Specific gravity, water absorption	IS:2386	A	Physical	Once for each source & for every change of source	IS: 2386 Part-III, 1S:456. IS-383/Tech Spec.		SR/LB/ Test Report	√	
iii		Sieve analysis, flakiness index, elongation index,	IS : 2386	B	Physical	One per 100 cum., or part thereof	IS:2386 Part-I, IS:383/Tech Spec		SR/LB	√	
iv		Deleterious materials (coal & lignite, clay lumps, material finer than 75 micron sieve, soft fragment , shale)	IS :2386	A	Physical	Once per source/on every change of source	IS: 2386 Part-II IS:383/Tech Spec		SR/LB/ Test Report	√	
V		Soundness	IS:2386	A	Physical	-do-	IS: 2386 Part-V, IS : 383		SR/LB/ Test Report	√	
vi		Alkali aggregate reactivity		A	Physical	-do-	IS: 2386 (Part-VII), IS:383 /Tech Spec/ASTM C-1260 / ASTM 1293		SR/LB/ Test Report	√	The aggregate type (deleterious/innocuous result should be supported by petrographic examination
vii		Petrographic examination	IS:2386 Pt VIII	A	Physical	-do-	IS:2386 Part-VIII, IS : 383 /Tech Spec		SR/LB/ Test Report	√	
viii		Crushing value, abrasion value and impact value	IS : 2386	A	Physical	-do-	IS :383. IS-2386 Part IV/Tech Spec		SR/LB/ Test Report	√	
3.3	Fine Aggregate										
i		Moisture content, water absorption	balance, oven etc	B	Physical	To be done every day before start of work	IS : 2386 Part-III IS:383		SR/LB/TR	√	
II		Deleterious materials (coal & lignite, day lumps, material finer than 75 micron sieve, soil fragment,shale)	IS : 2386	B	Physical	Once per source & for on every change of source	IS : 2386 Part-II. IS:383		SR/LB/TR	√	
ii		All other tests similar to coarse aggregates as mentioned above.					IS-2386. IS-383		SR/LB/TR-	√	Except test for flakiness index, elongalion index, abrasion value, impact value
3.4	Water										
i		Test for acidity *&* alkalinity, sulphate and chloride content.	Buret, conical flask pipette etc	B	Testing	One per 3 month for each source	IS:3025 part 22 and 23 (for test procedure) IS:456 for aceptance)		SR/LB/TR	√	
ii		Tests for ascertaining limit of solids	As per IS Code	B	Physical	One per 3 month for each source	IS:3025 part 18 (organic),IS:456		SR/LB/TR	√	
ii		Tests for pH Value	pH meter	B	Testing	One per 3 month for each source	!S :3025, IS:456		SR/LB/TR	√	
3.5	CONCRETE										
i		4 Trial mixes to ascertain the workability and cube strength	After receiving the recommended mix design from specialist agency	A	Physical	One for each mix proportion	Tech specification		SR/LB	√	

LOGO	SUPPLIERS NAME AND ADDRESS:	INDICATIVE FIELD QUALITY PLAN									ANNEXURE- IV A
		ITEM : CIVIL WORK SUB-SYSTEM : GEOTECH INVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING ETC.		QP NO.: REV. NO.: DATE: PAGE:		1 0 Page 4 of 18	PROJECT : PACKAGE : CONTRACT NO. MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / instruments		Class of Check	Type of Check	Quantum of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9		10
ii		Crushing strength (works Tests cubes)	IS:516	A	Physical	One set of 6 cubes per 50 CuM or part thereof for each grade of concrete per shift whichever is earlier.	IS:516, IS:456. Tech. Spec.		SR/LB/ Test Report	√	Min. of 6 cubes for each mix, 3 specimen shall be tested at 7 days remaining 3 shall be for 28 days comp. Strength.
iii		Workability - slump test	IS :1199	B	Physical	At the time of concrete pouring at site every two hrs.	IS:456/ Tech, Spec,		SR/LB/TR	√	
IV		Water content		B	Physical	Once per shift	As per approved design mix.		SR/LB	√	At batching plant
3.5.1	Admixtures for Concrete	Type of admixture	As per IS:9103	A	EIC Approved source arid review of MTC/test reports	For each lot received at site	Design mix and IS:9103		Test Report	√	Admixture of appd. Brand and tested quality shall be used (each lot of admixture shall include brochure in which the type of admixture and its properties shall be clearly indicated.
		Suitability	As per IS:9103	B	Physical	For each lot received at site	Design mix and IS:9103		SR/LB/T R	√	Relative density, pH and slump retention on each batch / lot of admixture and to compare these properties with MTC
3.6	Concrete conveying, placing & compaction										
i		mixing of concrete shall be done in a approved mixer such as to produce a homogenous mix				To be calibrated at the time of starting and subsequently once in three months, and shall conform to IS:4925	Review of calibration chart/ Certificate, IS 4926			√	
ii		Arrangement for transportation & placement of concrete,	As required	C	Visual	100%	Before clearance for concreting		Inspection Report	√	
iii		Calibration of Batching Plant	batcher should comply with reqirement of IS 4926/IS:4925	A	Physical	To be calibrated at the time of starting and subsequently once in three months, and shall conform to 1S:4925	Review of calibration chart/ Certificate		Calibration Certificate	√	Provision of online printer is mandatory
iv		Handiing and Transportation of concrete	As required	B	Physical	100%	As per construction/erection methodology (to be approved one week prior to start of work)		SR	√	
V		Placement of concrete	Visual	B	Physical	100%	As per construction/erection methodology and tech.specs / No segregation		SR	√	
Vi		Temperature Control of Concrete for top deck of TG Foundations.	Thermometer	B	Physical	100%	Temperature as per technical specification		SR	√	
vii		Placement	Visual	B	Physical	100%	As per approved construction methodology		SR	√	
viii		Compacting	As required	B	Physical	At Random	IS:456		SR	√	
ix		Curing	As required	B	Physical	At Random	Period of curing as per IS 456 (use gunny bags / curing compound)		SR	√	
3.7	TEST/CHECK ON RCC STRUCTURE IN HARDENDED CONDITIONS										
		Visual inspection of concrete surface of all dynamic foundations just after removal of shuttering	As required	A	Visual	100%	As per Technical Specification		SR	√	
		Embeddment of inserts in concrete shall be checked for gap if any using hammer for all dynamic foundations	Hammer	A	Visual	100%	As per Technical Specification		SR	√	No hollow sound

LOGO	SUPPLIERS NAME AND ADDRESS:	INDICATIVE FIELD QUALITY PLAN									ANNEXURE-IVA
		ITEM : CIVIL WORK SUB-SYSTEM: GEOTECHINVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING ETC.		QP NO.: REV. NO.: DATE: PAGE:		1 0 Page 5 of 18	PROIECT: PACKAGE: CONTRACT NO. MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
i		Ultrasonic test on top deck of TG foundation	IS :13311	A	Physical	As per Technical Specification	IS:13311		Test report	√	
ii		Core Test	IS: 516	A	Physical	As required by Engineer.	As per IS :456, IS 516		SR/LB/ Test Report	√	
iii		Rebound Hammer test	1S :13311	A	physical	As required by the engineer	As per relevant tech. Specification.		SR/LB	√	
iv		Dimensional check on finished structures & Dimensional tolerances	As required	B	Measurement	Approved Drawing	As per IS:456/ tech. Specification.		SR/LB	√	
V		Water Tightness Test of liquid retaining structure/ tanks	As required	A	Test	100%	IS:3370/ Tech. Specification		SR/LB	√	
3.8	REINFORCEMENT STEEL										
i		Physical and Chemical Properties for each lot as per relevant IS codes	As required/ agreed	A	EIC Approved source and review of MTC/test reports	Each batch of delivery	IS: 1786, IS :432, IS:1566, Tech Specs and Const. Drawings		MTC	√	Applicable if steel is procured by Contractor
ii		Freedom from cracks surface flaws. Lamination.	As agreed / required	B	Visual	Random in each shift	IS : 1852, IS:432,18:1786. Tech Specs and Const. Drawings		SR		To be checked at site. Steel collected from source should be free from excessive rust. To be stored as per Technical Specs.
3.9	PLACEMENT OF REINFORCEMENT STEEL										
i		Bar bending schedule with necessary lap, Spacers & Chairs	As agreed / required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const Drawings, IS :2502		SR	√	
ii		Bending of bars, cutting tolerance	As agreed / required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings, IS :2502		SR	√	
iii		Acceptance - Cover, spacing of bars, spacers and chairs after the reinforcement cage is put inside the formwork.	As agreed / required	B	Visual & Measurement	Random in each shift	Approved Drawings, Tech Specs and Const. Drawings		SR	√	
3.10	STAGING AND FORMS										
i		Materials and accessories	As agreed / required	B	Visual	Once before start of work	As per relevant IS, Tech Specs and Const. Drawings		SR		
ii		Soundness of staging, shuttering and scaffolding including application of mould oil / release agent	As agreed / required	B	Visual	Once before start of work	As per manufacturer's spec. and as per 3696,4014,4990, Tech Specs and Const. Drawings		SR		
iii		Acceptance of formwork before start of concreting		B	Physical / visual	Before start of each concreting	As per provisions and tolerances, Tech Specs and Const. Drawings		SR	√	
3.11	INSPECTION OF CONCRETE SURFACE JUST AFTER REMOVAL OF FORM WORK										
i	Visual inspection jointly with ENGINEER IN CHARGE.	Concrete surface, position and alignment of embedded parts and inserts	-	B	Visual	Once for TG.BFP& MILL foundations	As per provisions and tolerances of equipment supplier, Tech Specs and Const. Drawings			√	Inspection protocol shall be signed Jointly by Contractor, Engineer & Erectors over such foundations/structures.
ii	Submission of grouting / repair methodology if concrete surface / position and alignment of embedded parts / inserts are found defective		-	B	Review and approval	once for each type of defect	As per provisions and tolerances, Tech Specs and Const. Drawings			√	
3.12	EMBEDDED PART(INCLUDING LAYING OF RAILS & ANCHOR FASTENERS)										
i		Position / alignment / levels of embedded parts / bolt hole / pipe sleeves / rails / PVC pipes / etc	As agreed / required	B	Physical/ measurement	100%	As per drawing, Tech Specs and Const. Drawings		SR/ Protocol	√	Exposed surfsce of the embeded parts other than holding down bolts are to be painted with as per technical specifications
ii		Welding / tieing of embeddrment to reinforcement	As agreed / required	B	Physical/ measurement	Random in each shift	As per drawing, Tech Specs and Const Drawings		SR		

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Sl. No	Activity and operation	Characteristics' Instruments		Classof Check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
3.13	PRE-CAST CONCRETE										
i		Crushing strength	compression strength testing machine	A	Physical	one sample of six cubes per 50 m3 or part thereof	IS:516&IS:456		SR/LB	√	A minimum of three specimen shall be tested for 7 and 28 days compressive strength
ii		Workmanship and dimensions	Visual	B	Physical	100%	As per IS:456/ Tech. specification.		Register		
iii		Load Test	As required	B	Physical	1% up to 1000 nos. and 0.5% for more than 1000 nos, for each type	!S:456/ As decided by Site Engr. Incharge.		Inspect on Report	√	
3.14	JOINTS IN CONCRETE										
i		Joint material - bitumen impregnated fibre board, PVC water stops. Sealing compound, Expanded polystyrene board, Hydrophiilic strip. Acrylic polymer etc.	As per manufacturer Standards	A	EIC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const. Drawings, IS 1838, IS 1834. IS12200		MTC	√	
ii		Acceptance of installation	As agreed / required	B	Acceptance	Each installation random!y	Tech Specs and Const. Drawings				
3.15	DAMP PROOF COURSE						Tech Specs and Const, Drawings				
i		Material - Hot bitumen and water proofing materials etc	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each batch of delivery at site	Tech Specs and Const. Drawings, IS 702		SR	√	
II		Acceptance of damp proof course	As agreed / required	B	Acceptance	100%	Tech Specs and Const. Drawings		SR		
3.16	GROUTING										
i		Material	As agreed / required	A	EIC Approved source arid review of MTC/test reports	Each batch of delivery	Tech Specs and Const Drawings		SR	√	
		Type of mix - fluid mix, plastic mix, stiff mix etc.	As agreed / required	B	Physical	Prior to start of work	Tech Specs and Const Drawings		SR	√	
ii		Mixing, placement, application and grout pressure	As agreed / required	B	Physical	Random in each shift	Tech Specs and Const Drawings		SR		
iii		Compressive strength	As agreed / required	A	Physical	Random in each shift	Tech Specs and Const Drawings		SR	√	
IV		Acceptance of the grouts	As agreed / required	B	Physical	Each grout section	Tech Specs and Const Drawings		SR		
3.17	SLIPFORM SHUTTERING										
i		Submission of Slipform Work system		B	Submission	Before Comencement of work	As per specifications		SR		
ii		Check for the Slipform shutters	As required	B	Physical	Before Comencement of work	As per specifications		SR		Check for water level system, Controls, Watkways etc.
iii		Details Positions and arrangement of Jacks	-	B	Approval	Before Comencement of work	As per specifications		SR		Submitted to Engineer for approval
iv		Details of Proposed arrangement for continuous slipform operation		B	Approval	Before Comencement of work	As per specifications		SR		Submitted to Engineer for approval
v		Check for All type of openings, Chases, Fixtures	As required	B	Physical	100% during execution	Construction Drawings and specifications		SR		No openings ,chases, blocks other than that shown in the construction drawings or approved by Engineer shall be executed in the concrete.
vi		Details of proposed method for concrete pouring		B	Approval	Before Comencement of work	Construction Drawings and specifications		SR		Submitted to Engineer for approval
vii		Check of Concrete Curing and Protection	As required	B	Physical	At Random	Construction Drawings and specifications		SR		Concrete shall not remain uncured for period longer than 12 hours
viii		Check for Sliding Operation	As required	B	Physical	Each Sliding	As per specifications		SR		Rate of Sliding, Delays in sliding, Discontunity , stop or start of sliding to be checked.
		Monitoring of Sliding Portion									

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Sl. No	Activity and operation	Characteristics / instruments		Class of check.	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
ix		Progress Height	As required	B	Physical	Six hourly intervals	As per specifications		SR		To be recorded in tabular form and on graphs immediately after each monitoring
X		Centre line in relation to the centers at the time of concrete pouring	As required	A	Physical	Six hourly intervals	As per specifications		SR	√	To be recorded in tabular form and on graphs immediately after each monitoring
Xi		Internal wall faces in relation to the concreting	As required	B	Physical	Six hourly intervals	As per specifications		SR		To be recorded in tabular form and on graphs immediately after each monitoring
xii		Wall thickness	As required	B	Physical	Six hourly intervals	As per specifications		SR	√	To be recorded in tabular form and on graphs immediately after each monitoring
xiii		Twist	As required	B	Physical	Six hourly intervals	As per specifications		SR	√	To be recorded in tabular form and on graphs immediately after each monitoring
xiv		Verticality of the structure	Optical Theodolight	B	Physical	Every day in morning	As per specifications		SR		To be recorded in tabular form and on graphs immediately after each monitoring
xv		Check for Tolerances for Chimney construction	As required	B	Physical	For every day monitoring	As per specifications		SR		
4.00	BRICK MASONARY										
4.1	Test on Bricks										
		Dimensions. shape, compressive strength, water absorption, warpage, efflorescence,	As agreed / required	A	Measurement/ Physical Test	As per relevant IS Code/ One Sample for 30,000 nos. or part thereof	IS: 1077. IS:13757, IS: 12894 /Tech Specs and const. Drawings		Inspection Report	√	Efflorescence shall be checked at each source.
4.2	Test on Mortar										
i		Compressive strength	As agreed / required	B	Test	At random	IS 2250-1981, Tech Specs and Const. Drawings		LB		
i	Sand	Grading	As agreed / required	B	Test		IS :2116		SR/LB		
43	Masonry construction	Workmanship, verticality and alignment	As agreed / required	B	Visual/ Physical	100%	IS 2212, iS 1905. Tech Specs and Const. Drawings		SR/LB		
5.00	FINISHING AND ALLIED WORKS										
5.1	PLASTERING-MATERIAL										
i.	Sand	Deleterious Material	As agreed / required	B	Physical	Once per source	IS: 2386 (Part-I &II) & IS :2116. Tech Specs and Const. Drawings		SR		
ii		Grading	As agreed / required	B	Physical	50 Cum/or part thereof	Tech Specs and Const. Drawings		SR		
II	Galvanised wire mesh	Galvanized hexagonal wire netting for lafh plastering	As agreed / required	B	EIC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const. Drawings		SR		
5.2	PLASTERING - WORKMANSHIP										
i		Curing	As agreed / required	C	Physical	100%	Tech specifications, construction drawings and agreed methodology		SR		
ii		Thickness and finishing of plaster, grooves etc	As agreed / required	B	Visual/ Measurement	Random in each shift	Tech Specs and Const Drawings		SR/LB		
iii		Truness of plastering system	As agreed / required	B	Visual/ Physical	Random in each shift	Tech Specs and Const. Drawings		SR		
5.3	STONE GRIT PLASTER/ GRANULAR TEXTURED COAT FINISH										
i		Materia!	As agreed / required	B	Approved source and review of MTC	For each lot received at site	Tech Specs and Const, Drawings		SR	√	
ii		Thickness, finishing and grooves etc	As agreed/required	B	Visual/ Measurement	Random in each shift	Tech Specs and Const. Drawings		SR	√	

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Sl. No	Activity and operation	Characteristics/ instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	Remarks
1	2	3		4	5	6	7	8	9 D*	10
6.00	SHEETING AND OTHER WORKS									
6.1	PAINTING SYSTEM - CONCRETE WORKS AND PLASTERED MASONARY SURFACES									
i	Materials and accessories- Oil Bound, Acrylic Emulsion. Chemical Resistant, Oil Resistant Paint etc.	Shade, type from brand and manufacturer as approved by EIC	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const Drawings		SR/MTC √	
ii	Surface prepration	As required	As agreed / required	C	Physical /visual	Random in each shift	Tech Specs and Const. Drawings		SR	
iii	Acceptance of painted surfaces	As required	As agreed / required	B	Physical	Each surface at random	Tech Specs and Const Drawings		SR	
6.1.1	PAINTING SYSTEM - STEEL WORKS (OTHER THAN STRUCTURAL STEEL WORKS)									
i		Paining Materials and accessories		A	EIC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const Drawings		SR/MTC √	Mfr.'s T.C. shall be correlated with the consignment received.
ii		Submission of painting methodology	-	B	For Review of painting system	Before start of painting work	Tech Specs and Const Drawings			
iii		Surface prepration	As agreed / required	B	Physical /visual	Each Erection Mark	Tech Specs and Const. Drawings, Relevant code/ standards		SR √	
iv		Primer Thickness	Elcometer	B	Measurement	Each Erection Mark	Tech Specs and Const Drawings		SR √	
v		DFT of paint	Elcometer	B	Measurement	Each Erection Mark	Tech Specs and Const Drawings		SR √	
vi		Acceptance of painted surfaces	Elcometer	B	Visual and measurement	Each Erection Mark	Tech Specs and Const Drawings		SR	
6.2	Modular areated panel	As required	As agreed / required	A	Review of test report	Each batch of delivery	Tech Specs and Const Drawings		SR/LR √	
6.3	Permanently colour coated sheets, metal decking									
i		Storage	As agreed / required	B	Visual	Random in each shift	Tech Specs and Const. Drawings		SR	Prevention of distortion / blemishing / water staining
ii		Installation, lap alignment & workmanship.	As agreed / required	B	Visual/ Physical	Random in each shift	Tech Specs and Const. Drawings		SR	No gas cutting of sheets acceptable. FQP for structural steel shall also be applicable
iii		Finishing and acceptance	As agreed / required	B	Visual/ Physical	Random in each shift	Tech Specs and Const, Drawings		SR/LB	
6.4	INSULATION WORKS									
i	Material	Insulation material, galvanised wire net, aluminium foil, fasteners	As agreed / required	A	EIC Approved source and review of MTC/test	For each lot received at site	Tech Specs and Const Drawings		SR/LB √	All tests as per specification
ii		Acceptance of each type of installation	As agreed / required	B	Visual/ Physical	Each installation	Tech Specs and Const, Drawings		SR/LB	
6.5	PRE-ENGINEERED BUILDING	Installation and acceptance	As agreed / required	A	EIC Approved source and review	For each building	Tech Specs and Const. Drawings		SR/LB √	From approved source / fabricated as per MQP
6.6	CHIMNEY PAINTING									
i		Requirements for Steel Surfaces	As Required	B	Physical	Randomly	Tech Specs and Const. Drawings		SR SR	No of Coats applied and DFT/WFT to be checked as specified .
ii		Requirements tor Cast Iron Surfaces	As Required	B	Physical	Randomly	Tech Specs and Const, Drawings			No of Coals applied and DFT/WFT to be checked as specified.
iii							Tech Specs and Const. Drawings			No of Coats applied and DFT/WPT to be cheeked as specified.
iv		Requirements for Concrete Surfaces	As Required	B	Physical	Randomly	Tech Specs and Const, Drawings		SR SR	Requirement of DFT to he checked as per Specifications. Procurement to be done from
v		Material Requirements	As Required	B	Physical	Randomly	Tech Specs and Const. Drawings			approved/acceplable manufacturer/source.
vi		Preparation of Surfaces	As Required	B	Physical	Randomly	Tech Specs and Const. Drawings			AS per recommendations by Manufacturer along with Relevant IS Codes and
		Application of Paint	As Required	B	Physical	Randomly Randomly			SR SR	Specification requirements
7.00	DOORS. WfNDOWS VENTILATORS & GRILL									
7.1	Steel doors									
i.		Materials (MS sheet, fasteners, hinges, jambs, lock strike plate etc	As agreed / required	A	Visual/ Physical / test report	For each lot received at site	Tech Specs and Const. Drawings		SR/LB √	Review of test report
ii		Flush Door shutters, teak beading	As agreed / required	A	EIC Approved source and review of MTC/test reports	For each lot received at site	IS 2202, Tech Specs and Const Drawings		SR √	Review of test report

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Sl. No	Activity and operation	Characteristics / instruments		Class of Check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	Remarks
1	2	3		4	5	6	7	8	9 D*	10
iii		Hollow metal doors (material and dimensions)	As agreed / required	A	Visual/ Physical/Test report	For each lot received at site	Tech Specs and Const Drawings		√	Review of test report
IV		Acceptance	As agreed / required	B	Visual/ Physical	Random	Tech Specs and Const. Drawings		SR/LB	
7.2	Anodised aluminium works									
i		Materials-Aluminium sections, alkali resistant paint	As agreed / required	A	Visual/ Physical / test report	For each tot received at site	IS: 1948, IS: 1949, IS:733. IS1285, IS: 1868, IS: 11857/Tech Specs and Const. Drawings		SR/LB √	Review of test report. For aluminium door/windows, check for anodisation as per Tech, Spec
ii		Particle Door	As agreed / required	A	EIC Approved source and review of MTC/test reports	For each lot received at site	IS:12823 (phenol formaldehyde synthentic resin, BWP type), Tech Specs and Const. Drawings		SR √	Review of test report
iii		Acceptance	As agreed / required	B	Visual/ Physical	Random	Tech Specs and Const. Drawings		SR	
7.3	Fire proof doors									
i		Source of supply	As agreed / required	A	Review of purchase order (unpriced copy) / drawings of suppliers / certificate of CBRI	For each source	Tech Specs and Const, Drawings		SR √	Procured from Approved parties as per relevant IS/Tech, The door drawing proposed for supply should have been tested and approved by CBRI Roorkee for the similar dimensions for minimum 2 hours fire rating.
ii		Receipt inspection	As agreed / required	A	Visual/ Physical/ Review of MTC	For each lot received at site	Tech Specs and Const. Drawings		SR √	
iii		Finishing and acceptance	As agreed / required	B	Visual / physical	Random	Tech Specs and Const. Drawings		SR	
7.4	Rolling shutters									
i		Surface finish and thickness of plate of approved make and DFT	As agreed / required	A	Physical / visual / review of MTC	Random for each lot of delivery	Tech Specs and Const. Drawings		SR √	
ii		Finishing and acceptance	As agreed / required	B	Physical and acceptance	Random	Tech Specs and Const, Drawings		SR	
7.5	Steel windows / Grills/ Louvre									
i		Material fabrication and fixtures	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery	IS: 1038 / IS: 1361. IS: 7452 and Tech Specs and Const, Drawings		SR √	
ii		Finishing and acceptance	As agreed / required	B	Visual / physical	Random	IS: 1038 / IS: 1361. IS: 7452 and Tech Specs and Const. Drawings		SR √	
7.6	Glass and glazing									
i	Clear float glass, wired glass, tinted glass, curtain glass, hermetically sealed glass	Material	As agreed / required	B	EIC Approved source and review of MTC/test reports	For each lot received at site	IS: 14900, IS:1081, IS: 3648, IS:5437 Tech Specs and Const, Drawings		SR √	
ii		Installation finishing and acceptance	As agreed/required	B	Visual/ Physical	Random	Tech Specs and Const, Drawings		SR	Leak proof installation with neoprene gasket
7.7	Curved dome on roof/ Poly Carbonate Sheet									
i	Source of supply	impact strength, K value, light transmission value with class -1 fire rating	As agreed / required	A	EIC Approved source and review of MTC/test reports	For each lot received at site	Tech Specs and Const, Drawings		SR √	
ii		Installation finishing and acceptance	As agreed /required	B	Visual / physical	Random	Tech Specs and Const. Drawings		SR	
7.8	Reflective toughened glass									
i		Material	As agreed/required	A	EIC Approved source and review of MTC/test reports	For each lot received at site	Tech Specs and Const. Drawings		SR √	

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Sl. No	Activity and operation	Characteristics / instruments		class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms,,,	Format of .....Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
ii		Installation finishing and acceptance	As agreed / required	B	Visual / physical	Random	Tech Specs and Const. Drawings		SR		
7.9	False Ceiling										
i		Materials (gypsum glass, glass fibre membrane, fibre board acoustical tiles etc)	As agreed / required	A	EIC Approved source and review of MTC/test reports	For each tot received at site	Tech Specs and Const Drawings		SR	√	Compare MTC with technical specification and requirement
ii		Installation finishing and acceptance	As agreed / required	B	Visual / physical	Random	Tech Specs and Const Drawings		SR		
7.10	WATERPROOFING										
		Methodology for the application of water proofing system	As required	B	Review	for each type of treatment	Tech Specs and Const Drawings		SR	√	
7.10.1	General Requirement- Water Proofing										
i	Polyurethene based coating, polyester scrim cloth, extruded HD dimpled polyurethene	Material	As agreed / required	A	EIC Approved source and review of MTC/test reports	For each lot received at site	Tech Specs/Const Drawings		SR	√	MTC shall contain all the parameters specified in the technical specifications
ii		Acceptance of water proofing work	As agreed / required	B	Physical	100%	Tech Specs and Const, Drawings				
7.10.2	Roof / Basement Treatment										
i	Graded under bed	Levels / slopes	As required	C	Physical	100%	Tech Specs and Const. Drawings				
ii	Elastomaric coatings	Material- Primer coat, finishing coat	As required	B	EIC Approved source and review of MTC/test reports	Each lot of delivery	Tech Specs and Const. Drawings		SR	√	
iii	Wearing course	Materials - PCC, chicken wire mesh, elastomeric sealant	As required	B	Review of MTC	Each lot of delivery	Tech Specs and Const. Drawings		SR	√	
iv		Acceptance of water proofing work	As agreed / required	B	Physical	100%	Tech Specs and Const Drawings				
7.11	Fencing and Gates										
i	PVC coated chain link fencing (IS 2720), Welded wire mesh (IS 1566), Reinforced barbed !ape galvanised (IS 2629) etc.	Materials	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const, Drawings		SR/MTC	√	MTC shall contain all the parameters specified in the technical specifications
i	Structural steel, painting system, caster wheel, ball and bearing, fixtures and fasteners	Materials	As agreed / required	A	ESC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const. Drawings		SR/MTC	√	MTC shall contain all the parameters specified in the technical specifications
ii		Alignments, erection painting, DFT etc.	As agreed / required	B	Physical / measurements	Each installation	Tech Specs and Const Drawings		SR		
iv		Acceptance of the installation and working	As agreed / required	B	Physical / measurements	Each installation	Tech Specs and Const. Drawings		SR		
7.12	FLOOR FINISHES AND ALLIED WORKS										
7.12.1	Cement Concrete Flooring										
		Glass/ PVC strips in joints	As agreed / required	B	Physical	Random in each shift	Tech Specs and Const Drawings		SR		
ii		Finishing and acceptance	As agreed / required	B	Physical	100%	Tech Specs and Const Drawings		SR		
7.12.2	Tiles										
i	Ceramic, vitrified, glass mosaic, acid alkali resistant, heavy duty cement concrete tiles	Materials	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery	Tech Specs and Const Drawings		SR	√	MTC shall contain all the parameters specified in the technical specifications
ii		Finishing and acceptance	As agreed / required	B	Physical	100%	Tech Specs and Const. Drawings		SR		

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Sl. No	Activity and operation	Characteristics / instruments		Class of Check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Formal of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
7.12.3	Interlocking Blocks										
i		Materials	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery	Tech Specs and Const Drawings		SR	√	MTC shall contain all the parameters specified in the technical specifications
ii		Finishing and acceptance	As agreed / rewired	B	Physical	100%	Tech Specs and Const. Drawings		SR		
7.12.4	Kota Stone, Granite and Marble										
i		Quality, texture, thickness, coiour for each lot of delivery from approved source	As agreed / required	B	Physical	Each batch of delivery	Tech Specs and Const Drawings		SR	√	
ii		Finishing and acceptance	As agreed / required	B	Physical	100%	Tech Specs and Const Drawings		SR		
7.12.5	Metallic /non-metallic hardener										
i		Material	As agreed / required	B	Physical	Each batch of delivery	Tech Specs and Const. Drawings		SR	√	
ii		Finishing and acceptance	As agreed / required	B	Physical	100%	Tech Specs and Const Drawings		SR		
7.12.6	Acid / alkali and oil resistant high built seamless epoxy based resin and treatment										
i	Material	Bricks, vitreous files, mortar, sealing, paints, coatings, sheets, fillers etc.	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const Drawings		SR	√	Experienced workers under supervisors recommended/ appointed by manufacturer to be deployed
ii		Surface preparation	As agreed/required	B	Physical	Random in each shift	Tech Specs and Const. Drawings, IS				
iii		Finishing and acceptance	As agreed / required	B	Physical	100%	Tech Specs and Const Drawings		SR		
7.12.7	Rubber Flooring										
i		Material	As agreed / required	A	EIC Approved source arid review of MTC/test reports	Each batch of delivery	Tech Specs and Const Drawings		SR	√	MTC shall contain all the parameters specified in the technical specifications
ii		Finishing and acceptance	As agreed / required	B	Physical	100%	Tech Specs and Const. Drawings		SR		
7.13	Doors/Windows Sections										
i	Material -Rolled Steel,.Z Sections,T-iron frames sections. Plates etc.	Review of MTC/ make / Physical checks, tests (if MTC is not available)	As agreed / required	A	EIC Approved source and review of MTC/lest' reports	For each batch of delivery	Tech Specs and Const Drawings		SR	√	
ii		Acceptance of Steel Glazed doors and T-iron frames sections after fixing	As agreed / required	B	Physical and acceptance	Random for each installation	Tech Specs and Const Drawings		SR		
8.0	WATER SUPPLY/ SANITORY INSTALLATIONS										
8.1	Water supply fittings and fixtures										
i	Materials	GI/ MS pipes and fittings	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	Tech Specs and Const, Drawings		SR	√	
ii	Disinfection	Before use	As agreed / required	B	Physical	Each installation	Tech Specs and Const. Drawings		SR	√	
ii	Hydraulic test	Before use / leakage	As agreed / required	A	Physical	Each installation	Tech specs and const drawings		SR	√	
iv		Acceptance and working	As agreed / required	B	Acceptance	Random	Tech Specs and Const, Drawings		SR		
8.2	Sand cast iron / cast iron pipes										
i	Material	SCI / CI pipes and fittings /joints	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	Tech Specs and Const Drawings		SR	√	
ii		Acceptance and leakage	As agreed / required	B	Physical	Random	Tech Specs and Const Drawings		SR		

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		ITEM : CIVIL WORK SUB-SYSTEM: GEOTECHINVI, FOUNDATIONS, EXCAVATION & FILL SITE LEVELLING, CONCRETE, ROAD, BUILDING ETC.		QP NO.: REV. NO.: DATE: PAGE:	1 0 Page 12 of 18	PROJECT: PACKAGE: CONTRACT NO. MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / instruments		Class of Check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	Remarks
1	2	3		4	5	6	7	8	9 D*	10
8.3	Sanitary fittings and fixtures									
i	Material	Sanitary items and fixtures i.e. water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap containers, geyser, water cooler, etc, water supply / sanitation pipes, manhole cover and frames etc.	As agreed / required	B	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	Tech Specs and Const Drawings		SR √	
ii		Acceptance of installations of ail sanitary terns and fixtures	As agreed / required	B	Acceptance	100%	Tech Specs and Const Drawings		SR	
8.4	RCC Pipes									
i	Material	RCC pipes	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings		SR √	
ii		Acceptance and leakage	As agreed / required	B	Physical	Random	Tech Specs and Const Drawings		SR	
8.5	Water Storage Tanks									
i	Material	Over head / loft type	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	Tech Specs and Const. Drawings		SR √	
ii		Acceptance and leakage	As agreed / required	B	Acceptance	Random	Tech Specs and Const. Drawings		SR	
9.0	SPECIAL ITEMS									
9.1	Earthing Mat (Grounding System)									
i	Material	Earthing mat	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	As per relevant IS and Tech. Specs / Manufacturer's, IS 3043		SR/MTC √	
ii		Weld sizes & length	Visual/Tape	B	Visual/ Measurement	100%	Tech Specs and Const, Drawings			Approved electrodes shall be used
ill		DP test	DP test Kit	A	Physical	10% at random of the offered lot	Tech Specs and Const, Drawings		TR √	
iv		Earth test	Earthing test kit	A	Physical	100%	Tech Specs and Const Drawings,		SR √	
9.2	Bitumen layer for tank foundation									
i	Material	Grade of bitumen	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	As per relevant IS and Tech. Specs /MTC		SR/MTC √	
ii	Acceptance and workmanship	Application / workmanship	As agreed / required	B	Physical	Random	Tech Specs and Const Drawings		SR	
9.3	Composite Aluminium Panels and structural glazing									
i	Material	Type of aluminium panels / structural glazing / fasteners and fixtures / silicon sealant	As agreed /required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	Technical specifications / drawings		SR/MTC √	MTC shall cover all the properties / parameters as per technical specifications.
ii	Acceptance and workmanship	Installation / workmanship	As agreed / required	B	Physical	Random	Technical specifications/drawings		SR	
9.4	Pressure Release Valves									
i	Material		As agreed / required	A	EIC Approved source and review of MTC/test reports	Each lot of delivery as per Specifications	Technical specifications / drawings		SR/MTC √	
ii	Acceptance and workmanship	Acceptance / Installation / workmanship	As agreed / required	B	Physical	Random	Tech Specs and Const Drawings		SR √	

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
10.0	ANTI WEED TREATMENT										
i		Anti-weed treatment materials	As agreed / required	A	EIC Approved source and review of MTC/test reports	Each batch of delivery	Tech Specs and Const. Drawings		SR	√	
ii		Execution of treatment	As agreed / required	B	Physical	Random check for each treatment	Tech Specs and Const. Drawings		SR		
11.0	PILING WORK (if Applicable)										
11.1	Execution										
i		100 mm Dia Borehole	As required	A	Physical	100%	Tech. Specs		SR/LB	√	if carried out by the contractor
ii		Pile layout	Total station	B	Measurement	100%	As per approved Drawings and technical specification		SR/LB	√	
iii		Recording ground level	As required	B	Measurement	Random	IS:29l1,as per appd. Drawings and technical specification		SR/LB	√	
iv		Cleaning/Flushing of pile bore	As required	B	Visual	Random	As per appd. Drawings and technical specification		SR/LB	√	
V		Size of bore and during boring of pile record commencement of SPT/ core recovery to ensure socketing length equivalent in terms of the Diameter of the pile below the socketing horizon.	As required	B	Measurement	100%	As per appd. Drawings and technical specification		SR/LB	√	
vi		Trial mix to ascertain the workability and cube strength	After receiving the recommended mix design from specialist agency.	B	Physical	One for each mix proportion	Tech Specification		SR/LB	√	Necessary correction for moisture content and water absorption according to mix design recommendation may be carried out during the trial mix
VII		Cement content	As required	B	Physical	Once per shift	As per approved design mix.		SR/LB	√	At batching plant
viii		Pouring of concrete to project above cutoff level.	As required	B	Measurement	100%	As per appd. Drawings and technical specification		SR/LB	√	
IX		Pile termination level	SPT & core recovery	A	Soil data	As per Specifications	As per appd. Drawings and technical specification		SR	√	
11.2	Testing										
i		Bentonite	1S:2720	A	Physical/testing	Once per source	As per IS:2720 / tech. Specs.		SR/LB	√	Review of test report
ii		Density check on sample of mud collected from pile bore bottom	Sample collection	A	Physical	As per Tech. Spec.	As per Tech Spec.		SR/LB	√	Tests to be done before placing concrete. Samples to be collected from pile bore bottom.
iii		Sump test of concrete	IS:1199	B	Physical	Every 2 hrs at pouring point of concrete	IS:2911, As per appd. Drawings and technical specification		SR/LB	√	
iv		Cube sampling for works cube test	IS:456	B	Physical	One set of 6 cubes per 50 Cu.M or part thereof for each grade of concrete per shift whichever is earlier.	IS:29l1,As per appd. Drawings and technical specification		SR/LB	√	
V		Initial pile load test. Vertical (Compression), Lateral (horizontal) and pullout (tension).	IS:2911 /as required	A	Testing	100% for 3 nos. for each type or as specified in BOQ/Tech. Spec.	IS:2911, As per appd. Drawings and technical specification		SR/LB	√	In case of compression test method the loading shall be cyclic.
Vi		Routine pile tests, compression and horizontal	Caiibrated dial gauges etc, as required.	A	Testing	100% for 0.5% of the total number of piles provided for each type of test/Tech. Spec.	IS:2911, As per appd. Drawings and technical specification		SR/LB	√	Routine Test shall be conducted by direct loading method,
vii		Integrity Tests	PEM	A	Testing	100%	!S:2911, As per appd. Drawings and technical specification and suppliers manual		Tes1 Report	√	CHP
12.0	FOUNDATION SYSTEM										
	SHALLOW FOUNDATIONS										
i		Foundation excavation - Location, Layout. size, depth etc	As required / agreed	B	Physical	Each location	As per technical specifications and construction drawings		SR		lines and levels to be checked

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1	2	3		4	5	6	7	8	9	D*	10
ii		Foundation casting - Layout, Shape, dimensitions, Reinforcement, concreting, curing etc	As required / agreed	B	Physical	Each foundation	As per technical specifications and construction drawings		SR		lines and levels to be checked. Concrete Grade to be checked as per Mix Design
13.0	ROAD WORKS										
13.1	Construction of Sub-Grade and earthen/hard soulders										
i		Standard proctor Test	As per IS: 2720	A	Physical	One in every 2000 cum for each type and source of fill materials	As per Tech Specs and Const. Drawings,Section 900 of MOSRTH specification IS 2720 (Pt.VII)		SR/TR	√	In cutting or existing levelled ground -quantum of check shall be one per 1000 SQM
ii		Moisture content of fill before compaction	As per IS: 2720	B	Physical	One in every 2000 cum for each type and source of fill materials	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification, IS 2720 (Pt.II)		SR/TR		In cutting or existing levelled ground -quantum of check shall be one per 1000 SQM
iii		Dry density by core cutter method — OR— Dry density in place by sand displacement method	As per IS: 2720	A	Physical	One in every 500 SQM area for each compacted layer.	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification, IS 2720 (Pt. XXIX)/ IS 2720 (Pt. XXVIII),		SR/TR	√	Both for embankment and cut formation quantum of check - One in every 1000 SQM area for each compacted layer.
iv		Lines, grade and cross section	As required / agreed	B	Physical	One in every 500 SQM area	As per Tech Specs and Const. Drawings		SR		Template, straight edge
13.2	Water Bound Macadam (Non-Bituminous) for base course and sub-base course										
i		Aggregate Impact value	Aggregate impact value Test Apparatus	A	Physical	One test per 200 cum of Test aggreqate	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification,		SR	√	
ii		Grading	Set of IS Sieves	B	Physical	One test per 100 cum of aggregate	As per Tech Specs and Const Drawings, Section 900 of MOSRTH specification		SR		
iii		Flakiness index and elongation index	Flakiness test gauge	B	Physical	One test per 200cun of agregate	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
IV		Atterberg Limits of binding material	Atterberg limits . determination	A	Physical	One test per 25 cum of bindinq material	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification,		SR	√	
V		Atterberg Limits of portion of agreggate passing 425 micron sieve	Atterberg limits determination	A	Physical	One test per I00 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification.		SR	√	
vi		Camber, surface, slope	As required / agreed	B	Physical	One in every 500 SQM area	As per Tech Specs and Const. Drawings		SR		Template, straight edge
13.3	Bituminous Macadam for base and binder course										
i		Quality of binder	Penetrometre with St. needle	A	Physical	No. of samples per Lot & tests as per 1S:73, tS-217,1S:8887 as appli cable.	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification, IS 73		SR	√	
ii		Aggregate Impact Value / Los angles abrasion value	Aggregate Impact ValueTest apparatus	A	Physical	Once per source	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
iii		Flakiness Index and elongation index oF aggregates	Flakiness test gauge	B	Physical	One test per 50 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
IV		Stripping value of aggregate (Immersion tray test)	As required / agreed	B	Physical	Initialy one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
V		Water sensitivity of mix	As required / agreed	A	Physical	Initialy one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const Drawings, Section 900 of MOSRTH specification		SR	√	
vi		Grading of aggregates	Set of Sieves	B	Physical	Two test per day per plant both on individual constituents and mixed aggregate from dryer	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
Vii		Water absorption of aggregate	As required / agreed			Initially one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const Drawings, Section 900 of MOSRTH specification		SR		

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1	2	3		4	5	6	7	8	9	D*	10
VIII		Soundness { Magnesium and Sodium Sulphate)	As required as per IS:2386	A	Physical	Once per source by each method and on every change of source	As per Tech Specs and Const, Drawings, Section 900 of MOSRTH specification		SR	√	
IX		Percentage of fractured faces	As required / agreed	B	Physical	When gravel is used one test per 50cum of aggregates	As per Tech Specs and Const Drawings, Section 900 of MOSRTH specification		SR		
X		Binder content and aggregate grading	Bitumen extractor	A	Physical	Periodic, subject to a min of two tests per day per plant	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
xi		Control of Temperature of binder and aggregate for mixing and of the mix at the time of laying and rolling	Thermometer	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
xii		Rate of spread of mixed materials	As required / agreed	B	Physical	Regular control through checks of layer thickness	As per Tech Specs and Const, Drawings, Section 900 of MOSRTH specification		SR		
xiii		Density of compacted Layer	As required / agreed	A	Physical	One test per 250 sq.m of area	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
13.4	Bituminous Surfacing . Open	graded premix carpet and Seat coat									
i		Quality of binder	Penetrometer with St. needle	A	Physical	No. of samples per Lot & tests as per 1S:73, IS:217. IS:8887	IS 73,Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
ii		Aggregate Impact Value / Los angles abrasion value	Aggregate Impact ValueTest apparatus	A	Physical	One test per 5O cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
iii		Flakiness Index and elongation index of aggregates	Flakiness test gauge	B	Physical	One test per 50 cum of aggregate	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification.		SR		
IV		Stripping value of aggregate (Immersion tray test)	As required / agreed	B	Physical	Initialy one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
V		Water absorption test		A	Physical	Initialy one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const Drawings, Section 900 of MOSRTH specification		SR	√	
VI		Water sensitivity of mix	As required / agreed	A	Physical	Initialy one set of 3 representative specimen per source, and on every change of source.	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
VI!		Grading of aggregates	Set of Sieves	B	Physical	One test per 25 cum of aggregates	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
viii		Soundness (Magnesium and Sodium Sulphate)	As required as per IS:2386	A	Physical	One per source by each method and on every change of source	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
ix		Polished stone value	As required as per BS :812 (Part 114).	B	Physical	As required	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
X		Temperature of binder at application	Thermometer	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
XI		Binder content	Bitumen extractor	A	Physical	One test per 500 cum& not less than two tests per day	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
xii		Rate of spread of materials	As required / agreed	B	Physical	One test per 500 cum and not less than 2 tests per day	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		

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1	2	3		4	5	6	7	8	9	D*	10
xiii		Percentage of fractured faces	Bitumen extractor	A	Physical	When gravel is used one test per 50cum of aggregates	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
13.5	Tack Coat/ Prime coal/ fog coat										
i		Quality of binder	Penetrometre with Standard needle	A	Physical	No. of samples per Lot & tests as per IS:73, IS:217,IS:8887	IS 73,Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR	√	
ii		Temperature of binder at application	Thermometer	B	Physical	At regular close intervals	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
iii		Rate of spread of binder	As required / agreed	B	Physical	One test per 500 cum and not less than *2* tests per day	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
13.6	RCC Pavements	Concrete - Material, Mix design. Trial Mixes, Production, Transportation, Placement, Compaction, Curing, Test on green concrete. Test on hardened concrete etc.	As required / agreed			Refer FQP for concrete Works	Refer FQP for concrete Works, Tech Specs and Const, Drawings, IRC & MOST				FQP for Concrete Works shall be application for all concrete works
13.7	Alignment, Level, Surface regularity and rectification										
i		Horizontal alignment, Surface levels and Surface regularity	As required / agreed	B	Physical	As per section 900 of MOSRTH specification	As per Tech Specs and Const. Drawings, Section 900 of MOSRTH specification		SR		
ii		Rectification	As required / agreed	B	Physical	Each rectification	As per Tech Specs and Const Drawings, Section 900 of MOSRTH specification		SR	√	
14.0	ASH DYKE										
14.1	Embankment filling works										
i		Core cutler with dolly hammer oven balance with weight in-situ Dry Density		A	Physical	i) Once for every 3000 cum for earth or part there of.	iS: 2720 and Technical Specifications		SR/TR	√	Atleast one test for every full or part shift of compaction operation irrespective of progress
				A	Physical	ii) Once for every 5000 cum for earth or part there of separately for cut off trench, homogeneous embankment and core & outer shells, of zoned embankment	95% of maximum of dry densily (standred procter) for homogeneous embankment and outer shells 98% for cut off trench for impervious and 100% for filling in pipe trenches if less additional rolling to be done till specified density is achieved		SR/TR	√	
				A	Physical	iii) Once for every 5000 sq.m of area on the trimmed slopes.	---------do ----------		SR/TR	√	
				A	Physical	iv) Once every 250 m length of dyke in each layer separately for cut-off trench,embankment ,core and outer shells.	---------do ----------		SR/TR	√	
				A	Physical	v) Once for every 50 m width or part thereof ,in each layer separately for core/shell of the dyke.	---------do----------		SR/TR	√	

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1	2	3		4	5	6	7	8	9	D*	10
ii		Moisture Content	Oven moisture dish,	A	Physical	One test for every sample	IS: 2720 & Tech Spec,		SR/TR	√	
			physical bal.								
			and weight								
iii		Permeability	As per	A	Physical	Once for every	IS: 2720		SR/TR	√	For cut-off trench impervious clay blended with 2 % bentonite and permeability k = 1 $X10^{-6}$ to be used
			relevent IS:			5000 cum for	The coefficient of permability,				
			code			cut off trench	K shall be less than 1x10 $^{-6}$ cm/sec				
						and core (for					
						clayey soil as well					
						as soil-bentonite					
						mix.)					
IV	Dyke Geometry										
a		Top width	As per	B	Physical	Once for every	Technical Specifications		SR/TR		
			Technical			100m length of	Not less than 6.0 meter				
			Specification			trimmed					
						completed dyke					
b		Outer Slope	As per	B	Physical		Tecnnicai Specifications and construction drawings		SR/TR		
			Technical			----- DO -------					
			Specification								
							Technical Specifications and construction drawings				
c		Inner Slope	As per	B	Physical	— Do ------			SR/TR		
			Technical								
			Specification								
14.2	Preparation of foundation surface										
											The foundation shall be free from all organic materia!. vegetables
		For embankment founda-	Visual	B	Physical	Onces for every	IS:2720 & Technical Specifications		SR/TR		and weak layers of compressive materials such as clays and low
		tions only visual				2000 sq.m. of					density sills,
		inspection to see				foundation area					
		that all voids									For all excavations made for test pits and other sub surface investigations and all other existing cavities found within the zone below the established lines of excavation for embankment foundation.
		have been filled									
		up and no cracks									
		are exposed.									
14.3	Coarse Aggregate for concrete and aggregate filters										
		a) check for gradation	IS:sieves	B	Physical	Once for each stack and each change of source	IS:2386 part I and IS:383 and Technical Specifications		SR/TR		As per IS:383 for concrete and as per filter criteria of technicai specification chapter II
		b) specific gravity	pycnomeler	B	Physical	Once for each stack and each change of source	IS:2386 Part 1. and IS:1122 and Technical Specifications		SR/TR		Minimum Sp Gravity 2.40 for concrete and 2.5 for filter
		c) crushing value (for concrete only}	as required	A	Physical	Once for each source	IS:2386 Part IV Technical Specifications		SR/TR	√	as per 1S:383
		d) sulphate soundness	Chemicals, balances etc	A	Physical	Once for each source	1S:2386 Part V, IS:1126 Technical Specifications		SR/TR	√	as per !S:383 for concrete and maximum 10 % weight loss after five cycles for filter materials
		f) impact value	as required	A	Physical	Once for each source	IS:2386 Technical Specifications		SR/TR	√	maximum 30 %
		g))water absorption	weight balance etc	A	Physical	Once for each source	IS:2386 Technical Specifications		SR/TR	√	Maximum 2.5%
		h) slake durability (for filter only)	as required	A	Physical	Once for each source	IS:10050 Technical Specifications		SR/TR	√	percentage retained after two 10 minutes cycles shall be more than 85%

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Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
14.4											
i		moisture content (for concrete and mortar only)	as required	B	Physical	Once per week	IS:2386, IS:363 and Technical Specifications		SR/TR		
ii		gradation- grain size analysis	sieve set	A	Physical	Once for each source	IS.-2386 Part I. IS :9429 & IS :383 and Technical Specifications		SR/TR	√	
iii		specific gravity	pycnometer	A	Physical	Once for each source	IS:2386 part-I and Technical		SR/TR	√	min 2.40
14.5 Rock Material for Rip Rap, Rock Toe and Random Rubble Masonry											
i		Specific gravity	as required	A	Physical	Once for each source	IS:1122 and Technical Specifications		SR/TR	√	Min 2.5
ii		sulphate soundness	Chemicals, oven balance etc,	A	Physical	Once for each source	IS:1126and Technical Specifications		SR/TR	√	Maximum 10% weight loss after five cycles
iii		Impact Value	Impact Value testing appratus	A	Physical	Once for each source	IS:2386 and Technical Specifications		SR/TR	√	Max. 30%
iv		Water absorption	Balance, oven	A	Physical	Once for each source	IS:2386 and Technical Specifications		SR/TR	√	Minimum 2.5%
v		slake Durability	as required	A	Physical	Once for each source	IS:10050 and Technical Specifications		SR/TR	√	Minimum 85 % after two cycles of 10 minutes
vi		placement profile thickness	as required	B	Physical	Random in each shift	IS:8237 and Technical Specifications		SR/TR	√	
15.0	GEOTECHNICAL INVESTIGATION WORK										
i		Deployment of approved Geotechnical Investigation Agency - Equipments, Manpower etc	As required/agreed	A	Physical	Once before commencement of work	As per technical specifica!tons and relevant IS Codes		SR	√	
ii		Execution of Geotechnical Investigation locations, type etc as per scheme	As required / agreed	B	Physical	Each Location	As per technical specifications and relevant IS Codes		SR	√	
iii		Collection of disturbed and undisturbed samples, their packing and storage	As required / agreed	B	Physical	each sampling	As per technical specifications and relevant IS Codes		SR		
iv		Conducting filed tests as per investigation scheme- such as, SPT/ERT/SCPT/PLT/PMT etc	As required / agreed	B	Physical	each field test	As per technical specifications and relevant IS Codes		SR		
V		Submission of Field Borelogs in approved format	As required / agreed	B	Review	Within 24 hours after completion of each BH	As per technical specifications and relevant IS Codes		SR	√	
vi		Submission of laboratory test schedule and selection of samples for laboratory testing	As required / agreed	A	Review and acceptance	as per consultation with Engineer during dispatch of samples to approved laboratory	As per technical specifications and relevant IS Codes		SR	√	
VI!		Submission of Final Geotechnical investigation report along with recommendations	As required / agreed	B	Physical	After completion of investigation work and review of draft reports	As per technical specificalions and relevant IS Codes			√	
		Legend to be used: Class #: A - Critical, B-Major, C=Minor, SR, TR, MTC, LB									

LOGO	SUPPLIERS NAME AND ADDRESS:	INDICATIVE FIELD QUALITY PLAN				ANNEXURE-IVB				
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Sl.No.	Activity and operation	Characteristics / instruments	Class* of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3	4	5	6	7	8	9	D*	10
1.00	STRUCTURAL STEEL MATERIAL									
i	Issued by OWNER	Material-Visual Examination, Identification and marking for grade/ type of steel	B	Visual	Each plate/ Section	Tech Specs and Const, Drawings				MS steel conforming to IS 2062 and IS 8500 to be clearly demarcated by application of distinct coloured paint strips on each piece/ off-cuts of respective grades/ type of steel.
ii	Procured by contractor	Structural steel procured from OWNER approved sources- Mechanical (YS, UTS, Elg, UT if specified),,and Chemical properties (CE as per IS)	A	Review	For each batch of each section delivered at site	Technical Specification and Construction Drawings, IS 2062,8500		SR	√	Correlated MTC shall be verified. In the event of non submission of MTC , sample shall be selected by FQA for testing
1.01	PRE-WELDING REQUIREMENTS									
i		Welding Procedure Specification * (WPS*)	A	Review	Each Welding Process	Technical Specification and Construction Drawings, ASME IX/AWSD 1.1		WPS	√	To be approved by CQA
ii		PQR and Welder's Qualification -	A	Physical	Each welder	PQR/ WQR AWS-D1.1/ASME-IX, Technical Specifi - cation and Construction Drawings		Test Report	√	
iii		Welding consumables .	B	Physical	Random in each shift	Approved WPS, Latest Rationalized		SR	√	
1.02	FIT-UP									
i		Marking and Cutting	Tape, ruler etc	B	Visual & Measurement	Each plate/ Section	Technical Specification and Construction Drawings/ Approved cutting plan		SR	
ii		Match markings for trial assembled components -		B	Physical	Each fit-up	Technical Specification and Construction Drawings		SR	
iii		Weld Fit Up- Edge Preparation/ Gap/ Alignment	Tape, ruler etc	B	Physical	Each fit-up	Technical Specification and Construction Drawings, IS 7215		SR	√	If required suitable stiffners shall be provided to prevent deflection.
1.03	PRE HEATING (wherever applicable)									
i		Pre-Heating Temperature	Thermal chalk	B	Measurement	Each pre-heating	Technical Specification and Construction Drawings, Approved WPS		SR	√	
ii		Post Weld Heat Treatment (PWHT). if required	Thermo couple with time temperature recorder	A	Time & Temperature	Each PWHT	Technical Specification and Construction Drawings, Approved WPS		SR	√	
1.04	WELDiNG REQUIREMENTS									
i		Sequence of welding -		B	Physical	Random in each shift	Technical Specification and Construction Drawings, Agreed scheme		SR	
ii		Removal/ grinding of temporary attachments -		B	Measurement	All cleats/ attachments	Technical Specification and Construction Drawings, Approved Drg.		SR	
iii		Completeness after welding-Dimensions/ distortion	Weld gauge	B	Visual	Each structure component	Technical Specification and Construction Drawings, IS 822		SR	√	

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Sl.No	Activity and operation	Characteristics / instruments		Class # of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
iv		Completeness of welding (each butt & fillet weld)		B	Visual	Each structure component	Technical Specification and Construction Drawings, Approved Drg.		SR	√	
2.00	NON DESTRUCTIVE AND DESTRUCTIVE TESTING										
2.1	FILLET WELDS										
i		size and visual examination	As required/ agreed	B	Visual/ Measurement	100%	As per technical specifications and construction drawings, IS 822, AWS D 1.1		SR		As per requirement of OWNER's Engineer
ii		Macro-etch Examination on production test coupons	As required/ agreed	B	Physical	Main fillet weld with min one joint per built up beam, columns and crane girders	As per technical specifications and construction drawings, IS 822, AWS D 1.1		SR	√	
iii		Dye Penetration Test	As required/ agreed	B	Physical	25% weld length of tension member of crane girder and 5% of Weld length with min. 300mm at each location except crane girder to all other fillet welds	As per technical specifications and construction drawings, IS 822, AWS D 1.1		SR		
2.2	BUTT WELDS										
i		Visual examination	As required/ agreed	B	Visual	Random in each shift	As per technical specifications and construction drawings, IS 822, AWSD 1.1		SR		As per requirement of OWNER's Engineer
ii		DPT	As required/ agreed	B	Physical	100% on all butt welds after back gouging on root run and 10% on final weld.	As per technical specifications and construction drawings, IS 822, AWS D 1,1		IR		All butt welds to be back gouged before DPT
iii		Mechanical testing on production test coupons	As required/ agreed	B	Physical	Min. one joint per built up beams, coloums and crane girder.	As per technical specifications and construction drawings, IS 822, AWS D 1.1		IR	√	Test on production test coupons
iv		Radiography Test	As required/ agreed	A	Physical	100% radiography test on butt welds of tension flange (bottom flange) of crane girder. All other butt welds shall be subjected to 10% weld length of each welder.	As per technical specifications and construction drawings, IS 822, AWS D 1.1		IR	√	Wherever RT is not feasible UT to be carried out. In case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at that particular loaction. Acceptance criteria of NDT on welds shall be as per AWS D1.1.
2.3	COAL BUNKER / B!NS										
		i) DPT	As required/ agreed	B	Physical	10% DPT after back gouging.	As per technical specifications and construction		IR		
		ii) Spot radiography test on butt welds	As required/ agreed	A	Physical	5% spot RT on butt welds	As per technical specifications and construction drawings		IR	√	Where access not available, UT shall be carried out with prior approval of Engineer incharge

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2.4	FULL PENETRATION WELDS (OTHER THAN BUTT WELDS)										
		Ultrasonic Testing	As required/ agreed	A	Physical	i) 100% UT on the web to flange joint of crane girder ii) 10% UT on other full penetration joints	As per technical specifications and construction drawings, IS 822, AWS D 1.1		IR	√	In case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1.
2.5	NON DESTRUCTIVE AND DESTRUCTIVE TESTING FOR CHIMNEY STEEL LINER										
i		Visual examination	As required/ agreed	B	Visual	100%	As per technical specifications and construction drawings, IS 822, AWS D 1.1		SR	√	As per requirement of OWNER's Engineer
ii		DPT	As required/ agreed	B	Physical	100%	As per technical specifications and construction drawings, IS 822. AWS D 1.1		IR	√	
iii		RT	As required/ agreed	A	Physical	10% FOR SHOP BUTT WELD AND 15% FOR SITE BUTT WELDS	As per technical specifications and construction drawings, IS 822, AWS D 1.1				
3.00	FOUNDATION CHECKS										
i		Dimensions and levels- Shape, lines (including diagonal checks)	Theodolite, Tape etc	B	Physical/ Measurement	Each Foundation	Tech Specs and Const Drawings		SR	√	
ii		Foundation Bolts and Embedments verticaitty, Levels, pitch distance	Theodolite, Tape, Piano wires etc	B	Physical/ Measurement	Each Foundation	Tech Specs and Const. Drawings		SR	√	
4.00	PAINTING SYSTEM										
i		Paining Materials and accessories	-	A	Review of MTC	Each batch of delivery	Tech Specs and Const. Drawings		SR/MTC	√	Mfr.'s T.C, shall be correlated with the consignment received.
ii		Submission of painting methodology	-	B	For Review of painting system	Before start of painting work	Tech Specs and Const, Drawings				
iii		Surface prepration	As agreed / required	B	Physical / visual	Each Erection Mark	Tech Specs and Const. Drawings, Relevant code/ standards		SR	√	
iv		Primer Thickness	Elcometer	B	Measurement	Each Erection Mark	Tech Specs and Const. Drawings		SR	√	
v		DFT of paint	Elcometer	B	Measurement	Each Erection Mark	Tech Specs and Const. Drawings		SR	√	
vi		Acceptance of painted surfaces	Elcometer	B	Visual and measurement	Each Erection Mark	Tech Specs and Const. Drawings		SR		
5.00	PRE-ASSEMBLY CHECKS										
i		Punch Erection marks and match marks on members	-	B	Visual/ Physical	Each structural member	Tech Specs and Const, Drawings				Markings for - Assembly designation. Part number, Weight, Any other important identifications.
ii		Pre-assembly as per match mark	-	B	Visual/ Physical	Each structural member	Tech Specs and Const. Drawings				
iii		Camber, sweep and total length after trial assembly of structure.	Theodolite, Tape, plumb, piano wires etc	B	Visual/ Physical	Each structural member	Tech Specs and Const. Drawings		SR	√	
iv		Control assembly check at shop	Theodolite, Tape, plumb, piano wires etc	B	Visual/ Physical	Every first and tenth set of identical structure	Tech Specs and Const. Drawings				

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1	2	3	4	5	6	7	8	9	D*	10
v		Completion of primer & intermediate coat of paint	B	Visual / Physical	Random	Tech Specs and Const Drawings		SR		
5.1	INSTALLATION AND ALIGNMENT OF STEEL LINER									
i		Submission of Installation/ Erection Scheme/ methodology for all structures	-	B	Approval	Once prior to erection of each structure	Approved drawings and Technical Specifications	SR	√	
ii		Check for Erection Marks	-	B	Visual	100%	Approved drawings and Technical Specification	SR		
iii		Check for Installation of Steel Liners	As required	B	Visual/ Acceptance	100%	Approved drawings and Technical Specifications	SR		
iv		Check for Site Joints	As required	B	Visual/ Acceptance	100%	Approved drawings and Technical Specifications	SR		
v		Check for Installation of Inlet Transition Ducts	As required	B	Visual/ Acceptance	100%	Approved drawings and Technical Specifications	SR		
vi		Check for Installation of Insulations and Expansion Compensators	As required	B	Visual, Physical, Acceptance	100%	Approved drawings and Technical Specifications	SR		Each layer of expansion Compensator lobe checked at shop for thickness, unit weight, tensile strength & elongation along with temp. withstandability for composite joints
vii		Ensure the Erection of all steel structures along with permissible tolerances and their acceptance	As required	B	Visual/ Acceptance	100%	Approved drawings and Technical Specifications	SR		
viii		Check and approval for Dismantling, Modification and Re-erection, if required for any reason	As required	B	Visual/ Acceptance	100%	Approved drawings and Technical Specifications	SR		
6.00	ERECTION CHECKS									
i		Alignment, slopes, level, tolerances of erected member	Theodolite, Tape, plumb, piano wires etc	B	Measurement	Each structural member	Tech Specs and Const. Drawings	SR	√	
ii		Tightening of bolts/ Torque including foundation bolts with lock nuts	Wrench/ Torque wrench if specified	B	Visual/ Physical	Each structural member	Tech Specs and Const, Drawings	SR	√	
iii		Completion of all erection fillet & butt welds		B	Visual	Each structural member	Tech Specs and Const. Drawings	SR	√	
iv		Acceptance of erected structure	Theodolite, Tape, plumb, piano wires etc	B	Visual/ Physical	Each erected structure	Tech Specs and Const, Drawings, IS 7215 and IS 12843	SR	√	
7.00	PERMANENT BOLTS AND NUTS AND WASHERS									
i		Material- Permanent mild steel Bolts, mild steel Nuts, High strength structural Bolts, Washers-Dimensions, properties, Class, storage along with MTC	Screw gauge, Vernier, Tape etc.	A	Physical and MTC Review	Once for each lot of delivery	Tech Specs and Const, Drawings	SR/MTC	√	
ii		Contact surfaces before bolting	-	B	Physical	Random before asembly for bolting	Tech Specs and Const, Drawings, IS 4000	SR		
iii		Inspection of the assembled bolts	-	B	Physical	Randomly in each shift for assembeled bolts	Tech Specs and Const. Drawings, IS 4000	SR		
iv		Tensioning	As agreed / required	B	Physical	Randomly during snug tight test and after full tensinoning	Tech Specs and Const. Drawings, IS 4000	SR	√	
V		Acceptance of installed bolts	-	B	Physical	Each bolt	Tech Specs and Const Drawings	SR		

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1	2	3		4	5	6	7	8	9	D*	10
8.00	ELECTROFORGED GRATINGS										
i		Material from approved source	As agreed / required	A	Physical and MTC Review	Once for each lot of delivery	Tech Specs and Const. Drawings		SR/MTC	√	Also refer the approved MQP
ii		Acceptance of Erection, alignment and each Installation	As agreed / required	B	Physical	100%	Tech Specs and Const Drawings		SR		
9.00	GALVANISED STEEL HAND RAILS										
i		Material		A	Physical	Once per tot	Grade IS:2062, Technical specifications,.Galvanised as per IS 4736		SR/LB	√	Galvanising shall be carried out as per the technical specifications.
ii		DPT	As required	A	Physical	Random	AWS D1.1 / Technical specifications		SR/LB	√	
10.00	FLEXIBLE OPEN ENDED BELLOW STRAP										
i		Check for the Material from approved source	As agreed / required	A	Physical and MTC Review	Once for each lot of delivery	Tech Specs and Const. Drawings		SR/MTC	√	
ii		Acceptance of installation of Strap	As agreed / required	B	Physical	Each installation	Tech Specs and Const. Drawings		SR		
11.00	PTFE SLIDING BEARINGS AND ELASTOMERIC BEARINGS										
i		Check for the Material from approved source	As agreed / required	A	Physical and MTC Review	Once for each lot of delivery	Tech Specs and Const Drawings		SR/MTC	√	
ii		Acceptance of installation of bearings	As agreed / required	B	Physicai	Each installation	Tech Specs and Const Drawings		SR		
12.00	HEADED SHEAR STUDS FOR METAL DECK SHEETS										
i		Procurement of material from approved source	As agreed / required	A	MTC Review	Each lot	Tech Specs and Const. Drawings / ASTM A 29/AWSD1.1		SR/MTC	√	
ii		Approval of welding procedures/specification and welding procedure qualification	As agreed / required	A	Visual and destructive as per ASME-IX	100%	ASME sec.IX/ AWS D 1.1/Approved WPS		Test Report	√	
iii		Welders Qualification test	As agreed / required	A	Visual and destructive as per ASME-IX	100%	ASME sec.IX/ AWS D 1.1/Approved WPS		Test Report	√	
iv	Workmanship	Studs shall be free from rust, oil, moisture etc		C	VISUAL	100%	Tech Specs and Const Drawings		SR		
V	Pre Production Testing	Visual & Bend Test	As agreed / required	B	Visual & Physical	first two studs before start of work for each day or shift	Tech Specs and Const Drawings		SR	√	Testing shall be repeated whenever there is a change in the essential variables or
13.00	CW LINERS										
13.1	MATERIALS										
i		Steel Plates/ Sections for liners and flanges	Material-Visual Examination	B	Visual	Each plate/ Section	Tech Specs and Const Drawings				
ii		Inspection of Materials on receipt at site	Steel tape/Visual	C	Visual	100%	Physical Visual veification, No damage		LB	√	
iii		Storage of materials at work site	-	C	Visual	100%	As per SCC		LB	√	
iv		Check for Pittings distortion rolling defects etc.	-	C	Visual	100%	IS 2062 gradeA		LB	√	
V		Plate thickness	Dmeter	C	Measurement	100%	IS 2062 grade A		LB	√	
13.2	FABRICATION										
i	Marking, squaring, cutting and edge preparation	Steel Tape	-	C	Visual	100%	As per approved drawing		LB		
ii	Prebend of Plate	Template		C	By template	100%	As per approved drawing		SR		
iii	Roll to required size	-		C	By template	100%	As per approved drawing		-		
iv	Tack weld and provision of internal bracings to keep in proper shape	-		B	Measurement of Dia	100%	As per approved drawing		SR		

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1	2	3		4	5	6	7	8	9	D*	10
13.3	PAINTING										
i	Submission of painting methodology			B	For Review of painting system	Before start of painting work	Tech Specs and Const. Drawings				To be accepted by Engineer In Charge
ii	Surface preparation	Cleaning	As reqd.	B	visual	100%	Tech Specs		Inspn Report	√	
iii	Primer and subsequent coats	Elcometer	As reqd.	B	Visual	100%	Tech Specs		Inspn Report	√	Uniform thickness & type of paint and shade for each coat
13.4	COAL TAR PROTECTION TAPE/ WRAPPING AND COATING										
i	Submission of coating methodology			B	For Review of painting system	Before start of painting work	Tech Specs and Const Drawings				To be accepted by Engineer In Charge
ii	Surface preparation	Cleaning	As reqd.	B	Visual	100%	Tech Specs		Inspn Report	√	
iii	Holiday detection Test	Electrical Testing	As reqd.	B	Physical	100% surface area	Tech Specs		Inspn Report	√	
iv	Adhesion Test		As reqd.	A	Physical	2 Tests per days production	Tech Specs		Inspn Report	√	
V	Coating Thickness		As reqd.	A	Physical	Once for every 100 Sq M	Tech Specs		inspn Report	√	
13.5	WELDING (SHOP / FIELD WELDS)										
i		Approval of welding procedures/specification and subsequent welding procedure qualification	-	A	Visual and destructive as per ASME-IX	100%	ASME sec.IX/ Approved WPS		Test Report	√	
ii		Welders Qualification test	-	A	Visual and destructive as ASME-IX	100%	ASME sec.IX/Approved WPS		Test Report	√	
iii		Fit up and gap	By Filler gauge	B		100%	As per approved drawing /IS-3589		Shop Register		
iv		Check of surface defects		B		100%	Free from surface defects		Shop Register		
13.6	INSPECTION OF WELDS {shop and field erection welds)										
i		DPT on root run after back gauging / grinding of butt welds	DPT Kit	B	NDT	100%	IS-3658 No Line and round indication and no crack		Shop Register	√	Pipe diameter where back gouging is not possible grinding of root run for DPT
ii		DPT on fillet welds	DPT Kit	B	NDT	100%	-do-		-do-	√	
iii		DPT on finished butt welds	DPT Kit	B	NDT	10%	-do-		-do-		
iv		Radiography test on shop but welds (welding done on the floor other than pit area)	RT Equipments	A	NDT	5%	ASME sec V and ASME Sec. VIII Div.1		RT Films	√	The extent of check shall be modified to the criteria written elsewhere in the technical specification if any.
V		Radiography on field Butt welds (welding done on the pit)	RT Equipment	A	NDT	5%	ASME sec.V and ASME Sec. VIII Div.1		RT Films	√	
13.7	DIMENSIONS										
i		Dimensional Conformity	steel tape	B	Measurement	100%	As per approved drawing		SR	√	

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ii		Tolerance OD / ovality	steel tape	B	Measurement	100%	As per approved drawing		SR		
13.8	HYDRO TESTING										
		Leakage tightness	Hydro test Arrangement	A	Leakage tests	100%	Tech Specificatiort		SR	√	For shop welded joints before encasement in concrete/ painting and erection joints
14.00	STOP LOG GATE, TRASH RACK AND LIFTING BEAM										
14.1	MATERIAL										
		Check Quantity (in case of receipt) and completeness and damage, surface defects		C	Visual	100%	Challan / Release No damage, surface defect note		SR	√	
14.2	ERECTION										
		Alignment levelling	Plumb, Piano wire,water level	C	Measurement	100%	Specfication/ Approved drawing		Inspection Report		Welding, if any, involved at site will be done by welders and procedure qualified as per ASME-IX in presence of OWNER's Engineer
14.3	PAINTING / SURFACE PREPARATION										
i		Shade		B	Visual	100%	Specfication/ Approved drawing		Inspection Report		The type of painting/ surface treatment of parts shall be as per Technical specification
ii		DFT	Elcometer	A	Measurement	Random	Specfication/ Approved drawing		-do-	√	
14.4	TESTING										
i.	Free movement of stop log / trash rack in guides under dry and under lull water condition	Lowering or raising for full length for 2/3 times		A	Physical	100%	Smooth operation, Tech. Specification, iS:4622		-do-		
ii	Leakage for stop Log	Measurement of leakage	As read,	A	Physical	100%	Leakage rate within limit		-do-	√	Maximum leakage rate 5 litre/minute/metre length of seal under max-head as per IS:4622
iii	Load test for lifting beam	Load Test	As reqd.	A	Physical	100%	No deflection /No Deformation		-do-	√	
		LEGEND: D * Records, identified with Tick" (√) shall be essentially included bv supplier in QA									
		Legend to be used: Class #: A= Critical, B=Major, C=Minor, SR, TR, MTC, LB									
Manufact urer/ Sub supplier	Main-supplier	Categorization Witnessing & Accepting (As per owner QA&I System) Category 'A' FQA Engineer In association with Executing Engineer, Category 'B' Executing Engineer, Category 'C' Executing Engineer ;SR - Site Register, TR= Test Report,MfrTC = Manufacturer's Test Certificate									
Signature		This document shall be read in conjunction with owner Tech. Specifications, BOQ, Drawings									

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SECTION: XVI

TECHNICAL SPECIFICATION

MASONRY & ALLIED WORKS

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SECTION - XVI

MASONRY & ALLIED WORKS

1.00.00 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Soling

2.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling as shown as the drawings. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.02.00 Brick Edging

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.03.00 Masonry

2.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.03.02 Mortar

Mix for mortar shall be specified in the Schedule of Items. When lime is used hydrated lime shall be mixed with water to form a putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 seive and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a water-tight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement. No mortar, which has stood for more than half an hour, shall be used.

2.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.03.04 Exposed Brickwork

Brickwork in superstructures which is not covered by plaster shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brick-work shall be cleaned at the end of days work. If face bricks are specified in the drawings, the brickwork shall be in composite bricks, with face bricks on the exposed

face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.03.05 Reinforced Brickworks

Reinforcements shall be as specified in the drawings. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

2.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. Al least two stones shall run the full width of the wall for every square meter of surface area.

2.03.07 Exposed Stonework

Stonework which is to be kept exposed shall be as shown on drawing or described in the Schedule of Items. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 sq.m. in area shall be built and approved by the Engineer and all works shall match with this sample.

2.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

2.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

2.04.00 Damp Proof Course

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS:1609. The number of courses shall be as mentioned. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The successful bidder shall be obliged to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS:1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
IS:1597	:	Code of Practice for Construction of stone Masonry.
IS:1609	:	Code of Practice for laying Damp-proof treatment using bitumen felts.
IS:2212	:	Code of Practice for Brickwork.
IS:2250	:	Code of Practice for preparation and use of Masonry Mortar.
IS:5134	:	Bitumen Impregnated Paper & Board.

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SECTION: XVII

TECHNICAL SPECIFICATION

FINISH TO MASONRY AND CONCRETE

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SECTION - XVII

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment. Before commencing finishing items the successful bidder shall obtain the approval of the Engineer regarding the scheduling of work to minimise damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval or the Engineer shall be taken as to the acceptability of the base.

2.02.00 Plastering

2.02.01 Mortar

Mortar for plastering shall be as specified in the drawings.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

For lime gauged plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No plaster which has stood for more than half an hour shall be used; plaster that shows tendency to become dry before this time, shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats - a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat, the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The under- coat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the successful bidder shall make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a

smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.2.2 but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the top coat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS:2114 latest edition. Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.2.2. While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-Cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.2.2 after being levelled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2. Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

2.02.04 Curing

All plastered surfaces after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to Masonry

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers.

The mortar for plastering shall consist of 1 part cement, 1/2 part lime and 4 parts sand by volume, or 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.2.1. The application, finish etc. shall be as specified under relevant clause above. A 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The successful bidder shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as shown on drawings.

4.00.00 I.S. CODES

Important relevant code for this Section :

a) IS:1661 : Code of practice for cement and cement-lime plaster finish on walls & ceilings.

b) IS:4101 : Code of practice for external facings and veneers.

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SECTION-XVIII

TECHNICAL SPECIFICATION

SINGLE AND SANDWICH METAL CLADDING

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SECTION-XVIII

SINGLE AND SANDWICH METAL CLADDING

1.00.00 GENERAL

1.01.00 Description

1.01.01 This section covers, providing, furnishing and installation of sandwich/double skin metal cladding with insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes, conductors etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The contractor shall furnish all labour, materials, tools and equipment required to complete the work.

1.02.00 Applicable Codes and Standards

1.02.01 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/owner's approval.

1.02.02 ASTM - American Society for Testing Materials.

1.02.02.1 A446 - Zinc-coated (Galvanized) steel sheets of structural quality. Coils and cut lengths.

1.02.02.2 A611 - Steel, cold rolled sheet.

1.03.00 Submittals

1.03.01 The contractor shall submit to the owner the following items for review before commencing work.

1.03.01.1 Samples

a) Three 300 x 300 mm pieces of each type of pre-coated and preformed metal sheet for top skin and bottom skin.

b) Type of insulation proposed for use and its thickness and density.

c) Fabricated sandwich metal cladding- Sample size shall be 300 x 300 mm three nos.

d) Edge sealing and flashing.

1.03.01.2 Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.

1.03.01.3 Manufacturer's certification of compliance with each delivery.

1.03.01.4 Shop Drawings

Showing fabrication details of sandwich/double skin metal cladding with Insulation, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.

1.03.02 Test Reports

Two copies of Test Reports and Source of Quality Control Tests.

1.03.03 Supplier Certificates

Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.

1.04.00 Product Handling

1.04.01 Delivery of Materials to job site in manufacturer's original unopened packaging.

1.04.02 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.

1.04.03 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.

2.00.00 PRODUCTS

2.01.00 General

2.01.01 All goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner

2.01.02 Roof insulation shall have a minimum R-value of 2.083 M^2 ^oK/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.

2.01.03 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be interlocking type 150mm wide strip and inner sheet shall be

mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

2.01.04 Material

2.01.04.1 Base Material — High tensile steel

2.01.04.2 Metal protection — Galvalume

2.01.04.3 Organic coating — Silicon Modified Polyester (SMP) Fluoro polymer (PVF_2) and plastisols to resist aggressive climate of the jobsite

2.01.05 Material shall be prefabricated sandwich panel with polystyrene insulation/high density rock wool slab insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.60 mm or as recommended by manufacturer to resist the climate of the jobsite for Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel.

2.01.06 Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirement of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg / M^3 for polystyrene and shall have minimum R-value 2.083 M^2 ^oK/Watt.

2.01.07 Panel size shall be largest available size.

2.01.08 Warranty for precoated profiled metal sandwich /double skin cladding shall be for a minimum period of 40 years.

2.01.09 Sealants

Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.

2.01.10 Profile HDPE Filler

2.01.10.1 Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.

2.01.10.2 Metal flashing shall be of similar material and colour of top skin.

3.00.00 DOUBLE SKIN INSULATED METAL CLADDING

3.01.00 General

3.01.01 Metal cladding may be of double skin separated by an approved insulation in between. External sheet shall be of interlocking type.

3.01.02 Providing, erecting, fitting & fixing at all elevations double skin insulated roofing / wall cladding with Luxalon or equivalent 150 F and profiled steel sheets made out of 0.55mm (TCT) permanently colour-coated galvalume steel (150gsm Zinc Aluminium alloy coating total of both as per AS 1397:1993) having 550 MPa yield strength. Colour coating shall comprise of Polyester coating of approved colour. The Polyester colour coating shall comprise of 15-20 micron finished coat over 5 micron primer coat on the exposed side and manufacturer's back coat of 5 microns over a primer coat on the inner side.

The external sheet shall be Luxalon or equivalent 150 F fixed on to the hat sections with the help of specially designed carriers to hold the external Luxalon cladding. The inner sheet shall have 980mm cover width, 28mm high crest at 195 mm c/c. with special male / female side-laps and anti-siphoning features to prevent leakage. Two small ribs are there in between the two profiles. The inner sheet along with sub-girths of size 50mm x 50 mm x 50 mm manufactured out of 1.6mm GI sheet in 'C' / 'Z' shape would be fixed to the purlin by means of self-drilling fasteners (12G - 14TPI x required length). Outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer-head Zinc-coated self-drilling fasteners / screws on to the sub-girths. The clips shall be concealed and no fasteners are to penetrate the external sheeting.

An insulation of 50 mm thick Rockloyd Resin-bonded Rockwool of density 48 kg./m^3 conforming to IS:8183 shall be provided and fixed between two sheets.

3.01.03 Providing and fixing of double skin prefabricated factory assembled rock wool insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55 mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 550 Mpa yield strength. The colour coating shall comprise of SMP / super polyester PVF2. The inner sheeting shall be 0.50mm/0.6mm TCT of SMP / super polyester PVF2 coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side. The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti-siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure

by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the steel runner. The clips shall be concealed and no fasteners are to penetrate the external sheeting. Insulation of density 100 Kg/m^3 and average thickness 50 mm. conforming to IS 8183 having a thermal conductivity value of 0.034 W/mk at 50 degree C mean temperature. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

4.00.00 EXECUTION

4.01.00 Inspection

4.01.01 the contractor shall examine the area, which will be covered, and the masonry wall where the edge of the sandwich/double skin cladding will be fixed and the structural alignments.

4.01.02 Contractor shall correct any unsatisfactory conditions prior to start of work.

4.02.00 Installation

4.02.01 Sandwich panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

4.02.02 Double skin wall cladding shall be installed strictly as per manufacturer specification and details.

4.02.03 All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

4.02.04 Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.03.00 Clean-Up

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.

5.00.00 RATES

Rates shall be for unit rate for complete item described in the Schedule and shall include all wastages.

6.00.00 METHOD OF MEASUREMENT

a) No allowance shall be made for laps.

b) Roofing and side sheeting shall be measured for net area of work done. Corrugated / Trough sheeting shall be measured flat and not girthed. Openings less than 0.1 Sq.m shall not be deducted.

c) Special features like flashings, ridge pieces, caves, corner pieces, north-light curves etc. shall be measured for length of installation.

d) Gutter and down comers shall be measured for length along their centre lines and bends, junctions, shoes ends, etc. shall not be considered for measurement.

e) Opening area of Doors, Windows, Louvers, Cutouts which falls under metal clad area shall be measured for deduction form total metal clad / clad area.

f) Curved roofing sheets shall be measured for area of curve.

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SECTION-XIX

TECHNICAL SPECIFICATION

CARPENTRY AND JOINERY

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SECTION-XIX

CARPENTRY AND JOINERY

1.00.00 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the schedule. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified in the "Schedule of Fixtures".

2.00.00 INSTALLATION

2.01.00 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from decay, fungal growth, boxed heart, pitch pockets or steaks on the exposed edges, splits, large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter's work, the Tendered shall have the rough timber approved by the Engineer.

b) Plywood

Plywood boards are formed by gluing and pressing three or more layers of veneers with the grains of adjacent veneers running at right angles to each other. The veneers shall be either rotary cut or sliced and shall be sufficiently smooth to permit an even spread of glue. Face veneers may be either decorative on both sides or one side commercial and the other decorative. Ply wood shall be BWP grade or BWR grade as per IS 303. Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of B W R grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush door shutters shall have a solid core with commercial or decorative or non-decorative (Paintable type as per IS 2202 Part I) faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified in the "Schedule of Items". The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS 1708.

Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0mm and 3.0mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5mm for commercial veneers and between 0.4 mm and 1.0mm for decorative veneers, provided that the combined thickness of both is not less than 2.2mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8mm to 10mm. The rebating shall be either splayed or square type as shown in the drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

Opening for glazing

When required, glazing shall be provided and unless otherwise specified the opening for glazing shall be 250mm in height and 150mm or 200mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25mm. Opening for glazing shall be provided where specified or shown in the drawing.

Tolerance

Tolerance on the width and height shall be +3 mm and tolerance on nominal thickness shall be ± 1.2mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

e) Panelled Glazed or Panelled and Glazed Shutters

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per “Schedule of Items” and as per drawing or as recommended and approved by Engineer in charge.

Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fiber board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any wrap or bow and shall have smooth well planed face at right angles to each other.

Other considerations shall be as mentioned in item (d) above.

Window and Ventilator Shutters

Window and Ventilator shutters shall conform to IS 1003 (Part 2)

f) Laminated Veneer Lumber (LVL)

Laminated Veneer Lumber door frames and shutters shall conform to IS 14616

Material

i) Laminated Veneer Lumber (LVL)

Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued tighter having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Rapture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5mm.

ii) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects or cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of ± 5 percent.

iii) Adhesives : Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

iv) Preservatives : Veneers used for LVL shall be given preservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall than be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m^3 Veneers shall be scarf joined only length wise and not in the direction of width

with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600mm.

Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

g) Laminated Veneer Lumber (LVL) Door Shutters

This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, measurements, rates and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals, etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

The material of each lot shall be supported by a certificate to that effect:

Each lot of LVL materials shall be accompanied by the test reports. Fabricated shall take up manufacturing of shutters only if provisions of clause mentioned above fulfilled, failing which, shutters so manufactured are liable for rejection.

Panelling Materials

Plain Particle Board : Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848.

Pre-laminated Particle Board : Pre-laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per stated above.

Medium Density Fiber Board : Medium density fibre board used for panels shall confirm to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

Pre-laminated Medium Density Fiber Board : Pre-lamination in pre-laminate medium density fiber board shall confirm to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fiber board used in pre-laminated medium density fiber board shall be as per stated above.

Glass: Glass for glazing shall confirm to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass may also be specified by the Engineer-in-Charge.

Wire Gauze : Wire gauze shall generally confirm to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm.

h) Construction and Workmanship

Laminated Veneer Lumber (LVL) paneled, glazed and panelled and glazed shutter shall be constructed in he form of LVL framework of stiles and rails with panel inserted conforming (as per stated above) of plain or perlaminated particle board, plain or perlaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beadind as specified. The stiles top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints. Rails having width of 150 mm or more shall have plain double tenon joints. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutters complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon and mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubberwood /plantation wood lipping. Lipping shall be seasoned and chemically treated. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m^2.

All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any wrap and bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

Beading : All the panels except glass and wire gauze shall be fixed with grooves but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable handless nailing

or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401–1982.

Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only.

Muliions and glazing bars shall be stubtenoned to the maximum depth which the size of the member wood permit or to a depth of 25 mm, whichever is less.

The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.

LVL shutters shall be manufactured in factories under controlled conditions.

i) Panelling

Plain and perlaminated Particle Board Panelling : The panels shall be made of one piece of plain or prelaminated particle board of thickness 12 mm or more.

Wire Gauze Panelling : Wire gauze panel shall be so designed that no single panel shall exceed 0.5 sqm. in area.

j) Rebating

In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or squire type as per IS 1003 (part-1).

k) Gluing of Joints

The contact surfaces of tenon and mortice shall be treated before putting together as per IS 1003 (part-1). All the tenon and mortice joints should be glued together and pinned to full thickness of the door with Bamboo pins.

l) Tolerances

Tolerance on the size of door shutter shall be +3 mm and in thickness +1.2 mm.

m) Location of Fittings and Accessories

Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50 mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of 850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described above.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per scheduled by the user. The fittings shall conform to specifications as described above.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, size and shape of louver or vision panel opening shall be as specified.

n) Finish

All the four edges of the shutter shall be squire. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

o) Glazing

Glazing in the shutters of door and window shall be as per in specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.

p) Fixtures

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the “Schedule of Fixtures”. However minimum number of fixtures shall be as follows :

1. For external single leaf door :

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer.
- Rain drip

2. For external double leaf door :

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge on both shutters.
- 10mm dia & 300mm long SS tower bolt on inside face on both shutters.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer on active shutter.
- Rain drip

3. For external single leaf window :

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- SS pull ring minimum 6mm thick and 50~75mm dia.
- SS window stay piece.

2.02.00 Partitions

These shall be conform to drawings an all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

a) Materials

Gypsum Board conforming to IS 2095 (Part-1)

Non asbestos multi-purpose cement board conforming to IS 14862
Tapered edge calcium silicate board

Tapered Edge Calcium Silicate Board is manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made

in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminium or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

b) Installation

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge.

c) Jointing & Finishing

Joints of the boards are finished with specially formulated joining compounding and fiber tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

d) Fitting and Fixtures

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

e) Tolerance

Tolerance in dimensions shall be ± 5 mm.

2.03.00 UPVC-Door Frames

a) Material

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desied proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

b) UPVC Door Frame

UPVC door fame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extrude UPVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm ± 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm ± 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge.

c) Fixing of Frames

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The fames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the fames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the centre. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

2.04.00 PVC Door Shutters

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

24 mm thick PVC Door Shutter
30 mm Thick PVC Door Shutter
Sampling and Criteria for Conformity

a) General Precautions

The test specimens shall not have been exposed to a temperature below 400C for 24 hours immediately preceding the test and shall be free from all / visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.

If the test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

b) Sampling

Sampling criteria for conformity shall be in accordance with IS 4020 (Part-I)

Lot in any Consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to from a lot.

The number of shutters to be selected at random from a lot shall depend upon its size.

c) Fixing of Shutters

PVC door shutters shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm / 30 mm. The hinges used should be of stainless steel.

d) Tolerance

The tolerance on the width and the height of the door shall be ± 5 mm and the tolerance on the nominal thickness of the door shall be ± 2 mm.

e) Fittings

Fittings shall be provided as per scheduled of fittings decided by Engineer-in-Charge. In moisture prone areas M.S fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

2.05.00 PVC Door Frame

Solid PVC Door Frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheet having density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The weight per running metre of the door frame including reinforcement should be a minium of 1.5 kg./sqm. The depth of the rebate of door frame shall be 10 mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts of the door frame are to be jointed to each other using solvent adhesive conforming to IS 14182. A

tolerance of ± 3 mm. shall be permitted in the specified dimension of PVC section in the door frames.

The solid PVC door frames shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge.

Fixing of Frames : As stated earlier

2.06.00 Panel PVC Door Shutter

Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. The Solid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The shutters shall be fabricated at factory as per nomenclature of the item and directions of the Engineer-in-Charge.

a) 30 mm thick panel PVC door shutters.

2.07.00 Fibre Glass Reinforced Plastic (FRP) Door Frames

Door frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up to resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./sqm. and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with lsophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of lsopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat.

a) FRP door shall be manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

b) Tolerance : Tolerance of size of frame to be ± 2 mm. and on size of rebate to be +1 mm.

c) Finish : The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregration, colour bolts and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable.

Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour and shade as approved by Engineer-in-Charge.

d) Fixing of Frame : As stated earlier.

2.08.00 Fibre Glass Reinforced Plastic (F.R.P.) Shutters

a) F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge.

b) Blocks of any seasoned hard wood of bulk density not less than 450 kg / cum At 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

c) Location of Fittings and Accessories : The lock rail of door shutters shall be so placed that is centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable location by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminium.

d) Sampling & Criteria for conformity : As stated earlier

e) Finish : Stated earlier

f) Fixing of Shutter : Stated earlier

g) Tolerance: Stated earlier

2.09.00 Solid PVC Fome Profile Doors

a) Solid PVC Foam Profile Frame

Solid PVC foam profile frame doors are made from solid PVC foam profiles 60 x 30 mm with integral skin cut to required size. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel to provide scratch resistance surface. The frame shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge. PVC door frame should have shore hardness more than 70.

b) Fixing of Frames: Stated earlier

2.10.00 Solid PVC Foam Shutters

Solid PVC foam shutters are made from solid PVC foam profiles with integral skin. Door are provided with naturally strong stiffener frame and sandwich paneled to offer sound and heat insulation with pressure laminate/infill panel provides scratch resistance surface. Door shutters can be nailed, screwed, drilled, glued, sawn lapped or welded just like wood and characterized by excellent screw holding strength (200 kgf.).

a) 28 mm Thick Door Shutters

Profile is cut in required length to make vertical & horizontal site. Mitered cut joint are made using solvent based PVC adhesive & epoxy solvent. GI 'C' stiffener 39 x 19 x 19 or 40 x 20 x 19g. M.S. Pipe is fixed in the grooves made in frame. Telescopic polymeric corners are provided at corners are provided at corners for better rigidity. Infill panel 3 mm thick HPL sheet is fixed with is fixed with csk screws of required size to the profile frame as specified. Mirror image of shutter frame is jointed using solvent based PVC adhesive as well as csk type sheet metal screws of required size at four corners at top & bottom. Additional bonding strength is provided by using silicon sealant epoxy sealant at joints. Lock rail is provided by using PVC profile & 'C' type GI stiffener 40 x 10 in the groove & fixed with adhesive to frame & infill. Decorative corner moulding is fixed to impart elegant look.

The fabrication shall be done in done in factor as per nomenclature of the item and directions of Engineer-in-Charge.

b) Sampling and Criteria for conformity : Stated above

c) Fixing of Shutters: Stated above

d) Tolerance: Stated above

e) Fittings: Stated above

2.11.00 Factory Made Fibre Glass Reinforced Plastic Chajja

F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chaja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge.

Material

1) Glass Fibre (chopped strand mat) shall be as per IS 11551
2) Unsaturated Polyester Resin shall be as per IS 6746
3) Surface Burning Characteristics of Building Material – ASTM E84-77a
4) Unsaturated Polyester Resin Gel coat shall be as per IS 6746
5) Curing Agents – Cobalt Napthanate and MEKP
6) Test of Products – IS 14425
7) Glass Fiber Roving – IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modules of elasticity, good textile processing and excellent fiver reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture and corrosion resistance.

Tolerance

Tolerance of ± 10 mm in overall size of FRP chajja is permissible.

2.12.00 Workmanship

2.12.01 General

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. that will come in contact with masonry after fixing shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particleboard. The edge of all plywood, block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M. S. grills or guard bars shall be provided to windows where called for in the drawings or schedule of items.

2.12.02 Finish

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.12.03 Surface Treatment

When shown on drawings or called for in Schedule, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.03 Cupboard Shutters

Shall operate smoothly without jamming and locks, holding chains, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.04 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.05 Loose Furniture

When placed on level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 RATES

Rates shall be unit rates including preservatives, shop coats, primers varnishing, polishing etc. against items mentioned in Schedule. No separate payment will be made for fixing caulking etc. unless separately provided for in Schedule.

5.00.00 METHOD OF MEASUREMENT

5.01.00 Door and Window Frames, Handrails etc.

Woodwork in frames handrails etc. shall be measured for the volume of timber used, i.e. the minimum theoretical rectangular section from which the shape can be obtained multiplied by the length of timber required. In computing the length, timber required for tennons, scarves, embedding to walls over the finished length shall be added. Mitred pieces shall be measured along the longest length.

5.02.00 Holdfasts

Shall be measured for actual number used.

5.03.00 Door and Window Shutters

Shall be measured for actual outer area of shutters for different thickness and types described in Schedule.

5.04.00 Glass and Glazing

Shall be measured and paid separately under relevant items.

5.05.00 Fittings and Fixtures

Shall be measured separately in actual numbers used for different sizes and types described in Schedule.

5.06.00 M S Grills and Guard Bars

Shall be measured and paid separately under relevant items.

5.07.00 Partitions, Paneling, etc.

Shall be measured for actual area excluding door shutters. Door shutters shall be measured and paid separately under relevant items.

5.08.00 Pelmet, Shelves, etc.

Shelves shall be measured for actual area of finished surface. Pelmets shall be measured for length of different types enumerated in the Schedule.

5.09.00 Furniture

Shall be measured for actual number of each type.

6.00.00 IS CODES

Some of the important relevant Codes for the Sections are:

IS : 4021	-	Timber door, window and ventilator frames
IS : 1003	-	Timber paneled and glazed shutters.
IS : 2191	-	Wooden flush door shutter (Cellular and hollow core type)
IS : 2202	-	Wooden flush door shutters (Solid core type)

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SECTION-XX

TECHNICAL SPECIFICATION

METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, CURTAIN WALL, STRUCTURAL GLAZING, ETC.

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SECTION-XX

METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, CURTAIN WALL, STRUCTURAL GLAZING, ETC.

1.00.00 SCOPE

The work in general shall consist of supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. as shown on drawings with all materials complete excluding supply of glass and glazing. The scope of work shall also include the assembly and the Owner from the store at site shall supply erection of all doors, windows, louvers, glazed partitions, etc. for which fabricated materials. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing and schedules.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to IS: 733 and 1285 for chemical composition and mechanical properties. The stainless steel screws shall be grade AISI 304.The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified in “Schedule of Fixtures” and the best quality from approved list of manufacturers shall only be used. The Tenderer shall specifically state the list of manufacturer’s materials he proposes to use. “Schedule of Fixtures” is for the purpose of stating the minimum requirement and improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor’s responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors weighing 61-

80 Kg. unless otherwise stated in schedule. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix- A.

The Contractor shall submit three samples of each type of hardware to the Engineer for approval. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS: 1081 and/or as approved by the Engineer.

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, Louvers, etc.

a) Door Frames

Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose “T” masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centers.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated. Where shown on drawing or called for in the schedule of items the

doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown in drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louvres blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.

Wherever required as shown on drawings, provisions for fixing glass panes, louvers, etc. shall be made.

The manufacturing shall be done as specified in “Double Plate Flush Door Shutters”.

d) Sliding Doors

These shall be manufactured as per drawings and specification. These shall be fabricated from mild steel sheet.

The shutter shall be double or single leaf shutter as specified. The shutters shall be fabricated of specified size of M.S. angle iron frame diagonally braced with the same size of M.S. angle riveted/ welded together with 3mm gusset plate at junction to form a rigid frame. Sliding doors shall be either double plate or single plate construction as called for in drawings and schedules made out of 18 gauge steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop and submit the manufacturer’s catalogue of the sliding gear he proposes to use. Where shown on drawings or call for in the Schedule of Items, these shall be provided with top and bottom guide rails of specified size angles or T-irons and 25mm diameter pulley or with 25mm diameter ball bearing at the bottom and guide block with steel pulleys at the top. The shutters shall be provided with locking arrangement, handles, stoppers, and holdfasts, other fittings as specified in the description of item. Doors

shall close positively to exclude rainwater from seeping in. When called for in schedule, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

The guide rail shall be sufficiently long and continued along the wall on both ends so that the sliding shutters can against the walls, giving full opening when so required.

FIXING : The guide rail shall be fixed to the floor by means of anchor bolts embedded in the cement concrete floor. The steel section at the top shall be suitably supported from the walls. Two channel sections shall be suitably fixed vertically below the extreme clamps in the wall and floor to avoid the shutter from going out of the supports at top and bottom. A suitable clamping arrangement will be provided at either end of the opening to avoid the shutters from rolling back into the opening.

The adjoining work damaged in fixing shall be made good to match the existing work.

e) Door Threshold

Door threshold shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings or called for in the Schedule of Items.

All welds shall be dressed flush on all exposed and contact surfaces.

Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings and/or specified under Schedule of Items. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors, frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 0.6 mm thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.

Where required factory made evenly baked powder coated coloured aluminium extruded sections shall be used. DFT shall not be less than 0.8 mils. Colour shall be as per Colour Schedule or as per instruction of the Engineer-in-Charge.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.02.03 Fire Door

Hollow metal fire rated doors should be as per IS 3614 Part-1 & Part-2.It should be made of pressed Galvanised steel conforming to IS 277. It should be tested at CBRI or ARAI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision lites/ panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates will not be allowed. Proper label conforming the type of door and the hourly rating is mandatory.

Door Frame : Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60mm (16 gauge) minimum thick G.I. sheet (zinc coating not less than 120gm/sqm) duly filled with vermiculite based concrete mix. Suitable for mounting 60 minutes fire rated door shutters. The frame is fitted with intumuscent fire seal strip of size 10 x 4 mm (minimum) all-round the frame and fixing with dash fastener of approved size and make, including applying a coat of approved brand fire resistant primer. Frames shall be metered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers

should be provided on the skirting jamb. Frames should be provided with black plate bracket for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry of approved proportion necessary for fire doors on the clear masonry opening.

Door Shutter : Door shutters will be 50 mm thick (unless otherwise stated in the drawing) of 60 minutes fire rating conforming to IS: 3614(Part-II) tested and certified as per laboratory approved by Engineer-in-Charge with suitable mounting on door frame, consisting of vertical styles, lock rail, top rail 100 mm wide, bottom rail 200 mm wide, shall fully flush double skin door with or without vision lite. Door shall be manufactured from 1.6 mm (16 gauge) minimum thick SWG G.I. sheet (zinc coating not less than 120gm/sqm) duly filled FR insulation material and fixing with necessary stainless steel ball bearing hinges of approved make (if mentioned in the drawing) including applying a coat of approved fire resistant primer. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. All doors shall be factory prepared for receiving appropriate hardware and provided with necessary reinforcement hinges, locks and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. 200 x 300mm Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

The door leaf and frame shall have passed minimum 250hours of salt spray test.

Paint : All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour.

Rate : Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule.

2.03.00 Structural Glazing

Aluminium semi unitised vertical Structural glazing system with single glass vision panel and spandrel panel of approved make having main frame of verticals and horizontals made out of specially designed extruded aluminium sections to withstand wind pressure of 175 kg/sq.m at a height of 40m and fabricated, fixed at all levels, elevation and heights to the Masonry / RC walls with necessary clamps, brackets and anchor fasteners. All clamps and brackets shall be Mild Steel Hot dip galvanized minimum 80 microns thick and shall conform to IS: 4759-1996. The extruded aluminium section shall be anodised in approved colour with a anodic coating of minimum 20 microns. Extruded section shall be of 6063 T5 or T6 alloy conforming to ASTM B 221.

Any other fastening straps, nuts, bolts, rivets, washers, Fire stops at all floor levels etc. shall be in stainless steel SS 304 grade. All tapes shall be of approved make.

The system shall be designed to withstand a wind pressure of 200 kg/Sqm and shall be fixed to the masonry/RC walls with necessary clamps, brackets and anchor fasteners, clamps and brackets shall be Hot dip galvanized minimum 80 microns thick, all complete as per manufacturer's manual and specifications. The spandrel panel shall have 50mm thick fiber glass insulation of 48 kg/cum density of approved make conforming to IS-8183 and 1.0 mm thick Twiga black tissue conforming to BS 476 Part 7. This insulation shall be enclosed in a GI tray fabricated out of 1mm thk. GI sheet and fixed to the glazing framework with stainless steel fasteners.

The gap between the GI framework and the concrete framework shall be sealed with Aluminium flashing fixed with stainless steel fasteners. All gaps shall be sealed with Silicone sealant of approved brand. Insulation should be provided in between the Structural glazing aluminium frame work (i.e., behind the spandrel glazed panel) and the structure. Providing 6 mm thick toughened fully tempered hard coated glass of blue/green/blue-green or approved colour having VLT = 35 to 50 % ,External reflectance= 6 to 15% ,Internal reflection = 8 to 15%, Solar factor = 0.36 to 0.43, U Factor = 2.8 to 3.0 W/sqm K etc.

2.04.00 Aluminium Curtain Wall System

2.04.01 General

1) Aluminium Curtain Wall System shall be designed for the following effects :

   a) Permanent Deformation, thermal expansion.

   b) Wind and seismic load

   c) Air and water infiltration or leakage.

   d) Lateral deflection per floor height

2) Unless otherwise specified the design of the system shall be prepared by the specialized firm for executing such works and submitted to the EIC / Department for approval after detailed scrutiny and checking design calculations and drawings.

3) The work shall bear five years guarantee. It will be obligatory on the part of the contractor to execute the work systematically and conduct the necessary mock-up unit tests, before taking up the work to the satisfaction of EIC / Department.

2.04.02 Specification for Materials used for Curtain Wall

1	Glazing	Glazing work shall be as specified in the description of the item and / or as described under the chapter Glass & Glazing of this book.
2	Framing system	Aluminium anodized extruded sections manufactured by reputed approved manufacturers, for all types of members like brackets, mullions, transom etc.
3	Sealant	As specified in the item or silicon sealant
4	Insulation	50 mm thick rock wool of minimum density 48 kg/cum sandwiched with black polythene sheet 100 micron on one side and aluminium foil of 100 micron on the other side or as specified by manufacturer at spandrel area. The surface after fixing insulation shall be plain without any distortion
5	Heat Reflective Toughened Glass	As specified elsewhere in the specification. Colour of any shade approved by the Engineer-in-Charge.

2.04.03 Aluminium Alloy Extruded Sections

Extruded sections to be used for fabrication of framing system for curtain walls shall be manufactured and supplied by approved reputed companies. In absence of specific extruded section, sections available conforming to BIS specification, manufactured by approved reputed companies, shall be used in the works. Dimensions and weights of the sections shall be as per approved drawings.

2.04.04 Components, General specifications, Glazing, Panelling etc. for Curtain Wall System : These shall be generally as per relevant Chapters in this book.

2.04.05 Scope of Work

2.04.05.01 Preliminary Requirements

i) The contractor shall design, test, fabricate, deliver, install and guarantee all construction necessary to provide a complete curtain wall system, all in conformity with the drawings and approval of the Engineer-in-Charge.

ii) Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the drawings,

iii) The curtain wall system shall also include the following activities :

a) Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings, metal closure, windows etc.

b) All anchors attachments, reinforcement and steel reinforcing for the systems required for the complete installations.

c) All thermal insulation associated with the system. (d) All fire protection associated with the system.

d) All copings and closure and metal cladding to complete the system.

e) All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.

f) Isolation of dissimilar metals and moving parts,

g) Anticorrosive treatment on all metals used in the system, (i) Polyester powder coating aluminium sections,

iv) The contractor shall also be responsible for providing the following :

a) Engineering proposal, shop drawings, engineering data and structural calculations in connection with the design of the curtain wall system.

b) Mock-ups, samples and test units.

c) Performance testing of the curtain wall framing and glazing assembly. (d) Co-ordination with the work of other trade.

d) Insulation with glass wool 48 kg/cum at spandrels area.

e) All final exterior and interior cleaning and finishing of the curtain wall system.

f) Protection.

g) As built record drawings and photographs.
h) Guarantees and warranties.

i) All hoisting, scaffolding, staging and temporary services.

j) Conceptualising and design of a suitable maintenance system for curtain glazing,

v) The water tightness and structural stability of the whole curtain wall system shall be the prime responsibility of the contractor. Any defect or leakage found within the guarantee period shall be sealed and made good all at the risk and cost of the contractor.

vi) The curtain wall system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects, specific details should be designed to accommodate thermal and building movements.

2.04.06 Design Requirements

i) Curtain wall shall comply with all government codes and regulations, building bye-laws, if any.

ii) All curtain walling, individual aluminium and glass components and all completed work shall be designed and erected to comply with the following requirements.

2.04.06.01 Basic requirement

The basic design and architectural requirements shall consist of the size of window, net glass area, ventilator, configuration of windows and spandrels to be retained. However the contractor may propose alternatives on the construction details for approval of the Engineer-in-Charge, provided that all basic functional and architectural requirements are fulfilled.

2.04.06.02 Quality Consideration and other Activities

i) The contractor while submitting the detailed design calculations should submit the following information on the quality of materials to be used and other aspects as detailed below:

1) Metal quality, finishes and thickness

2) Glass quality, coating and thickness and proposed manufacturer's brand names.

3) Aluminium extruded sections including mullions and transoms together with structural calculations and proposed manufacturer's brand name and also the name of agency proposed for fabrication work.

4) Arrangement and jointing of components.

5) Field connections especially mullion to mullion and transom to mullion.

6) Fixing and anchorage system of typical wall unit together with structural calculations.

7) Drainage system and provision in respect of water leakage in the curtain wall system.

8) Provisions for thermal movements.

9) Sealant and sealing methods.

10) Glazing Method

11) Wind load and seismic load and any other specific load considered in the design

ii) Design concept over lighting protection link-up system of the curtain wall for connection and incorporation into the lighting conductor system of the building (Lighting conductor system of the building shall be done by other approved specialized agency).

iii) The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case these tolerances exceed those specified in the specification.

2.04.06.03 Tolerances : Any parts of the curtain wall, when completed, shall be within the following tolerances:

1) Deviation from plumb level or dimensioned angle must not exceed 3 mm per 3.5 m length of any member, or 6 mm in any total run in any line.

2) Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle must not exceed 9mm total at any location.

3) Change in deviation must not exceed 3mm for any 3.5 m run in any direction.

2.04.06.04 Samples : The contractor shall also submit samples of aluminium extruded sections; mullion and transom sections in lengths of 300 mm with the same finish and workmanship as per the tender proposals and 300 mm x 300 mm samples of glass for approval of the EIC. (samples to include exposed screws and other exposed securing devices if any).

2.04.06.05 Ancillary Requirements to be fulfilled by the contractor

i) The contractor / approved specialized agency shall submit a maintenance manual for the curtain wall system inclusive of all metal parts, glass and finish etc.

ii) During detailed design scrutiny and also during the actual execution of the work any additions and extra provisions that will have to be made as per theoretical requirements or site conditions shall be implemented and executed by the contractor at his own cost, without claiming any thing extra under any circumstances.

2.04.07 Execution of work

2.04.07.01 Performance Testing - General Requirements

i) Mock-up units shall be constructed by the contractor and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the face of the building.

ii) After the approval of structural calculations and the drawing for construction of the curtain wall, one test unit for performance testing of the curtain wall shall be constructed by the contractor at an independent laboratory or at a laboratory approved by the Engineer-in-Charge.

iii) Erect mock-up under manufacturer's / Fabricator's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

iv) The contractor shall submit to the Engineer-in-Charge the test procedures to be adopted, test schedule and location for testing before the work of actual testing is taken up.

v) Prior to the fabrication of test units, the contractor shall submit shop drawings and design calculations of the test unit for approval of the Engineer-in-Charge.

vi) The contractor shall not start the work of erection of curtain wall on site till the approval for the successful completion of the mock up test and clear instruction in writing to start the work is received from the Engineer-in-Charge.

vii) The decision of the Engineer-in-charge in respect of the procedure to be adopted, in conducting the mock-up test and the judgment over the net results, shall be final and binding on the contractor.

2.04.07.02 Test of Wind Pressure

i) The equivalent load of wind pressure or wind suction shall be given to the test unit as increasing or decreasing the inside pressure in the "pressure chamber" at which the test unit is fixed.

ii) The static wind pressure shall be applied up to 1.5 kpa at maximum wind pressure.

iii) The variation of dynamic pressure shall be of any approximate sine curve line.

iv) Deflection on each observational points of the test unit shall be observed and recorded under static pressure as described above.

v) Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

vi) The deflection on the main structural parts in this condition shall not exceed :

1) 1/175 of the span between supports or 20 mm, whichever is less for vertical elements.

2) 1/250 of the span between supports for horizontal elements.

3) The extent of recovery of deformation, 15 minutes after the removal of the test load, is to be at least 95%.

2.04.07.03 Test of Lateral Deflection per floor height

i) Lateral deflection per floor height shall occur on the test unit, when the structural frame which fixes the test unit is deflected horizontally.

ii) The deflection of every ± 2.5 mm shall be increased up to ± 13 mm on the test unit (static deflection test)

iii) The dynamic deflection shall be applied up to ± 13 mm.

iv) The variation of dynamic deflection shall be of an approximate sine curve line, one period of 3 seconds.

v) The dimensions of the deflection on each observational point of the test unit shall be measured under the condition as described above and the damage shall be observed.

vi) Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall except the damage to sealant at maximum deflection.

2.04.07.04 Water-tightness Test

i) Water shall be sprinkled to the Test Unit' under wind pressure.

ii) Pressure shall not be applied to the test unit.

iii) The volume of the sprinkling water in one minute shall be 5 litres per sqm minimum.

iv) All water leakage and drainage system at the joint and the open able sash of the curtain wall system shall be observed from the outside of the chamber.

v) Hold the test two times, in sequence as described below, conforming to the above mentioned conditions.

vi) Water leakage shall not be observed inside at all parts of the test unit during first water-tightness test.

1) Install the test unit.

2) Hold first water-tightness test.

3) Hold test of wind pressure as described above.

4) Hold second water-tightness test.

5) Lateral deflection test.

2.04.07.05 Test Report : The contractor shall submit five copies of test report to the Engineer-in-charge.

2.04.07.06 Cost of Performance Test

i) The contractor shall allow in his tender for the cost of the performance testing and fabrication, erection, corrections to and demolition of the test units including any special provision required in the testing laboratory for the tests mentioned above.

ii) The contractor shall allow for amendments and adjustments to the mock-up unit as instructed and required by the Engineer-in-Charge / Architect or the consultant.

iii) If the mock-up test unit fails to pass the initial testing, the contractor shall make the necessary corrections to the test unit and shall get the test unit retested by the testing laboratory until it passes the test.

iv) Cost of corrections to the test unit and the cost of retesting shall be borne by the contractor.

v) The contractor shall be allowed six calendar months time after the work is awarded to set up the test unit and conduct the required test as described above to the satisfaction of the Engineer-in-charge.

vi) In case the contractor fails to conduct the necessary tests as described above or fails to meet the required test results, without any genuine cause within the allotted period of six months, the Engineer-in-charge shall be free to rescind the contract with all costs including the forfeiture of E.M.D. and any other securities deposited by the contractor under the condition of contract.

2.04.07.07 Record of Test and Drawings

i) The testing laboratory shall keep the approved copy of the shop drawing and calculations of the test unit at testing laboratory during testing of test unit.

ii) The testing laboratory shall accurately and nearly record on the above mentioned shop drawings all changes, revisions, modifications etc. made to test unit, which shall become the record drawing.

iii) On completion of testing and after approval of the test reports the testing laboratory shall submit the final record drawings to the Engineer-in-charge.

2.04.07.08 Fabrication and Erection

i) Frames shall be square and flat, both the fixed and openable frames shall be constructed of sections, which have been cut to length,

mitred and mechanically jointed at the corners, Sub-dividing bar of units shall be tenoned and riveted into frames.

All frames shall have corners welded to true right angles. For jointing hollow sections flash butt welding, argon arc welding or mechanical jointing by inserts shall be used. (Gas welding or brazing shall not be done). Concealed screws shall be used for joining the sub-units.

ii) The grid for the curtain wall system shall be fabricated carefully with aluminium extruded sections like mullions and transom in the exactly same pattern as per the final drawings with amendments if any received from the laboratory after conducting the mock-up unit test.

iii) The sizes of different members of the curtain wall system shall be exactly as adopted for the mock-up unit tests and the grid shall be fixed to the building member as shown in the drawing, received after conducting the mock-up unit test.

iv) Care should be taken to see that any gap between the frame and support and the frame itself is sealed with silicon sealant.

v) Finish of grid frame shall be either anodized, organic coating, backed enamel finish or as specified in the item of work, no visual variation in anodizing / colour shall be accepted.

vi) Care shall be taken to see that the curtain wall system is not deformed, damaged during erection and it shall be protected from direct contact with wet or intermittent wet cement concrete mortar etc.

2.04.08 Representative of the contractor

Full time attendance of a qualified civil engineer with sufficient experience in construction of curtain wall system shall be provided for erection of test unit, all testing and later on actual construction.

2.04.09 Performance Guarantee

The contractor shall provide a performance guarantee as indicated in the Schedule of Quantities for a period of five years, to provide for expenses to cover the risk and cost of rectification of defect, noticed during the five years guarantee period. Guarantee period shall start from the date of completion and handing over of the project.

2.04.10 Measurements

i) The breadth and the height of the finished work including the openable windows shall be measured in metres and cm and the net quantity for payment shall be calculated in sqm up to two places of decimal.

ii) The area to be considered for measurement shall be the net area of the exterior face of the curtain wall as fixed including the openable windows, if any, as part of the curtain wall.

2.04.11 Rate

The rate shall include the cost of all operations described above including the cost of materials, labour, design, shop drawings, erection and testing, mock-up test units, fabrication, erection, finishing, scaffolding, undertaking performance guarantee etc. No other claims of any kind pertaining to this work shall be entertained.

2.05.00 Aluminium Sun Louver With Stringer System

Plain panel Aluminium Sun Louver system as per manufacturers specification of approved colour, shall consists of panel 84 mm wide x 16 mm deep x 0.6mm thick in standard length of upto 6m. The panel shall be coil coated in a continuous paint line, double baked and roll formed from stove enameled corrosion resistant aluminium Alloy AA 5050/3005 for higher strength and roll forming characteristics. The panel shall be clipped on to a backed & enamelled aluminium stringer 33mm wide x 86mm deep made from 0.95mm thick backed & enamelled aluminium alloy AA 5050 (sl.mg.) in standard length of 5 m in white colour with cutouts to hold the panels in a module of 86mm c/c. The first stringers shall be fixed at 150mm from both ends and thereafter at a distance of 0.75mm c/c depending on wind load. The stringer shall be fixed to a suitable sub-structure/wall with Nut/Bolt and washer.

Paint Finish

Panel shall have exterior paint finish which will be of 3 layers:

The Anorcoat Pretreatment

The colour coating and

Transparent top coat

The paint used shall be epoxy based & finished with a polyamide/Nylon coating. The paint system shall have the following characteristics.

Coating thickness	:	24-32 Microns
Gloss	:	28 (+/-5)

Gloss Variation	:	+/-3 units (within delivery)
Adhesive Impact/Bending	:	No Loss of Adhesive
Durability	:	Higher Category
Humidity Resistance	:	Blisters less than size 2

2.06.00 Shop Coat or Paint

The shop paint for steel doors, windows, etc. shall be best lead or zinc chromate primer paint from approved manufacturer conforming to IS 2074. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for in the Schedule of Items all steel doors, windows, etc. shall be hot dip galvanised to give a coating weight of 1-1/2 - 2 Oz per sft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.07.00 Handling & Storage of Fabricated Material

All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are upto the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

2.08.00 Assembly & Erection at Site

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081 and as shown on drawings. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers,

etc. including transoms and mullions for composite units in respective places as shown on drawing keeping proper lines and levels, and in approved workman like manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. For all frames supplied by either the Owner or the Contractor mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For Fabricated Items

a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures.

h) Provisions for hardware and fixtures to be installed at site.

I) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

3.02.00 For Installed Items

a) Installations shall be at correct location, elevation and in general on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings.

c) Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners, etc. shall engage positively. Keys shall be non-interchangeable.

g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for doors, windows, etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

b) He shall submit a programme of work to be done for the approval of the Engineer.

c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.00.00 RATES

Rates shall be unit rates for items described in schedule.

6.00.00 METHOD OF MEASUREMENT

a) Supply and installation of doors shall be measured in number of each type used. The types shall be as shown on drawings and described in Schedule of Items.

b) Supply of windows shall be measured in number of each type of unit used either single or in combination.

c) Installation including assembly and erection of windows shall be measured in number of types of combinations mentioned in the Schedule of Items.

d) Supply and installation of louvers shall be measured for area of opening in which the louver is to be installed.

e) Supply of mullions and transoms shall be measured for net length of different types shown on drawings and described in Schedule. In computing the length, the length required for embedding in concrete or masonry shall not be considered. No extra payment shall be made for end or cover plates.

f) Vision panels, louvers to doors and insulation between door faces shall be measured for actual area and paid separately over the basic rate doors.

g) Glazing beads, weather stripping, fixing devices etc. shall not be measured separately but shall be included in the supply rate of respective items.

h) And curing or grouting to concrete and masonry or welding and drilling to steel required for installation shall be included in the installation rate. No separate payment shall be made for caulking and jamming or frames or making good to concrete or masonry.

I) Glass and glazing shall be measured and paid under relevant items.

j) Door and window fixtures, locks, door closures etc. shall be measured in actual numbers use.

7.00.00 I.S. CODES

Following are some of the important I.S. Codes as relevant to this section :

Steel doors, windows and ventilators	-	IS : 1038
Steel windows for industrial buildings	-	IS : 1361
Aluminium doors windows and ventilators	-	IS : 1948
Aluminium windows for industrial buildings	-	IS : 1949
Steel doorframes	-	IS : 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows, And ventilators.	-	IS : 1081
Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineer		

Purposes) – Specification	-	IS : 733
Wrought Aluminium and Aluminium Alloy sheet, and strip for General Engineer Purposes - Specification	-	IS : 737
Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) –Specification	-	IS : 1285
Anodic coating on Aluminium and its Alloys – Specification	-	IS : 1868
Specification for Aluminium equal leg angles	-	IS : 3908
Specification for Aluminium unequal leg angles	-	IS : 3909
Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.	-	IS : 3965
Method of testing anodic coating on aluminium and Its alloys	-	IS : 5523
Measurement of coating thickness by Eddy Current Method	-	IS : 6012
Floor springs (Hydraulically regulated) for heavy doors Specifications		IS : 6315
Dimensions of extruded hollow section and tolerances	-	IS : 6477

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SECTION-XXI

TECHNICAL SPECIFICATION

ROLLING STEEL SHUTTERS, GRILLS AND COLLAPSIBLE DOORS

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SECTION-XXI

ROLLING STEEL SHUTTERS, GRILLS AND COLLAPSIBLE DOORS

1.00.00 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills/partly closed and partly grilled/collapsible doors with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick of CR grade for shutters upto 4.5 M wide and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

b) Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.

f) Shafts shall be of steel pipe of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as described by the Engineer.

i) Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in Schedule or drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters / Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general manually operated shutters shall be push pull type for openings upto 9 sq. metre in area. Larger shutters shall be either chain or gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described in Schedule or as desired by the Engineer.

2.03.00 Power Operated Shutters / Grills

These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for in Schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Rolling Shutters without grill

Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitably fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with mechanical device supplied by the firm. Shutters up to 10 sq. metre shall be of push and pull type and shutters with an area of over 10 sq. metre shall

generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

Shutter : The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90mm for the shutters up to 3.5m width and not less than 2.25 mm thick of CR grade for shutters 5.5 M wide and above. Shutters above 9 metres width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure of 100 kg/sq.m. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

Spring : The spring shall be coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454 - Part I.

Roller and Brackets **:** The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161 to carry the tortional load with a maximum deflection of $1/360^{th}$ of span. For shutter up to 6 metre width and height not exceeding 5 metre, steel pipes of 50mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x 3.15 mm for shutters up to clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 10 mm for shutters of clear height above 3.5m and up to 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall connected by means of pretensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

When the width of the opening is greater than 3.5 mtr, the cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self aligning two row ball bearings with special cast iron casings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15 mm and at least 4 number flats running throughout length of roller shall be provided.

In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

Guide Channel **:** The width of guide channel shall be 25mm the minimum depth of guide channels shall be as follows :

Clear width of shutter	Depth of guide channel
Up to 3.5 m	65mm
3.5m up to 8m	75mm
8m and above	100mm

The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

Cover **:** Top cover shall be mild steel sheets not less than 0.90mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

Power unit **:** Power unit shall be suitable for 3 phases, 50 cycles, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in Schedule or drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

Fixing **:** The arrangement for fixing in different situations in the opening shall be as per IS 6248.

Brackets shall be fixed on the lintel or under the lintel as specified with rawl plugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and brackets shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in workmen like manner that the operation of the shutter is easy and smooth.

Measurements :

Clear width and clear height of the opening for rolling shuttering shutter shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height.

The area shall be calculated in square metres correct to two places of decimal.

Unless included in the main team, whether stripping at bottom bar and mullions shall be measured separately for length.

Cylinder locks shall be for actual numbers used. Pad locks shall be supplied by others.

Rate

The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover and spring except ball bearing and mechanical device of chain and crank operation, which shall be paid for separately.

2.05.00 Rolling Grills – Shutters

Rolling grill shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter. The situations where a certain amount of ventilation combined with safety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rolling grill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter. The total height of the grill portion in all the segments of rolling shutter-cum grill shall not exceeded 1.0m and the height of the grill portion in any individual segment shall not be more than 0.5m.

Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 10.8 shall be applicable to rolling grills shutters except in respect of the shutter portion and shall conform to IS 6248.

Shutters

Rolling grill shutter and the rolling grill portion of the rolling shutter-cum grill shall be fabricated with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20mm wide and 5mm thick mild steel flat links. Straight bars shall be spaced not exceeding 150mm centre to centre and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Unless otherwise specified or directed by the Engineer-in-charge, bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 100 to 120mm and the depth of corrugation is 80 to 100mm. all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes and the length of the links shall be such that the distance from the centre of the hole to the nearest edge of the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All links shall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as centre to centre distance between two consecutive crests/ troughts of the bars bent to the required profile. Each bar and link shall be continuous single piece without any joint.

Measurement & Rate

The measurement and rate shall be as specified in clause 2.02.01(g). In case of Rolling Shutter-cum-Grill, where the area of the grill portion is half or less than half the area of opening, it shall be measured and paid as rolling shutter and where the area of grill portion is more than half the area of opening, it shall be measured and paid as rolling grill.

2.06.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat. Wherever galvanized door not specified, the door shall be painted with synthetic enamel paint with two coats

2.07.00 Erection

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

2.08.00 Collapsible Gate / Door

2.08.01 These shall be of approved manufacture and shall be fabricated from the mild steel sections.

2.08.02 The gates shall consist of double or single collapsible gate depending on the size of the opening. These shall consist of vertical double channels each 20 x 10 x 2 mm. at 10 cm. centre to centre braced with flat iron diagonals 20 x 5

mm and top and bottom rails of T- iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 10 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

2.08.03 Fixing

T- iron rails shall be fixed to the floor and to the Lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centers alternatively in the two flanges of the T- iron. The bottom runner (T- iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channel with T-iron rails and also by hold- fasts bolted to the end double channel and fixed in masonry of the side walls on the other side. In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee-section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing of gate shall be made good to match the existing work, without any extra cost.

2.08.04 Painting

All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer conforming to IS 2074 before fixing them in position.

2.08.05 Measurements

The height and breadth shall be measured correct to a cm. The height of the gate shall be measured as the length of the double channels and breadth from outside to outside of the end fixed double channels in open position, of the gate. The area shall be calculated in square metres, correct to two places of decimal.

2.08.06 Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 RATES

Rates shall be unit rates for complete items for supply and/or erection of rolling shutters, including all drives, accessories, hardware etc. No extra payment shall be made for cutting, drilling, welding, grouting etc. to structure for installation of the shutters.

The rates shall include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections.

5.00.00 METHOD OF MEASUREMENT

a) Rolling shutters or grills shall be measured for area of opening in which they shall be installed. Alternatively, shutters shall be measured for actual number of different sizes used.

b) Cylinder locks shall be for actual numbers used. Pad locks shall be supplied by others.

6.00.00 I.S. CODE

IS : 6248 - Metal rolling shutters and rolling grills.

IS : 10521 - Collapsible Gate

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SECTION-XXII

TECHNICAL SPECIFICATION

GLASS AND GLAZING

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SECTION-XXII

GLASS AND GLAZING

1.00.00 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc wherever required as shown on drawings and specifications, supply of metal glazing beads and neoprene gaskets shall not be included in this scope.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions from approved manufacturer, shall have uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Clear glass shall be float glass and should be approved by the Engineer-in-Charge and shall be at least 4 mm thick for windows and for doors & glazed partitions shall be minimum 8mm thick or as indicated in doors' and windows schedule. It shall be clear, float transparent and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900. The thickness of float glass shall be measured with micrometers or a calliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.

b) Obscure glass shall have a cast surface in one side.

c) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type float glass on outer side and 6mm thick clear float glass on inner side with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system.

d) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.

e) The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators

etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer-in-Charge shall only be used. The contractor shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge.

The EPDM gasket shall meet the requirements as given in Table below :

SL. No.	Description	Standard Follow	Specification
1	Tensile strength kg.f/cm^2	ASTM-D 412	70 Min.
2	Elongation at break %	ASTM-D 412	250 Min.
3	Modulus 100% Kgf/cm^2	ASTM-D 412	22 Min.
4	Compression set % at 0º CC 22 Hrs.	ASTM-D 395	50 Max.
5	Ozone resistance	ASTM-D 1149	No visible cracks

Quality of glass

a) All glass shall comply with ECBC 2007 requirements.

b) Single glass panels shall have properties like –
VLT = 35 to 50%, external reflection=6 to 15%, internal reflection=8 to 15%, solar factor=0.36 to 0.43, U value=2.8 to 3.0 W/sqm K to be provided.

c) Double glazed panels with glass having properties like-
VLT = 30 to 45%, external reflection=8 to 20%, internal reflection=15 to 30%, solar factor=0.26 to 0.29, U value=1.8 to 1.9 W/sqm K. shall be provided.

2.02.00 Reflective Glass

Definitions

i) Shading Coefficient : The shading coefficient is the ratio of total solar transmittance to the transmittance through 3.2 mm (1/8") clear glass. Windows with low shading coefficient values improve comfort for building, lower the total cooling load of the building and help smooth out of the difference in cooling loads between perimeter & core zones.

ii) Luminous Efficiency Constant (Ke) indicates a windows relative performance in rejection solar heat-while transmitting day light. It is the ratio of the visible transmittance to the shading coefficient; clear glass which lets in roughly equal amounts of visible light and solar

near-infrared energy has a Ke close to 1.0. The solar radiation contains about 50% invisible near-infrared & ultra violet light. Therefore, a perfectly selective glazing, which would all allow visible light pass through while blocking all of the invisible near-infrared & ultraviolet light, would have Ke of about 2.0.

iii) Resistance to Heat Conduction (R-valve) : It is a measure of resistance to heat flow that occurs because of temperature difference between the two sides of the windows. The inverse of R-value is termed as U-value.

Reflective Glass

This is an ordinary float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass i.e. reflective glass has better shading coefficients because they reflect rather than absorb infrared energy. However, most of reflective glazing blocks day light more than solar heat.

Types of Coatings : There are two types of reflective glass, Pyroltic (Hard) coated and vacuum (soft) coated.

i) Pyroltic : It is a coating applied during glass manufacture. The coating is fused in to the glass at 1200ºC.

ii) Vacuum Coated Glass : It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat; because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than Pyroltic products.

Performance of Reflective Glass : The performance of reflective glass 6 mm of nominal thickness is given below:

Sl. No.	Parameter	Threshold Ratio in %age
1.	Visible Light - Transmittance (%) - Reflectance (%)	 15-46 12-24
2.	Total Solar Energy: - Transmittance (%) - Reflectance (%)	 16-24 8-12
3.	Ultra Violet Rays: - Transmittance (%)	 2-10
4.	U-Value - Summer - Winter	 0.58 0.45

5.	Shading Coefficient	0.25-0.35

Testing : The reflective glass shall be tested for the followings :

i) Physical/Field Test: In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image should coincide.

ii) Laboratory Test: In the laboratory, the reflective glass shall be tested for the parameter specified in the table above.

2.03.00 Glazing, Setting and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing clips shall be provided per glass pan, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Necessary glazing clips, putty, mastic cement etc. shall be supplied by the Contractor. The Contractor shall be responsible for damage of glass supplied by the Owner, during handling, transportation, fixing etc maximum wastage allowance shall be 5%.

After completion of glazing work, the Contractor shall remove all dirt stains, excess putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the Contractor's own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by EPDM gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 RATES

a) Rates shall be unit rates for supply and / or installation of different kinds of glass mentioned in the Schedule of Items.

b) No separate payment shall be made for glazing clips, mastic cement, putty, nails etc. for drilling holes in frames for inserting glazing clips.

c) No separate payment shall be made for cutting of glass to require size, edge finishing etc.

d) No separate payment shall be made for cleaning the glass after installation.

5.00.00 METHOD OF MEASUREMENT

All supply and / or installation of glass shall be measured for actual area of work done.

6.00.00 IS CODES

Following are some of the important I.S.Codes relevant to this Section;

IS : 3548 - Code of practice for glazing in building.

IS : 1083 - Code of practice for fixing and glazing metal doors, windows and ventilators.

IS : 14900 - Transparent Float glass- Specifications.

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SECTION-XXIII

TECHNICAL SPECIFICATION

FLOOR FINISHES AND ALLIED WORKS

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SECTION-XXIII

FLOOR FINISHES AND ALLIED WORKS

1.00.00 SCOPE

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below:

a) In Situ Finishes

- i) Integral finish to concrete base
- ii) Red Oxide of Iron finish
- iii) Terrazzo finish
- iv) Granolithic finish
- v) Patent Stone
- vi) Metallic Hardener like “Ironite” or equivalent finish
- vii) Mastic Asphalt finish
- viii) Chemical Resistant finish

b) Tiled Finishes

- a) Terrazzo tile
- b) Chequered tile
- c) Glazed tile
- d) Tesserae (Mosaic etc.)
- e) Chemical Resistant
- f) Rubber, Vinyl etc.
- g) Stone slab
- h) Steelcrete tile
- i) Vitrified tiles

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.02.00 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered under Specification “Properties Storage and Handling of Common Building Materials”. Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer’s permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires that the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any

special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish to Concrete Base

Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah, courtyard, kitchens & baths shall have slope ranging from 1:48 to 1:60 depending upon location and decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1:30 or as decided by the Engineer-in-Charge to drain off washing water. Further, necessary drop in flooring in bath, WC, kitchen near floor traps ranging from 6mm to 10mm will also be provided to avoid spread of water. Necessary margin to accommodate this drop shall be made in base concrete. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it. While the surface of the concrete laid as per specification for 'Cement Concrete has been fully compacted and levelled but the concrete is still green thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin a possible by using 2.2 kg. of cement per sq.m. of area. in verandah, courtyard.

Laying

Panels : Flooring of specified thickness shall be laid in the pattern including the borders given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450mm in width and the joints in the boarder shall be in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm. The joints of borders at corners shall be mitred for provision of strips.

Laying of Flooring with Strips : Normally cement concrete flooring shall be laid in one operation using glass/aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 4mm thick glass strips or 2mm PVC strips or 2mm aluminium or brass strips shall be fixed with their tops at proper level, giving required slopes. Use of glass and metallic strips shall be avoided in areas exposed to sun. Cost of providing and fixing strips shall be paid separately.

Concreting : Cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel and beaten with thapy or mason's trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge. Surface of flooring be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

Laying of Flooring without strips : Laying of cement concreting flooring in alternate panels may be allowed by the Engineer-in-Charge in case strips are not to be provided.

Shuttering : The panels shall be bounded by angles iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

Concreting : The concreting shall be done in the manner described earlier. The angle iron/flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1:2 (1 cement: 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

Finishing

The finishing of the surface follow immediately after the cessation of beating. The surface shall be left for some time till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture stiffening the concrete to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.

Fresh cement shall be mixed with water to form a thick slurry and spreaded @ 2 to 2.2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.

The edge of the sunk floors shall be finished & rounded with cement mortar 1:2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement.

The junction of floor with wall plaster, dado or skirting shall be rounded off where so specified.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

Curing

The curing shall be done for a minimum period of ten days. The surface shall be kept in shade for 24 hours and then cured for at least 10 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after laying. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies bag shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings. The marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

Precautions

Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4ºC. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot whether, precautions shall be taken to see that the temperature of wet concrete does not exceed 38ºC. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

Measurement

Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

2.01.02 Red Oxide of iron finish

It shall consist of an underbed and a topping over already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm or as per schedule of item for horizontal and 20 mm or as per schedule of item for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius off 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

ii) Topping

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand by volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

c) Laying

The underbed shall be laid in panels of mixing area 5 Sq.M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq.M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat ‘green’ but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with slurry made with already prepared cement and

pigment mixture. About 2.0 kg of the mixture shall be consumed/per sq.m for horizontal surface, and 1.0 kg for vertical surface. The surface shall be cured for seven days by keeping it moist.

d) Polishing

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.01.03 Terrazzo Finish: In Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 50 mm for horizontal and 20 mm or as per schedule of items for vertical surface of which the topping shall be not less than 10 mm or as per schedule of items. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1 1/2 parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water is to be added to give a workable consistency. The panels shall be of uniform size, not exceeding 2 sqm in area or 2 m in length for inside situations. In exposed situations, the length of any side of the panel shall not be more than 1.25 metre. Cement slurry @ 2.00kg per sqm shall be applied before laying of under layer over the base cement concrete/RCC base.

ii) Fixing of Strips

4 mm thick glass strips or 2mm thick PVC strips/aluminium strips/brass strips/stainless steel strips/copper strips unless otherwise specified shall be fixed with their top at proper level to required slope. Strips of stone or marble or any other material of specified thickness can also be used if specifically required. Use of glass and metallic strips shall be avoided in areas exposed to sun. The fixing and laying shall be as specified earlier.

iii) Topping

The mix for the topping shall be composed of cement, with or without colour pigment, marble dust, marble chips and water. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. 3 parts of this mixture 1 part marble powder by volume or weight shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1½ parts of marble chips by volume shall be added and thoroughly mixed dry again.

The marble chips shall be white or pink Makrana, black Bhainslana, Chittor black, Jaisalmer Yellow, Baroda green, Dehradun white, Chittor pink, yellow Patam cherala (Madras), Grey Gadu (Surat), Chitoor green and yellow and Alwar black or as specified. It shall be uniform in colour and free from stains, cracks, decay and weathering. The maximum thickness of the top layer for various sizes of marble aggregates (marble chips) shall be as shown in Table below.

Grade No.	Size of Aggregates in (mm)	Proportion of Aggregates to Binder Mix	Minimum Thickness of Top Layer(mm)
00	1 – 2	1.75:1	6
0	2 – 4	1.75:1	6
1	4 – 7	1.75:1	9
2	7 - 10	1.5:1	12

Where aggregate of size larger than 10 mm are used, the minimum thickness of topping shall not be less than one and one third times the maximum size of the chips. Where larger size chips such as 20mm or 25mm are used, it shall be used only with a flat shape and bedded on the flat face so as to keep the minimum thickness of wearing layer.

Before starting the work, the contractor shall get the sample of marble chips approved from the Engineer-in-Charge. This shall be done in advance by mixing different colour marble chips and panel samples of minimum 1 m x 1 m size shall be prepared and got approved from the Engineer-in-Charge

before laying of flooring. The cement to be used shall be ordinary grey cement, white cement, cement with admixture of colouring matter of approved quality in the ratio specified in the description of the item in the ratio to get the required shade as ordered by the Engineer-in-Charge. Colouring materials where specified shall be mixed dry thoroughly with the cement and marble powder and then marble chips added and mixed as specified above. The full quantity of dry mixture of mortar required for a room shall be prepared in a lot in order to ensure a uniform colour. This mixture shall be stored in a dry place and well covered and protected from moisture. The dry mortar shall be mixed with water in the usual way as and when required. The mixed mortar shall be homogeneous and stiff and contain just sufficient water to make it workable.

The pigment must be stable and non-fading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Sieve No. 30. The size of marble chips may be between 1 mm to 10 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 2 sq.m. in area of which no side shall be more than 2.0 M long. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips as stated earlier shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but firm enough to receive the topping. Slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Curing

The surface shall be left for curing for about 12 to 18 hours depending on atmospheric temperature conditions and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polishing

The grinding and polishing may be commenced not before 2 days from the time of completion of laying for manual grinding and not before 7 days for machine grinding. When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no. 60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no. 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no. 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no. 60), second rubbing with medium grade (no. 80) and final rubbing and polishing with fine grade (no. 120).

Where use of machine for polishing is not feasible or possible, rubbing and polishing shall be done by hand, in the same manner as specified for machine polishing except that carborundum stone of coarse grade (No. 60) shall be used for the 1st rubbing, stone of medium grade (No. 80) for second rubbing and stone of final rubbing polishing.

The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 33 gm. per. sq.m sprinkled with water on to it and rubbed hard with a nemdah block (Pad of Wooden rags). The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

Curing shall be done by suitable means such as laying moist sawdust or ponding water.

Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned. Any damage done to WC's squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4ºC. The concrete placed shall be protected against frost by suitable coverings. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see the temperature of wet concrete does not exceed 38ºC. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.

2.01.04 Wax Polishing

Application, Polishing and Precautions

Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the flooring/skirting.

When the layer of the wax is shifted and surface of the floor is saturated with the polish, polishing shall be restored with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained.

The fresh polished wall surface shall be spreaded with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed.

2.01.05 Crazy Marble Flooring

Base Concrete

Crazy marble stone flooring shall be laid on cement concrete base. The base concrete shall be provided with slope required for the flooring in verandahs and courtyards to drain off washing and rain water. The surface of base shall be roughened with steel wire brushes, without disturbing the concrete, wetted and smeared with a floating coat of cement slurry at 23 kg of cement spread over an area of one sqm so as to get a good bond between base and flooring.

Before laying the flooring on RCC slabs, the laitance shall be removed, the surface of slab hacked and a coat of cement slurry at rate of 2 kg of cement spread over an area of one sqm shall be applied so as to get a good bond between RCC slab and floor.

Under layer

The under layer of crazy marble flooring shall be of cement concrete of thickness 25mm or as specified. The mix shall normally be 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 12.5 mm nominal size) by volume unless otherwise specified.

Top layer

The mix of crazy marble stone flooring shall consists of white cement with or without pigment, marble powder, marble chips of 00 Nos. and marble stone pieces and water. The marble stone pieces shall be hard, sound, dense and homogeneous in texture with crystalline and concrete grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. Before starting the work the contractor shall get the sample of marble stone approved by the Engineer-in-Charge. The marble stone pieces shall be of sizes as approved by the Engineer-in-Charge but the thickness shall be according to the overall thickness specified which could be achieved when laid over the under layer as specified. Thus for 50mm thick floor, the thickness of marble pieces will be 25mm while for 40mm thick floor, the thickness will be 15mm.

The white cement and marble powder shall be mixed in proportion of three parts of cement and one part of marble powder by weight, and the proportion of marble chips to binder mix by volume shall be 7 parts of marble chips to 4 parts of binder mix. The marble chips shall be as specified. It shall be hard, sound, dense and homogeneous in texture. It shall be uniform in colour and free from stains, cracks decay and weathering.

Laying

A coat of cement slurry at the rate of 2 kg of cement per sqm of area shall be spread and then the marble stone pieces shall be set by hand in such a manner that the top surface of all the set marble stones shall be true to the required level and slopes. After fixing the stones, the cement marble chips mixture shall be filled in between the gaps of laid marble stone pieces. The filled surface then shall be trowelled over, pressed and brought to the level of the laid marble stone pieces.

Polishing

Curing and Finishing shall be as described earlier.

Precautions

Flooring in lavatories and bathrooms shall be laid after fixing of water closet and squatting pans and floor traps. Traps shall be plugged, while laying the floors and opened after the floors are cured and cleaned.

Measurements

Length and breadth shall be measured correct to a cm before skirting, dado or wall plaster and it shall be calculated in sqm correct to two decimal places. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metres. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metres. Nothing extra shall be paid for laying floor at different levels in the same room or courtyards.

2.01.06 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand: 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification “Cement Concrete” and levelled up to the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully “green” the topping shall be laid evenly to proper thickness and grade. If it is considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone-chips.

For large areas the laying shall be in panels of maximum 25 Sq.M area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base.

The base concrete shall be prepared as stated in clause 7.1.2.0.3 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

e) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny

bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.03 (e) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

g) Finishing

Where specified, sodium silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified in the Schedule of Items. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.07 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.03(a) except that the topping shall be 6 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.03 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

c) Laying

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be as in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.01.08 Cement Concrete Flooring with Metallic Hardener Topping

Wherever floors are required to withstand heavy wear and tear, use of floor hardener shall be avoided as far as possible by using richer mixes of concrete, unless the use of a metallic hardener is justified on the basis of cost.

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is “Green”.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be of approved quality consisting of uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

c) Mix

The top layer shall consist of 12mm thick layer of mix 1: 2 (1 cement: 2 stone aggregate 6mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1:4 (1 metallic concrete hardener: 4 cement) by weight or as per manufacturer’s specification relevant to medium/heavy duty floor. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone aggregate 6mm nominal size or as otherwise specified in the ratio of 1:2 (1 cement :2 stone aggregate) and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete.

d) Laying

The concrete floor shall be laid as per specification “Cement Concrete” and levelled upto the required grade. The forms, if any

shall remain sufficiently projecting to take the finish. The surface shall be roughened by wire brush as soon as possible.

The mixture so obtained shall be laid in 12mm thickness, on cement concrete floor while the concrete under bed is still very “green” within 2 to 4 hours of it’s laying. The topping shall be laid true to provide a uniform and even surface without trowel marks, pin holes etc. It shall be firmly pressed into the bottom concrete so as to have good bond with it. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.09 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing or schedule of items.

b) Materials

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick and 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform to IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg. or prepared at site. If brought in blocks, these shall be re-melted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the re-melting and mixing process, shall the temperature exceed 205^{o} C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 15 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.10 Acid or Alkali Resistant Tiles

Manufacture and Finish

The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed two percent. The tiles shall be vitrified at the temperature of 1100ºC and above and shall be kept unglazed. The finished, tile, when fractured shall appear fine grained in texture, dense and homogeneous. The tiles shall be sound, true to shape, flat and free from flows and manufacturing defects affecting their utility.

The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of required colour.

Dimensions and Tolerances

Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 x 98.5 mm, 148.5 x 148.5mm and 198.5 x 198.5mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the under side of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be ± 2 percent.
Shape

The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for square ness and warp as per IS 4457.

Performance Requirements

The tiles when tested in accordance with method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

Loss in Abrasion

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

Marking

Tiles shall be legibly marked on the back with the name of the manufacturer or his trade mark. Manufacturer's batch number and year of manufacture.

Each tile may also be marked with the ISI certification mark.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The average thickness of the bedding shall be 10mm or as specified while the thickness for dado/skirting to be 12mm or specified on item.

Alkali resistant mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over the mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of acid alkali resistant cement per square metre over an area up to one square metre. Tiles shall be socked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

After tile has been laid surplus cement slurry shall be cleaned off.

Pointing and finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout the lugs remaining exposed. The floor shall then be kept wet for 7 days. After surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where covers are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metres. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10squre metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. For tiles of sizes up to 0.16 sqm, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cost (Swan) tiles in the work.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo tile and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

Terrazzo tiles shall generally conform to IS 1237-Edition 2.3. The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be manufactured in a factory under pressure process subject to pressed hydraulically to a minimum of 140 Kg. per sq.cm and shall be given the initial grinding with machine and grouting of the wearing layer before delivery to site. The wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edges of wearing layer may be rounded. Tiles shall be packed properly to prevent damage during

transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals. Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform. The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be $\pm$ 1 mm and the thickness +5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and 3 mm on thickness. Face of the tile shall be plane, free from pinholes and other blemishes.

The proportion of cement to aggregate in the backing of tiles shall be not leaner than 1:3 by weight. Where colouring material is used in the wearing layer, it shall not exceed 10 percent by weight of cement used in the mix.

The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips ranging from the smallest up to 6mm and also, not less than 5 mm for size of marble chips ranging from the smallest up to 12mm, and not less than 6mm for size of marble chips varying from the smallest up to 20mm.

The topping shall be as specified under clause 2.01.03 (b) (iii).

c) Mix : Underbed

Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar of specified proportion and in conformity with provisions in relevant para of chapter on ‘Mortar’

Cement mortar 1:4 (1 cement: 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20mm and the thickness at any place shall not be less than 10 mm.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, neat cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. The tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying.

The joints between tiles shall be as close as possible and not more than 1 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.03 (b ii) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shape of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No.60). Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120)

The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding - coarse grade stone (No. 60)

Second grinding - medium grade (No. 80)

Final grinding - fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per sqm sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

If any tile is distributed or damaged, it shall be refitted or replaced, properly jointed and polished.

The finished floor shall not sound hollow when tapped with a wooden mallet.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01

b) Tiles: Chequered

The tiles shall be of nominal sizes such as 20 x 20 cm, 25 x 25 cm and 30 x 30 cm or standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Engineer-in-Charge. The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.2.1 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

c) Underbed

As per clause 2.02.01 (c).

d) Laying

As per clause 2.02.01 (d)

e) Grinding and Polishing

As per clause 2.01.03 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Pressed Ceramic Tile Flooring

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tile shall be tested as per IS 13630.

Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1, 3, 5 and 7 of IS 15622 give the modular preferred sizes and table 2, 4, 6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width up to 2 mm for uncertified floor tiles and up to 2mm for uncertified floor tiles and up to 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tile shall conform to table 10 of IS 15622 with water absorption to 3% to 6% (Group BII)

The tiles surface of the tiles shall be glazed. Glazed shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50% of the surface area of the edges.

Coloured Tiles

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

Decorative Tiles

The type and size of the decorative tiles shall be as follows :

i) Decorated white back ground tiles

The size of these tiles shall be as per IS 15622

ii) Decorative and having coloured back-ground

The sizes of the tiles shall be as per IS 15622.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness

of the bedding shall be 20mm or as specified while the thickness under any portion of the tiles not to be less than 10mm.

Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

Over the mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per squre metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edge rubbed smooth to ensure straight and true joints.

Tiles which are fixed in the floor adjoining the wall shall enter not less than 10mm under the plaster, skirting or dado.

After tiles have been laid surplus cement slurry shall be cleaned off.

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

Pointing and Finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where covers are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. For tiles of size up to 0.16 sqm. Unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cut (swan) tiles in the work.

Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

2.02.04 Pressed Ceramic Tile Flooring (Vitrified Tile Flooring)

Tiles shall conform to Table 12 of IS and the joint thickness in flooring shall not be more than 1mm.

a) Materials : Vitrified Tiles

The tiles shall be of approved make and shall generally conform to the approved standards. They shall be flat and true to shape, free from cracks, crazing spots, chipped edges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The tiles shall be square or rectangular of nominal sizes such as: 600 x 600 mm; 900 x 900 mm or as per tender schedule / drawings or as directed by the Engineer-in-Charge. Thickness shall be as per

recommendations of the approved manufacturers. However the floor tile thickness shall not be less than 10mm.

Technical specifications of the tiles shall be generally conforming to the following standards:

Technical Specifications for Vitrified Tiles

No.	Property	Expected Standards
1	Deviation in length	(+/-) 0.6%
2	Straightness of sides	(+/-) 0.5%
3	Rectangularity	(+/-) 0.6%
4	Surface flatness	(+/-) 0.5%
5	Water absorption	< 0.50%
6	Mohs. Hardness	> 6
7	Flexural strength	> 27 N / mm2
8	Abrasion resistance	< 204 mm2
9	Skid resistance (friction coefficient)	> 0.4
10	Glossiness Min.	85% reflection

The tiles shall conform to the relevant standards in all respects. Samples of tiles shall be got approved from the Engineer-in-charge before bulk procurement for incorporation in the work.

b) Preparation of Surface for Flooring

Following procedure shall be followed :

- Sub grade

  Concrete or RCC slab or side brick wall / or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped as specified for terrazzo tile flooring.

- Mortar and bedding

  Cement mortar for bedding shall be prepared of mix 1:4 or as specified in the schedule of items, to a consistent paste and shall conform to the specification for materials; preparations etc. as specified under cement mortar. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard

lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed the base shall be cleaned off all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be evenly and smoothly spread over the base by use of screed battens to proper level or slope.

Once the mix is prepared, no further water be added and the same shall be used within one hour of adding water.

Apply on an average 20 mm thick bedding of mortar over an area of 1 sqm at a time over surface of the area for laying tiles, in proper level and allowed to harden sufficiently to offer a fairly good cushion for the tiles to set.

c) Laying Of Tiles for Flooring

The tiling work shall be done as per the pattern shown in the drawing or as directed by the Engineer-in-Charge. As a general practice laying of tiles shall be commenced from the centre of the area and advanced towards the walls. Cut tiles, if any, shall be laid along wall with necessary border pattern as shown / directed by the Engineer-in-Charge. Tiling work shall be completed by pressing tiles firmly into place along the wall /floor. White cement slurry to the back of the tile to be applied to ensure proper and full bedding. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles, which are fixed on the flooring adjoining the wall, shall be so arranged that the surface on the round edge tiles shall correspond to the skirting or dado. Press gently the tile with wooden mallet for even adherence at the back of the tile. Do not use an iron hammer or some heavy material to press the tile. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with white / matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

d) Fixing Tiles For Dado & Skirting / Facia

The fixing of tiles on wall surfaces shall be done only after completing fixing of the tiles on the floor. Following procedure shall be followed:

DAE / DCSEM: 102: SPN-CVL

The back of tiles shall be cleaned off and covered with layer of approved adhesive like BAL-ENDURA or equivalent with proper trowelling as per manufacturers recommendations.

The edges of the tiles shall be smeared with the adhesive and fixed on the wall one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly fixed in level with the adjoining tiles. There shall be no hollows on the back or in joints. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with approved adhesive. The joints shall be kept in straight line or as per the approved pattern.

While fixing tiles in dado / skirting work, care shall be taken to break the joints vertically. The top line shall be touched up neatly with the rest of the plaster above. If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

The fixing shall be done from bottom of wall to upward without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. All tiles faces shall be in one vertical plane.

e) Grouting Of Joints In Floor / Skirting / Dado

The joints, if specified, shall be cleaned off and all dust and loose particles removed. Joints shall then be filled with approved adhesive like BAL-ENDURA or equivalent grouts.

After finishing the grouting process, after 15 minute, wipe off excess grout with a damp sponge and polish the tiles with a soft & dry cloth for a clean surface. The Finished work shall not sound hollow when tapped with a wooden mallet.

f) Cleaning

As directed by the Engineer-in-Charge, the tiles shall be cleaned by mild acid (However, Hydrofluoric acid and its derivatives should not be used). After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout / adhesive that may have come out of the joints shall be cleaned off before it sets. The dado / skirting shall be thoroughly cleaned. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When drying, the floor shall be covered with oil free dry sawdust. It shall be removed only after completion of the construction work and just before the floor is used.

g) Mode of Measurement and Rate

Dado / flooring / skirting shall be measured in sqm correct to two places of decimal. Length and breadth shall be measured correct to 1

cm. between the exposed surfaces of skirting or dado. No deductions shall be made nor extra paid for any opening of area upto 0.1 sqm. The rate shall include all the cost of labour and materials involved.

h) Cleaning Agents for Vitrified Tiles

Vitrified tiles are resistant to all chemicals (except hydrofluoric acid and its derivatives), hence commercially available detergents and cleaning agents can also be used for regular maintenance. Any spills and stains must be removed immediately. If left dry they may leave stains, which may be difficult to remove completely.

Cleaning Agents for Vitrified Tiles

Stains	Cleaning Agent
Robin Blue	Household detergent / Warm water
Marker ink	Turpentine / Acetone / Trichloroethylene
Pen ink	Acetone / Isopropyl alcohol
Methylene blue	Isopropyl alcohol / Acetone
Sauce	Ammonia solution
Cement	Turpentine / Acetone / Trichloroethylene / Conc. HCL
Tea	Hydrochloric acid / Bleaching powder
Coffee	Sodium hydroxide / Potassium hydroxide
Beer	Sodium hydroxide / Potassium hydroxide
Diesel	Acetone / Petrol
Lab indicator	Acetone / Isopropyl alcohol
Cement and grouting	Hydrochloric acid
Pencil mark	Benzene or Toluene or Xylene
Plaster of Paris (POP)	Ammonium sulphate solution

Stains	Cleaning Agent
Iodine (Tincture iodine)	Sodium hydroxide / Potassium hydroxide
Hair dye	Per chloric acid
Paan	Lemon juice or citric acid
Marker pen	Acetone

Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

2.02.05 Pressed Ceramic Tiles In Skirting And Dado

The tiles shall be approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze or more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze; however, any glaze if unavoidable shall be permissible on only up to 50% of the surface area of edges.

The glaze shall be free from welts, chips, craze specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

Dimensions and Tolerances

Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5, & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when joined together (with 1mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified.

The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs and capping beds shall be of the shape and dimensions as required and thickness of fittings shall be the same as the thickness of tiles given above.

Preparation of Surface

The joints shall be raked out to a depth of at least 15mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

Laying

12mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals.

The tiles should be soaked in water, washed clean and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and joined. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these

shall be cut (swan) to the required size and their edges rubbed smooth. Skirting/ dado shall not project from the finished "surface of wall" by more than the thickness, undulations if any shall be adjusted in wall.

Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

2.02.06 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 20 mm and 40 mm.

b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns. Mosaic tiles shall be of grey/white base as per the requirement and as per directives of Engineer-in–charge.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix : Underbed

Same as clause 2.02.01(c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise

clause 2.02.01(d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.02.07 Chemical Resistant Tiled Finish

This shall include all verities of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.02.03.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/Cm2. The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.08 Rubber, Vinyl or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be $\pm$ 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be non-fading and uniform in appearance, insoluble in water and resistant to alkalise, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number and date of manufacture.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty: 1 part cement: 4 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.02.09 Stone Slab Finish: Marble, Stone and Similar Fine Grained Stone

a) Dressing of slabs

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waive ness. In case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid any where along the machine cut surface is in contact with every point on it. The sides and top surface of slabs shall be machined rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane.

b) Thickness

The underbed shall be average 20 mm thick. The thickness of the slabs shall be 18, 30, or 40mm as specified in the description of the item. Tolerance of ± 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of ± 2% shall be allowed.

c) Stone Slab

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

d) Mix: Underbed

Same as clause 2.01.03 (c).

e) Laying

Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as given in the description of the item.

The average thickness of the bedding mortar under the slab shall be 20mm and the thickness at any place under the slab shall be not less than 12mm.

The slabs shall be laid in the following manner :

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1 mm.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of veins/streaks or as directed by the Engineer-in-Charge.

The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Slabs which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

f) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be done as specified under clause 2.01.03 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for. Cement slurry with or without pigment shall not be applied on the surface before each polishing.

2.02.10 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.10 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed up to ± 3 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

2.02.11 Marble Stone In Risers Of Steps And Skirting

Marble Stone Slabs and Dressing of slabs shall be as specified in Clause no. 2.02.09 except that the thickness of the slabs shall be 18mm. A tolerance of ± 3% shall be allowed, unless otherwise specified in the description of the item.

Preparation of Surface

It shall be as specified in 2.02.05 where necessary; the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.

Laying

The riser of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed in to the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1cement: 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but nor more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.

The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

Curing, Polishing and Finishing

It shall be as specified in 2.02.01(e) as far as possible, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

2.02.12 Kota Stone Flooring

Kota Stone Slabs

The slabs shall be selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-Charge.

Dressing

Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the sides of the stone shall be in full contact with it. The sides (edges) shall be table rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slab after it is dressed shall be 20, 25, 30, or 40 mm as specified in the description of the item. Tolerance of ± 2 mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of ± 5 mm for hand cut slabs and ± 2 mm for machine cut slabs shall be allowed.

Preparation of Surface and Laying

The specification as described in 2.02.10 except that the edges of the slabs to be joined shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1 mm.

Polishing and Finishing

The specifications shall be as described in 2.02.10 except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

2.02.13 Kota Stone In Risers of Steps, Skirting and Dado

Kota Stone Slabs and Dressing shall be as specified in 2.02.12 except that the thickness of the slabs shall be 25mm or as specified in the description of the item. The slabs may be of uniform size if required.

Preparation of surface shall be as specified in 2.02.11.

Laying shall be as specified in 2.02.11 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

Curing, Polishing and Finishing shall be as specified in 2.02.11 except that first polishing with coarse grade carborundum stone shall not be done.

2.02.14 Wooden Flooring

Seasoning and Preservation

All timber used for timber floors shall be thoroughly seasoned in accordance with IS 1141. After seasoning the timber shall be treated with preservative in accordance with IS 401. Seasoning and preservative treatment shall be paid for separately unless otherwise specifically included in the description of the item of flooring.

Supporting Joists

Main beams and joists of the class of wood sections specified in the description of the item for beams and joists, or as instructed by the Engineer-in-Charge shall be fixed in position to dead levels. The width of the joists shall not be less than 50mm. The arrangement and spacing of beams joists etc. shall be as per design furnished.

Boards

It shall be the class of timber and thickness specified in the description of the item. Only selected boards of uniform width shall be used. Unless otherwise specified or shown in the drawings, the width of boards selected shall not be less than 100 mm nor more than 150 mm. The same width of boards shall not be maintained throughout except where the width of the room is not an exact multiple of the boards. In the latter case, the difference shall be equally adjusted between the two end boards (adjacent to walls). The length of the boards shall not exceed 3 metre anywhere. Ordinarily, the minimum length of boards shall be such that the boards shall rest at least on three supports, except where otherwise required by the pattern specified in the drawings or as directed by the Engineer-in-Charge.

The boards shall be planed true on the top face only unless otherwise specified in the description of the item. Where the bottom face is exposed and it is also required to be planed, then such planing shall be paid for extra.

Unless otherwise described in the item, the longitudinal joints of planks shall be tongued and grooved to a minimum depth of 12 mm while the heading joints shall be of the squire butt type and shall occur over the centre line of the supporting joists. Heading joists in adjacent boards shall be placed over the same joists.

Iron screws

Iron Screws shall be of the slotted counter sunk head type, of length not less than the thickness of planks plus 25 mm, subject to a minimum of 40 mm, and of designation No. 9 confirming to IS 451.

Fixing

The joints on which the planks shall be fixed shall be checked and corrected to levels. The end boards shall be accurately fixed with the sides parallel and closed to the walls. Each adjoining board shall be carefully jointed and shall be tightened in position and screwed. For fixing the boards to the joists, two screws shall be used at each end of the boards and one screw at each of the intermediate joists in a zig zag manner. The screws shall be countersunk and screw holes filled with approved stopping.

The junction between timber flooring and adjacent flooring shall be formed by inserting a metal strip (brass or aluminium) at the junction. The metal strip shall be fixed to the end of the planks by screws. The strips shall be paid for extra.

The flooring shall be truly level and plane. The joints shall be truly parallel and or perpendicular to the walls, unless otherwise specified.

The floor shall be planed in both directions and made perfectly even, true and smooth.

Note : No wood of any kind shall be placed within 60 cm of any fire place or flue. Provision shall be made for ventilation in the space below the floor in case of ground floor and between floor and top of ceiling in the case of upper floors. Such arrangements shall be paid for separately.

Finishing

The surface of the floor shall be bees waxed or finished otherwise as directed by the Engineer-in-Charge. The lower face shall be painted or treated with wood preservative as directed. The finishing shall be paid for separately unless specifically included in description of the flooring item.

2.02.15 Anti Static PVC Flooring

PVC flooring of 2mm thick should be of approved make & brand with scratch proof, flexible & impregnated polyurethane reinforced (PUR) permanently static conductive Vinyl sheet, consists of impregnated polyurethane homogeneous mixture of PVC, plasticizers, urethane, colour pigments and filler calendared of approved colours and pattern detail. The material should be fixed with synthetic acrylic adhesive after preparing the floor, leveling & smoothening when necessary with suitable putty, as per the design & instruction of the Engineer-in-charge. Electrical resistance should be min $R10^8$ ohm as per ESD approval, SP-method 2472. Anti-static sheets should be confirming clean Room Test Class A as per ASTMF 51/100.

2.02.16 Heavy Duty Cement Concrete Tiles (Steelcrete or equivalent)

1. Materials

Cement - Cement used in the manufacture of tiles shall be ordinary Portland cement conforming to IS: 269-1976t or rapid hardening Portland cement conforming to IS: 8041-1978 or white Portland

cement conforming to IS: 8042-1978t or Portland Puzzolana cement conforming to IS: 1489-1976.

Aggregates - Aggregates used in the backing layer of tiles shall conform to the requirements of IS: 383-1970s. For the wearing layer, unless otherwise specified aggregates shall consist of natural stone chips, like carborundum.

Pigments - Pigments, synthetic or otherwise, used for colouring tiles shall have durable colour. It shall not contain matters detrimental to concrete and shall according to the colour required be one of the following or their combination:

Pigments	Relevant Indian Standard
a) Black or red or brown pigment	IS: 44-196911
b) Green pigments	IS: 54-19757
c) Blue pigments	IS: 55-1970 or IS: 56-1975 or IS : 3574 (Part II)-1966
d) White pigments	IS: 411-196845
e) Yellow pigments	IS: 50-19791111 or IS : 3574 (Part I)-1965

Colours other than mentioned above may also be used. The pigments shall not contain zinc compounds or organic dyes. Lead pigments shall not be used unless otherwise specified by the purchaser.

2. Manufacture

2.1 Cement concrete flooring tiles shall be manufactured from a mixture of cement, natural aggregates, and colouring material where required, by pressure process. During manufacture the tiles shall be subjected to a pressure of not less than 14 N/mm” (140 kg/cm”).

2.2 The proportion of cement to aggregate in the backing of the tiles shall be not leaner than 1: 3 by mass.

2.3 Where colouring material is used in the wearing layer, it shall not exceed 10 percent by mass of cement used in the mix.

2.4 On removal from the mould, the tiles shall be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of this standard. Tiles shall be stored under cover.

3. Dimensions

The size of cement concrete flooring tiles shall be as follows :

Length (mm)	Breadth (mm)	Thickness (mm)

200	200	20
250	250	22
300	300	25

Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles in the floor shall have dimensions which shall be such as to make two half tiles when joined together, match with the dimensions of the one full tile.

4. Tolerances

4.1 Tolerances on length or breath of tiles shall be ± 1mm. In addition the difference in length of side between the longest side and shorter side in the sample shall not exceed 1mm.

4.2 Tolerance on thickness shall be +5 mm. In addition the difference in thickness between the thickest and the thinnest tile in the sample shall not exceed 3 mm.

4.3 Thickness of Wearing Layer - The minimum thickness of wearing layer for the various classes of cement concrete flooring tiles shall be as specified in Table 1.

4.3.1 The thickness of the wearing layer shall be measured at several points along the fracture line of the tile that was tested for wet transverse strength in accordance with 11.5. The arithmetic mean of the two measurements which yielded the lowest value shall be the minimum thick- ness of the wearing layer.

TABLE 1 THICKNESS OF WEARING LAYER

SL. NO.	CLASSIC OF TITLE	MINIMUM THICKNESS OR WEARING LAYER (mm)
(1)	(2)	(3)
i)	Plain cement and plain coloured tiles for general purpose	5
ii)	Terrazo tiles with chips of riie varying from the smallest up to 6 mm, for general purpose	5

iii)	Terrazo tiles with chips of size varying from the smallest up to 12 mm, for general purpose	5
iv)	Terrazo tiles with chips of size varying from the smallest up to 20 mm, for general purpose	6
		6
v)	Plain cement and plain coloured tiles, for heavy duty	

5. General Quality

5.1 Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of the wearing layer. The wearing layer of the tiles shall be free from projections, depressions, cracks (hair cracks not included), holes, cavities and other blemishes layer may be rounded.

6. Finish

6.1 The colour and texture of the wearing layer shall be uniform through-out its thickness. No appreciable difference in the appearance of the tiles, from the point of view of colour of aggregate, its type and its distribution on the surface of the wearing layer shall be present.

6.2 When indenting for terrazzo tile, the purchaser shall state the size of chips to be used in the wearing layer of size 2B.

7. Physical Requirements

7.1 The tests on tile shall not be carried out earlier than 28 days from the date of manufacture.

7.2 Flsitness of the Tile Surface - The tiles when tested, the amount of concavity and convexity shall not exceed 1 mm.

7.3 Perpendicularity - When tested the longest gap between the arm of the ‘square’ and the edge of the tile shall not exceed 2 percent of the length of the edge.

7.4 Straightness - When tested the gap between the thread and the plane of the tile shall not exceed 1 percent of the length of the edge.

7.5 Water Absorption - When tested according to the procedure laid down by the method for determination of water absorption that is given below, the average percentage of water absorption shall not exceed 10.

8. Method For Determination Of Water Absorption

1. Six full size tiles selected in accordance with 14 shall be used for the test. They shall be immersed in water for 24 hours, then taken out and wiped dry.

2. Each tile shall be weighed immediately after saturation and wiping as in D-l. The tile shall then be oven-dried at a temperature of 65 f (±) 1°C for a period of 24 hours cooled to room temperature and reweighed.

3. The water absorption for each tile shall be determined as follows:
Water absorption, percent by mass =(M_1 - M_2) / M_2x 100 where
MI = mass in g of the saturated specimen, and MB = mass in g of the oven-dried specimen.

4. The average value shall be reported.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for :

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colour, texture

e) Surface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Performance

i) Precautions specified for durability

4.00.00 RATES

Rates shall be for the complete finishing work including necessary forms, underbed, sticker and preparation of the surface including cutting and chipping to receive the finish but exclusive of the base unless specially included in Contract.

The dividing strips in case of in situ terrazzo finish shall be included in the rates. Similarly, indentations, laying in desired patterns and in panels shall be inclusive in the rates.

All necessary cutting tiles, slabs, etc. cost of specials if any shall be included in the rates. No extra shall be paid for rounding corners and edges. Unless specifically mentioned otherwise, same rates will apply to floor, skirting, dado, treads, nosing, etc.

5.00.00 METHOD OF MEASUREMENT

The finished surface shall be measured for area. Any opening less than 0.1 Sq.M. (and 0.05 Sq.M. in case of marble finish only) shall not be taken into account neither any extra shall be paid for it.

For terrazzo finish, either in situ or tiled shall be paid at the same rate unless mentioned separately in the schedule of items.

Except in case of in situ terrazzo finish and unless mentioned in the Schedule dividing strips shall be measured in length.

6.00.00 I.S. CODES

Important relevant codes for this section:

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.
IS: 4457	:	Specification for ceramic unglazed vitreous acid resisting tiles
IS: 4441	:	Code of practice for use of silicate type chemical resistant mortars.

IS: 4443	:	Code of practice for use of resin type chemical resistant mortars.
IS: 4832 (part I)		Specification for chemical resistant mortar: silicon type.
IS: 4832 (part II)		Specification for chemical resistant mortar: resin type.
IS: 4832 (part III)		Specification for chemical resistant mortar: sulphur type.
IS: 13753	:	Specification for dust pressed ceramic tiles with water absorption of E>10%
IS: 13755	:	Specification for dust pressed ceramic tiles with water absorption of 3%, E6% (Group B11a)

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SECTION-XXIV

TECHNICAL SPECIFICATION
FOR
FALSE FLOORING

CONTENT

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SECTION-XXIV

TECHNICAL SPECIFICATION
FOR
FALSE FLOORING

1.00.00 SCOPE

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

2.00.00 FALSE FLOORING SYSTEM

2.01.01 Base

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

2.01.02 Supporting Structure

The supporting structure shall comprise of fabricated jacks made out of 25 mm. dia. MS rounds having 150 mm. threads at top. This jack shall be welded to 100 mm x 100 mm x 6 mm thick MS base plate pedestal. Pedestals shall be vertically true and located at 600 mm. centre to centre to conform to the size of the floor panels and shall be fixed to the RCC floor slab with ARALDITE. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut. The capital shall be of aluminium alloy die cast and shall receive cold rolled MS floor supporting channels of size 40 mm x 40 mm x 3.15 mm thickness as per drawings, both for main and cross runners. The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

2.01.03 Floor Panel

The floor panels shall be made of phenol formaldehyde bonded particleboard treated with fire resistant paint as per schedule items. Size of each panel shall be 600 mm. x 600 mm. with all panel edges finished to a tolerance of $\pm$ 0.25 mm. on the diagonals. The edges of the floor panels shall be covered by 4 mm. thick rigid PVC edging. The underside of the panel shall have 0.05-mm. thick Aluminium foils, which shall be fixed to the particleboard with resin-based adhesive.

3.00.00 STRENGTH

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2

mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

4.00.00 SURFACE FINISH

All removable panels shall have the top surface finished with 2 mm thick Antistatic Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

5.00.00 SKIRTING

Skirting shall be of the same Antistatic Vinyl tiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

6.00.00 INSTALLATION

All steel surfaces are to be protected by pointing over a primer, as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with Kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

7.00.00 METALLIC FALSE FLOORING

7.01.00 Laminated Panel

Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate – PVC / Conductive PVC on a semi - automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment

7.02.00 Sub Structure-Pedestal Assembly

Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of 65 mm to a maximum of 600 mm from the existing floor level. Pedestal design shall confirm speedy assembly and

removal for relocation and maintenance. The assembly shall provide easy adjustment of leveling and accurately align panels for a maximum of ± 25 mm in the vertical direction. Pedestals shall support an axial load without permanent deflection and an ultimate load as laid out in System Performance requirement.

The Pedestal head assembly shall consist of a 75 x 75 mm x 3.5 mm embossed head mechanically riveted to a 100mm long 19 mm Dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-irrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 22.20 mm OD pipe of thickness 1.6mm mechanically locked on a press for perpendicularity and then welded to a base plate of 100 x 100 x 2mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

7.03.00 Stringers

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x 570 mm length.

PERFORMANCE CONFORMING TO MASTER SPECS 10270 / 096900 (USA)

A. Structural Performance : CISCA A/F, 'Recommended Test Procedures for Access Floors'

- Concentrated Loads

  540 Kgs (1200 lbf) with a top-surface deflection under load and a permanent set not to exceed , respectively, 2.54 & 0.25 mm (0.10 & 0.010 inch) according to CISCA A/F, Section I '' Concentrated Loads''

- Ultimate Concentrated Load

  1350 Kgs (3000 lbf) without failing according to CISCA A/F, Section II '' Ultimate Loading''

- Rolling Loads

  270 kgs (600 lbf) of the following magnitude, with a combination of local and overall deformation not to exceed 1.02 mm (0.040 inch) according to CISCA A/F, Section III '' Rolling Loads''

CISCA AF Rolling Load: 10000 Passes

- Stringer Load Testing

  204 Kgs (450 lbf) at the centre of the span with a permanent set not to exceed 0.25mm (0.010 inch) as determined by CISCA A/F, Section IV, '' Stringer Load Testing''

- Pedestal Axial Load Test

  22 Kn axial Load per pedestal, according to CISCA A/F, Section V, ''Pedestal Axial Load Test ''

- Pedestal Over Turning Moment Test

  113 N x meters, according to CISCA A/F, Section VI, ''Pedestal Overturning Moment Test''

B. Other Optional Structural Parameters

- Floor Panel Impact – Load Performance

  100 lbf when dropped from 36 inches (914 mm) on to 1-Sq.Inch (6.5 sq.cm) area located anywhere on Panel without failing.

- Uniformly Distributed Load (UDL)

  1620 kg/m^2 with a maximum permissible deflection of not more than 1.52 mm as per definition of "Uniform load" of CISCA tested over an area of 300x300 mm square for 100kgs load

Note : The uniform load rating of an access floor panel as specified here in should not be confused with the "uniform live load" as specified in seismic zone application.

C. Other Non structural Parameters

- Fire Rating

  The Panels shall confirm to Class O & Class 1 Fire Ratings tested as per BS 476 Part 6 (Fire Propagation) & 7 (Surface spread of flame) as also ASTM E84 1998 (Flammability) and ASTM E136 (Combustibility)

- Electrical Resistivity

  As per ASTM F150/ NFPA 99 / ANSI S7.1 but modified for surface to ground to place one electrode on the floor surface and to attach the other electrode on the pedestal. Resistance to be tested at 500 volts

  1. Conductive range : $2.5x10^4$ – $1x\ 10^6$ Ohms (surface to ground)

2. Static dissipative range : $1x10^6$- $1x10^9$ Ohms (surface to ground)

3. Anti static range : $1x10^9$ – $2x10^{10}$ Ohms (surface to surface)

- Fabrication Tolerance

A. Floor panel flatness : ± 0.76 mm in any direction

B. Floor panel width or length from specified size : ± 0.25 mm

C. Floor panel squareness : ± 0.38 mm

7.04.00 Acceptance Criteria

The false flooring system shall be checked specially for :

a) Level

b) Alignment of joints

c) Thickness of joints

d) Surface finish

e) Colour and texture

VOLUME : II-G/3

SECTION-XXV

TECHNICAL SPECIFICATION
FOR
PAINTING, WHITE WASHING AND POLISHING ETC.

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SECTION-XXV

TECHNICAL SPECIFICATION
FOR
PAINTING, WHITE WASHING AND POLISHING ETC.

1.00.00 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces on wood work, masonry, masonry surface with lime punning or white cement putty, concrete plastering, plaster of Paris punning, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, schedule or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing those results.

Before commencing painting, the painting contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations. Contractor shall keep record of number of coats of painting. Before applying second coat, the contractor shall obtain prior approval of Engineer in Charge

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be Grade-1 quality from well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained from the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All

such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Washing

Preparation of Surface : Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings an foreign matters.

Preparation of Lime wash : The lime wash be prepared from fresh stone white lime (Natural or Dehradun quality) or fat lime, or a mixture of both as instructed by the Engineer, and shall conform to IS: 712 latest editions and shall be submitted to the Engineer for approval and approved sample shall be brought to site in unslaked condition. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 10 cubic decimeter of the cream. The approximate quantity of water to be added in making the cream will be 5 liters of water to one kg of lime.

Indigo (Neel) up to 3 gm per kg of lime dissolved in water, shall then be added and stirred well. Water shall then be added at the rate of about 5 liters per kg. of lime to produce a milky solution.

Application: The white wash shall be applied with moonj brushes to the specified number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next coat is applied. Further each coat shall be inspected and approved by the Engineer-in-Charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

For new work, three or more coats shall be applied till the surface presents a smooth and uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

Protective Measures : Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces

cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

Measurements : Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

Measurements for Jambs, Soffits and Fills etc. for openings shall be as described earlier.

Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

Corrugated non-asbestos cement sheet 20%

Semi corrugated non-asbestos cement sheet 10%

Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements.

The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared.

The rate shall include all material and labour involved in all the operations described above.

b) Colour Washing

The mineral colours, not affected by lime, shall be added to white wash. Indigo (Neel) shall however, not be added. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor.

For new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats, shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface has been prepared (as described above) a coat of colour wash shall be applied over the patches and repairs. Then a single coat, or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

Other specifications as described eallier.

c) Dry Distemper

Materials : Dry distemper of required colour (IS 427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer-in-Charge before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using6 decilitres (0.6 litre) of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency.

Distemper shall not be mixed in larger quantity than is actually required for one day's work.

Preparation of Surface : Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

New plastered surfaces shall be allowed to dry completely, before applying, distemper.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the resular coat of distemper is applied.

Priming Coat : A priming coat of whiting shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper.

The treated surface be allowed to dry before distemper coat is given.

Application : In the case of new work, the treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface shows an even colour.

For old work, the surface prepared (as described before) shall be applied one or more coats of distemper till the surface attains an even colour.

The application of each coat shall be as follows :

The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

The subsequent coats shall be applied only after the previous coat has dried.

The finished surface shall be even and uniform and shall show no brush marks.

Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

After each day's work, the brushes shall be washed in hot water and hang down to dry. Old brushes which are dirty or caked with distemper shall not be used.

The specifications in respect of scaffolding and protective measures shall be as described before.

d) Oil Emulsion (Oil Bound) Washable Distemper

Materials

Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufactures shall be used. The primers where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of the work, till this item of work has been completed and passed by the Engineer-in-Charge.

Preparation of the Surface

For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing & scrubbing. The surface shall then be allowed to dry for that at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming Coat : The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described before.

Note: If the wall surface plastered has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surface if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint confirming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced.

For old work no primer coat is necessary.

Distemper Coat : For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hang down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

The specifications in respect of scaffolding, protective measures shall be as described before.

e) Cement Primer Coat

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalies present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints.

Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.

Preparation of the Surface : The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

Application : The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied.

The specifications in respect of scaffolding, protective measures shall be as described before.

f) Cement Paint

Material : The cement Paint shall be (confirming to IS 5410) of approved brand and manufacturer.

The cement Paint shall be brought to the site of work by the contractor in its original containers is sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant

item of the work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of the Surface : For new work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement Paint shall be applied over patches after wetting them thoroughly.

Preparation of Mix : Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities.

In case of cement Paint brought to in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application : The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The salutation shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the days work.

The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

Precaution : Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry

or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces.

If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

The specifications in respect of scaffolding and protective measures shall be as described before. The coefficient for cement paint on RCC Jalli shall be 2 x (for painting all over).

g) Exterior Painting on Wall

Material : The paint shall be (Textured exterior paint / Acrylic smooth exterior paint / premium acrylic smooth exterior paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The material shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained form the Engineer-in-Charge.

Preparation of Surface : For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection before painting is commenced.

Application :

Base coat of water proofing cement paint – All specifications in respect of base coat of water proofing cement paint shall be as described before.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with portable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-Charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

The specifications in respect of scaffolding and protective measures shall be as describe before.

3.00.00 PAINTING

Materials

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empties shall not be removed from the site of the work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Commencing Work

Painting shall not be started until the Engineer-in-Charge has inspect the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the

approval of the Engineer-in-Charge after inspection, before painting is commenced.

Application

Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over the Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, to or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by through ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of moulding etc. shall be left on the work.

In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need to be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

Brushes and Containers

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that Paint dose not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

Measurements

The length and breadth shall be measured correct to a cm. The area shall be calculated in the sqm. (correct to two places of decimal), except otherwise stated.

Small articles not exceeding 10 sq. decimeter (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

Note: Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sqm. irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

Table 1
Equivalent Plain Areas of Uneven surface

Sl. No.	Description of Work	How measured	Multiplying Coefficients
I.	Wood Work Doors, Windows etc.		
1.	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2.	Ledged and battened or ledged, battened and braced doors, windows etc.	Chowkhat or frame, Edges, chocks, cleats, etc. shall be deemed to be included in the item.	1.30 (for each side)
3.	Flush doors etc.	. --- do ---	1.20 (for each side)
4.	Part paneled and part glazed or gauzed doors, window etc. (Excluding painting of wire gauze portion)	. --- do ---	1.00 (for each side)
5.	Fully glazed or gauzed doors, windows etc. (Excluding painting of wire gauze portion)	. --- do ---	0.80 (for each side)
6.	Fully venetioned or louvered doors, windows etc.	. --- do ---	1.80 (for each side)
7.	Trellis (or Jaffri) work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2.00 (for painting all over)
8.	Carved or enriched work	Measured flat	2.00 (for each side)
9.	Weather boarding	Measured flat (not girthed supporting frame work) shall not be measured separately	1.20 (for each side)
10.	Wood single roofing	Measured flat (not girthed)	1.10 (for each side)
11.	Boarding with cover fillets and match boarding	Measured flat (not girthed)	1.05 (for each side)
12.	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.08 (for painting all over)

Sl. No.	Description of Work	How measured	Multiplying Coefficients
II.	Steel Work Doors, Windows etc.		
13.	Plane sheeted steel doors or windows	Measured flat (not girthed) including frame edges etc.	1.10 (for each side)
14.	Fully glazed or gauzed steel doors and windows (Excluding painting of wire gauze portion)	. --- do ---	0.50 (for each side)
15.	Part paneled and partly glazed or gauzed doors and windows etc. (Excluding painting of wire gauze portion)	. --- do ---	0.80 (for each side)
16.	Corrugated sheeted steel doors or windows	. --- do ---	1.25 (for each side)
17.	Collapsible gates	. --- do ---	1.50 (for painting all over)
18.	Rolling shutters of interlocked laths	Measured flat	1.10 (for each side)

Sl. No.	Description of Work	How measured	Multiplying Coefficients
III.	General		
19.	Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard bars, balustrades, railing partitions and MS Bars in windows frames.	Measured flat overall; no deduction shall be made for open spaces; supporting members shall not be measured separately	1.00 (for Paint all over)
20.	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel	. --- do --- (See note no. 12)	1.00 (for Paint all over)
21.	Corrugated iron sheeting in roofs, side cladding etc.	. --- do --- Measured flat (not girthed)	1.14 (for each side)
22.	AC corrugated sheeting in roofs, side cladding etc.	. --- do ---	1.20 (for each side)
23.	AC semi corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plane sheets	. --- do ---	1.10 (for each side)
24.	Wire gauze shutters including painting of wire gauze	. --- do ---	1.00 (for each side)

Explanatory Notes for Table 1

1. Measurement for doors windows etc., shall be taken flat (and not girthed) over all including chowkhuts or frames, where provided. Where Chowkhuts or frames are not provided, the shutter measurements shall be taken.

2. Where doors, windows etc., are of composite types, different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.

3. The coefficients for doors and windows shall apply irrespective of the size of frames and shutter members.

4. In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.

5. When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

6. In the case where shutters are fixed on both faces of the frames, the measurement for he door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.

7. Where shutters are provided with clearance at top or / and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.

8. Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel vertical. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.

9. Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings etc.

10. Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

11. The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in

frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

12. For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisade do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top standards when the letter are higher than the top rails or the palisades.

Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.

For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas will be measured in sqm. and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

Precautions

All furnitures, fixtures, glazing, floors etc. shall be protected by covering and stains, smears, splashing, if any shall be removed and any damages done shall be made good by the contractor at his cost.

Rate
Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items

4.00.00 PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

Primer

The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

Primer for plaster / wood work / Iron & Steel / Aluminium surfaces shall be as specified below.

Table-2

Sl. No	Surfaces	Primer to be used
1.	Wood work (hard and soft wood)	Pink conforming to IS 3536
2.	Resinour wood and plywood	Aluminium primer confirming to IS 3585
3.	(A) Aluminium and light alloys	Zinc chromate primer confirming to IS 104
	(B) Iron, Steel and Galvanized steel	Red Oxide Zinc chromate Primer confirming IS 2074
4.	Cement/Concrete/RCC/brickwork, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	Cement primer confirming to IS 109

The primer shall be ready mixed primer of approved brand and manufacture.

Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg :1 litre : 1 litre.

The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

i) White Lead : The white lead shall be pure and free from adulterants like barium sulphate and whiting. It shall confirm to IS 103.

ii) Red Lead: This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall confirm to IS 102.

iii) Raw Linseed Oil: Raw linseed oil shall be lightly viscous bit clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928.

Note: The oil shall be mellow and sweet to the taste with very little small. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall confirm in all respects to IS 75. The oil shall be of approved brand and manufacture.

iv) Double Boiled Linseed Oil: This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall confirm in all respects to IS 77. The oil shall be of approved brand and manufacture.

Turpentine : Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall confirm to IS 533.

All the above materials shall be approved manufacture and brought to site in their original packing in sealed condition.

4.01.00 Preparation of Surface

4.01.01. Wooden Surface : The wood work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material confirming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the woo work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

4.01.02. Iron and Steel Surface : All rust and scales shall be removed by scrapping or by brushing with wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

4.01.03. Plastered Surface : The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

Application

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described before.

Treatment on Steel for Aggressive Environment

A second coat of ready mixed red oxide zinc chromate primer may be applied where considered necessary in aggressive environment such as near Industrial Establishment and Coastal regions where the steel members are prone to corrosion. The second coat (which shall be paid for separately) is to be applied after placing the member in position and just before applying Paint. The second coat of primer is not necessary in case of painting with synthetic enamel Paint as it is applied over and under coat of ordinary Paint.

Painting Priming Coat On Wood, Iron Or Plastered Surfaces

Synthetic Enamel

Paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S sheets shall be painted with a priming coat of one coat of redoxide zinc chromate Paint. Primer shall be applied before fixing sheets in place.

Preparation of Surface

Painting New Surface : The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm. of area and is applied for ensuring proper adhesion of Paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.

Painting Old Surface : If the old Paint is firm and sound, it shall be cleaned and grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described before. Such removal shall be paid for separately and painting shall be treated as on new work.

Application

The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning.

The second or additional coats shall be applied when the previous coat has dried.

5.00.00 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS

The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic Paint, aluminium Paint or other type of Paint as specified in the description of the item.

Painting New Surface

Preparation of Surface : The surface shall be prepared for priming coat as described earlier.

Application : The number of coat of painting over the priming coat shall be as stipulate in the description of the item. The application of Paint over priming coat shall be carried out as specified above.

Measurements : Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

Rate : The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

Painting on Old Surface

Preparation of Surface : If the old Paint is firm and sound, it shall be cleaned and grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described before. Such removal shall be paid for separately and painting shall be treated as on new work.

Application : The specifications for application shall be as described earlier.

Measurements : Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

Rate : The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

6.00.00 PAINTING WITH WOOD PRESERVATIVE

Oil type wood preservative of specified quality and approved make, confirming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

Painting on New Surface

Preparation of Surface : Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

Application : The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

Painting on Old Surface

The work shall be done in the same manner as on new surface except that only one coat shall be done.

7.00.00 COAL TARRING

Coal tar of approved manufacture confirming to IS 290 shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

Coal Tarring on New Surface

Preparation of Surface : This shall be done as specified in 4.01.00 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

Application : The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred, shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sqm respectively. Thinning with kerosene oil shall be suitable done to ensure this.

Coal Tarring on Old Surface

The work shall be done in the same manner as specified above (Coal Tarring on New Surface) except that only one coat using 0.12 litre per sqm. area shall be done.

8.00.00 SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE

The work shall include a priming coat of 'Distempering Primer' or 'Cement Primer' as specified in the description of the item. Flat wall Paint shall normally be applied on walls 12 months after their completions, in which case Distemper primer will suffice. If the walls are to be painted earlier, the primer coat shall consist of cement primer.

The primer and the flat wall Paint shall be of approved brand and manufacture and of the required shade.

Preparation of the Surface : The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

Application

Priming Coat : The specified primer shall be painted or sprayed over the surface in an even and uniform layer.

Painting Coats : When the surface is dry, the spray painting with the wall Paint in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and lightly rubbed with every fine grade of sand paper and loose particles brushed off before the next coat is sprayed.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted.

At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

If after the final coat of wall Paints, the surface obtained is not upto the mark, further one or more coats as required shall be given after rubbing down the surface and dusting off all loose particles to obtain a smooth and even finish.

If the primer or wall Paint gets thickened during the application, it shall be thinned suitably with the thinner recommended by the manufacture.

Adequate ventilation shall be provided to disperse spray fumes. Fitments and floor shall be protected from the spray.

9.00.00 SPRAY PAINTING WITH FLAT WALL PAINT ON OLD SURFACE

Where the old Paint is in sound condition, renewal shall be carried out as described below, otherwise the old Paint shall be completely stripped and spray painting shall be carried out as over new work. Such removal shall be paid for separately.

The flat wall Paint shall be of approved brand and manufacture and of required shade.

Preparation of Surface

The surface shall be washed to remove dust and dirt. A mild detergent solution like soap water shall be used for washing and surface shall also be rubbed down lightly with abrasive paper when dry. Any patches appearing on the surface shall first be touched up with a coat of Paint. These shall be allowed to dry and then rubbed down tightly.

Application

The paint shall then be applied with spraying machine in uniform and even layer. A second coat shall be applied if considered necessary by the Engineer-in-Charge but only after the first coat is complete dry and hard.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they result in variable spray patterns, runs, sags and uneven coats.

10.00.00 WALL PAINTING WITH PLASTIC EMULSION PAINT

The plastic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel.

Plastic emulsion Paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

Painting on New Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, morter droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commended.

Application : The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Precautions

a) Old brushes if they are to be used with emulsion Paints, should be completely dried of turpentine or oil Paints by washing in warm soap water.

   Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush.

b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

d) Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

Painting on Old Surface

Preparation of Surface *:* This shall be done, generally as specified in 4.01.01 except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.

Application : The number of coats to be applied shall be as in description of item. The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is

applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Except the above the thinning with water shall not normally be required.

11.00.00 PAINTING WITH SYNTHETIC ENAMEL PAINT

Synthetic Enamel Paint (confirming to IS 2933) of approved brand and manufacture and of the required colour shall be used for the top coat and an under coat of ordinary Paint of shade to match the top coat as recommended by the same manufacture as far the top coat shall be used.

Painting on New Surface

Preparation of Surface *:* Preparation of surface shall be as specified in 4.01.00 as the case may be.

Application : The number of coats including the undercoat shall be as stipulated in the item.

a) Under Coat : One coat of he specified ordinary Paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

b) Top Coat: Top coat of synthetic enamel Paint of desired shade shall be applied after the under coat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

Other details shall be as specified in 'EXTERIOR PAINTING ON WALL' as far as they applicable.

Painting on Old Surface

Preparation of Surface : Where the existing Paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform.

If the old Paint is blistered and flaked it will be necessary to completely remove. Such removal shall be paid for separately and the painting shall be treated as on new surface.

Painting : The number of coats as stipulated in the item shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If

however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

12.00.00 PAINTING WITH ALUMINIUM PAINT

Aluminium Paint shall be (confirming to IS 2339) of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

Preparation of Surface

Steel Work (New Surfaces) : All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

C.G.S. Sheets (New Surfaces) : The preparation of surface shall be as specified in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting New Surface'.

Steel Work or C.G.S. Sheets (Old Surfaces) : The specifications shall be as described in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting Old Surface'.

Application

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

13.00.00 PAINTING WITH ACID PROOF PAINT

Acid proof Paint of approved brand and manufacture and of the required shade shall be used.

Preparation of surface and application shall be as specified under 11.00.00 for new/old surface as the case may be.

Other details shall be as specified in 3.00.00 as far as they applicable

14.00.00 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT

Ready mixed Paint (confirming to IS 158) shall be of approved brand and manufacture. It shall be black, lead free, acid-alkali-heat-water resistant.

Preparation of surface and application shall be as specified in 13.32 for Painting on new or old surfaces as the case may be.

The drying time between consecutive coats, however, shall be not less than 3 hours.

Other details shall be specified in 3.00.00 as far as applicable.

15.00.00 FLOOR PAINTING

Floor Paint of approved brand and manufacture and of the required colour shall be used.

Preparation of Surface

All dirt, grease shall be removed from the floor by wiping with rags, soaked in turpentine and scraping where necessary and then washing with warm water, containing caustic soda or washing soda in solution. The floor should then be rinsed thoroughly with water and dried. Cracks and holes shall then be filled with specified filler as recommended by the manufacture and rubbed smooth.

It should be noted that the painting with floor paints shall not be done over concrete surfaces less than two years old.

Old surface shall be prepared as specified in 'PAINTING WITH SYNTHETIC ENAMAL PAINT, Painting on Old Surface, Preparation of Surface'.

Application

The number of coats as in the description of the item shall be applied. Each coat shall be allowed to dry for not less than 24 hours before the next coat is applied. The flooring should not be brought into use for a week after final coat so that the painted surface can thoroughly harden.

16.00.00 VARNISHING

Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler.

Varnish (confirming to IS 347 for the finishing and undercoats shall be of the approved manufacturer.

Varnishing on New Surfaces

Preparation of Surface : New wood work to be varnished shall have been finished smooth with a carpenter's plan. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:

On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

Sizing or Transparent Wood Filler Coat : The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

a) Sizing : When sizing is stipulated, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow.

   Any jointing up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

   Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household untensils which are likely to disturb the size coatings and thus expose bare wood.

   Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

b) Transparent Wood Filler Coat : Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described earlier, shall be given as application of the application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

Application of Varnish : The number of coats to be applied shall be as stipulated in the description of the item.

The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhance the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, letter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnished shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean.

Rubbing down and flatting the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from droughts and dump air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary Paint brushes. Brushes shall be well worn and perfectly clean.

Other details shall be as specified in 3.00.00 as far as they are applicable.

Varnishing on Old Surface

Preparation of Old Surface : If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in ‘Varnishing on New Surfaces, Preparation of Surface’. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish and such removal shall be paid for separately outside the rate for varnishing. Future the varnishing itself will have to be done like new work and will be paid for as such.

Application : The specification shall be same as described in ‘Application of Varnish’ as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

Other details shall be as specified in 3.00.00 as far as they are applicable.

17.00.00 FRENCH SPIRIT POLISHING

Pure shellac confirming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Ready made polish confirming to IS 348 can also be used.

Polishing New Surface

Preparation of Surface : The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

Application : The number of coats of polish to be applied shall be as described in the item.

A pad of wooden cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to given an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

Other details shall be as specified in 3.00.00 as far as they are applicable.

Polishing Old Surface

Preparation of Surface : If the old polished surface is not much solid it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to do done like new work and will be paid for as such.

Application : The specifications shall be same as described above and as far as applicable.

Other details shall be as specified in 3.00.00 as far as they are applicable.

18.00.00 EPOXY COATING/PAINTING

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 -15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

18.01.00 Protection

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

18.02.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

19.00.00 ACCEPTANCE CRITERIA

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

20.00.00 RATES

Rates shall be unit rates for complete items described in the Schedule of Items. No extra payment will be made for preparation of surface before painting or for cleaning up after the work is complete.

21.00.00 METHOD OF MEASUREMENT

a) All structural steelwork whose any or all faces are to be painted shall be measured and paid according to Table-1.

b) Painting or whitewashing to concrete or masonry shall be measured and on the area painted. For measurement of openings whose jambs, sills, soffits etc. are to be painted the following procedure shall be followed:

i) For openings up to 0.5 sq.m. but not exceeding 3.0 sq.m. each deductions shall be made for half the area of openings and no additions shall be made for jambs, sills, etc.

ii) For openings exceeding 0.5 sq.m. but not exceeding 3.0 sq.m. each deductions shall be made for half the area of openings, and no additions shall be made for jambs, sills etc.

iii) For openings exceeding 3.0 sq.m. each, deductions shall be made for the whole area, and additions shall be made for the jambs, sills soffits, reveals etc.

c) For openings, pipes, sleeves etc. whose sides are not finished no deductions shall be made for openings etc. upto 0.1 sq.m. in area each and full deductions shall be made for all openings above 0.1 sq.m. in area each.

d) No extra shall be paid for painting etc. done around openings, sleeves, pipes, ducts, inserts, etc.

e) No extra payment shall be made for painting, etc. on wall features such as grooves, ducts, beads, projections, cornices, etc. unless give different finish or otherwise specified in the “Schedule of Items”. The actual area of the features shall be girthed and included in the wall measurements.

f) For painting of uneven surfaces in doors, windows, ventilators, louvers, guard bars, balustrades, gratings, railings, gates, etc. equivalent plain areas shall be measured as given in Clause 17.2 (Table II) of IS:1200.

g) Corrugated surfaces shall be measured flat as fixed and not girthed. The quantities as measured shall be multiplied by the following factors to get equivalent plain area :

i) Corrugated steel sheets - shall be multiplied by 1.14.

ii) Corrugated asbestos sheets with large corrugations shall be multiplied by 1.20

iii) Semi-corrugated asbestos cement sheets shall be multiplied by 1.10.

iv) Any other non-standard corrugated surfaces shall be measured as decided by the Engineer.

h) For painting pipes for sanitary and plumbing work, measurement shall be made on actual work done in R.M. for different diameters. Measurements shall be along the central lines of pipes laid. No deductions or additions shall be made for valves, fittings, etc.

i) Unless specifically stated on the schedule of items, all painting, varnishing or polishing of wood shall be measured and paid on the area treated. For measurement of uneven surfaces, equivalent Main area shall be measured as per Clause 17.2 (Table II) of IS: 1200.

22.00.00 I. S. CODE

Important relevant IS Codes for this Sections are listed below :

IS: 348	:	Specification for French polish
IS: 427	:	Specification for Distemper, dry colour as required.
IS: 428	:	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS: 2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS: 2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS: 2932	:	Specification for enamel, synthetic, exterior, type-I.
IS: 5410	:	Specification for cement paint, colour as required.

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SECTION-XXVI

TECHNICAL SPECIFICATION
FOR
SUSPENDED CEILING

CONTENT

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SECTION-XXVI

TECHNICAL SPECIFICATION FOR SUSPENDED CEILING

1.00.00 SCOPE

The work under this Section shall include the supply and insulation of suspended ceiling using insulation / acoustic boards, plaster of paris boards. Perspex etc. together with the suspension system as shown on drawing or specified in Schedule with all materials labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air conditioning diffusers etc. as shown on drawings or instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M S sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer. All wood supports shall be painted with two coats of “Solignum” or other approved wood preservative before erection.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or approved equal. Steel grid ceiling system shall be snap grid as manufactured by Anil Hardboards Ltd. or approved equal.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and end tees shall rest on the moulding, unless otherwise shown on drawings.

2.01.03 Timber Grid Suspension System

Unless otherwise shown on drawings, the suspension system shall consist of 50 mm x 50 mm pre-treated teakwood batten grid suspended in the same manner described for metal grid system. The spacing of timber battens shall be as shown on drawing. Extra battens shall be provided where necessary for openings for light fixtures A C grills etc.

2.02.00 Ceiling Panels

2.02.01 Materials

Ceiling panels shall be best quality material in thickness and properties call for in the “Schedule of Items”. The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of the following types :

a) Plaster of Paris boards

b) Expanded polystyrene insulation boards

c) Fibre insulation boards

d) Wood particle boards

e) Glass fibre reinforced polystyrene sheets

f) Glass Reinforced Gypsum Board / Gypsum Board or Tiles

g) Mineral Fibre Board

h) Aluminium Panel – Linear / square / plank type false ceiling

i) Calcium silicate Board or tiles

Acrylic plastic sheets translucent or figured glass sheets moulded plastic louvers etc. shall be from approved manufacturers and in thickness specified in schedule.

2.02.02 Installation of Ceiling Panels

Installation of ceiling panels shall be strictly as per manufacturer’s instruction.

For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Engineer.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and schedule of items, 6 mm thick cement : lime : sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.03.00 False ceiling systems with different materials

2.03.01 Glass Reinforced Gypsum (GRG) or Gypsum Moisture Resistant Tiles / Board

1. Load bearing galvanized light gauge sections shall be used for supporting of (seamless) finished ceiling. G.I. channels of size 0.55 mm thickness having one flange of 300 mm. and a web of 27 mm. shall be fixed along with perimeter of ceiling, screw fixed to brick wall/ partition with the help of nylon sleeves & screws at 610 mm centres. Then suspending G.I. intermediate channels of size 45 mm. 0.9 mm. thick with two flanges of size 15 mm. each from the soffit at 1200 mm centres with ceiling angle of width 25 mm X 25 mm X 0.55 mm thick fixed to soffit with G.I. cleat and steel expansion fastner. Ceiling section of 0.55 mm thickness having knurled web of 51.5 mm and two flanges of 26 mm each with lips of 10.5 mm are then fixed to the intermediate channel with the help of connecting clips and in direction perpendicular to the intermediate channel at 457 mm centres. 12 mm thick GRG/Gyp MR Board is then screw fixed to ceiling sections with 25 mm dry wall screws at 230 mm centres. The board shall be joined and finished to have a flush look.

2. For profiled and curved surface, supporting structure from galvanized steel shall be made in required shape. Board shall be formed in to the curved shape while wet before fixing.

2.03.02 Mineral Fibre Board

For laying Mineral Fibre Board in tile of 600 mm X 600 mm the supporting grid system shall be formed by light gauged galvanized steel T- sections. Supporting grid system shall be rolled formed double web galvanized tees and shall meet the requirements of ASTM C-635. Nominal size of T-section shall be 24x38 mm for main runner. Exposed flange surface i.e. 24 mm wide shall be precoated or provided with a matching coloured cap. Main supporting section shall be suspended from RCC soffit / steel member with 4 mm dia galvanized rod & spring steel clip @ 1200 mm c/c. Suspensions from RCC shall be taken using expansion fasteners. The main supporting member shall be placed @ 1200 cross T-sections is inserted into the slots provided in main supporting member at 600 mm c/c so as to give a maximum size of 1200 mm x 600 mm.

Mineral Fibre Board Tiles shall be laid onto the grid 4 nos. of PVC holding clips shall be provided for each panel.

Aluminium Panels – Linear / Square tiles (lay-in or lay-on type) / planks

Aluminium panel ceiling, perforated or un-perforated as per requirement, of approved make, colour consisting of panel 150 mm wide x 15.5 mm deep x 0.5 mm thick with bevel edge, panel length up to 6 mtr, Coil Coated on a Continuous Paint Line, Double baked and roll formed from enamelled corrosion resistance Aluminium alloy AA 5050(Al.mg) for higher strength and good roll forming characteristics. The Panels about each other with a narrow V grove. Panel shall be clipped to a baked enamelled Aluminium Panel carrier of 32 mm wide x 39 mm deep x 0.95 mm thick in standard length of 5 mtr made of double baked enamelled Aluminium alloy AA 5050 (Al.mg) black with cut-outs to hold the panels in a module of 150 mm closed at a distance 1.00 mtr. Panel carrier shall be suspended by means of G.I. suspension rod 4-mm diameter and a Galvanised suspension spring clip at a distance of 1.7 mtr c/c. Paint Finish: Aluminium Panels shall be chromatised for maximum bond between metal and paint enamelled twice under high temperature, one side with a full primer and finish coat the other side (inner side) with a primer coating and Skin Coat on a Continuous Paint Line. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.

Or tile of 600mm wide and 600mm long manufactured out of 0.7mm thick Aluminium alloy AA 5050(Al.mg). Tile ends will be raised with pips and stops to ensure positive engagement into the spring to enable for de-mounting of individual panels. The Tile sides will be sufficiently high to ensure a minimum deflection across the length of Tile. All Tiles will be bevel edged. The Tile shall be Polyester based, powder coated in white colour. The Tile shall be clipped into clip in profile of 0.5mm thick G.I. The clip in profile shall be supported from slab by means of rigid suspension of 4mm G.I. Rod, Hold on Clamp with Clip. Mode of Measurements: Measurements shall be wall to wall without any deductions for lights, diffusers, columns etc.
Or Aluminium lineal ceiling system shall be “Luxalon 84C” or approved equal and the installation shall be strictly as per manufacturer’s instruction/ specification subject to approval of the Engineer. Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 12mm dia 50mm long anchor bolts and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cut-outs for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

4.00.00 RATES

Shall be unit rates for complete items called for in the "Schedule of Items". No extra payment will be made for arrangement for lighting fixtures air conditioning diffusers access panels, etc. The rate shall include all cutting and wastage from standard size sheets boards, runners, etc.

5.00.00 METHOD OF MEASUREMENT

a) Actual area of work done shall be measured.

b) No deduction will be made for opening upto 0.25 sq. metre in area each

c) Where a rigid steel framework is required to support the ceiling, it shall be measured and paid separately under relevant item in the Schedule.

6.00.00 I. S. CODES

IS: 2441 - Code of Practice for fixing ceiling coverings.

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SECTION-XXVII

TECHNICAL SPECIFICATION
FOR
SHEET WORK IN ROOF AND SIDE WALL

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SECTION-XXVII

TECHNICAL SPECIFICATION
FOR
SHEET WORK IN ROOF AND SIDE WALL

1.00.00 SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or other sheet plain /corrugated/trough covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium gutters, flashings etc., as shown on drawings and schedule of items.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

This shall be of the thickness specified in the description of the item and shall conform to IS 277. The sheets shall be of 275 grade of coating unless otherwise specified in the description of item.

The sheet shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanizing shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposit on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.
Purlins : Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters and the spacing will be as specified in the drawing.

Slope : Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal or as specified in the drawing. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

Laying and Fixing : The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridges, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Lapping in C.G.I. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.I. sheet, before the sheets are fixed in place.

Sheet shall not generally be fixed in to gables and parapets. They shall be bent up along their side edges close to the wall and junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.

The laying operation shall include all scaffolding work involved.

Sheets shall be fixed to the Purlins or other roof members such as hip or valley rafters etc. with galvanized J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washers filled with white lead as directed by the Engineer-in-Charge. While J hooks are used for fixing sheets on angle iron Purlins, and L hooks are used for fixing the sheet to R.S. joists, timber or precast concrete Purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

The galvanized coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

The galvanized coating should conform to IS 1367 9pt. XIII). The mass of coating per square meter of the surface shall be as under:

Mass and Equivalent Thickness of coating

Minimum Mass (g/m^2	Average Thickness(µm)	Minimum Mass (g/m^2)	Individual Thickness(µm)
375	54	300	43

Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanized iron bolts and nuts 25 x 6 mm size, each bolt provided with bitumen and a G.I. limpet washers or a G.I. limpet washers filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

Finish : The roof when completed shall be true to lines, and slopes and shall be leak proof.

Measurements : The length and breadth shall be measured correct to cm. Area shall be worked out in sq.m. correct to two places of decimal.

The specified area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc. shall be included in the measurements of the roof.

Roof with curved sheets shall be measured and paid separately. Measurements shall be taken on the flat and not girthed.

No deduction in measurement shall be made for opening up to 0.4sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

Rate : The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.I. sheets. This includes the cost the cost of roof sheets, galvanized iron J or L hooks, bolts and nuts, galvanized iron seam bolts and nuts, bituminous and galvanized iron limpet washers etc.

Ridges and Hips of Plain Galvanised Steel Sheets

Ridges and Hips : Ridges and hips of C.G.I. roof shall be covered with ridge and hip sections of plain G.S. sheet with a minimum lap of 20 cm on either side over the C.G.I. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G.I. sheet, 0.6mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.`

Fixing : Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips on either side. If this is not possible extra hook bolts shall be provided.

The end laps of ridges and hips shall be joined together with C.G.S sheet by galvanized iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

Surface of C.G.I. sheets of ridge and hip sections and roofing sheets which overlap each other shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.I. sheets before they are fixed in place.

Finish : The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

Measurement : The measurements shall be taken for the finished work in length along the centre line of ridge or hip, as the case may be, correct to a cm. The laps in ridges and hips and between ridges and hips shall not be measured.

Rate : The rate shall include the cost of all labour and materials specified above, including painting, cost of seam bolts and any extra G.I. hook bolts, nuts and washers, required.

Valley and Flashing of Plain Galvanised Steel Sheets

Valley and Flashing : Valley shall be 90 cm wide overall plain G.I. sheet 1.6 mm thick or other size as specified in the item bent to shape and fixed. They shall lap with the C.G.I. sheets not less than 25 cm width on other side. The end laps of valley shall also be not less than 25 cm.

Valley sheets shall be laid over 25 mm thick wooden boarding if so required.

Flashing shall be of plain G.I. sheet of 40 cm overall width 1.25 mm thick or 1.00 mm thick as specified in the item bend to shape and fixed. They shall lap not less than 15 cm over the roofing sheets. The end laps between flashing pieces shall not less than 25 cm.

Laying and Fixing : Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5 cm inside masonry with the mortar of mix 1:3 (1cement: 3 coarse sand).

Surface of G.I. sheets under overlaps shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.I. sheets.

Finish : The edges of valley and flushing should be straight from end to end. The surface should be true and without bulges and depressions.

Measurements : The length of the valleys and flashing shall be measured for the finished work correct to a cm. The laps along the length of the valley or flashing pieces, including the portion embedded in masonry, shall not be measured.

Rates : The rate for valleys, shall be for all the labour and materials specified above, including painting, cost of seam bolts and the cost of requisite G.I. hook bolts, nuts and washers required over and above those needed for connecting the roof sheets to the roof members. The rate for valleys shall exclude the cost of boarding underneath which shall be paid for separately. The rate for flashing shall be for all the labour and materials specified above, and shall include the cost of painting and mortar for fixing in wall.

Gutters Made of Plain Galvanised Steel Sheets

Gutters : Gutter shall be fabricated from plain G.I. sheets of thickness as specified in the item

Eaves gutters shall be of the shape and section specified in the description in the item. The overall width of the sheet referred to their in shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form rounded edges. The ends of the sheets at junction of pieces shall be hooked in to each other and beaten flush to avoid leakage.

Slope : Gutters shall be laid with a minimum slope of 1 in 120.

Laying and fixing : Gutters shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.

Where these brackets are to be fixed to the sides of rafters, they shall be of 40 x 3 mm section bend to shape and fixed rigidly to the sides of rafters with 3 nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap rafter not less than 30 cm and the connecting bolts shall be at 12 cm centers.

Where the brackets are to be fixed to the purlins, the bracket shall consist of 50 x 3 mm M.S. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 nos. of 10 mm diameter bolts, nuts and washers. The bracket will be stiffened by provision of 50 x 3 mm M.S. flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 nos. 6 mm dia M.S. bolts, nuts and washers

and its shorter leg fixed to face of purlin with 1 no. 10 mm dia bolt, nut and washer. The overhang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.

The gutter shall be fixed to the brackets with 2 nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.

For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.I. sheet of the same thickness as the gutter and reverted to the gutter, the other end tailing in to the socket of the rain-water pipe. Wherever stop ends, angles etc., should be provided.

Finish : The gutters when fixed shall be true to line and slope and shall be leak proof.

Measurements : Measurements shall be taken for the finished work along the centre line of the top width of the gutter connection to a cm. The hooked lap portion in the junctions and gutter lengths shall not be measured. The number of brackets which are fixed to purlins with stiffener flats should be measured.

Rate : The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends or funnel shaped connecting pieces, stop ends etc., flat iron brackets and bolts and nuts required for fixing latter to the roof members. Brackets of 50 x 3 mm flats fixed to purlins with stiffener flats will be paid extra.

2.02.03 Fiber Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as mentioned in the Schedule of Item. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheeting the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in schedule of items. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure as mentioned in Schedule.

2.02.04 Precoated metal sheet

Precoated metal sheeting for roof shall be of precoated cold rolled sheet of total coated thickness (TCT) 0.58 to 0.68 mm of approved manufacturer. The sheet shall be metallic hot deep coated with an alloy of 55% aluminium, 43% zinc and 1.55 silicon coating mass shall be 150 gms/sq.m. sheet shall be fixed with fastening clip and self tapping fastener. Ridge for slope roof shall be of similar material and shall be fixed with necessary self tapping screws as per manufacturer details.

Thermally insulated sandwiched metal cladding for external facade shall be of approved manufacturer. Sheeting shall Hi Rib 0.5 mm troughed sheeting manufactured from aluminium alloy high tensile steel (550Mpa) coated with fluro polymer (PV F2 or equivalent) and shall have life span sustenance

against aggressive weathering action. Inner profiled sheet shall be with profile sheet of .6 mm thick (total coated thickness) permanently coated galvanised sheet.

Galvanised coating shall be not less than 120 gm/sq.m. and sandwiched insulation of 25 mm thick or as per design requirement shall be bonded mineral wool blanket or equivalent conforming to IS: 8183 (minimum density of 32/kg/cum for glass wool and 48/kg/cum for rock wool) having minimum coefficient of thermal conductivity of 0.49 m W/cm deg C (at 50 degree C) Cladding shall be fixed to supports/rails by nuts, bolts, hooks, washers self tapping screws of stainless steel Austentic grade) conforming to IS:1367 (part 14) including sealants, gaskets, PVC tape 0.25 mm thick, flashing, black synthetic rubber external trough filler and 25X3 mm aluminium earthling.

2.02.04 Polycarbonate Sheeting Work

Solid Polycarbonate sheet of minimum 4mm thick should be of UV resistant and high temperature resistant. Sheet should be of approved brand and quality, colour and transparency for ceiling/ roofing on plain, sloped, curved surfaces to any pitch or height including fixing purlins with polymer quoted galvanized self drilling, self tampering metal screws and fasteners and EPDM washers, rubber gasket with closing caps, adequate adhesive and sealants as per manufacturer's specification etc. complete but excluding the cost of purlins, rafters, trusses etc.(if any). Polycarbonate sheets shall be uniform pigmentation and thickness with out air pockets and shall conform to IS: 14443: 1997 and including cutting to required length and size including profile machine bending of sheets to achieve the desired profile by conforming minimum joints and laps as per drawing.

3.00.00 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing

4.00.00 RATES

Rates shall be for unit rate for complete item described in the Schedule and shall include all wastages as mentioned earlier.

5.00.00 METHOD OF MEASUREMENT

a) No allowance shall be made for laps.

b) Roofing and side sheeting shall be measured for net area of work done. Corrugated sheeting shall be measured flat and not girthed. Openings less than 0.4 Sq.m shall not be deducted. Detailed stated earlier.

c) Special features like flashings, ridge pieces, caves, corner pieces, north-light curves etc. shall be measured for length of installation.

d) Gutter and down comers shall be measured for length along their centre lines and bends, junctions, shoes ends, etc. shall not be paid properly.

e) S-type asbestos louvers shall be measured for area of opening in which it is installed.

f) Curved asbestos roofing sheets shall be measured for area of curve.

g) Asbestos ventilators, roof lights shall be measured and paid under relevant items.

6.00.00 IS CODES

The following are some of the important IS Codes relevant to these sections:

IS : 3007	:	Code of practice for laying of asbestos cement sheets
IS : 2527	:	Code of practice for fixing rain water gutters and down pipes for roof drainage
IS : 1626	:	Specification for asbestos cement building pipes gutters and fittings
IS : 277	:	Specification for galvanised steel sheets (plain and corrugated)
IS : 1200 (PT.IX)	:	Method of measurements of building and civil engineering works: Part – 9 Roof covering (including cladding)
IS : 2633	:	Method of testing uniformity of coating on zinc coated articles.
IS : 3144	:	Method of test for mineral wool thermal insulation materials.
IS : 3346	:	Method of the determination of thermal conductivity of thermal insulation materials.
IS : 8183	:	Bonded mineral wool

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SECTION-XXVIII

TECHNICAL SPECIFICATION
FOR
ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

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SECTION-XXVIII

TECHNICAL SPECIFICATION FOR ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This specification covers providing, furnishing, installation, repairing, finishing, curing, testing,, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to take the fiber cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

2.01.01 There is no necessity of hacking the surface to be treated shall be cleaned including removing the mortar dropping from the surface.

2.01.02 Grading Underbed

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.03 The grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be thoroughly mixed dry and them water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.02.00 Concrete

The concrete shall be used where the sub-grade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.
The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.03.00 Insulation

The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days.

2.03.01 Foam Concrete

This shall be of light weight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.03.02 Expanded Polystyrene Blocks

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall have to secure manufacturer's supervision.

Material: Expanded polystyrene shall conform to IS 4671. It is of two types given below :

Type N-Normal

Type SE – It shall be of self extinguishing type when tested in accordance with IS 4671.

Dimensions : The size of the finished boards shall be 1.0 x 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100mm.

Tolerance : The tolerances on the length, width and thickness of the finished board shall be ± mm.

Requirements for Expanded Polystyrene for General Use :

Sl. No.	Characteristics	Requirements at various nominal apparent densities in kg/cum					Test Reference
		15	20	25	30	35	
1.	Thermal conductivity (k. value) (a) at 0ºC (b) at 10ºC	 0.34 0.37	 0.32 0.35	 0.30 0.33	 0.29 0.32	 0.28 0.30	IS 3346
2.	Compressive strength at 10% deformation in kg/sq.cm Minimum.	0.7	0.9	1.1	1.4	1.7	IS 4671
3.	Cross breaking strength in kg/sq.cm Minimum.	1.4	1.6	1.8	2.2		IS 4671
4.	Water vapour permeance in g/sqm 24 hrs. Max.	50	40	30	20		IS 4671
5.	Thermal stability Percent Max.	1	1	1	1		IS 4671
6.	Water absorption	Less than 0.5% by volume (after 24 hrs. immersion)					IS 4671

Sampling : In a single consignment all the items of the same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judgment conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table given below. The sample shall be taken at random from the lot.

No. of items in the lot	No. of sample items	Permissible number of defective sample items
1	2	3
Up to 25	3	0
26 to 100	5	0
101 to 300	8	0
301 to 1000	13	0
1001 to 3000	20	1
3001 and above	32	2

All the sample items selected from the lot shall be tested for all requirements of the specifications. Any item failing in one or more of the requirements shall be regarded as defective.

General : Expanded polystyrene can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled ober the suspended false ceiling.

Measurements : Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of area up to 40 square decimeter. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimeter in area deduction for the full opening will be made, but nothing extra will be paid for any extra material/labour involved in forming such openings.

Rate : The rate shall include the cost of material and labour in providing and fixing the polystyrene boards.

2.03.03 With Resin Bonded Fiber Glass Wool (Bonded Mineral Wool)

Material : The material shall be mineral wool made from sock slag or glass processed from a molten state in to fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall be 25, 40, 50, conform to specifications of group I of IS 8183.

Dimensions : The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cms, and length of 100, 120 and 140 cms and the thickness of the bonded material wool shall be 25, 40, 50, 65 or 75 mm.

Tolerance : For width and length, the dimensional tolerance of the bonded material wool shall be -1/2 %. For nominal thickness in the range 25 to 75 mm the tolerance shall be -2 mm. An excess, in all dimensions is permitted.

Requirements for Fiber Glass Wool

Sl. No.	Characteristics	Group I	Test Reference
1.	Bulk density	12 to 15 kg/cum	IS 3144

2.	Recovery after compression	Not less than 90% of original thickness	Annexure. A of IS 3144
3.	Shot content max	500 micron-5% 250micron-15%	IS 8183
4.	Moisture content and absorption	Not more than 2%	IS 3144
5.	In combustibility	Incombustible	IS 3144
6.	Thermal conductivity deg. C at mean temperature 50 deg. C	0.49 mw/ cm^{o}C	IS 3346
7.	Sulphur content	Not more than 0.6%	IS 3144

General : Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

Measurements : Length and breadth of roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas up to 40 square decimeter. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimeter in areas, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surface in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

Rate : The rate shall include the cost of all materials and labour required in providing bonded mineral wool.

Either of above items (cl. No. 2.3.1 or 2.3.2 or 2.3.3) can be adopted subject to approval of engineer.

2.04.00 Fillets

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.05.00 Water proofing by epoxy resin based application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be throughly

cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, and light traffic. The application shall be resistant to growth of fungus and proof against saltpeter action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application.

2.06.00 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer, instead of being finished with pea-sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.07.00 Elastomeric Membrane

2.07.01 Primer Coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless spray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 sq.m per liter depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by vigorous brushings, fungal growth with proprietary fungicide as recommended. Priming coat shall not be applied to damp substrate.

2.07.02 Finishing Coats

The finishing coats shall consist of two successive liquid coatings of high solid content urethane pre-polymers material to form an elastomeric membrane. Application shall be with brush or spray to form an uniform joint less elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by at least 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency.

2.07.03 Surface Finish

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:11/2:3(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealant or elastomeric compound to ensure perfect waterproofing.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS: 13801 shall be provided. The tiles shall be laid as per IS 1443.

2.08.00 Under Deck Insulation

2.08.01 Insulation material shall be Closed Cell Elastomeric Nitrile Rubber

2.08.02 Density of Material shall be between 40 to 60 Kg/m3

2.08.03 Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C

2.08.04 The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’ Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990

2.08.05 Material should be FM (Factory Mutual), USA approved.

2.08.06 Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10-14 Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor ‘μ’ value should be minimum 7000.

2.08.07 Under-deck insulation thickness shall be as per HVAC requirement and calculation.

2.08.08 Under-deck insulation shall be provided for all AC areas having roof exposed to sun.

2.09.00 Spray able Insulation and waterproofing system

2.09.01 For roofs with structural slope:
Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Spray applied an average 40 mm thick two component Hydro flouro carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m3 as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope with 25mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.
All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

2.09.02 For roofs having no structural slope:
Compressed air cleaning has to be done so as to make the surface free of dust, debris, laitance etc. Repairing cracks by cutting and making V-groove in 25x25 mm, with polymer modified mortar, filling the groove with Cement Mortar (1:3) mixed with polymer10% by weight of cement. Spray applied an average 40 mm thick two component Hydro flouro carbon(CFC free), polymeric M.D.I based closed cell(96-98% as per ASTM D2856) multilayer, waterproof, insulated polyurethane foam, mixed in a ratio of 1:1 by volume with a nominal core density of 45-50 Kg/m3 as per ASTM D1622 , and a thermal conductivity of 0.023 W/m.k at 25 degree mean temperature as per ASTM C518/91 possessing waterproofing properties as per ASTM C-518/91 ,ASTM C-272 and complying to Fire resistance Class B2 as per DIN 4102. Top of insulation foam shall have a minimum 1.5mm thick sealer coat, which

is a single component cold applied elastomeric waterproofing coating with >=500% elongation confirming to ASTM C836 applied by a spray/brush/roller in 2 coats. Water ponding/flood test is to be conducted after application. Water shall be filled up and retained for at least 24 to 48 hours. Loosely laid 120-150 GSM geotextile (non-woven polyester) shall be provided over the Elastomeric coating. Laying protective slope (1:100) with 75mm average thick (thickness will depend upon the required slope and span of the building) M20 grade screed mixed with polypropylene fibers and admixed with integral liquid waterproofing compound conforming to IS: 2645. Green stage saw cutting on the screed will be done in panels (3mx4m) with grooves 10mmx10mm. Finally the groove will be sealed with suitable elastomeric sealant. Finally top shall be finished with 20mm thick 600x600 concrete roof tiles over 20mm thick cement: sand (1:4) bed mortar.
All around on the roof, at the parapet wall junction, an angular fillet 50mm x 50mm shall be trowel applied in cement-sand mortar(cement, sand mortar shall be supplied by you) in 1:3 proportion. A latex based bonding agent should be added (10% by weight of cement) and also a glass cloth must be inserted around the junctions while the angle fillet is being constructed.

2.09.03 For vertical surfaces (Parapet)
Surface preparation, minor cleaning works, removal of loose concrete, laitance, dust particles, etc and filling cracks with polymer modified mortar using latex based bonding agent. Removal of algae if present is to be done. Providing and applying a water based acrylic primer over the entire surface of the parapet walls(2 part primer : 1 part water). Providing and applying 2 coats of a high performance elastomeric coating, composed of acrylic emulsion polymers having anti-carbonation properties, UV resistant and DFT of 110 microns, conforming to ASTM-D412-02, D1202-97, D 4587, D 4645, BS-EN 12390 over the exterior wall surface.

Note: Waterproofing materials should be applied by the manufacturer in-house application wing or authorised applicators only under supervision of manufacturer's authorised person. Performance Guarantee should be given by the manufacture to the owner after completion of the roof waterproofing work.

3.00.00 ACCEPTANCE CRITERIA

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner. Any bad work or any damage to the treatment shall be repaired and made good by the contractor at his own cost.

4.00.00 I.S. CODES AND STANDARDS

a)	IS:73	:	Paving Bitumen
b)	IS:702	:	Industrial Bitumen
c)	IS:1203	:	Methods of testing tar and bitumen
d)	IS:1322	:	Bitumen felts for waterproofing and damp proofing
e)	IS:1346	:	Code of Practice for waterproofing of roofs with bitumen felts
f)	IS:3384	:	Bitumen primer for use in waterproofing and damp proofing.
g)	IS:2645	:	Specification for integral water proofing compounds for cement mortar and concrete.
h)	IS:3144	:	Methods of test for mineral wool thermal insulation materials.
i)	IS:4641	:	Expanded polystyrene for thermal insulation purpose.

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SECTION-XXIX

TECHNICAL SPECIFICATION
FOR
WATER SUPPLY

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SECTION-XXIX

TECHNICAL SPECIFICATION FOR WATER SUPPLY

1.00.00 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

General Requirements

Any damage caused to the building, or to electric, sanitary water supply or other installations etc. therein either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the contractor. Nothing extra shall be paid for it, except where otherwise specified.

All water supply installation work shall be carried out through licensed plumber.

It is most important to ensure that wholesome water supply provided for drinking and culinary purpose is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be constructed a permissible substitute for complete absence of cross-connection.

Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only in to a cistern, and by a pipe or fitting discharging in to the air gap at a height above the top edge of the cistern equal to twice its normal bore, and in no case less than 15 cm.

No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such that can cause undue deterioration of the pipe.

Where the laying of any pipe through fouled soil or previous material is unavailable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.

The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, and reflux or non-return valves shall not be relied upon to prevent such back flow.

All pipe work shall be so designed, laid or fixed, and maintained so that it remains completely watertight, thereby avoiding wastage of water damage to property and the risk of contamination of the water conveyed.

In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if required, and to avoidance or airlocks, noise transmission and unsightly arrangement.

To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.

Change in diameter and direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially reduce or alter the cross-section.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

Where the service pipe is of diameter less than 50mm the stop valves shall be of the screw-down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

In flats and tenements supplied by a common service pipe a stop valve shall be fixed to control the each branch separately. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps so as to minimize interruption of the supply during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head by friction.

Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.

Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.

Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water

to facilitate repairs. There shall be draining taps or draw-off taps (not under ground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided. Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have easy bends, and where quietness is particularly desired, holder bats or claps shall be insulated from the piping by suitable pads.

The rising pipe to the storage cistern, if any, or to any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools. Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for insertion of the pipe and to allow freedom for expansion, contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joints.

Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cistern which shall have supply from storage tank.

No service or supply pipe shall be connected directly to any hot water system or to any apparatus used for heating other than through a feed cistern thereof.

1.01.00 Materials

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order is to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.02.00 Pipes and Pipe Fittings

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types:

a) Cast Iron

b) Steel: lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanised.

c) Reinforced Concrete

d) Prestressed Concrete

e) Asbestos Cement

f) Lead (Not to be used for potable water)

g) P. V. C.

h) Copper

i) Brass

j) Wrought iron

k) Galvanized Iron- heavy & medium duty pipes- is 1239 & is 4736

l) PP-R Pipes – IS 15801

1.03.00 Water Tanks

Water tanks shall be made of PVC, HDPE, MS pressed steel, GI, Concrete masonry. PVC/HDPE/Pressed Steel tanks shall be factory made and from reputed brand with proper test certificates. The capacity of tanks shall be as per drawing design or as per instruction of Engineer-in-Charge.

1.04.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Specification.

1.05.00 Regulation

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities. The fee paid to the Authorities shall be reimbursed by the Owner.

2.00.00 INSTALLATION

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.01.00 Pipe Lines

2.01.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.01.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.01.03 Contamination

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.01.04 Underground Pipings

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.01.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.01.06 Jointing of Pipes

Jointing of pipes shall be completely leak proof and durable. Instruction of the manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance:

a) Cast Iron

i) Spigot and Socket Joints

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

ii) Flanged Joints : Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degrees of all bolts in a joint are similar. Damaged gaskets shall be replaced.

b) Steel

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

c) G I Pipes

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

d) Asbestos Cement Pipes

Socket and spigot ended pipes shall be jointed by caulking with tarred gaskets and grouted with 1:3 cement sand mortar.

e) Lead

Lead and lead alloy pipes shall be jointed with wiped solder joints.

f) Concrete

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

g) P. V. C. / UPVC/ HDPE/PP-R

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

h) Tyton Joint

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the jont fully.

2.01.07 Painting

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. and M.S. pipes shall be given one coat of red lead or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.02.00 Storage Tank - Pressed Steel Tank

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition..

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.02.01 G. I. Water Tank

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised / iron stay rods, one fixed to angle framing at top and two in the body of the tank for extra strength. Holes for riveting shall be drilled and not punched. White lead shall be applied to the joints before riveting.

In case it is desired by the Engineer that corners of tank should be welded instead of riveted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubber, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.02.02 Polythene Water Storage Tanks

Material

Polythene used for manufacture of tanks and manhole lids may be high density (HDPE), low density (LDPE) or linear low density (LLDPE) and shall conform to IS 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be 2.5 ± 0.5 percent and it shall be uniformly distributed. The materials used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminated the water nor impart any test, colour, odour or toxity to water.

Manufacture and Finish

The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

Shape, Size and Capacity

The tank shall be cylindrical vertical with closed top having a manhole. Diameter and height of the tank of various capacities shall be as per manufacturer's specifications and a clearance of ± 3 percent shall be

permitted on these dimensions. Capacity of the tank or up to the bottom of the inlet location whichever is less. Capacity of the tank shall be specified. Extra capacity if any shall be ignored.

Weight and Wall Thickness

The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon the capacity and the location tanks may be suitably anchored as per the directions of the Engineer-in-Charge. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering of leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

Manhole Lid

The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter in to the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

The tank and its components shall conform to the local bye-laws for preventions of mosquito menace.

Sl. No.	Capacity (litres)	Minimum Wall Thickness (mm)	Minimum Weight of Empty Tank (kg)
1	2	3	4
1.	200	4.4	7.8
2.	300	4.4	9.0
3.	400	5.5	15.0
4.	500	6.0	18.0
5.	700	7.0	23.5
6.	1000	6.6	33.0
7.	1250	7.0	40.0
8.	1500	7.0	47.0
9.	1700	7.0	54.0
10.	2000	7.0	64.0
11.	2500	8.2	81.0
12.	3000	8.2	96.0
13.	4000	8.8	138.0
14.	5000	10.4	191.0
15.	6000	10.7	209.0
16.	7500	10.7	250.0
17.	10000	11.5	363.0
18.	15000	11.5	550.0
19.	20000	13.2	814.0

Rates

The rate shall include the cost of the tank. Manhole lid, carriage and delivery at the place specified. Hoisting, installation, fittings, platform and anchoring shall be payable separately.

2.02.03 Tube Wells with Hand Pumps

Casing Pipe

The casing pipe shall be of M.S. or W.I. of 100 mm dia. And strong enough to stand hammering and vibrations to which it is subjects.

Filter and Brass Strainer

The filter shall consist of a G.I. pipe of the required diameter with 15 mm diameter holes covered with brass strainer both inside and outside. It shall have a driving point riveted or welded to it.

Hand Pump

This shall be of approved quality. It shall be complete with necessary bolt and nuts for jointing to the masonry or concrete base.

2.03.00 Valve, Cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers. These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.04.00 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection Before Installation

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.02.00 Testing of Mains after Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with

a stop cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/CM^2 or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.03.00 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely water-tight. All piping, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

4.00.00 RATES

Rates shall be unit rates for the complete work as mentioned in the specification unless any particular portion is specifically excluded in the Schedule of Items.

If any material, fittings or fixtures are provided by the Owner f ree, the Contractor shall have to take delivery, keep in safe custody and be responsible till fitted and handed over.

5.00.00 MEASUREMENT

For method of measurement regarding works under scope of the specification IS: 1200 (Part-XVI) latest edition shall be followed unless contrary to the following:

5.01.00 Trenches

Unless particular items are included in the schedule, no separate measurement shall be made to lead, lift, dewatering, dressing, storing, backfilling, consolidation etc. that may be required in this connection.

5.02.00 Concrete Masonry

The measurement shall be on gross area or volume basis as mentioned under the relevant items.

5.03.00 Soling

No separate measurement should be made for dressing and ramming the surface. The soling shall be measured on gross area of the work under the item.

5.04.00 Pipe Works

No separate measurement shall be made for specials, supports and fixtures, cutting chases, holes and rectification unless specially indicated in the Schedule of Items. If the specials are separately indicated in the Schedule, the measurement for these shall be over and above the measurement of the pipe work as mentioned below :

The pipes of different nominal bores shall be measured separately.

The pipe work shall be measured in length inclusive of sockets, specials, fittings etc. in position.

5.05.00 Fittings and Fixtures

Measurement for fittings and fixtures where applicable shall be in number. No separate measurement shall be made for anchors unless they form a separate item in the Schedule.

5.06.00 Chases, Holes

If items for cutting and remaking of chases, holes and similar works are included in the Schedule the measurement shall be on gross length, area or volume as appropriate.

5.07.00 Painting

Painting pipe works shall be measured on the basis of length for different nominal diameters of the pipes. Painting of steel work may be on the basis of weight or area or otherwise as mentioned against the particular items.

6.00.00 I.S.CODES

Important relevant IS Codes for this Specification are listed below :

Latest editions shall always be consulted.

IS:2065	:	Code for Practice for water supply in buildings
IS:1172	:	Code of basic requirements for water supply, drainage and sanitation
IS:1200	:	Laying of water and sewer lines including (Pt.XVI) appcurtnant items.
IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm

nominal diameter)

IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter)
IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
IS:784	:	Prestressed concrete pipes
IS:458	:	Concrete pipes (with or without reinforcement)
IS:783	:	Code of Practice for laying of concrete pipes
IS:1592	:	Asbestos cement pressure pipes
IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
IS:404	:	Lead pipes
IS:3076	:	Low density polyethylene pipes for potable water supplies
IS:4984	:	High density polythylene pipes for potable water supplies
IS:2501	:	Copper tubes for general engineering purposes
IS:407	:	Brass tubes for general purposes
IS:1230	:	Cast iron rain water pipes and fittings
IS:804	:	Rectangular pressed steel tanks
IS:4736-1986	:	Hot-dip zinc coatings on steel tubes. (Reaffirmed – 2001)

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SECTION-XXX

TECHNICAL SPECIFICATION
FOR
DRAINAGE AND SANITATION

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SECTION-XXX

TECHNICAL SPECIFICATION FOR DRAINAGE AND SANITATION

1.00.00 SCOPE

1.01.00 This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

2.00.00 INSTALLATION

2.00.01 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.01.00 Rainwater Down comers & Soil and Drainage Pipes

Rainwater downcomers shall be standard Cast Iron, UPVC, and Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure.

All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.
Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.01.01 Unplasticized Polyvinyl Chloride (UPVC) Pipes

The specification covers requirements for plain and socket end unplasticised polyvinyl chloride (UPVC) pipes with nominal outside diameters 40 mm to 160 mm for use for soil and waste discharge system inside buildings including ventilating and rain water applications. In this specification nominal outside diameter DN of pipes are 40, 50, 63, 75, 90,110,125,140 and 160 mm.

Surface colour of the pipes shall be dark shed of grey. For other details and specifications refer code IS: 13592-1992 (amended to 1995)

Above quality of pipes are divided into two types. Type –A (IS 13592) meant for rain water pipes & Type- B meant for soil pipes.

Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified.

Marking

Each pipe shall be clearly and indelibly marked with the following information at intervals not more than 3 meters.

a) Manufacturer's name or trade mark.

b) Nominal outside dia of pipe.

c) Type 'A'

d) Batch number.

Dimensions

Diameter and Wall Thickness : Mean outside diameter, outside diameter at any point and wall thickness for type-A or type-B manufactured plain or with socket shall be as given in Table-1 of IS 13592.

UPVC rain water/ soil pipe shall of the dia, specified in the description of the item and shall be in nominal lengths of 2, 3, 4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerance on specified length shall be + 10mm and – 0 mm.

Fixing and Jointing

Pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x50x50 mm hard wood plugs, screwed with M.S. screws of required length i/e cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

Installation in Wall/ Concrete

The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted in to the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

Fittings

Fittings used shall be of the same make as that of the PVC pipes injection moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 302 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

Measurements

The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. including or excluding all fittings along its length as stated/described in the BOQ.

2.01.02 Cement concrete pipes (with and without Reinforcement) (Light Duty, Non-Pressure)

The pipes shall be with or without reinforcement as required and shall be of class not less than NP2. These shall conform to IS: 458. The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process while un-reinforced cement concrete pipes by spun or pressure process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Concrete used for the manufacture of reinforced concrete pipes and collars shall not be leaner than 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

2.01.03 Cast Iron (Centrifugally cast) Pipes and Specials

The spun iron pipes shall conform to IS 1536. The spun iron pipes shall be cast iron cast centrifugally and vary in diameters from 80 mm to 750 mm. These shall be of class LA, class A and class B, as specified. Pipes shall be tested hydrostatically at the pressure specified in the IS Code.

Specials : The special shall conform to IS 1538. The hydraulic test pressure of each class shall be as detailed mentioned in the IS Code.

2.01.04 Pipes-Galvanised Iron

The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) HIRW or HFW screwed and socketted conforming to the requirements to IS 1239 Part – I for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

Galvanising shall conform to IS 4736 : The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare batches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be clearly finished, well galvanized in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be cleaned and well cut. The ends shall be cut clearly and square with the axis of the tube.

All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

All tubes shall withstand a test pressure of 50 kg/sq.cm without showing defects of any kind.

Fittings : The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part-2) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

2.02.00 Gutters

The gutters shall be made of G.I. or A.C. All gutters shall be supplied by reputable specialized firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

2.03.01 Gradients

If not specified the minimum gradients of soil and drainage pipe line shall be as follows :

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

2.03.02 Relation with water supply pipe lines

Unless specifically cleared by the Engineer, under no circumstances shall special drainage and soil pipes be allowed to come close to water supply pipelines.

2.03.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.03.04 Support and Protection on Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be hunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

Laying Of Cement Concrete Pipes : Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.

If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.

In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipe shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.

In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal dia of the pipe subject to the min. of 10 cm and a maximum of 30 cm. The concrete shall extend up to the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and over a dia. The pipe shall be laid in this concrete bedding before the concrete has set.

2.03.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

2.03.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

2.03.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-siphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C.I. unless desired otherwise by the Engineer.

2.03.08 Manhole and Inspection Chambers

The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. In addition, at every change of alignment gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise.

Manhole shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgment for any splashing in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement,

sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I. covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

2.03.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

2.03.10 Jointing

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water-tight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Care shall be taken to place the collar centrally over the joint.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. Then the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be covered with damp cloth or other suitable materials.

d) Vitrified clay pipes

These shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, Specification for Building it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1) which shall have very little water and levelled to form a splayed fillet at an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo-welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron soil pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe or drain communicating with a sewer, the beaded spigot end of such cast iron soil pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe or drain and the joint made with mortar consisting of one part of cement and one part of clean sharp sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earth ware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fiber.

2.04.00 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future

settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

2.05.00 Fixtures

The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturer's current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3 kg. per 25 mm dia per meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test reports and convince the Engineer about their durability.

Unless specified in the contract the fixtures shall be as specified hereinafter.

2.05.01 Water closet

a) Raised type

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

b) Squatting type

It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. The flushing cistern shall be painted as desired by the Engineer.

2.05.02 Urinals

It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

2.05.03 Wash basin

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.04 Sink

It shall be made of glazed stoneware. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.05.05 Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05.06 Glass shelves

Glass shelves shall consist of 6 mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.05.07 Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.05.08 Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.05.09 Liquid soap dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

2.05.10 Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.05.11 Installation

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane,

location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Contractor.

2.06.00 Septic tank & effluent disposal

2.06.01 Septic tank

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia. Whose top shall be provided with a suitable mosquito proof wire mesh and cowl, Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

2.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

2.06.03 Soak pit

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia. pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

2.06.04 Open joined SW Pipe / dispersion trenches

Minimum dia. of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for filling the top of trench.

2.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.00.00 TESTING AND ACCEPTANCE

3.01.00 Inspection before installation

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

3.02.00 Testing of Pipelines

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below :

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

b) Water test

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimeter of diameter per kilometer may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases :

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazed ware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

c) For straightness

i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipe line is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipe line is not straight.

3.03.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm.

3.04.00 Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.00.00 RATES

Rates shall be unit rates for the complete work as detailed out in the Specification unless any particular portion is specifically excluded in the Schedule of Items.

If any material fittings or fixtures are provided by the Owner free, the Contractor shall have to take delivery, keep in safe custody and be responsible till fitted and handed over.

5.00.00 MEASUREMENT

For method of measurement regarding work under scope of this Specification IS: 1200 (Part-XVI) shall be followed unless contrary to the following:

5.01.00 Trenches

Unless particular items are included in the Schedule, no separate measurement shall be made for lead, lift, dewatering, dressing, storing, backfilling consolidation etc. that may be required in this connection.

5.02.00 Concrete, masonry

Unless lumped with other items in the Schedule the measurement shall be on gross area or volume basis as mentioned under relevant items.

5.03.00 Pipe work

No separate measurement shall be made for special supports and fixtures, cutting chases, holes and rectification unless specially indicated in the Schedule of Items. If the specials are separately indicated in the Schedule, the measurement for these shall be over and above the measurement, of the pipe work as mentioned below:

The pipes of different nominal bores shall be measured separately. The pipe work shall be measured in length inclusive of sockets specials, fittings etc. in position.

5.04.00 Fittings and fixtures

Measurement for fittings and fixtures where applicable shall be in number for the complete item inclusive of anchors, brackets and fasteners required. However, in special cases anchors, brackets and similar items may be measured separately if included as such in the Schedule of Items.

5.05.00 Chases and holes

No measurement shall be made for cutting chases, holes etc. and making good for any work within the scope of this specification and shall be inclusive.

5.06.00 Painting

All items likely to rust shall be painted with one coat of primer which shall not be measured separately. Where finishing coat of paints are supplied that shall be measured as indicated in the Schedule of Items. Usually, painting of pipes shall be measured in length for each different nominal diameter without giving any extra allowance for specials sockets, etc.

5.07.00 Septic tank, Soak pit

Usually it shall be measured in number for the complete septic tank or soak pit as per drawing. All earthwork, backfilling masonry, concrete, manhole, pipes and fittings included. In case, it is intended to pay for individual items the same shall be indicated in the Schedule and measured in number, length, area or volume as appropriate.

6.00.00 CODES AND STANDARDS

Some of the important Codes and Standards relevant to this specification shall be followed: Latest editions shall always be consulted.

IS: 1172 - Code of basic requirements for water supply drainage and sanitation.

IS: 1200 - Laying of water and sewer lines including appurtenant (Pt. XVI) items.

IS: 1239 - Mild Steel Tubes and Mild Steel Tubular and other (Pt.I & II) wrought steel pipe fittings.

IS: 1536 - Centrifugally cast (Spun) iron pressure pipes for water gas and sewage.

IS: 1537 - Vertically cast iron pressure pipe for water, gas & sewage.

IS: 3486 - Cast Iron spigot & socket drain pipes.

IS: 1742 - Code of Practice for building drainage.

IS: 5329 - Code of Practice for sanitary pipe work above ground for buildings.

IS: 2470 - Code of Practice for designs and construction of septic tank for small and large installations.

IS: 3076 - Low density polythelene pipes for potable water supplies.

IS: 4984 - High density polythelene pipes for potable water supplies.

IS: 1537 - Vertically cast iron pressure pipes for water, gas and sewage.

IS: 1538 - Cast Iron fittings for pressure pipes for water, gas & sewage.

IS: 1230 - Cast Iron rain water pipes and fittings.

IS: 3889 - Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.

IS: 1729 - Sand cast iron spigot & socket soil, waste and ventilating pipes and accessories.

IS: 1626 - Asbestos cement building pipes, gutters and fittings (spigot & socket types).

IS: 458 - Concrete pipes (with and without reinforcement)

IS: 783 - Code of Practice for laying of concrete pipes.

IS: 784 - Prestressed concrete pipes.

IS: 651 - Salt glazed stoneware pipes & fittings.

IS: 4127 - Code of practice for laying of glazed stoneware pipes.

IS: 1726 - Cast Iron manhole covers and frames intended for use in drainage works.

IS: 5961 - Cast Iron gratings for drainage purposes.

IS: 5219 (Part 1) - 'P' & 'S' traps.

IS: 771 - Glazed earthen-ware sanitary appliance.

IS: 772 - General requirements of enamelled cast iron sanitary appliances.

IS: 774 - Flushing cistern for water closets & urinals (valve less siphonic type).

IS: 775 - Cast Iron brackets & supports for wash basins and sinks.

IS: 2548 - Plastic water closet seats & covers.

IS: 2527 - Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

IS: 1703 - Water fittings- copper alloy float valves (horizontal plunger type)
- Specification.

IS: 1795 - Specification for pillar taps for water supply purpose.

IS: 2556 (Part-1, Part-2, Part-3, Part-4, Part-5, Part-6, Part-7, Part-14, and Part-15)
- Part-1: General requirements
- Part-2: Specific requirements of wash-down water closets.
- Part-3: Specific squatting pans.
- Part-4: Specific requirements of wash basins.
- Part-5: Specific requirements of laboratory sinks.
- Part-6: Specific requirements of Urinal & Partition plates.
- Part-7: Specific requirements of accessories for sanitary
- Part-14: Specific requirements of integrated squatting pans.
- Part-15: Specific requirements of universal water closets.

IS: 3989 - Specification for centrifugally cast 9spun) iron spigot and Socket soil, waste and ventilating pipes fittings and accessories.

IS: 4827	-	Specification for electroplated coating of nickel and chromium on copper and copper alloys.
IS: 4985	-	Unplasticised P.V.C pipes for potable water supply-Specifications.
IS: 4127	-	Code of Practice for Laying of Glazed Stone Ware Pipes.
IS: 4885	-	Specifications for Sewer Bricks.
IS: 12592	-	Pre-cast Concrete Manhole Covers and Frames – Specifications.

SECTION - D

STANDARD TECHNICAL SPECIFICATION

SECTION – D comprises of sub-sections as mentioned below:

Sub-section D1: Earthwork in excavation and backfilling

Sub-section D2: Cement concrete (Plain and reinforced) and formwork

Sub-section D3: Carpentry and joinery

Sub-section D4: Roof and underground structures water proofing, insulation and allied works

Sub-section D5: Metal doors, windows, ventilators, louvers etc.

Sub-section D6: Glass and Glazing

Sub-section D7: Rolling Steel Shutter and Grills

Sub-section D8: Miscellaneous Metal

Sub-section D9: Masonry and allied works

Sub-section D10: Finish to masonry and concrete

Sub-section D11: Painting, Whitewashing, polishing

Sub-section D12: Floor finish and allied works

Sub-section D13: Sheet work in roof and siding

Sub-section D14: Suspended ceiling

Sub-section D15: Water supply, drainage & sanitation

Sub-section D16: Road & drainage

Sub-section D17: Fabrication of structural steelwork

Sub-section D18: Erection of structural steelwork

Sub-section D19: Roof decking

Sub-section D20: False flooring

Sub-section D21: Bored cast-in-situ RCC piles

Sub-section D22: Site levelling & grading works

Sub-section D23: Anti-termite treatment

Sub-section D31: Landscaping work

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SECTION - D

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

SPECIFICATION NO. PE-TS-999-600-C001

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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2.00.00	GENERAL	3
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STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.3.0 Codes and Standards

All works shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts
IS: 3764	Excavation work – code of safety

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following

manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

2.7.0 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction

likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. All records of levels, measurements etc. and also any drawing, cross-section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the

engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.4.0 Classification

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) Hard Soil

This shall include :
i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
iii) soling of roads, paths, etc., and hard core ;
iv) macadam surfaces such as water bound, and bitumen/tar bound;
v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :
i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded

in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :
i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;
ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the

workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.5.2 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades

etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

3.5.4.1 Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.5.4.2 Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be

provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his

responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

3.5.4.5 Restrictions in Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.

All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably praticable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer’s prior approval on the method of pumping to be adopted shall be

taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9.0 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS: 4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.0.0 RATES AND MEASUREMENTS

5.1.0 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

f) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.2.0 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS: 1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

e) Tree cutting having girth more than 300mm shall be measured in number and are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.2.0 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

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VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-999-600-C002

SECTION – D

SUB SECTION – D2

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Prepare working drawings of formworks, scaffolds, supports, etc.

d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Prepare detailed drawings of supports, templates, hangers, etc. required for

installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

f) Submit for approval detailed schemes of all operati ons required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and subm it for approval conc rete mix designs req uired to be adopted on the job.

Furnish samples and submit for approval results of tests of various p roperties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental item s not shown or specified in particular but reasonably impliedor necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor m ay have to produce, if dire cted by the Engineer, a guarantee in appro ved Perform a fo r satisfactory perform ance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

a) Source and arrangem ent of processi ng of aggregatesproposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other◆waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour

Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engin eer and the records of compliance by the Contractor, deviations allowed by th e Engineer and any other relevant information will be written on acco mpanying sheets attached to th e Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placem ent of concrete. One of the mix desig ns developed by the Contractor as p er the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the E ngineer, the choice being dicta ted by the requir ements of designs and workability. The m ethods of m ixing, conveyance, placem ent, vibration, finishing, curing , protection and testin g of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be i ncorporated in t he work or used te mporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than f or the critical structures identified below. However, other types of cement such as ordinary Portland cem ent conform ing to IS:26 9, Portland slag cem ent conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete m ixes shall be in genera l of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

a) TG foundation top deck and sub structures including raft.

b) Spring Supporting decks of all machine foundations.

c) Structures requiring grade of concrete of M30 and above.

In spe cial cases, R apid H ardening Portland Cement, Low Heat C ement, Sulphate resistant cem ent, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.
For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ran ging between 4.75 mm and 150 m m will be term ed as

Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS:3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

a) Accelerating admixture

b) Retarding admixture

c) Water reducing admixture

d) Air entraining admixture

e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval

of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the

edges o f the stock piles from getting in termixed. Stacks of fine and coarse aggregates shall be kept suf ficiently apart with proper arrangement of drainage. T he aggregates sha ll be stored in easily m easurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the E ngineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinf orcing ste el m ay be coated w ith ce ment w ash bef ore stacking to prevent sc ale and rust at no extra cost to the O wner. The stacks shall be e asily m easurable. S teel ne eded for immediate u se shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and m aintain quality control for different items of work and materials as m ay be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture: Type, quantity, physical, and ch emical properties that affects strength, workability, and durability of concrete.

For air entraining adm ixtures, dosage to be adjusted to maintain air cont ents wi thin desirable limits.

b) Aggregate: Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.

c) Water: Impurities tests.

d) Cement: Tests to satisfy relevant IS Specifications.

e) Formwork: Material, shapes, dim ensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

f) Reinforcement: Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of we lded splices.

Material tests or Certificates t o sati sfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.

h) Batching & Mixing: Types and capacity of plant, concrete mixers and tran sportation equipment.

i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.

j) Embedded and Anchorage Items: Material, shape, location, setting.

k) Placing: Preparation, rate of pouring, weather limitations, time in tervals be tween m ixing and placing and between two s uccessive lifts, covering ov er dry or wet surfaces, cleaning and p reparation of sur faces on which co ncrete is to be p laced, application o f mortar/slurry fo r pr oper bo nd, p revention of cold joint, types of chutes or conveyors.

l) Compaction: Number of vibrators, their prim e m over, frequency and am plitude of vibration, diam eter and weight of vibrato rs, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.

n) Concrete Finishes: Repairs of surf ace de fects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, recor ds of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requ irements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirem ents m entioned in this section of the specification do not

cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete sh all be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of ap proved m ake may be used with the Engineer's approv al in accordance with IS-456 to m odify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approv al. The adm ixture shall be used strictly in acc ordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grad es designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

a) Proportioning of ingred ients of con crete m ade with prelim inary tests by designing the concrete m ix. Such concrete shall be called "Design Mix Concrete".

b) Pro portioning of ingred ients of concrete m ade without prelim inary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design m ix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engin eer. In all cases the Propor tioning of ingredients and works control shall be in accordance with IS: 456 and shall be

adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.

e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at

site. Based on various tests resu lts and as per Engineer, the enviro nment condition shall be adopted for which minimum cement content shall be considered. No extra paym ent shall be made on account of any variation in environment condition.

a) Sufficient number of trial m ixes (to be decided by the Engineer) will be taken at the labo ratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

b) All tests will be done in presence of the Engineer wh o shall be the final authority to decide upon the adopt ion of any revised minimum cement content. The Con tractor will always be responsib le to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

c) The Engin eer will always have th e un questionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance o f deterioration of q uality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix C oncrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The va lues of w ater-cement rati os f or different gr ade and mix designs will have to b e established after conducting sufficiently large num ber of preliminary te sts in the la boratory to the sa tisfaction of the E ngineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests p roduce un satisfactory results. No twithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear al l the consequences in case of default rem ains unaltered.

In ca se of nominal m ix concre te, t he m aximum wa ter-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The a cceptance test criterion for nominal mix concrete sha ll be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of form work and around the reinforcement and embedments and to give the required surface finish shall depend◆on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of	Slump in mm with Standard Cone as	Use for which concrete is suitable

workability	per IS: 1199		
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, fo r any grad e of concrete, if the water has to be inc reased in special ca ses, c ement shall a lso be inc reased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of c oarse aggrega tes f or dif ferent loc ations shall be as follows unless otherwise directed by the Engineer

Very narrow space - 12 mm

Reinforced concrete
Except foundation - 20 mm

Ordinary Plain concrete and Reinforced
concrete foundations - 40 mm

Mass concrete - 80 mm

Lean concrete - 40 mm

Grading of coa rse aggregates f or a particular size shall conform to relevant I.S. Codes and shall also be such as to produ ce a dense concrete of the specified proportions, strength and consistency that will wo rk readily into position without segregation.

Coarse aggregate will norm ally be separated into the f ollowing sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 m m to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 m m to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in differe nt si ze frac tions is necessary so th at they may be remixed in the desired propor tion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The te mperature of f resh conc rete shall not exce ed 23 °C when plac ed. A suitable measuring device for m easuring the tem perature of concrete as approved by the Engineer shall be used. For m aintaining the lim iting temperature of the 23°C, crushed ice shall be used as m ixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the q uantity of cru shed ice to be m ixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator founda tions and top decks of all m achine foundations shall be cast in a continuous operation without any con struction joint.

3.10.00 Mixing of Concrete

Ingredients of the con crete mix shall be measured by weight. Concrete shall always be m ixed in m echanical mixer. W ater shall not norm ally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are alread y in the drum and mixed for at least one m inute. Mixing of each batch shall b e continued until there is a uniform distribution of the materials and the mass is uniform in colour and con sistency, but in no case shall mixing be done for less than 2 (two) m inutes and at least 40 (forty) revolutions after all the m aterials and water are in the drum. When absorbent Aggregates are used or when the mix is very d ry, the mixing tim e shall be extended as m ay be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10 % additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be ca rried out a s dire cted by the Engineer as per IS: 4634 o n all m ixers employed at site only those m ixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is perm itted by the Engineer, for unimportant out of the way locat ions i n sm all quantit ies, it shall be carried out on a water-tight platform and care shall be taken to ensure that m ixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved m eans and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be u sed. If, in-spite of all precautions, segregations does occur during transport, the concrete sha ll be properly re-m ixed bef ore placem ent. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If nece ssary, the container m ay have to be covered and insulated. Conveying equi pments for concrete shall b e well maintained and tho roughly cleaned be fore, com mencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specif ically covered, the relevant I.S . C ode wi ll be f ollowed f or the procedure of surfa ce prepara tion, placem ent, consolidation, curin g, finishes, repairs and maintenance of concrete. If , how ever, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as m ay be specified by the Engineer, will be

adopted. Concrete m ay have to be placed against the following types of surfaces:

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old constructi on joint has to b e r oughened by wire brushing, chipping , sand blasting or any other appr oved m eans for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placem ent of concrete is a llowed, w ill be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placem ent, before it has sufficiently set and hardened.

Formwork, reinf orcement, preparation of surf ace, em bedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete sha ll be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which m ay cause segregation. A ny drop over 1500 m m shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against m oist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleane d thoroughly and sm eared lightly with form oil or grease of approved quality just prior to placement.

A layer of m ortar of thickness 12 mm of the sam e or less w/c ratio and the same proportion as that of the concrete be ing placed or cement slurry will be spread thoro ughly on the rock Fou ndation or construction jo int just prior to placement of concrete.

After concrete has been placed, it sha ll be spread, if necessary & thoroughly compacted b y approved mechanical vibration to m aximum, sub sidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators m ust be operated by experienced workmen and the work carri ed out as per relevant IS Code of

Practice: In thin m embers w ith hea vy congestion of reinforcem ent or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doub tful, in addition to immersion vibrators the contractor may have to em ploy form vibrators conform ing to IS: 4656. For slabs an d other similar st ructures, th e contractor will additionally em ploy screed vibrator as per IS: 2506. Hand tam ping m ay be allowed in rare cases, subject to the approval of the Engineer. Care m ust be taken to ensure that the inserts, fixtures, reinforcem ent, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fr esh concrete is placed always against green Concrete, which is still plastic and workable. No concrete sh all be placed in open, during rains. During rainy season, no placem ent in the open is to be attem pted unless sufficient tarp aulins or other sim ilar protective arrangem ent for com pletely covering the still green concrete from rain is kept at the site of placement. If there has been any sig n of washing of cement and sand, th e en tire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard ag ainst rains before leaving the fresh concrete unattended. No accumulation of water shall be pe rmitted on or around freshly laid concrete.

Slabs, beams, and similar members shal l be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as sho wn on the drawing s or as dir ected by the En gineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be em bedded in concrete as sh own on the drawings or as directed by th e Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports g et disp laced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placem ents of concrete of different ages com ing in contact with each other, taking in consideration th e degree of m aturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop- board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators

can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the join t thoroughly and systematically vibrated.

b) In case concrete has hardened a bit m ore than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed co mpletely without disturbing the rest of the concrete in depth. A rich m ortar layer 12 *mm* in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be th oroughly and systematically vibrated p enetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and m ortar or slurry doe s not rai se inspite of ext ensive vibration, the j oint, will be l eft to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unform ed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate m ethods o f ha ndling, placing, and cons olidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, rem oved and replaced by sound concrete at the Contractor's cost. The Engineer m ay, at his sole discretion, allow to retain concrete with minor defects provided th e Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth shape.

c) Cleaning of reinf orcement & embedments. It m ay be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and com pacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing wit h a suitable mortar either cem ent or resin m odified mortars.

k) Polymer modified patching and adhesive repair& m ortar for beam s & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unform ed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the sur face of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden fl oat fairly sm ooth rem oving all laitance. No over trowelling, to obtain a very sm ooth surface, shall be done, as it will prevent adequate bond with the subsequen t fini sh. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be com pacted and struck of f at t he spec ified levels and slopes with a sc reed, prefera bly a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used w here there is likelihood of spillage of oil or water ca n be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bo nd can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved m eans from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth du ring and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, o r with water drainin g from such ground, during placing of concrete and for a period of at least th ree days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pum ping out or othe r adequate m eans of drainage to prevent floatation or flooding. Steps, as approved by the En gineer, shall be taken to protect im mature concrete from dam age by debris, excessive 'Loadings, vibration, abrasion, m ixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be a llowed if the Engineer is satisfied with the a dequacy of the arrangements made by the Con tractor. Quality of water for curing sh all be as per IS: 456.

If p ermitted by the Engineer, liqu id curing com pound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing co mpound shall be sprayed on newly laid concrete surf aces to f orm a thin film barrier against premature water loss without disturbances to nor mal setting action. The curing com pound shall be emulsified paraffin based and shall comply with A STM re quirements f or acceptance.

The curing compound shall be applied following the final finishing operation and im mediately af ter disappea rance of water f rom concrete surf ace. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no ex tra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision fo r curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the par t of the Co ntractor, he will inform the Contractor or his supervisor verbally or in writing to correct the def iciency in c uring. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such in struction, the Engineer will be at liberty either to em ploy sufficient means through any agency to make good the d eficiency and recover the cost thereof from the Contractor, o r deduct certain am ount from contractor's payment for the part where inadequate c uring w as noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round b ars, TMT b ars, Hot rolled deform ed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per dra wings and directions. In an ag gressive env ironment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The C ontractor shall prepare B ar B ending Schedules sho wing clearly the arrangements proposed by the Contractor to m atch available stock of reinforcing steel, progressively, starting wi thin one we ek of rec eipt of approval on corresponding design of RC C structure. As decided by the Engineer, som e or all the detailed draw ings and schedules will have to be submitted for a pproval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of h is oblig ations to m eet the o ther requirem ents of the contract. The contractor for record and distribution shall s ubmit si x prin ts of the fin al drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accord ance with the procedure specified in IS: 2502 or as appr oved by the Engineer. Bend s and shapes shall comply strictly with the dim ensions corresponding with the

final Bar Bending Sched ules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a m anner that wi ll injure t he m aterial. Rebending can be done on ly if approved by the Engineer. Rein forcing bars shall be b ent by machine or other a pproved means prod ucing a gradual and even m otion. All the ba rs shal l be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very e xceptional c ircumstances except for bars who se strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinf orcements shall be accurately f ixed and m aintained in position as shown on the d rawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are int ended to be in cont act and sha ll be se curely he ld. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such tha t the m ain bars do not sag perc eptibly betw een adjacent spacers. Before actua l placing, the Contractor shall study the drawings t horoughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearan ce from the Engineer.

3.16.05 Welding

Lapping shall nor mally do splicing o f reinforcement. For M.S. reinforcement bars, butt-welding m ay be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in acco rdance with relevant Indian Standards for we lding of m ild ste el bars used in reinforced concrete construction as per IS: 275 1 and I S: 456. For High yield strength deformed bars, lap welding may be done, if perm itted by the Engineer, und er certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417. Welding of High yield strength deformed bar shall not be allowed.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections

as directed by him shall be ca rried out. Lap s and anchor age lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps sha ll be staggere d as far as practicable and as dire cted by the Engineer. Arrangements for placi ng concrete shall be such th at reinforcement in position doe s not have to bear extra load an d get disturbed. The cover f or concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cove r and positioning reinfo rcement, they shall be made of mortar not leaner than 1 (one) part cem ent to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the c oncrete block s shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the C ontractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive tem perature control by precooling, post cooling or any other m ethod, if re quired, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall pre pare, bef ore commencement of actual w ork, designs and working drawings for form work and cen tring and get them approved by the Engineer. The form work shall conform to the sha pe, grade, lines, levels and dim ensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capab le of withstanding the working load and rem ain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or t ubular steel except when specifically

permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall

be scrupulously rem oved from the interi or of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brush es brooms etc. shall be used f or cleaning. The in side surface of the formwork sha ll be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that o il or other com pound does not co me in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to acc umulate at the bottom of the form work. The oiling of the formwork will be inspected just prio r to placem ent of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any prop s or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the colum n, one side shall be left op en and built up in se ctions, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of' Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreti ng shall start a s early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under consta nt vigilance agains t any interference. In case of delay beyond three days, a fr esh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as m entioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory com pletion of work without any ex tra cost. Before rem oving any formwork, the Contractor m ust no tify the E ngineer w ell in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved m anner, the date on which concrete is pla ced in each part of the work and the date on which the formwork is removed there fr om and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of dam age

through prem ature rem oval of form work or loading shall be rejected and entirely reconstructed by him without any extra cost to th e Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any oth er typ e of cement other than ord inary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be rev ised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The form work shall be so made as to produce a finished concrete, true to shape, lines, levels, plum b and dim ensions as shown on the drawings subject to the following tolerances unless otherwise specified in t his specification or drawings or directed by the Engineer:-

For - a) Sectional dimension - ± 5 mm
b) Plumb - 1 in 1000 of height
c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are sp ecified for local aberrations in .th e finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of form work, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engin eer, if no ticed in any lift of th e structure after stripping of forms, shall be corrected in the subsequent wo rk to bring ba ck the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork sh all not be used/re-used if de clared unf it or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class f ormwork shall be used unless otherwise specified.

a) **Ordinary:** These shall be used in places wh ere ordinary surfa ce finish is required and shall be com posed of steel and /or ap proved good quality partially seasoned timber.

b) **Plywood:** These shall be used in expo sed surfaces, w here specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use m ay on ly be perm itted af ter special i nspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

c) **Ornamental:** These shall be use d w here orna mental and curved surf ace are required and shall be made of selected best qua lity w ell seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the item s noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the sa tisfaction of the E ngineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary tem plates, jigs, fixtures, s upports etc. shall b e u sed as m ay be required or directed by the Engineer.

Items to be embedded

a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be lef t em bedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of other contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work.

g) Any misc. embedments and fixture as may be required.

Correct location and a lignment, as pe r drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in conc rete stru ctures shall be provided at specific plac es as per details indicat ed on the drawings. The m aterials and types of joints shal l be as specified he reinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leaka ge of liquids as m ay be specified on the drawings or as directed by the Engineer. All materials are to be procured from reli able m anufacturers a nd m ust have the approval of the Engineer. W here it is the r esponsibility o f the Contractor to supply the m aterial, the Engine er m ay dem and te st certificates for the materials and/or instruct the Contractor to ge t them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dim ension, and quality as pe r drawings and specifications. Prior approval of the method of form ing the joints shou ld be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It m ust be dur able and waterproof. It shall be compressible and possess a high degree of rebound. The dim ensions of the board should be equal to that of the joint being formed. It should, preferably be m anufactured in o ne piece, m atching the dimension of the joint and not prepared by c utting to size smaller pieces from larger boards at site. At th e exposed end, the join t shall be sealed with approved sealing co mpound to a depth of at least 25 m m after application of an approved prim er. The sealing compound and the prim er shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products

commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide

unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise a nd shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A m inimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints w ill b e allo wed only under unavoidable circumstances and with the specific approval of the Engineer. The m ethod of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to m atch the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The m inimum thickness of Rubber sea ling strips sh all be 3 mm and the minimum width 100 m m. The actual size and shape will be as shown in drawings or as directed by the Engi neer. The m aterial w ill be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from t he ac ids, a lkalis and chemicals norm ally en countered in service. The physical properties will be ge nerally as fo llows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity : 1.1 to 1.15

Shore Hardness : 65A to 75A

Tensile Strength : 25 - 30 N/Sq.mm

Maximum Safe Continuous Temperature : 75 °C

Ultimate Elongation : Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity : 1.3 to 1.35

Shore Hardness : 60A to SOA

Tensile Strength : 10 - 15 N/Sq.mm

Maximum Safe Continuous Temperature : 70 Deg.C

Ultimate Elongation : Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be

put below machine or other fou ndations as shown on the drawings. The rubber shall have a unit weigh t of 15 00 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In ge neral, the m ix shall be 1 (one) part cement and 1 (one) part sand and ju st enough water to m ake it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips m ay have to be used in the m ix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout sh all be pla ced under expert supervision, so th at there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. m ay have to be added with the grout in required pr oportions. Prem ixed non-shrink grout of approved m anufacture having proper strengt h shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast c oncrete will be sim ilar as f or the cast-in-place concrete described herein and as suppl emented in this se ction. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used a s a sof fit f ormer of the units, it shall be paved with concrete or masonry and pr ovided with a layer of plaster (1:2 proportion) with smooth neat cem ent finish or a layer of M. S. she eting. W here directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipm ent, curing tank, finished material storage space etc. shall be designed such that the units are not li fted from the mould befo re 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of tim ber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed b y the Engineer, shall be embedded in correct p osition of the un its to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast c oncrete units, w hen ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling, and plumbing shall be done as per instruction s of the Engineer. The Contractor shall render all help

with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and a lignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no ca se bef ore 14 (f ourteen) days. T he joint between precast roof planks shall be pointed with 1:2 cem ent: sand m ortar where c alled f or in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of conc rete str uctures shall be ensured internally by suitable design of th e concrete m ix, addition of suitable admixtures in the concre te or mortar at th e time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be m ade watertight by adop ting "structural waterproofing" as per specification. The design, m aterial, a nd workm anship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor be fore pr ocurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the jo ints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3. 23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing . In case of water bars being used at the construction joint, fixing of the sam e has to be done carefully, so that th e water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on th e joint surface of the previou s pour in case of joint on the wall an d in case of floor the same shall be applied on the form work against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of form work. The form work shall be removed within 24 hours after concreting. W ithin 2 hours of striking o f the formwork the retarder shall be washed off with strong water jet to m ake surface rough and clean. Then a rich cem ent m ortar using cement, sand and a ggregates (maximum size 8 m m) alon g with synthetic rubber em ulsion type water resistant bonding agent shall be ap plied for a depth of 50 m m just before

pouring the nex t stage of concreting. In case of walls, the above bonding agent will be m ixed with water, wh ich will be used for m aking the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solven t free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per m anufacturers specification. The contractor shall prov ide m anufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding l.5 m centre to ce ntre shall be pla ced in concrete along the construction jo int during casting. I njection of cem ent water together with a suita ble waterproof expanding grouting admixture of approve d quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection sh all be done under pressure of approxim ately 2 to 4 kg/sq.cm. The nozzles shall be se aled of f with suitable adm ixture after the injection is ov er. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing adm ixture for concrete a nd c ement mortar/plaster shall conform to IS: 2645. The adm ixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The adm ixture shall not affect the setting tim e by m ore than 5%. The maximum permissible dosag e of adm ixture will be 3% (th ree percent) by weight of cement, but a lower dosage w ill always be preferred. The product shall be stored in strong moisture pr oof pack ings. Ho wever, in case of important structures where M25 or higher grade concrete is specified, the use of m elamine based, high range water reducing concrete adm ixture shall be used to provide a waterpro of concrete, For achieving high strength concrete having cem ent content around 400 kg/cu.m . a melamine based super plasiticizer will be preferable.

a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The m ethod of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the m anufacturer's supervisor at no extra cost to supe rvise the w ork, if desired by the Engineer.

b) In P laster: T he c oncrete surf ace, to be plastered, sha ll be hacked to Engineer's satisfaction, cleaned th oroughly and kept wetted for 24 hou rs. The plaster shall be in cement sand mortar m ixed in proportion varying from 1:1 to 1:4 by volum e along with the appro ved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor sha ll have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surf ace shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

a) Nozzles spaced as required after the concre te is com pleted shall be drilled into surf aces to be rendered watertight. Non-sh rink cement grout with waterproofing com pound as per manufacturers specifica tions shall be injected under pressure to seal all voi ds. Special care shall be taken at joints b y providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1:4) plaster of 12 mm thic k eac h with waterproofing compound as per manufacturer's specification shall b e provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying th e waterproof course on the outside and inside of the walls and bases of structures.

The m aterials sh all conform to IS: 1322, and the workm anship to IS: 1609.

The bitum en felt should be h essian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well-known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, pr oviding, necessary co rner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickw ork on /against conc rete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory perform ances shall be gi ven by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in th e work within this guarantee period w ill be ca rried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitum en 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 25 0-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,

v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitum en (straight run grade) to IS: 73-1961 at 1. 0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/undergrou nd water, if shown o n drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the spec imens tested in a laboratory approved by the Engineer and submit to the Engineer the teat results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative sam ples w ill be taken f rom each consignm ent of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting tim e and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a partic ular c onsignment/batch will be used on the works unless satisfactor y 3 (three) days and 7 (seven) days test results for compressive strength are know n. Th e Engineer and Contractor will join tly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bea ring on the ac ceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the te sts on aggregate s as m ay be required by the Engineer in accordance with IS: 2386 P ARTS-I to VIII. The acceptance criteria of the samples tested shall be in ac cordance w ith the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be car ried ou t by the Contractor at r egular i ntervals and wh enever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinde r cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whe never directedby the Engineer, the C ontractor will check up the actual percentag es of ai r entrained and correspondi ng crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sam pling of concrete, m aking the test specim ens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Norm ally, onl y compression te sts shall be performed but under special circum stances the En gineer m ay require other tests to be perfo rmed in accordance with IS: 516. Sampling pro cedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of con crete from every m ixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specim ens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance w ith IS: 456. Concrete work fo und unsuitable for accep tance shall have to be dism antled and replacement is to be done as per specification by the Contractor at his own cost. In the course of d ismantling, if any damage is done to the em bedded items or adjacent structures, the sam e shall be made good, free of charge by

the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work im mediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 m ay be requ ired by the Engineer, when the strength of test sp ecimen results falls below the required strength.
If the member shows evident f ailure, the Contractor shall m ake the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dism antled and replaced by a new structure as per specification. The entire cost of dism antling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

a) The unit ra tes shall include the cost of labou r, m aterials, equip ment, handling, transporting, botching, m ixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. a t all eleva tions. This shall include the cost of curing by regular wetting or by using curing compound.

b) The unit rates shall in clude for all working conditi ons including at

locations under water, liquid, mud, in or under foul positions and extreme weather conditions.

c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.

d) The unit rates shall include all arrangement for maintaining stability of structure during execution.

e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.

f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be payable to the contractor as per BOQ item.

g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.

h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.

b) No deductions shall be made for the following:

i) Ends of dissimilar materials embedded in side for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;

ii) Opening upto 0.1 sq.m.

iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.

iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

c) The concrete works of differen t grades; belo w an d above ground floor finished level shall be m easured separately, unless otherwise specified in the sch edule o f items. Accordingly r ates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.

d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23^0C.

6.02.00 Reinforcement

6.02.01 Rates

a) The unit ra tes shall inc lude f or cover block, provi ding bind ing wire, welding, separator pieces between two or more layers of reinf orcement required for keeping the steel in position, etc. at all elevations.

b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bend ing, bin ding with annealed wire, welding, tack welding, placing the reinf orcement modification of already em bedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc.

c) However, lap w elding of reinforcement stee l i f perm itted shal l be paid under separate item as provided in the BOQ.

d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

e) Generally m embers are straight a nd hav e straight edges. Howev er, for bending, bin ding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

a) Bar or any oth er type of r einforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be m easured by weight in tonnes. The weight shall be arrived at by m ultiplying the act ual or theore tical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by th e sectiona l weights. Claims for payment for

this ite m shal l be subm itted w ith supporting docum ents giving the schedule of bars with sk etches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Con tractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule sh all be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

a) The unit rate s shall be inclusive of all staging, scaffolding, m aking the formwork watertight, etc. for all elevations and in all types of works.

b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.

c) The unit rates shall include the cost of la bour, materials etc. and the extra time, which shall be required for th e rem oval of shuttering/ su pport for satisfactory completion of work.

d) No extra payment shall be m ade on ac count of d ifficulty, wastage etc. for placement/removal of form work betwee n the network of clo sely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.

e) Payment f or curved shuttering shall be ma de for curved me mbers/wall whose centerline radius in plan is less than 6m.

f) If the contact surface area in pockets is less than or e qual to 0.1 sq.m . in each case, payment shall be done under item for providing form work in pockets.

6.03.02 Measurements

a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on ar ea basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.

b) Openings upto 0.1 sq.m or boxi ng left for inserts etc. for f acility of Contractor's work, shall be neglected as if nonexistent for the purp ose of formwork measurement of surface in which the openings occur.

For su spended floor, no deduction sha ll be m ade for flange area of secondary steel beams.

d) No m easurement shall be taken for the form work in pockets, opening s, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.

e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, m easurement shall be done under item for providing formwork in pockets.

e) Formwork, if required, f or joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

a) The unit rate for erection of em bedded steel parts, supplied by Engineer shall include transportation from Ow ner's store to the place of work, erection & installation including setting m aterial in concr ete, etc. complete.

b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, w elding, f abrication, erection, em bedding, and transportation to site. Unit rate shall also include the cost of the pipes.

c) Rate for expansion fasteners shall in clude cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

a) The measurement of th e embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.

c) For PVC pipes/conduits, m easurements shall be in quintals correct to second place of decimal for the net weight.

d) For mild steel pipes, measurement shall be in quintals, correct to second place of decim al, for the net weight of the steel p ipe supplied, fabricated, and installed.

e) The lugs shall be measured in Kg. correct to second place decim al for the net weight.

f) The expansion fasteners shall be measured in number according to tension capacity.

g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

a) Measurement shall be in cubic decimeters.

b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.

c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.

d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately.

Measurement of all work, except hi dden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of v oids, openings etc, shall be done on the same basis as that applied for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinf orcement in chi pping work for m aking of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

a) The unit rate shall include cost of preparation of casting yard, form work, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete un its with concrete, or cement mortar, curing, h andling, erection, groutin g, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-ca st concrete m embers shall be on the basis of volume of concrete in cubic m etres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with ce ment mortar shall not be measured separately The filling of concrete cem ent m ortar between the gaps of adja cent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to

the latest revisions and/o r replacements of the following or any other Indian Standard Specifications and Codes of Practice. In c ase any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as m ay be specified by the En gineer, shall be followed:-

IS: 73 - Indian Standard Specification for Paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 383 - Indian Standard Specification for Coarse and Fine Ag gregates from Natural Sources for Concrete

IS: 432 - Indian Stand ard Specific ation for Mild Steel and Medium Tensile Steel Bar s and Hard Dr awn Steel W ire for concrete Reinforcement

IS: 455 - Indian Standard Specification for Slag Cement

IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete

IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concr ete for Dam s and other Massive Structures

IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete

IS: 702 - Indian Standard specification for industrial bitumen.

IS: 1199 - Indian Standard Specification for Methods of Sam pling and Analysis of Concrete

IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement

IS: 1566 - Indian Standard Specification for har d drawn steel wire fab ric for concrete reinforcement.

IS: 1609 - Code of Practice for La ying Damp-proof Treatm ent using Bitumen Felts

IS: 1786 - Indian Standard Specification for High Strength Deform ed Steel Bars and Wires for Concrete Reinforcement.

IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.

IS: 2185 - Indian Standard Specification fo r Ho llow Cement Concrete Blocks

IS: 2210 - Indian Standard Specification forDesign of Reinforced Concrete shell Structures and Folded Plates

IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS: 2502 - Indian Standard Code of Practice for Bending and Fixingof Bars for Concrete Reinforcement

IS: 2505 - Indian Standard Specification for Concrete Vibrato rs, Immersion Type

IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables

IS: 2571 - Code of practice for laying in-situ cement concrete floors.

IS: 2645 - Integral cement water proofing compound

IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS: 2750 - Indian Standard Specification for steel scaffoldings.

IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete

IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.

IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

IS: 3414 - Code of practice for design and installa tion of joints in buildings.

IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete

IS: 3696 - Safety Code for Scaffolding and Ladders

IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete

IS: 4014 - Code of practice for steel tubular scaffolding.

IS: 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement

IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site

IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes

IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS: 4926 - Indian Standard Specification for Ready Mixed Concrete

IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS: 4991 - Indian Standard Specification for Blast Re sistant Design of structure for Explosion above ground

IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.

IS: 5256 - Code of practice for sealing joints in concrete lining on canals.

IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Com paction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcem ent in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.

IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.

IS: 5891 - Indian Standard Specification for Han d operated Concrete Mixers.

IS: 5892 - Indian Standard Specification for transit mixer and agitators.

IS: 6452 - Indian Standard Specification fo r High Alum ina Cem ent for Structural Use

IS: 6909 - Indian Standard Specification for Super sulphated Cement

IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.

IS: 6925 - Indian Standard Specification for Method of Test for Determination of W ater S oluble Chloride in Concrete Admixtures.

IS: 7242 - Indian Standard Specification for Concrete Spreaders.

IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.

IS: 7251 - Indian Standard Specification for Concrete Finishers.

IS: 7293 - Safety code for working with construction machinery.

IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.

IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.

IS: 7969 - Safety Code for Storage and Handling of Building Materials.

IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.

IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.

IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.

IS: 8989 - Safety Code for Erection of Concrete Framed Structures.

IS: 9012 - Recommended method for shortcreting.

IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.

IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.

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SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	6
5.00.00	RATES AND MEASUREMENTS	6

CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supp ly, fitting and fixing of tim ber frames to doors and windows with M S holdfasts, flush doo rs, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as sh own in drawings, includ ing a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Tim ber

Unless otherwise specified, all tim ber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be trea ted wi th approved woo d preservative befo re use, unless specified otherwis e. The rough tim ber shall be approved by the Engineer before incorp orating in the works and starting the c arpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically per mitted otherwise, the adhesive used in p lywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, fini sh and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certif icates shall be sub mitted for the approv al of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol form aldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Pa nel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood /commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows an d ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing o f specified thickness shall b e fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing tim ber and other work shall be close - fitting with proper wood joinery, accurately set to required line s or levels and rigidly secured in place. The surf ace of f rames etc., which will com e in c ontact with m asonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixin g external door and window frames. Special care shall be taken to m atch the grain of tim ber or ply wood, which will be subsequently polished. Screwing or n ailing will n ot be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to fram es and partitions shall generally be with 4 0 mm x 6 m m x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cem ent concrete. The gap between masonry and ex ternal door an d window frame shall be caul ked with polysulphide mastic. M.S. grills or guard ba rs shall be provided to windows where called for in the drawings.

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfa ces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When sh own on drawings or called for, decorative ply or lam inated plastic sheets shall be bon ded u nder p ressure to the surf ace to be finished. The adhesive used shall be of brand and bro ught to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shu tters shall be of proper size, shape, and design and free of warp. When fixed to fram es, these shall operate sm oothly without jamming and all latch ing or lockin g devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in a ll details. No unsightly nail marks et c. shall be perm itted. Plywoo d grains sh all be m atched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate sm oothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When plac ed on a level surf ace, ta bles tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered b y Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848	-	Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)
IS: 1003	-	Timber panelled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type).
IS: 2202	-	Wooden flush door shutters (solid core type).
IS: 4021	-	Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shal l inc lude of al l ac tivities m entioned in “Schedule of Item” for completion of the work. No sepa rate payment shall be m ade for fixing, caulking, application of prim er coat , polishing, providing of butt hinges,

holdfasts, sliding/tower bolts, do or st oppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

VOLUME: II B

SECTION – D

SUB-SECTION – D4

ROOF AND UNDERGROUND STRUCTURES WATER PROOFING, INSULATION AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C004

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA AND GUARANTEE	12
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ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix

by volume with 12 mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expended Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturer's supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

3) Hessian base self finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)

5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Hessian base self-finished felt, type 3, grade I.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)

3) Fiber base self-finished felt, type 2, grade 2.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

5) Fiber base self-finished felt, type 2, grade 2.

6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)

7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Fiber-base self-finished felt type 2, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)

5) Fibre base self-finished felt type 2, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

7) Fibre base self-finished felt type 2, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.

2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

3) Hessian base self-finished felt, type 3, grade 1.

4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)

5) Hessian base self-finished felt, type 3, grade 1.

6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

7) Hessian base self-finished felt, type 3, grade 1.

8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.

9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTMC836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70^0C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.

b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03 Waterproofing By Epoxy Resin Based Application

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at leas 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

a) 2 layers - for depths up to 5m below ground level

b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.

For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

i) Primer (For vertical faces only), as per I.S. 3384.

ii) Hot applied blown bitumen at the rate of 1.2 Kg/m2

iii) Hessian base, bitumen felt type 3 grades 2

iv) Hot applied blown bitumen @ 1.2 Kg/m2

v) Hessian base, bitumen felt type 3 grade 2

vi) Hot applied blown bitumen @ 1.2 Kg/m2

B) Extra Heavy treatment (Three layers of felt)

i) Primer (for vertical faces only) as per I.S. 3384

ii) Hot applied bitumen at the rate of 1.2 Kg/m2

iii) Hessian base bitumen felt type 3 grades 2

iv) Hot applied bitumen at the rate 1.2 Kg/m2

v) Hessian base bitumen felt type 3 grades 2

vi) Hot applied bitumen at the rate of 1.2 Kg/m2

vii) Hessian base bitumen felt type 3 grades 2

viii) Hot applied bitumen at the rate of 1.2 Kg/m2

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship as under:

For Bitumen Felt Treatment under clause no. 2.04.01: 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment.

For Elastomeric Membrane under clause no. 2.04.02: 10 (ten) years

In case guarantee is more stringent in owner specification, more stringent guarantee shall be applicable. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

a)	IS: 73	-	Paving Bitumen
b)	IS: 702	-	Industrial Bitumen
c)	IS: 1203	-	Methods of testing tar and bitumen
d)	IS: 1322	-	Bitumen felts for waterproofing and damp proofing.
e)	IS: 1346	-	Code of practice for waterproofing of roofs with bitumen felts.
f)	IS: 1609	-	Damp-proofing Treatment using Bitumen Felts – Code of Practice
g)	IS: 3067	-	Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
h)	IS: 3384	-	Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the "Schedule of Items".

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.
No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.

VOLUME: II B

SECTION - D

SUB-SECTION – D5

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

SPECIFICATION NO. PE-TS-999-600-C005

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	INFORMATION TO BE SUBMITTED	9
5.00.00	I.S. CODES	10
6.00.00	RATES AND MEASUREMENTS	10

ATTACHMENT

ANNEXURE – A	SCHEDULE OF FIXTURES	12

METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.

1.00.00 SCOPE

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The sco pe of workshall also include the assembly and er ection of all doors, window s, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION

2.01.00 Materials

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for fram es, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, win dows, partitions etc. shall be extruded section s confo rming to IS:7 33 or IS:1285 or as manufactured by Indian Alum inium Company Lim ited or ap proved equivalent. Alum inium door, windows and ventilator shall be fabr icated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall spe cifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequ ate st rength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fix tures shall be ab le to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless other wise stated. Each closer shall be guara nteed against manufacturing defect for one year and any defect found within this period shall be rectified or shal l be replaced free of char ge. Concealed door closers shall be either floor mounted or tran som m ounted, su itable for in stallation with m etal doors. It shall conform to the performance Requirem ents and endurance test stated in IS: 3564 - Appendix-A. The Co ntractor shall subm it samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor tow ards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.

2.02.00 Fabrication

2.02.01 Steel Doors, Windows, Ventilators, louvers etc.

a) Door Frames

Frames sha ll be f abricated from 16 gage(G) sheets. Th ey shall, be mortised, reinf orced, drilled, and ta pped for hinge lock and bolt strikes. Where necessary, fram es shall be reinforced for door closers. Welded construction with m itered Corners sh all be used. Rubber door silencers shall be furnished for the striking jam b. Loose "T" masonry anchors shall be provided. Frames shall finish fl ush with floor and adjustable floor anchors sha ll be installed. F rames sh all be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 m m th ick, com pletely flush design and shall comprise of the outer sheets o r 18 G steel s heets, rig idly con nected and reinforced inside with continu ous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. W here shown on d rawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardwares where necessary. A ny drilling a nd tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, visi on panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.

c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a f lush surf ace on the outside. The inside shall be stiffened with sem i tubular edge a nd cen tral stiffening rail, which shall convey the lock and other fixtur e. Th e fram es shall b e made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) “Double Plate Flush Door Shutters.”

d) Sliding Door

Sliding doo rs shall be either do uble plate or single plate Con struction made out of 18 gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of th e door in his shop and submit the manufacturer's catalogue of the slidi ng gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without bucklin g or jam ming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door th reshold shall be provided. Doors withou t threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The deta ils as ca lled f or in t he a bove c odes shall be applicable f or coupling m ullions, transoms, weathe r b ars, and pivot arrangem ents for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where com posite unit openin gs are required the ind ividual window units shall be joined together with requisite transom s and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specif ied. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02 Aluminium Door, Windows, and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sectio ns shall be approved by the Engineer befo re fabrication is taken up. Doo rs frames, mullions, transom etc. shall be anodized in a bath of su lphuric acid to provide a clear coating of minimum 15 micron thickness. Th e an odized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work sh all be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an uniform colour throughout the work. Work on the above, other than described, sh all be carefully fitted and assembled with neat joints w ith concealed fasteners. W herever possible, joints shall be made in concealed locations and on edge s of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 m m thick glazi ng. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00 Shop Coat or Paint

The shop Paint for steel doors, windows et c. shall be best lead or zinc chromate prim er paint f rom, approved manufacturer. A ll surf aces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1 ½ - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of alum inium fram e, whic h co me in contact with m asonry construction shall be (before shipment from workshop) protected with a heavy coat of alka li resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00 Handling & Storage of Fabricated Material

All m etal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated m aterials. Loading into wagon s and tru cks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy

himself that the items supplied are up to the sp ecified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortio n. Special care sh all be taken to prevent stain ing of aluminium products by rust, mortar etc.

2.05.00 Assembly & Erection at Site

In general, th e fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper “Lines and levels”, and in approved workm anlike m anner, to give tr ouble free and leak -proof installations. Installatio n shall be done according to instructions of the manufacturer, and/o r as appro ved by the Engin eer. If required by the Engineer, the installation shall hav e to be carried out under the supervision of the m anufacturer's staff. The C ontractor shall take all precaution against damage of the components during installa tion. Necessary holes, chases, etc. required for fixing shall be m ade by th e Contractor and m ade good again as per original, after installation, without any extra charge.

After installatio n of steel doors, windows, etc. all ab rasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the si te the cement in origina l seal ed containers of m anufacturer an d shall apply it as p er the instruction. For al l frames supplied by either the owner or the Contractor, m astic shall be supplie d by the Contractor and caulking done properly as per drawings, specificatio ns and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever requir ed, nylon cords of app roved quality shall be sup plied along with pivo ted sashes and shall be of adequate length to term inate one m etres from the floor. Loose ends of cords sh all end in m etal or plastic pull as approved by the Engineer.

2.06.0 Fire proof Door

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings w hether from internal f ire or f rom external fir e. The con struction details of door shall conform to the

requirements stipulated in IS:3 614(Part-1). Doors shall com ply with the testing requ irement m entioned in IS:3614 (Part-2) . The doors shall be approved by Tariff Adviso ry Committee and shall have m inimum 2 hrs. fire rating.

Metal covered (on both si des) Doo rs having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be p rovided with zinc silicate prim er (minimum DFT 75 micron) after blast cleaning the surf ace to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA

3.01.00 For fabricated Items

a) Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ±1.5 mm from the axis of the member.

c) Door and window shutters shall operate without jamming. The clearance at head and jam b for door shu tters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.

d) Door leaves shall be undercut where shown on drawings.

e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

f) All welds shall be dressed flush on exposed and contact surfaces.

g) Correctness of location and sm oothness of operations of all shop installed hardware and fixtures

h) Provision for hardware and fixtures to be installed at site.

i) Glazing beads shall be cut with mitered corners.

j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

k) Shop coats shall be properly applied.

l) Exposed alum inum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces sh all present a uniform and pleasing look.

3.02.00 For installed Items

a) Installations shall be at correct location, elevation and in general, on a true vertical plane.

b) Fixing details shall be strictly as shown on drawings.

c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.

d) All f rames on external walls shall be m astic caulked to pr event leakage through joint between frames and masonry.

e) All openable section shall operate smoothly without jamming.

f) Locks, fasteners etc. shall be engage positiv ely. Key shall, be non-interchangeable.

g) Cutting to concrete o r m asonry sh all be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

h) Aluminium doors, windows, etc. sh all be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

a) Names of manufacturers for Doors, windows etc.

b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall subm it det ailed f abrication draw ings to the Engin eer for approval. The fabrication shall be started only after approval of drawings.

b) He shall subm it a prog ramme of work to be done for the approval of the Engineer.

c) Before bulk supply, h e shall subm it for the approv al of the Engineer samples of all bought out items and sam ples of each type of fabricated items. The samples shall by retained by the Engineer for com parison of bulk supply and returned to the Contractor towards the end for fin al incorporation in the job.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733
Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285
Steel doors, windows, and ventilators	-	IS: 1038
Steel windows for industrial, building	-	IS: 1361
Aluminium doors windows, and ventilators	-	IS: 1948
Aluminium windows for industrial buildings	-	IS: 1949
Steel doorframes	-	IS: 4351
Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081
Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per "Schedule of Items".

Rates sha ll also include cost of surf ace preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall b emeasured in Sqm or Kg as per BOQ item. If measured in sqm, it shall be for net outer to outer (excluding fram e) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or alum inium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition fram es shall be in Kg. Panelling and glazing shall be paid separately if not covered in BOQ item description.

Measurement for fire pro of door shall be in SqM in net area outer to outer of the door.

ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

   i) 100 mm brass butt hinges with screws - 3 Nos.

   ii) 150 mm brass tower bolts with screws - 1 No.

   iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws - 1 No.

   iv) 30 mm brass ring pull handle with Plates and screws - 1 No.

   v) 150 mm brass coat hook with screws - 1 No.

   vi) Heavy duty, cylinder looks on ac tive leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

   i) Concealed hanging arrangement for door leaves.

   ii) Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.

   iii) Heavy duty, cylinder look on active leaf.

   iv) Pull handle of approved design on both leaves.

   v) Doors stops for both leaves.

   vi) Overhead door closure for both leaves.

ANNEXURE-A

C. STEEL DOORS AND WINDOWS

1. Doors

a) Double leaf doors

i) 100 mm butt hinges - 3 Nos. on each leaf.

ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom) On inside of inactive Leaf. 1. No. (Top only) On inside active leaf.

iii) 200 mm anodized aluminum pull handle - 1 No. of each leaf.

iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

i) 100 mm butt hinges - 3 Nos.

ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside face

iii) 200mm anodised aluminum Pull handle - 1 No.

iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, see "Door Schedule".

2. Windows, Ventilators, etc.

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 12" peg stays - 1 No. per leaf

ANNEXURE-A

iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Adjustable sliding fabrication assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.

ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.
(As per IS-1948 latest editions)

a) Side Hung Windows

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) 300 mm peg stays - 1 No per leaf

iii) 2 point handles - 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) A djustable sliding fabrication assembles - 2 Nos. per leaf

iii) 2 Point handles - 1 No. per leaf

c) Bottom Hung Ventilation & (Projecting In)

i) Hinges - As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.

ii) Concealed side arms for opening adjustment - 2 Nos. per leaf

iii) Spring Catch - 1 No. per leaf

VOLUME: II B

SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

SPECIFICATION NO. PE-TS-999-600-C006

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	4
4.00.00	I.S. CODES	4
5.00.00	RATES	5

GLASS AND GLAZING

1.00.00 SCOPE

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION

2.01.00 General

The Contractor shall supply and instal l all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, havi ng uniform refractive in dex and free from flaws, speck s, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

a) Glare reducing or beat absor bing glass shall be " Calorex" of Hindustan Pilkinton or appro ved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

b) Clear glass shall be fl at draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mmthick.

c) Wired glass shall be th ick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This m ay be of clear or coloured glass, as required.

d) Obscure glasses shall have a cast surface in one side.

e) Coloured and figured glass shall be as per approved sample.

f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It sh all be brought to site in the m anufacturer's original packing.

g) Neoprene g askets w ith snap-fit g lazing b eads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, m astic ce ment etc. as required shall be supplied by the Contractor.

All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of app roved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except fo r large panes were six or m ore clips sh all be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and sh all be bedded in putty and back puttied, except where m ouldings or gasket are specified, putty , m astic cement etc. shall be sm oothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00 ACCEPTANCE CRITERIA

a) All installation shall be f ree f rom cracked, broken, or dam aged glass. Edges of large panes of thicker gla ss and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.

b) Glazing shall be carefully done to avoid direct contact with metal frames.

c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00 I.S. CODES

Following are some of the important I.S.Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.

5.00.00 RATES

Rates of glass an d glazing if not in cluded in respective item s for supply and installation of window, ventilator, and partitions shall be paid separately as per BOQ item s provided. No separate payment shall be m ade for glazing clips, mastic cem ent, putty, sc rews; rails, etc. nor for drilling holes in fram es for inserting glazing clips.

VOLUME: II B

SECTION - D

SUB-SECTION – D7

ROLLING STEEL SHUTTERS AND GRILLS

SPECIFICATION NO. PE-TS-999-600-C007

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA & GUARANTEE	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	5

ROLLING STEEL SHUTTERS AND GRILLS

1.00.00 SCOPE

This Section covers the design and supply of m aterials, fabrication, delivery and erection of Rolling Shutters/Grills with m otor drive and/or m anual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION

2.01.00 Components

a) Slats for rolli ng shutters shal l be made fro m tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine ro lled at 75 mm rolling centers, interlocking with each other. The pr ofile wi ll be suc h as to pre vent excessive deflection under specified wind load.

b) Rolling grills shall be constructe d out of 6m m rods at 35 mm on centers running horizontally flexible connected with vertical lin ks spaced not more than 200 centers. Alternatively, rolling grills shall be m ade from perforated slats of approved design reinforced with 6mm dia rods.

c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.

d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. W hen shown on draw ings, a flexible weather strip shall be applied to make tight contact with the floor.

e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.

f) Shafts shall be of st eel pipe of sufficient size to carry the tensional load with a m aximum deflectio n of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

h) Locks shall be slide b olt and hasp, or cylinder lock op erable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be m ade as presc ribed by the Engineer.

i) Power unit sh all be suitable for 3 phase, 50 cycles, 400-volt A.C. power supply and be either floor or wall m ounted unit. The m otor sh all be of sufficient capacity, to move the shutter in either direction at a sp eed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reve rsing starter with built-in o verload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom ba r of m otor operated doors sh all be provided with a sensitive edge, electrical ly connected to stop the travel of the door on meeting an obstruction.

j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.

k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1 .3 m etres per second. In general, m anually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chai n and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. W here called f or, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc ch romate primer. Where specified, doors shall be g alvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door sh all be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer’s instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be

in strict accordance with the latest Indian Electricity Rules.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

3.01.00 Shop Inspection

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in “Schedule of Items”.

VOLUME: II B

SECTION - D

SUB-SECTION – D8

MISCELLANEOUS METAL

SPECIFICATION NO. PE-TS-999-600-C008

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	7
4.00.00	IS CODES	8
5.00.00	RATES AND MEASUREMENTS	8

MISCELLANEOUS METAL

1.00.00 SCOPE

This section covers supply, fabrication and erection of miscellaneous m etal items of light nature in gates, balcony and stair hand rails, structural work s, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above item s sh all be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S. & galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION

2.01.00 Fabrication/casting

2.01.01 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundary shop.

2.01.02 Shop Connections

a) All shop connections shall be riveted or welded except w hen noted otherwise on drawings.

b) Welding of steel shall be done in accordance with IS: 816.

c) Welding of alum inium shall be done accordance with IS: 2812, “Arc welding of Aluminium and Alloys.” Sp ecial care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leav ing the sh op, all m etal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given on e coat of approv ed metal protective paint, applied be brush t horoughly and evenly, well work ed into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel w ork shall be galvanised or pain ted with a co at of zi nc chromate prim er. Alum inium surf aces, which shall com e in contact with masonry, shall be given one coat of bituminous paint.

2.02.00 Erection

2.02.01 Bracing

The Contractor shall prov ide all nece ssary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure m ay be subjected, including erection of equipm ent and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the C ontractor shall plum up and level all members and shall securely bolt up to ta ke care of all dead load, wind load and erection stresses. Wherever erection equipm ent or other loads are carried by members during erection, proper pr ovision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be ream ed in the field, if required. All drilling or ream ing for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, weld ing sh all be don e in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of section s, flanges, webs of angles shall be done without the approval of th e Engineer. Where indicated on the drawings holes, cutting s, etc. shall be provided as required for installation, to the work by th e other Contractors. No additional holes or cuttings, than those sho wn on drawing s, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonabl e amount of reading an d cutting of excess stock from rivets m ay be perm itted. For this, light drifting m ay be allowed t o draw holes toget her. Twist dril ls shal l be use d to e nlarge as necessary to m ake connections, reaming that weakness the m embers or make it im possible to fill the holes properly or to adjust accurately af ter reaming shall not be allowed.

Any error in shop wo rk which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount or reaming and slight

chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be m ade good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and th e Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1½:3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of tw o type viz. light duty for carrying tensile load upto 0.5MT per fasteners and he avy duty for carryin g tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The C ontractor shal l subm it the Manufacture's literature sh owing the ave rage pull out and a verage shear va lue for anc hor of va rious sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The sa fe tensile load carrying capa city of the anchors shall b e arrived by providing the minimum factor of capacity of 2.5 for the cha racteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
b) Capacity of the anchor shall be established after consider ing the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
c) The selection for the particular type of bonding for the anchors sh all be made after considering the concrete grade, availab le em bedment depth, load to be transferred, space available for installing anchors.
d) The mechanical bonding anchor are torque controlled anchors m ade from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as

nut version are acce ptable. The bolt ve rsion anc hors c onsists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nu ts, th readed rod, w asher, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

e) Chemical bo nding anch or sh all consis t o f foil capsule and threaded rod. The f oil capsule shall c ontain the re sin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors o f size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall con form to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stu d shall have thread and the other end shall have cold formed conical head. All steel components of th e anchors shall be electro-galvanised to minimum 5 m icron thickness. The expans ion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING

2.03.01 Chain Link Fencing

The material requirement shall con form to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more then $\pm$ 0.05mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coa ting. T he l ine wire shall be 4.0mm dia. mild ste el. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 m m dia meter m ild steel. The tying wire f or sec uring the chain link fencing to the line wire shall be 1.6m m diameter mild steel. Hair pin chain staples for fastening down th e bottom of galvanised chain line fencing to the concrete si ll shall be 3.15mm wire. The en ds shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye

sufficiently threaded and f itted with a nut and washer. Two-way eye b olt strainer shall have suitable ring nuts f itted after the wires have bee n strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link f encing shall be stra ined between each pair of straining po sts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be th readed through appropriate adjacent row of m esh, care being taken that no m eshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The sec ond top line wire shall be strained in front of the fencing. The fe ncing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:
Continuous concrete sill 125m m wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25m m below the chain link fencing. Hair pin staples sh all be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02 Barbed Wire Fencing

The barbed wire shall be conform to IS :278 la test edit ion. The barded wire shall be galva nised and gal vanising shall conform to the req uirement lai d down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. W ire with excessive roughness blisters, salammoniac spots shall be re jected. The barbed w ire shall be made from two line w ire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and lo cated or locked as far as possible at right angle to each other. The barbs shall have a length of not less then 13mm and not more than 18mm. The distance between two barbs shall be 75$\pm$12mm.

Straining posts shall be provided at al l ends and corners of f ences or a t changes in direction or acu te variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link f abric in the direction of lin e of fence. Ther e shall be four evenly spaced row of line wire in al l. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tight ly by means of eyebo lts strainers or winders a t each straining points. Ea ch line wire shall be secured to e ach intermediate po st by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured

to the wire so that th ey could not be bunched to gether. Dr oppers for barbed wire shall be of mild steel of not less then 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastenin g the ba rbed wire to them . Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

a) All items shall be c orrect shape, si ze, weight etc. shown on drawings and schedule of items.

b) For installed items, the tolerances shall be as follows

i) Perm issible deviation from, straightness – 1 in 1000.

ii) Seats, stiffener connections etc. sh all be as per approved drawings and shall not interfere with architectural clearances.

c) All castings shall be free from blowholes, cracks, and other blemishes.

d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

IS:278 Sp ecification for Galvanised Steel Barbed wire for fencing.

IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.

IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.

IS:2721 Sp ecification for Galvanised Steel Chain Link fence fabric.

IS:2812 Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASURMENTS

5.01.0 Rates

Rates shall include supply, fabrication and installation for misc. metals works as required for com pletion of wor ks like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items.
Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements

Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other m isc. metals sh all be d one in MT unless otherwise specified in schedule of items.

VOLUME: II B

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	PAGE NO.
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4.00.00	I.S. CODES	10
5.00.00	RATES AND MEASUREMENTS	11

MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without

loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb m ore than 5 per cent of it s weight of water after 24 hours immersion. The type of ston e shall be as specified on drawings and/or instructed by the Engineer. Sam ples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) C ement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall subm it th e m anufacturer's ce rtificate for e ach consignment of cem ent procured to the Engineer. If a t any tim e, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cem ent shall be stored above th e ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engin eer sh all not be used by th e Contractor and shall b e rem oved from the site immediately.

d) C oarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editi ons, consisting of hard, strong and dur able pieces of cr ushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any oth er m aterial liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone con forming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired

by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concr ete or the specified proportions and strength and of consistenc e that will work readily in to po sition without

segregation.

Aggregates shall be stored o n brick soling or an equivalent platform so that they do not come in contact w ith dirt, clay, grass, or any other injurious substances at any stage.
Aggregate of different size sh all be k ept in separate s tacks. If so desired by the Engineer aggregate from di fferent sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not con tain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or othe r laminated m aterials in such f orms or qua ntities as to affect adversely the hardening, strength , durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Wa ter

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which m ay cause co rrosion, discoloration, efflorescence etc.

g) R einforcement

Reinforcement steel shall be c lean a nd free from loose m ill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall confor m to IS: 2062. Mild steel and m edium tensile steel bars and hard-dr awn steel wire for concrete reinf orcement shall conform to IS:432. Cold twisted stee l bar s shall co nform to IS: 1786. Hand drawn steel wire fab ric shall conform to IS: 1566. Hex agonal wire netting shall conform to IS: 3150 . All steel bar s including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement b ars shall be stored off the ground and under cover if so desired by the Engineer. If ne cessary, a coat of cem ent wa sh shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 m m thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cu t as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The ston es fo r soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to th e brick dim ensions and in perfect alignment. Bricks shall be firm ly placed by hammering with wooden mallets and sides and jo ints pack ed firm ly w ith earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built ag ainst structural m embers and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement m ortar shall be prepa red w ith materials specified in c lause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cem ent and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh m ortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to com plete bond or as clos ers. Bricks shall be laid with frog s upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in m ortar. Insi de faces shal l be buttered with mortar before the next b ricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to m inimum 10 m m depth using raki ng tool w hile the m ortar i s still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, wh ich is not covered by plaster, shall b e as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniform ity of brick course s. Masons m ust check workmanship frequently with plum b, spirit level, rule, and string. All br ickwork shall be cleaned at the end of days work. If face bricks are specif ied, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but m aintaining the bond fully. Where face brick s are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed c lean, and pointe d as specif ied. Where f ace bric ks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and f ully em bedded in mortar. W here M.S. bars a re used as reinforcement, the se shall be l apped wit h dowels if lef t in R .C. c olumns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of m ortar joints. Thickness of jo int shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept e xposed, shall be as shown on approved drawing. It shall be ex ecuted by specially skilled m ason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly a s the w ork proceeds in a manner called for in the drawings or instructions. A sam ple wall, 10 Sq.M. area shall be built and approved by th e Engineer and all works shall m atch with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is sp ecified the bond between them shall be ac hieved by bond stones o f dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 m m in thickness. Length an d sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be m ade as shown in drawi ngs. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc. , and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer . The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall

consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of d ry graded b rick aggreg ate, 40mm nom inal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or sligh tly overbumt an d den se brickbats. It sh all be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prep ared to the required slop e around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level fro m the excavated earth and ram med so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75m m thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slo pe of 1 in 50. Aggregates shall be ca refully laid and packed, bigger sized being placed at the bottom . T he brick a ggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron ra mmers. The f inished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specifie d strength in cem ent mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edg e in Diago nal/Herring Bone Bond or other paftem as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertic al joint s sha ll be f ully f illed from the top with mortar. The surface shall present a true plain surf ace with the required slope.

The pointing shall be done in cem ent m ortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and lev el with the edge s of the bricks so as give a sm ooth appearance. The edges shall be neatly trim med with a tr owel and a straight edge. The m ortar shall not spread over surface of the masonry.

Brick flooring & pointing sh all be k ept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Dam proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.

b) Preparing top sand sides of existing wall for joining old with new work.

c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.

b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.

c) Pipe and fixtures upto 300m m dia. and nothing extra shall be paid forthe mortar used for fixing.

d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc); up to 0.1 sqm in section;

e) Chases of section not exceeding 50 cm in girth;

f) Iron fixtures, such as wall ties and hold fasts for doors and windows;

g) Cement concrete blocks as fcr hold fasts and holding down bolts;

h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be m easured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protectio n shall be measured under respective item of works executed required for completion of the work as specified.

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SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	I.S. CODE	8
5.00.0	RATES AND MEASUREMENTS	9

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing item s for m asonry and concrete. This shall also include the wor k to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to m inimize damage by other trades. H e shall also undertake nor mal precaution to prevent dam age or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool m ade for the purpose while th e mortar is still green. Walls shall be rushed down with stiff wire brus h to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be rem oved from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cem ent concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly m oist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required lev el sh all be brou ght to the notice of the Engineer and his approval shall be take n regarding the m ethod and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.
For sand cement plaster, sand and cem ent in the specified proportion shall be mixed dry , on a watertight platform an d minimum water added to achieve

working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true pl astered surfa ce w ith the help of a wooden straight edge, the entire area shall be uniform ly treated with a paste of neat cem ent at th e rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This sha ll be done in the sa me w ay as specified in Clause 2.02.02 but using Coloured cem ent in place of ordinary cem ent. W hen coloured plastering is spec ified i n m ore tha n on e coat, the to pcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be m ixed with cem ent shall confor m to Appendix-A of IS: 2114 latest editions.

Samples of colouring m aterial shall be submitted to th e engineer for approval and m aterial pro cured, shal l conf orm in all re spects t o the approved samples, which shall rem ain w ith the Engineer. Al l coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisti ng of 1 part cem ent and 4 parts sand by volume shall be applied in th e usual m anner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20m m as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the m ortar with a wood float or the flat end of oil a trowel, in order to ensure satisfac tory bond between the dashing and the mortar.

e) R ough-cast Finish

A wet plastic m ix of 3 parts colour ed cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thro wn on to the wall by m eans of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, sha ll be scraped with a steel straight edge to rem ove the surface skin. Th e pattern shall be as approved by the

Engineer.

g) Textured Finish

Mortar consisting of 1 part cem ent and 3 parts san d by volume shall be applied in a m anner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by m eans of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The f irst coat or the scratch coat should be approxim ately 14m m and shall be continuously carried out without break to the full length of wa ll or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressu re, bro ught to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Be fore application of the second coat, the scratch coat shall be evenly dam ped. This c oat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of ev en coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a m inimum period of seven days, by an ap proved m ethod, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has har dened suffici ently and not susceptible to damage. Each individual coat of plaster shall be kept dam p continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose w hile the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to rem ove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on

the drawings. A ny surplus m ortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats et c. shall be as shown on dr awings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The m ortar for plastering shall consist of 1 part cem ent and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.0 1. Th e applicatio n, f inish e tc. shall be a s specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied o ver plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For pla stered surf aces, w here an even sm ooth surf ace is spec ified, lim e punning with 5 parts of shell lime properly slaked, strained and aged , mixed with 1 part clean, washed, sieved, fine sand by volum e shall be done. The thickness of lim e punning shall be not le ss than 2 m m and m ore than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punting shall b e applied by skilled wo rkman and given a smooth and ever finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, whe re specified shal l be f inished with P laster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall b e sm ooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sam ple of punning shall be done on roughly 10 Sq.M. areas an d approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be d one as shown on design drawings and

approved shop drawings. The stone sh all be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing ston e shall be not less than 25 m m unless otherwise specified on drawings.

The stone slabs shall be cut and f inished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall. not be less than 700 gm s per square m eter of surface) to prevent rust stains developing o n the finished su rface. There shall be at lea st 12 m m ga p between the ston e and m asonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, th e exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acc eptable to the Engineer.

Where pointing is specified on drawi ngs it shall be don e by m ortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to m asonry and c oncrete shall f ully comply with the Specifications, approved sam ples and in structions of the Enginee r wi th respec t to lines, levels, thickness, colour, text ure, pa ttern and any other spe cial crite ria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the f ollowing or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered b y Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and rem oving of scaffolding, surface preparation, curing a nd all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ce iling and walls shall be m easured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be m ade for openin g not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be m ade f or opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be m ade for reveals, jam s, soffits, sills etc.

In case o f opening exceeding 3.0 Sqm each, deduction shall be m ade for opening but jams, soffits, and reveals shall be measured and paid for.

VOLUME: II B

SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of woo d work, m asonry, c oncrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel item s, rain water down com er, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contract or shall obtain the approval of the Engineer in writing regarding the schedule of work to m inimize dam age; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed c ontainers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All m aterials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as f ar as possible and paint of one shade is obtained from the same manufacturing batch. Each and ever y supply of prim er, finish paint etc. shall be accom panied by manufacturer’s te st ce rtificate. A ll paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be com patible to the m aterial of the surf ace to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the lat est IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction o f the Engineer. In such cases, where sam ples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done fro m pure shell lim e or fat lim e, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per app roved sample shall be br ought to site in unslaked co ndition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it atta ins the con sistency of th in cream. 100 grams of gum to 6 l iters of w hite wash water and a little of indigo or synthetic ultramarine blue shall be a dded to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share confor m to IS: 427. The distem per shall be diluted with presc ribed thinne r in a m anner recommended by the manufacture. Only suf ficient quantity of distem per required for a day 's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil em ulsion type contai ning suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with a ccelerators, waterproofing age nts and fungicides. T he pa int shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolym er em ulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cem ent surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, sha ll be able to withstand wa shing with m ild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil w ith rut ile tita nium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowin g and d arkening with agin g. The paint shall conform to IS: 2932 and IS: 2933.

g) Al uminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for b rushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) Fren ch Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble in gredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on ba re wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage spa ce if allotted w ithin the building shal l be adequat ely protected from damage, disfigurement, & stains. Pain t shall be kept covered at all tim es and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before s tarting t he work the Cont ractor shall obtain the approv al of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitew ash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke an d anoth er from left to right before th e previous one dries up . Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Ow ner. No brush m arks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry f or at least tw o months. Ne w lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall sh all be tho roughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gm s. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall b e done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushi ng sh all not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil boun d washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, th e surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept m oist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be ap plied after providing one coat of ce ment prim er solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one m onth after plastering. A sample patch shall be pain ted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Subsequential coat shall not be applied till the previous coat is dry. Th e previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containe rs shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application o f a com bination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be a llowed to dry and be rubbed down lightly, wiped off and allo wed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atm osphere and draughts shall be avoided , and exposure to extreme heat or cold & dam pness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surfa ce with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any m istake in applicatio n, the va rnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dr y hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is app lied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted .The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish sha ll be appli ed with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly b ut uniformly applied over the entire area to give an even surf ace. A trace of linseed oil m ay be used on the pad f or c ase of application. The surf ace shall be allowed to dry bef ore further coats are applied in the sam e manner. To finish off, the pad shall be co vered with a fresh piece of clean fine cloth, slightly dam ped with m ethylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system sh all be used . Manufacturer' s recommendation shall be followed regarding the paint system , exposed to m oderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covere d so that no paint can fall on the m. W ork finished by othe r agencies sha ll be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to pro visions in gener al conditions th e Cont ractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Va riation from the drawings or specification or standard etc. shall not be acc epted. The C ontractor shall ascertain f rom the Engineer as to which parts will be inspected and passed from time to time. The Con tractor shall p rovide all necessar y arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary s caffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost f or scaffolding, approach, platform, lighting arrangem ent testing and inspection shall be b orne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall car ry out all sampling an d necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing p rocedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent acc epted Engine ering practice as pe r the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Ma terial/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the cont ract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the f ollowing or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered b y Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.

IS: 2338 (I & II)	Code of Practice for finishing of wood and wood based materials.
IS: 2339	Specification for Aluminium, Paints for general purposes in dual containers.
IS: 2395	Code of Practice for painti ng con crete, m asonry, and Plaster surface.
IS: 2932	Specification for enamel, exterior type-1.
IS: 5410	Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shal l be unit rates for com plete items described in the " Schedule of Items".

Rate shall include cleaning, preparation of surface, su pply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be m ade for openin g not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be m ade f or opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be m ade for reveals, jam s, soffits, sills etc.

In case o f opening exceeding 3.0 Sqm each, deduction shall be m ade for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surf aces shall be m easured f lat and m easured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D17, clause- 6.02.00.MODE OF MEASUREMENT) unless specified otherwise.

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SECTION - D

SUB-SECTION – D12

FLOOR FINISH AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C012

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Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

a) In Situ Finishes

i) Integral finish to concrete base

ii) Terrazzo finish

iii) Granolithic finishes

iv) Patent Stone

v) Metallic Hardener like “Ironte”/Hardonate Finish

vi) Mastic Asphalt finishes

vii) Chemical Resistant finish

b) Tiled Finishes

i) Terrazzo tile

ii) Chequered tile

iii) Glazed tile

iv) Tesserae (Mosaic etc.)

v) Chemical Resistant

vi) Rubber, Vinyl etc.

vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifical ly approved by th e Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant C odes w here available . In all ca ses these materials shall be of the be st quality available indigeno usly unless specified otherwise.

The m aterials f or finishing item s must be procured from well-reputed specialized m anufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the c onstruction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the m anufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and sim ilar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water an d hard brush and detergent if requ ired, unless o therwise directed by the m anufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.
The surface shall be bone dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surf ace of the concrete laid as per spec ification for 'C ement Concrete' has been fully compacted and levelled but the conc rete i s stil l `green' thick slurr y, m ade with neat cement shall be applied even ly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm com pact sm ooth surface without tro wel m ark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cu red for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the m arking shall b e of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid ov er an already laid and matured concrete base.

a) Thickness

Unless otherw ise specified the tot al thickness of the 'finish sha ll be minimum 40 mm for horizontal and 25 mm for vertical surf ace of which the topping shall be not less th an 10 mm. W hile the topping shall be of uniform thickness the un derbed may very in thickness to provide necessary slopes. The vertical surfac e shall project out 6 m m from the adjacent plaster or other finish. Necessary c utting into the surface receiving the finish shall be done to acc ate the specif ied thickness. All junctions of vertical with ho rizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a m ix of 1 parts cement, 1½ parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to

3 parts sand b y volum e. The sand shall be coar se. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. P roportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this m ixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 par t of this m ix 1 to 1½ parts of marble chip s by volume shall be added and tho roughly mixed dry again.

The pigm ent m ust be stab le and nonfad ing. It m ust be very finely ground. The m arble powder shall be from White marble and shall be finer than IS Seive No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to m ake it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall no t be more than 5 Sq.M. in area of which n o side shall be more than 2.5 M. long. Fo r exposed locations the m aximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has c ontracted to the full extent.

Dividing strips m ade o f alum inium or glass shall b e used for form ing the panels. The strips shall e xactly m atch the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and b rought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat “green” but f irm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled f or horizontal areas and thrown and pressed fo r vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.

d) Cur ing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surf ace or by covering w ith wet sack for f our days.

e) Grinding and Polish

When th e surface has sufficiently ha rdened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then th e surface shall be thoroughly washed and cleaned. A grout with already prepared m ixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be c leaned w ith water, the slurry applied again to fill up any pinholes that m ight have a ppeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get sm ooth surface without any pi nhole. A su itable machine shall do the grinding. W here grinding m achine can not be used hand grind ing m ay be allowed when the first rubb ing sh all be with carbor undum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no .: 120). The surface shall be cleaned with water, dried, and covered with soil free, clea n sawdust if dire cted by the Engineer. Th e final polis hing shall be postponed til l before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprin kled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall e ither be l aid m onolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall b e average 20 mm and m inimum 12 mm thick, unless specified otherwise.

b) Mix

The m ix shall consist of 1 part cement: 1 part coarse sand 2 par ts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 m m. Minimum quantity of water to get workability shall be added.

c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade . The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing

Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per

approved drawings or as instructed. The concentration and m ethod of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall hav e thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Ston e finish inclu ding the underbed shall be la id in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contrac tion of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping sh all be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surf ace is suf ficiently set, the finished floor shall be kept m oist for 7 days for curing. If desired the fi nish shall be polished as directed by the Engineer.

2.01.05 Metallic Hardener Like 'Ironite'/ `Hardonate' Finish

This will consist of a topping (incorporating ir on particles) to bond with concrete base while the latter is `green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening com pound shall be uniformly g raded iron particles fr ee from non-ferrous metal im purities, oi l, grease, sand soluble alkaline compounds or other injuriou s m aterials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the m anufacturer. How ever, in absence of any such direction 1 part metallic hardener shall be m ixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of sto ne chips by v olume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

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The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto re quired grade. The f orms, if any, shall remain sufficiently projecting to m ake the finish. The surface shall be roughened by wire brash as soon as possible.

The finish shall be laid while the concrete underbed is still very `green' within about 3 hours of lay ing of the latter. The finish shall be of uniform thickness and even dense surface without trowel m arks, pin holes etc. This topping layer shall be pressed firm ly a nd worked vigoursly and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.

a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen sh all be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 m m stone chips shall be used for finish upto 20 m m thick & 10 mm chips for thicker finish.

c) C omposition

Bitumen mastic shall conform IS: 1195 a nd shall be either brought to site in blocks weighing about 25 Kg or pr epared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, pref erably prehe ated f ed in succe ssive porti ons until the complete change is thoroug hly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot m astic shall be laid on dr y base surface cleaned thor oughly by wire brushing and sweeping. The mastic shall be leveled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if requir ed. No load shall be allowed ti ll the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07 Chemical Resistant in Situ Finish

Chemical re sistant in situ f inish shall be as epoxy resin with suitable filler material over a prim er. The m inimum thickness shall be 6 mm. About its performance th e Engin eer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or m asonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 m m for floors 30 mm for walls unless otherwise specified.

The skirting, dado and sim ilar verti cal surf aces sha ll project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surf ace rece iving the ti led finish, t o ac commodate the specified thickness shall be done.

b) Tiles: Terrazzo

The til es sha ll, unless specifically permitted in special cases be machine made under quality control in a sho p. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its bac k permanent and le gible tra demark of the manufacturer. All angles of the tiles sh all be right angles all arises sharp and true, colour an d texture of th e wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 m m. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).

The tile shall be cured at the shop for at last 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix : Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned

in advance and approval of the Engineer taken.

At the junction of ho rizontal surface with vertical surface the ti les on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be ke pt m oist and al lowed t o m ature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be sam e as Clau se 2.0 1.02(e). Grin ding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of m anufactured gray or coloured cem ent tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tile s shall conform to clause 2. 02.01 (b) except that these may have the topping in terr azzo or plain gray cement or colour pigm ent added to cement.

c) Under-bed
As per clause 2.02.01 (c).

d) Laying
As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 m m uniformly from the adjacent plaster or other wa ll finishes. The necessary cutting into the surface receiving the f inish, to accommodate the specif ied thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenwa re, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for len gth and breadth and ± 0.5 m m for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surf ace of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The c olour shall be unifo rm and fr actured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free f rom f laws like crac ks, cra ze, spe cks, c rawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix : Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

c) Laying

Same as clause 2.02.01 (d).

e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface sha ll be cleaned with soap or

suitable de tergent, w ashed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of m anufactured vitreous, glass, ceram ic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

b) Tesserae Finish

These shall usually b e 6 m m thick small piece of ceram ic vitreous china, tinted glass, or similar hard wearing, strong, and du rable m aterial in desired shapes and sizes and patterns.

The supply shall com e in the d esired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be expo sed. The gum us ed for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

c) Mix: Underbed
Same as clause 2.02.03 (c)

d) Laying

The specification for laying if given by the manufacturer of the item shall be follo wed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be m ade with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surf ace exam ined and cle aned, joints f lush pointed w ith white cement and cured for 7 days by keeping it wet.

2.02.05 Chemical Resistant Tiled Finish

This shal l include all veri ties of special t iles used for specif ic c hemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chem ical resistant tile s shall be of the best indigen ous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and a lkali). T he t iles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant t iles shall not absorb water more than 2% by weight. The tiles shall hav e at least co mpression streng th of 700 Kg/cm2. The surface shall be abrasion resistant and durable.

b) Laying

The m ortar used for setting or for unde rbed these tiles shall be d urable, strong and chemical resistant e poxy mortar. The gro ut, which sh all be to the full depth of tile, shall hav e equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06 Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive o n concrete or m asonry b ase. An und erbed m ay be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which af fect a ppearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalies, cleaning agents and usual floor polishes.

Each tile shall be m arked on the back legibly and indelibly with manufacturer’s trademark, the thickness, sizes, batch num ber, and date of

manufacturer.

Tiles shall be delivered securely pack ed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approv ed by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right t ype of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse s and m ixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this f inish shall be firm even tex tured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured f or at lea st 7 days by keeping it m oist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particle s shall be removed. Oil and grease if any shall be com pletely cleaned by use of detergent.

The adhesive shall be applied to f ully dry surf ace in desire d thic kness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the a pproved pattern and set w ith a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid form ation of air pockets under the tiles. The joints shall be very fine. Any adhe sive squeezed out th rough the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The su rface shall be c leaned with sof t soap, dried, and polished with an approved type of polish just before handing over.

2.02.07 Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone in cluding Kota stone

a) Thickness

The underbed shall be m inimum 12 m m and averag e 20 m m thick. The slabs will be 20 mm thick.

b) Ston e Slab

The stone slabs shall be made from se lected stock, which is hard, sound, homogeneous and d ense in textur e and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slab s shall come from specific regions and in specified quality with top surface f ine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed
Same as clause 2.02.01 (c).

d) Laying

The sides and top surface o f the slab s shall be m achine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden m allet to the proper level. Th e slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a li ttle. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the require d level. A ll surplus c ement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing an d finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02 .07 shall be foll owed except that the workm anship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Toleran ce may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the une venness shall be limited to ± 2 mm. The sides shall be chisel dres sed at least to ha lf slab dept h so that the maximum deviation from str aight line shall be within 25 m m. Beyo nd this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cem ent. If fine joints in the f looring are specified, the edges of slabs shall be cut in such a w ay that it shall f orm a inverted ‘Y’.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

a) Level, Slope, Plumb as the case may be

b) Pattern and Symmetry

c) Alignment of joints, dividing strip etc.

d) Colo ur, texture

e) S urface finish

f) Thickness of joints

g) Details at edges, junctions etc.

h) Perform ance

i) Precautions specified for durability

4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the f ollowing or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for lay ing and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of item s. Rates shall be applic able f or application on horizo ntal and vertical su rfaces at all e levations and f or all types of work including stairs tread and riser, layi ng in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The f inished surf ace shall be m easured in Sqm f or area unless otherwise specified. De duction shall not be made for opening or em bedded articles having area not exceeding 0.1 Sqm.

VOLUME: II B

SECTION - D

SUB-SECTION – D13

SHEET WORK IN ROOF AND SIDING

SPECIFICATION NO. PE-TS-999-600-C013

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	5
4.00.00	I.S. CODES	5
5.00.00	RATES AND MEASUREMENTS	6

SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All m aterials shall be store d by t he C ontractor in proper way to prevent all damage.

2.02.00 Workmanship

The work manship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer . Fixing of gu tters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J- bolts shall be 8 m m dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stiching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall b e minimum 150 m m for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 m m. Holes in C.G.I. sh eets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet fram ing by 8 mm dia. galvanised iron hook s or J-bolts a nd maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

2.02.03 Fibre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as specified. C olour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing de vice shall be sam e as used for general sheeting. W here used in lieu of glass, the fixin g shall be by means of timber or m etal glazing beads. In a ll cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.02.04 PERMANENT COLOUR COATED (SANDWICHED INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5m m m inimum thickness) shall b e used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be perm anently colour coated with Po lyfluro Vin yl Co ating (PVF $_2$) of Dry Film Thickness (DFT) 20 microns (m inimum) over prim er. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.

ii. Galvanised M.S. sheets of minimum 0. 6mm thickness shall be used as inner liner (internal face) of cladding system. T he exposed face shall be permanently colour coated with silicon m odified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suit able pre-coa ting of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm.

iii. The perm anent colour coated sheet sha ll m eet the general require ments of IS:14246 and shall conform to class 3 for the durability.

iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:2 77. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tappi ng / self dr illing type provided with suitable cap.

v. The insulation shall be of bonded mineral wool of m inimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool.

2.02.05 PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM

i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 m m m inimum thickness (o r High tensile steel sheet having

minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system . The outer side (exposed face) shall be permanently colour coated with PVF_2 paint of minimum DFT 20 microns over primer and the inner side (inte rnal f ace) sha ll be coated with sam e paint of minimum DFT 1 2 m icrons over prim er. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

ii . **FLASHING, CAPS, TRIM CLOSURES ETC.**

All flashings, trim closures caps etc. required for the m etal cladding system shall be m ade out of plain sheets having sam e m aterial and coating specification as m entioned above for the outer face of the sandwiched metal cladding.

3.00.00 ACCEPTANCE CRITERIA

The instal lations shall present a neat appe arance and shall be chec ked f or water tightness. The following shall be checked:

a) Side and end laps

b) Absence of cracks, holes or damages in sheet

c) Spacing of bolts

d) Provision of double washers (G.I. and asbestos or bituminous washers)

e) Proper installation of flashing.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the f ollowing or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered b y Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 3007	:	Code of practice for laying of asbestos cement sheets.
IS: 2527	:	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS: 1626	:	Specification for asbestos cement building pipes, gutters and fittings.
IS: 277	:	Specification for galvanized steel sheets (plain and corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in "Schedule of Items" and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps, flashings, sealing, fasteners etc. in sheeting works.

VOLUME: II B

SECTION - D

SUB-SECTION – D14

SUSPENDED CEILING

SPECIFICATION NO. PE-TS-999-600-C014

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	SAMPLES	5
4.00.00	SHOP DRAWINGS	5
5.00.00	ACCEPTANCE CRITERIA	6
6.00.00	RATES AND MEASUREMENTS	6

SUSPENDED CEILING

1.00.00 SCOPE

This section covers supply and installa tion of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipm ents. Th e wor k shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION

2.01.00 Suspension System

2.01.01 General

Suspension s ystem shall cons ist of th e grid supp orting the ceiling panels, intermediate runner supp orts for the grid if any and hangers, wall angles etc. required to suspend the grid or the runne rs from structural works, slabs and beams.

All m embers of the s uspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a def lection of 1/360th of thei r span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawi ngs shall be sec urely f ixed t o wal ls. All drilli ngs of structural concrete and installation of suitable anchoring device for installation including welding of the suspensio n system shall be included in the rate. All M.S. sections used for supports etc. shall b e given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be “Bead lock” as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as interm ediate members and steel channels, as end pieces w ill be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels,

unless o therwise shown on dr awings. A ngle cleats or other su itable fixing device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hanger s at m aximum 1.2 m etre centres. Extra ha ngers shall be provided at light fixtu res that are suppo rted from th e ceiling system . The spacing of main and cross runners shall b e as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels

2.02.01 Material

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for appro val before bulk supply. The ceiling panels may b e of following type:

a) Plaster of Paris board (decorative)

b) Expanded polystyrene insulation board with plastic fascia.

c) Fibre Insulation board.

d) Bonded wooden particle board (Plain and decorative)

e) Glass fibre reinforced polystyrene sheets.

f) Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ce iling panels shall be strictly as per m anufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. S pecial care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C " or approved equ al and the install ation shal l be stric tly as per manufacturer's instruction/ specification subject to approval of the Engineer.

Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium allo y panels stov e enamelled on both sides, fixed on roll-formed carriers m ade of enamelled 0.95 mm thick alum inium, 3 2 m m wide and 39 mm deep with prongs to hold panels in the module of 100m m, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with speci al he ight a djustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and m etal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length : each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be subm itted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all rela ted work and shall show the following information:

a) A reflected ceiling plan of areas indicated to re ceive the ceiling showing electrical and mechanical features.

b) Typical Intermediate framing for support where required.

c) Hanger fastening details.

d) Panels - unit support at ceiling penetrations.

e) Details of splicing method for main and cross runners.

f) A table indicating load bearing capacity of main and cross runner

g) A note stating that the suspension system member furnished will not deflect more than 1/360 of the span under the indicated loading.

5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the corre ct plane and present a pleasing and uniform a ppearance, f ree f rom, sags, w arps, disfigured, or dam aged board. Cutouts for ligh t fixtures, diffusers etc. shall be of exact d imensions and in exact locations.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

Rates shall be for the complete item called for in the "Schedule of Items". No extra payment will be m ade for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be m easured in Sqm correct to second place of decimal. However, no deductio n will be m ade for opening upto 0.25 Sqm. each in area.

VOLUME: II B

SECTION - D

SUB-SECTION – D15

WATER SUPPLY, DRAINAGE AND SANITATION

SPECIFICATION NO. PE-TS-999-600-C015

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	MATERIAL	3
3.00.00	INSTALLATION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	17
5.00.00	I.S. CODES	20
6.00.00	RATE AND MEASUREMENT	21

WATER SUPPLY, DRAINAGE AND SANITATION

1.00.00 SCOPE

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade confirming to IS: 1239 shall be used. The galvanising shall not be less than 400 gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation work s following type of pipe are coved in this Section:

a) Cast Iron pipe

b) Steel pipe (lined, coated with bi tuminous com position, out coated with cement concrete or mortar or galvanized)

c) Con crete pipe

d) Asbestos cement pipe

e) PVC pipe

f) Stoneware pipe

g) Vitrified pipe

h) Lead pipe (not to be used for portable water)

2.02.01 Fixtures

All material, fittings, fixtures, applian ces, ac cessories shall be of approved quality and shall be procured from reputed brands lik e Hindustan/Pasriware/ Cera or equivalent or as approved by Engineer. The bid der shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements sh all be m ade well in advance and should get in spected & approved im mediately by the Engineer. All f ixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chrom ium plating sh all be of grade-2 (10m icron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grad e SS-304 and from repu ted manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet

a) European type

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium

plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) **Squatting type**

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves

Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall m ounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be m ade o f chrom ium plated strong m embers. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll bolder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop c ocks, taps etc. shall confo rm to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for norm al working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved br and and m ake (Sy ntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION

3.01.00 General

Basic layouts m ay b e available in the drawings provided , the details might have to be su pplemented by th e Contra ctor and get the appro val of the Engineer before installation. Special attention shall be given to economise the layout. Sym metry of lay out is very important. Fittings m eant for operation

shall be located and oriented to allow easy reach and operation. Maintenance, repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines

3.02.01 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe work s shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipeshall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry orconcrete of the structure. The Contractor may co-ordinate with thebuilding Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly threaded/welded jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS

3.03.01 Pipes

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M. S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc.

Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type, or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shallbe provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fallof 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater downcomers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES

3.04.01 Gradients

If not specified the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120
300 mm nominal dia	:	1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the E ngineer, under no circu mstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and f or le vel. W here lengths of sewer or drain pipes are laid in trench, properly painted sig ht rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the po int where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood o f the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphi ll. Preferably the pipe shal l rest on solid and even foundation s for th e full length of the barrel. However, the pipe m anufacturer's instruction as approved by the En gineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. W here pipes are n ot bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. W here laid on rock or very hard ground which can not be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes sh all be as follows:

a) When cover is less than 2 metre below ground level and where p ipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

b) Where pipes are laid on soft soil w ith the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pi pe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 m m thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes m ay be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate su pports shall be as d ecided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring o f pipes where necessary sh all be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05 Entry into structures

For entry of the pipe lines in to any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checke d by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes are carrying of f the w aste f rom wa ter closets and waste water and overflow water from baths, wash basins , sinks to drain s shall be trapped immediately beneath such fixtures. Traps shall have m inimum water seal of 50 m m and sha ll be vent ilated whenever such ve ntilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer coverin g of the roof of the building or as shown on draw ings. All vertical ventilating, an ti-

syphonage and sim ilar pipe shall be c overed on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.

3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The m aximum di stance between m anholes shall be 30 meter unless specially perm itted otherw ise. Howev er, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise pr ovision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgem ent for any splashings in case of accidental flashing of the cham ber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand m ortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used f or the cutting so as to leave surface clean and square to the axis of the pipe.

3.04.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joint s alre ady made. If a ny joint is suspected to b e damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and m anholes shall be gas-tight when above grou nd and watertight when undergrou nd. Method of jointing shall be as per instru ctions of the pipe and fittings manufacturer and as approved by the Engin eer. However, in the absence of any instruction available fr om the m anufacturer the m ethods as detailed h ereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the sock et of the pipe by tightly caulking in sufficient

turns of tarred gasket or hem p yarn to have u nfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten le ad shall t hen be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in ca st iron pipes w ith special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be pro vided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. T he collar shall the n be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cem ent m ortar 1:2 (1 cem ent : 2 sand) wh ich sh all be rammed with caulking tool. After a day's work, any ex traneous m aterial shall be removed from the inside of the pipe and the newly m ade join t shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hem p yarn soaked in thi ck cem ent slurry sha ll f irst be placed round the sp igot of each pipe an d the spig ot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement : 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with dam p cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refracto ry clay m ixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and

shall be obtained from approved manufacturer.

Special care shall be taken in handli ng these pipes. The pipes shall not be jointed until the earth has been partly refilled over the portion of the pipe between the jo int holes. Befo re laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cem ent slurry (1 part of cem ent and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dip ped in neat cement paste or tar or bitumen, sha ll be inserted in the so cket of p ipe and driven hom e with caulking tools. The rope sh all fully encircle the spigot with a sl ight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall b e wrapped with two or three turns of tarred spun, as close to the end as possible, before insertin g into the socket. The joint shall then be completely f illed w ith c ement mortar (1:1), whi ch shal l have very li ttle water. A fillet shall be form ed r ound the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the m aximum length of the wiped so lder joints shall be 8 cm . and 9 cm. respectively. The solders shall gene rally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joint s sha ll be thermo welded or bolted as per m anufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthware trap connected to such a pan is to

be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron soc ket shall always be of a flexible nature. Such j oint shall be made with a mixture of bitumen and chopped asbestos fibre.

3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be su ch as to provide 200 m m clearance on either side of the pipe for facility of laying and jointing.

Excavated m aterial sh all be stacked su fficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the ex cavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface m aterial shall be set aside, turf being care fully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling sha ll be made to the sat isfaction of the Engineer. Sumps f or dewatering shall be located away from the pipe layout.

Where the excavatio n proceeds through roads necessary perm issions shall be secured by the Contractors from the appropriate authorities.

Special care sh all be taken not to da mage underground services, cables etc. These when exposed shall be kep t adequately supported till the trench is backfilled.

The backfilling shall b e d one only afte r the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall n ot be inconvenienced by heaping up unduly the backfilling m aterial to compensate future se ttlement. All future settlements shall be m ade goo d regularly to m inimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase sh all be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS

Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper s upports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank sh all be leakpro of and water tight.

The outlet pipe shall be 5 0 m m above the bottom of th e tank an d provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provi ded with al1 fittings for inle t, out let, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL

3.06.01 Septic tank

Septic tank shall consist of the tank it self with inlet a nd outl ets there f rom complete with all nece ssary earthw ork and backfilling. The d etails of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 10 0 m dia whose top shall he provide d with a suita ble mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 m eter when the septic tank is at least 15 m eter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be com plete. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cem ent mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open joined SW Pipe/dispersion trenches

Minimum dia of the SW pipes shall be 150 mm nominal. The trench for laying the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification as sociated directly with in stallation of water supply and sanitation system s shall com e unde r scop e of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section , sh all be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Autho rities and sh all abi de by al l the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Inspection Before installation

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective ite ms sha ll be clearly m arked as rejected and f orthwith removed from the site.

4.02.00 Testing of Water Supply pipe line

4.02.01 Testing of Mains After Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure sha ll be applied by m eans of a m anually operated test pum p, or in th e case of long mains or mains of a large diameter, by a po wer driven test pump, provided that the pum p is not left unattached. In either case due pre caution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pum p having been stop ped, the test pressure shall m aintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape av oiding all shock or water hammer. The service pipe shall then be inspected under working conditi ons of pressure and flow. W hen all draw-off taps a re closed, the se rvice pipes shall be absolute ly watertight. All piping, f ittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pip es, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The m ethod of actu al tests shall be decided by the Engineer. All test data shall be recorded and subm itted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground sh all be approved gastight by a sm oke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or sim ilar m aterial in the com bustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at le ast 1.5 m head of water at th e highest point of the section under tests. The tolerance figure of two litres per centimetre of diam eter per kilom etre m ay be allowed during a period of 10 (ten) minutes. The test shall b e carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system , with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end m ay be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required h ead is obtained and fix ed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

a) Absorption by pipes and joints

b) Sweating of pipes or joints

c) Leakage at joints or from defective pipes

d) Trapped air.

Allowance shall b e made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

i) By inserting at the high end of th e sewer or drain a sm ooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting th rough the joints, the ball with r oll down the invert of the pipe end emerge at the lower end; and

ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall b e filled up with water and allo wed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and lo ss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt.XVI)	:	Laying of water and sewer lines, including appurtenant items.
IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt.I & III)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 m m to 15 mm nominal diameter).
IS: 1536	:	Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
IS: 1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS: 1592	:	Asbestos cement pressure pipes,

IS: 1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types).
IS: 2065	:	Code of Practice for Water Supply in buildings.
IS: 2501	:	Copper tubes for general engineering purposes.
IS: 2556	:	Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement
IS: 2633	:	Method of testing, uniformity of coating on zinc coated articles.
IS: 3076	:	Low density polyethylene pipes for portable water supplies.
IS: 3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter).
IS: 3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter).
IS: 4827	:	Specification for electro plated coatings of nickel and chromium on copper and copper alloy.
IS: 4964	:	High-density polyethylene pipes for portable water supplies.
IS: 12701	:	Rotational moulded polyethylene water storage tanks

6.00.00 RATE AND MEASUREMENT

6.01.00 RATE

6.01.01 G.I. Pipes For Water Supply

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, cl amps, drain he ads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.

6.01.02 Rainwater Down-comers

Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also include cost of jointing and making good the opening in structure.

6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary a ppliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all com plete as per d escription of "Schedule of It ems". Ra te shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also incl ude cost of lead joints or othe r joint a s specif ied, cost f or painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusiv e of all excav ation, filling, repair, m aking good of opening in floor and walls, grating, pain ting etc. complete as described in "Schedule of Items".

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinf orcement steel etc. provided for com pletion of the structure as per drawing and specification s. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and in stallation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 MEASUREMENTS

6.02.01 Pipe for Water Supply and Drainage

For G.I.Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the m easurements shall be in ru nning m etres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works

All sanitary appliances & fixtures like sink, washbasin, W C, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in “Schedule of Items”.

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in re spective i tems of work l ike bri ck work, RCC, plastering etc. CI cover shall be measured in numbers as specified in “Schedule of Items”.

VOLUME: II B

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-999-600-C016

ROAD AND DRAINAGE

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.0	CODES AND STANDARDS	4
3.00.0	EXECUTION	7
4.00.00	TESTING AND ACCEPTANCE CRITERIA	36
5.00.00	MEASUREMENT	36

Standard Technical Specification
For Road and Drainage

1.00.00 Scope

The scope include all works required for the construction of ro ad including construction of embankment, sub-base cou rse, base cours e, tack co at, bituminous m acadam, wearin g course, liquid seal coat, shoulder and all incidental item s of work specif ied or not shown but reaso nably im plied or necessary for the completion of the work etc.

The scope also include all work s requi red for the construction of drainage including construction of r oad side drains, RCC culverts, pipe culverts, drainage pipes, m anholes and all othe r incidental item s necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided b y the contra ctor un less specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all re quired for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placem ent, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenev er required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under th is specification will be provided for by any ag ency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the wor k as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specif ication shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

a) Specification for road and bridge works of Min istry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers fo r expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm the refrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade	± 25 mm
Sub-base	± 20 mm
Base course	± 15 mm
Wearing course	± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the

positive tolerance on base course if the th ickness of the wearing cou rse is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surf ace regularity of the com pleted sub-base, base c ourse and wearing surfaces in the lo ngitudinal and transverse directions shall be within the tolerances indicated in Tab le - I. The longitudinal profile shall be checked with a 3m long straight edge at the m iddle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1 2		3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15 -		30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12 -		-	30	-	8
5.	Surface dressing◆◆(two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12 -		-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10 -		-	-	30	6
7.	Bitum inous macadam	10	-	-	-	20◆◆◆	6

8.	Semi-dense carpet	10	-	-	-	20◆◆◆	6
9.	Asphaltic Concrete	8	-	-	-	10◆◆◆	4

Notes:

1. ◆◆ For surface dressing in all other ca ses, the standards of surf ace evenness will be the sam e as those f or the surface rece iving the surface dressing.

2. ◆◆◆These are form achine laid su rfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be pe rmitted at the discretion of the Engineer. However this relaxation does no t apply to the values of maximum undu lation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of cont ract, the contractor shall prepare and submit to the Engi neer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dim ensions as per construction drawings and specification addin g his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval fro m the Engineer with m odifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix perm anent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer pr ior to the start of the wo rk will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

Before com mencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and rem oving roots upto a depth of 6 00mm below ground level or 300mm below f ormation le vel w hichever is deeper. After the rem oval of roots of

trees, the pot holes formed sh all be filled with good earth in 250m m layers (loose thick ness) and compacted unless otherwise d irected by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable m aterials an d rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful m aterials, saleable timbers, firewood etc shall b ethe property of the Owner and shall be stack ed prope rly at the w ork site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, m oorum, gravel or a m ixture of the above or any other material appr oved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harm ful sa lts and chemicals, organic materials, loose silts, fine sand s and expansive clays in order to provid e a stab le embankment. The filling and com paction operation should be such that the best a vailable m aterials are saved for the top po rtion and will result in an acceptable and uniform gradation of material and p rovide impermeability and st ability to the embankment when com pacted. The size of the coarse material in the m ixture of earth shall ordinarily not exceed 75m m. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisf ied that the same will not pr esent any difficulty as regard to the pla cement and com paction of the f ill m aterial are c oncerned. Ordinarily, only the m aterials satisfyi ng th e density requirements as given below in Table-II shall be employed for embankment construction.

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment b y filling shall co nform to the dimensions, slopes and other details shown in the a pproved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grub bing shall be stripped off to a m inimum depth of 150m m or m ore as directed by the Engineer in order to rem ove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats a re to be rem oved. In loc alities where most of the availab le em bankment fill m aterials are not conducive to plant grow th or when so directed by the Engineer, th e top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceed ing 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be com pacted by rolling with a m inimum six passes of 8-10 tonne roller and as d irected by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original g round does not already have a relative com paction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and f illed in layer s not exceeding 250m m in loose thickness and each layer sha ll be watered and com pacted to 100% maximum dry density of the fill material determined in a ccordance wi th IS:2720, Part-VII. However befo re re laying and compacting the loosened material, the surf ace below this level shall be suita bly compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be rem oved and replaced with approved materials suitably com pacted. Embankment work sh all not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exce eding 250m m in loose thickness. Successive layers of em bankment shall not be placed until the layer under construction has been thoroughly compacted to the requirem ents set down hereunder. Moisture content of the fill material shall be checked at the sou rce of supply and if found less than that specified for compaction, the same shall

be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials. Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically

free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approxim ately 50mm and the sod shall be fr ee from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil cover ing the grass ro ots dep ending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross se ction. S oil in the a rea shall be loosened, f reed from all stones larger than 50mm size, sticks, stumps an d any other undesirable foreign matters etc and brought to a r easonably granular texture to a depth n ot less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened an d wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and to p soiling (if required), fertilizer and ground limestone w hen specified shall be spr ead unif ormly. After spreading, the materials shall be inc orporated i n th e soil b y discing or other m eans. The prepared sod bed shall be m oistened if not alread y sufficiently m oist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close conta ct with each o ther and shall be ligh tly tamped with suitable wooden or metal tampers so as to elim inate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m , the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the long itudinal ax is of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods ha ve been la id in posi tion, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The C ontractor shall erect necessary wa rning signs and ba rriers, repair or replace the sods which are f ailing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in ac cordance w ith the requirem ents of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be m ade of selected earth or granular material as specif ied conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the lay ing of pavem ent courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trim med v ertical and the area enclosed between the shoulders shall be cleaned of all spille d materials before proceed ing with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be co nstructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder . Any spilled material drag ged o n to the pavement surface shall be im mediately rem oved without any damage to the

pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the req uired crossfall shall be m aintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall co nsist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The d epth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The w idth of the trench shall be m inimum and just suffici ent to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directedby the Engineer.

3.07.02 Materials

The materials to be use d for the work shall be natural sand, m oorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations th ereof dependin g upon the grading required. The m ixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
Grading	1	Grading 2	Grading 3
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base , the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitab ly ad justed by sp rinkling addition al water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water ha s been added, the material shall be processed by m echanical or other approved m eans if so directed by the Engineer until the layer is uniformly wet.

Im mediately thereafter, rolling shall be done with 8 to 10 tonne sm ooth wheeled rollers or with any other a pproved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions w here it shall progr ess from the low er to t he uppe r edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one thir d of the track made in the preceding pass. During rolling, the grade and camber shall be checke d a nd any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the dens ity achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on com pletion of com paction shall be well closed, free from m ovement under com paction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling an d bonded together with screenings , binding m aterial wherever necessary and water, laid on the prepared sub-g rade or sub-base as the ca se m ay be and finished in accordance with the spe cification and in conformity with the lines, grades a nd cross-sectio ns shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be eithe r crushed or broken stone . The ag gregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value ♦ or	IS : 2386 (Part IV)	50 percent maximum
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640♦♦	40 percent maximum
2.	Base	a) Loss Angeles Abrasion value♦ or	IS : 2386 (Part IV)	50 percent maximum
		Aggregate Impact Value	IS : 2386 (Part IV) or IS : 5640 ♦♦	40 percent maximum
		b) Flakiness Index ♦♦♦	IS : 2386 (Part I)	15 percent maximum

♦ Aggregates shall satisfy requirements of either of the two tests.

♦♦Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

♦♦♦The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river bore material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type- A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

Table - VII
Grading For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720,Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be

done from stockpiles along th e side of the roadway o r directly fro m the vehicles. In no case shall the a ggregate be dum ped in heaps directly on the surface prepared to rece ive the aggreg ates nor shall haulin g over perm itted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots rem edied by removing or adding aggregates as m ay be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spre ad shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers o f 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The w eight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated p ortions where the ro lling shall proceed from inner edge to the outer, rollin g shall begin from the edges gradually prog ressing towards the centre. F irst t he edge /edges shall be c ompacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller sha ll uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitu dinally with templates and any irregularities fou nd shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired ca mber and grade. In no c ase shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolle d, screenings to completely f ill the interstices shall be applied gradually over the surf ace. These shall not be damp or wet at the tim e of ap plication. Dry rolling shall be done while the screenings are being spread so that vibr ations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spre ading motion of hand shovels or by m echanical spreader or directly from truck s. Trucks operating for spreading the screen ings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous m aterial to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation ofBase

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any o ther extraneous m aterials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer a nd sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construc tion in a single cour se of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid im mediately after m ixing on a base prepared previously in acco rdance with the specification and in c onformity wi th the l ines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the

Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushe d stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, or ganic and other dele terious matter and adherent coats. The aggregates sha ll preferab ly be hydroph obic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII

Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value ◆	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value ◆	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

◆Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

Table-IX
Aggregates Grading For 75mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading For 50mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
Gr	ading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total m ix for aggregate Grading-A a nd B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportio ning of materials and producing a uniform mix. A variatio n in binder content

upto ± 0.3 percent by weight of total m ix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bitum inous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used f or preparing the mix. The temperature of binder at the tim e of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be th orough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the m ixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After m ixing, the mix shall be spread im mediately by m eans of a self propelled mechanical paver with suit able screeds capable of spre ading, tamping and finishing the m ix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the ava ilable plants cannot operate in the opinion of the Engineer may permit manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one lay er shall offset into the layer below by about 150mm. Howeve r, the joint in th e topm ost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of m ix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done im mediately after the paving operation. After this, the rolling sh all commence at the edges and progress towards the centre longitudina lly exc ept on superelevated portions where it shall progress from the lower to the upper edge par allel to the centre line of the pavement.

The initial o r breakdown rolling shall be done as soon as it is possible to roll the m ixture with out cracking the sur face and no m ix pick up on the roller wheels. The second or interm ediate rolling shall follow the break down rolling as early as possible and be done w hile the paving m ix is still at a temperature that wil l resul t in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When t he r oller ha s pa ssed o ver t he whole area on ce, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track m ade in the prece ding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case sh all fuel/lubricating oil be used for this purpose.

Rolling operation shall be com pleted in every respect bef ore the tem perature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid m aterial as it m ay lead to undue deformation. The edges along and transv erse of the bituminous macadam laid and com pacted earlier shall be cut to their full d epth so as to expose fresh surface which shall be pai nted with a thin surface coat of appropr iate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall co nsist of laying a nd compacting open graded carpet of specified thickness in a single course of suitable sm all siz ed a ggregates premixed with bitum inous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragm ents of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing ro ck, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegra ted m aterials, vegetable and any other deleterio us matter etc. They sh all preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set f orth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet		
i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m
Binder for premixing (quantities in terms of straight run bitumen)		
i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total 14.6	Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grad e and cross section in accordance with the draw ing, specification and a s directed by the Engineer. The surface shall be we ll c leaned by re moving caked ea rth and other foreign m atters with wire bru shes, sweeping with br ooms and finally dusting with sacks as necessary.

c) Tack Coat

A tac k coat complying w ith c lause 3.09.00 shall be applied over the base preparatory to laying of the carpet. Howe ver application of tack coat shall not be necessary when the laying of ca rpet fo llows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be h eated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The agg regates shall be dry and suitab ly heated to a te mperature as direc ted by the Engineer before these are placed in the m ixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spre ad on the road surf ace with rakes to the required thickness and cam ber or distributed evenly w ith the help of a drag spreader without any undue loss of tim e. The cam ber shall b e checked by means of camber boa rds and inequalities evened out. A s soon as suf ficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem ty pe or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except o n the superelevated portio ns where it shall progress from the lower to upper ed ge pa rallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. R olling sha ll then be continued until the entire surface has been rolled to com paction and al l the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wh eels shall be kept dam p to preven t the premix from adhering to the wheels and be ing picked up. In no case shall fuel/lubricating oil b e used for this purpose. Ro llers shall not stan d on newly laid material as it may lead to undue deformations.

The edges alo ng and transverse of the carpet laid and com pacted earlier shall be cut to their full depth so as to e xpose fresh surface which shall be painted

with a thin su rface coat of approved binder before the new m ix is placed against it.

f) Seal Coat

A sea l coat conf orming to clause 3. 12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A : Liquid seal coat com prising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B : Premixed se al coat com prising of a thin application of f ine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall con sist of angular fragments of clean, hard, tough and du rable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36m m sieve. The quantity used for spreading shall be 0.09 cu.m p er 10 sq.m area. The chippings shall sa tisfy the quality requi rements spelled out in Ta ble- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall cons ist of clean, hard, durable, uncoated dry particles and shal l be free from dust, soft or flaky material, organic m atter or oth er deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation ofBase

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before applic ation of seal coat, the surf ace shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suit able de sign to the temperature appropriate to the grade of bitumen approved by the Engineer an d sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive depo sits of binder caused by stopping or starting of the sprayer or throug h leakage or du e to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state sha ll be spre ad unif ormly on the surf ace preferably by m eans of a mechanical grit tier or othe rwise manually so as to cover the surface completely. If necessary the surf ace shall be broomed to e nsure uniform spread of chippings. Immediately after the application of the cover m aterial, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the cen tre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the precedi ng pass. W hile rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be h eated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregate s shall be dry and suitably heated to a temperature as directed by the Engine er before the same are placed in the mixer. Mixing of

binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Potholes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown

on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with sid e slopes as per the drawings a nd instructions of the Engineer after clearing the site etc. As described in th e "Specification for Earthwork in Excavation and Backfilling", backfill ing in layers with watering and compaction shall be d one after th e construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The spe cification f or Masonry and/or Pl ain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be m ade of R. C.C and shall be either class N P-2 or NP-3 as shown on the approved drawings . Pipe culverts shall be m ade of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with co llars as per manufacturer's specif ication. The tenderer shall specif ically m ention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cem ent as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of co ncrete pipes shall correspond to IS:783 and as per the specification given below.

a) The fo undation bed for pipe shall be excavated true to lines and grades shown on th e drawings and as directed by the Engineer. When trenching is involved, its width on either side of th e pipe shall not be less than 150mm and not m ore than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The side s of the tre nch shall be as nearly vertical as possible. Side sl ope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are com pleted, backfilling of the trenches shall be done as per "Specification for Earthwork in Exca vation and Backfilling" to the

satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be tak en down to at least 200 mm below the bottom of the pipe with prior permission of the En gineer and all rock/boulders in the a rea shall be rem oved and space filled w ith approved e arth f ree f rom stone or fragmented materials, sh aped to the requirements and thoro ughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separ ated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and f ittings shall be gradua lly lowered into the tre nch or placed on the supports by approved means taking due care to avoid any damage. Under no circu mstances the pipes shall be dropped in to the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding m ade up of fine granular m aterials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten per cent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the E ngineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls sh all be m ade with f irst class brickw ork in 1:4 cem ent mortar.

d) The pipe culverts sh all be made with proper care with respect to th e invert of the pipe, gradient if any etc as specified on the drawings and as in structed by the Engineer.

e) W here R .C.C pipes are enc ased in concrete at road crossings or at other places the pipes need be suitably supported avoiding rein forcements of concrete blo cks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single op eration or may be done upto som e height for pipes to be prop erly laid in p osition and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a m anhole or inspection cham ber. The distan ce between the m anhole or insp ection cham ber and gully cham ber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. Th e channel or drain at the bottom of chamber shall be plastered with 1:2 cem ent sa nd m ortar an d finished sm ooth to the grade. The channels and drains shall be shaped and laid to provide a sm ooth flow. Con nection to the existing pi pelines shall be through a m anhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing and Acceptance Criteria

All testing as m entioned in the specif ication and as m entioned in Clause No. 900 of the “Specification for Roads and Bridge Works, 1983” p ublished by IRC on behalf of Ministry of Shipping and Transport (Roads W ing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of m easurement shall be as per the latest version of IS:12 00, Part-17 and as directed by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	GENERAL	3
3.00.00	W ORKMANSHIP	19
4.00.00	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY	29
5.00.00	INFORMATION TO BE SUBMITTED	33
6.00.00	RATES AND MEASUREMENTS	34

SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification

and repairs of steelwork at site as may be required to complete the work s in accordance with the Contract.

2.02.00 Work by others

No work under th is specification will be provided for by any ag ency other than the contra ctor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless othe rwise specified in the contract, conform to th e requirem ents of the latest revision and/or replacements of the following or a ny other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS : 226 - Structural steel (Standard Quality)

IS : 800 - Code of Practice for general construction in steel.

IS : 806 - Code of practice fo r use of steel tubes in general building construction.

IS : 808 - Rolled steel beams, channels, and angle sections

IS : 813 - Scheme of symbols for welding

IS : 814 - Covered electrodes for metal arc welding of structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS : 817 - Code of practice for training and testing metal arc welders

IS : 818 - Code of practice for safety and health require ments in electric and gas welding and cutting operations

IS : 822 - Code of practice for inspection of welds

IS : 919 - Recommendations for limits and fits for Engineering
IS : 961 - Structural Steel (High Tensile)

IS : 1148 - Rivet bars for structural purposes

IS : 1149 - High tensile rivet bars for structural purposes

IS : 1161 - Steel Tubes for structural purposes

IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS : 1239 - Mild Steel Tubes

IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)

IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts andl locknuts (dia, range 6 to 39 mm)

IS : 1367 - Technical supply conditions for threaded fasteners

IS : 1442 - Covered electrodes for the m etal are welding of high tensile structural steel

IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS : 1730 - Dimensions for steel plate, sheet, and strip for structur al and general engineering purposes.

IS : 1731 - Dimensions for steel flats for structural and general engineering purposes

IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS : 1977 - Structural steel (ordinary quality) St-42-0

IS : 2062 - Steel for General Structural Purposes

IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS : 2595 - Code of Practice for Radiographic Testing

IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS : 3757 - High strength structural bolts

IS : 4759 - Specifications for Hot-Dip Zinc C oatings on S tructural S teel and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for subm erged arc welding o f structu ral steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of al l f abricated m aterials shall be in accordance w ith the provisions of the contract and/or as approved by the Engineer. Provision of al l relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required f or the wo rk w ill be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, la minations, fittings, rusts e tc. tha t m ay impair their strength, durability, and appearance. All materials sha ll be of te sted quali ty only unless otherwise perm itted by the Engineer and/o r Consultant. If desired by the Engineer, Test Certificates in respect of each consignm ent shall be s ubmitted in triplica te. W henever the materials are required to be used from unidentified stocks, if perm itted by the Engineer, a ran dom sample shall be te sted at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc w elding ele ctrodes shall be of appro ved reputed m anufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and con centric. With each container of electrodes, the manufacturer shal l furnish instructions giving recom mended voltage and amperage (Polarity in case of D.C. supply) for which the electro des are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural steel High Tensile

c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS : 1148 - Rivet Bars for structural purpose

b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS : 814 - Covered electrodes for metal arc welding of structural steel

b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS : 7280 - Bare wire electrodes for submerged arc welding of

structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS : 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this

contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, p olygonal, square, or rectangular in plan. Bottom hopper portion m ay h ave be c onical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 Fo r general requirements, fabrication and construction details IS: 9178 (Pt.l & 11) shall be followed as general guidanc e. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be m ade of m ild steel plates joined together wi th full strength butt weld and provided with stiffeners at regular interval. S tiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate ben ding machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (m anual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poki ng holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks m ay be requ ired to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in m arking schemes and fabrication carded out thereafter.

2.07.03 All such new erection m arks shall be considered under item of origin al fabrication work. As a result of add itional structures becoming necessary if the wo rk is delayed beyond the time schedule stipulated, the En gineer shall give suitable extension of tim e pr ovided he is satisfied ab out the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 20 62 shall be supplied , fabricated, transported, erected an d aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shal l be as deta iled in fabrication dr awings. The contractor shall subm it the grating design for different spans and load inten sities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be m ade up in pane l units designed to coincide with the span of the structura l steel f raming or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accura tely fabricated and f inished, free from wraps, twists, or any defects that would impair their strengt h, servic eability, and appearance.

2.08.05 Grating wo rk shal l include cu t o uts and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, m oment conne ctions, cap plates, and such other components of the steel str uctures en countered during the placem ent of the gratings. In all such cases, the trimming shall be done to follow the profile of the com ponents encountered . After tr imming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in grating s for pipes or ducts that are 150mm in size or diam eter or larger shall be provid ed with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grati ng units at all penetrations shall be m ade up in split section, acc urately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with al l necessary clips, bolts, nuts an d lock washers required for proper assem bly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and m anufacturer, as approved by Engineer. The unit rate quoted by him for this it em shall be inc lusive of transport of gratin gs to the project site , all ta xes, duti es etc. H e shal l also provide all f acilities and acc ess to the E ngineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dim ension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to f inishing all surfaces shall be cleaned, f ree f rom rust, m ill scale, grease, oil, or any other foreign m atter by blast cleaning. BS: 42 32 shall be followed for blast cleaning.

2.08.15 Primer can be applied by sp ray guns or by brushes, however the fin ish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop wor k is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc c oating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized su rface shall co nsist of a continuous and uniform ly thick coating of zinc, firm ly adhering to the su rface of ste el. The finished surface shall be cleaned and smooth and shall be fr ee fr om defe cts like discoloured patches, bare spots, un evenness of co ating, spelter th at is loosely attac hed to the steel, blistered surface, flaking or peeling off etc. The presence of any of

these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall b e no flak ing or loosening when struck squarely with a c hisel faced hammer. The galvanized steel member shall withstand m inimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be rem oved by 'bum ping'. The pr ocesses known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain m embers indicating presence of im purities in the galvanizing bath in quanti ties larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable torejection.

2.09.08 All structural steel shall be tre ated with so dium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricat ed & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of g rade SS 415M as m anufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	%	Remarks
Carbon	10.03%	Max.
Silicon	1.60%	M ax.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulpher	0.03%	Max.
Chromium	10.80% to 12.50%	

Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	Value	Remarks
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted pra ctice and in a ccordance with relevant I.S. and internation al specification as we ll as stipulations c ontained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication dr awing shall g ive th e cutting plan for each hopper plate. Such, cutting plan shall be b ased on the size of the S tainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fash ion to reduce the end wastage. Similarly the hopper plate element having different ra dii shall be placed one in side the other, to optimize the stainless steel plate use. Such optimization may also required adjustm ent in the size of the each elem ent of hoppe r pla te and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrica tion, weight of cut and scrap pieces generated. Contractor shall return to the O wner's store al l unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel piece s to the Ow ner's store will call f or the penal rec overy at three (03) tim es the maximum

procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cu tting of the stainless steel without approved cutting plan then all the wastage (i.e. the dif ference between the weight of stainle ss steel plate cuts and the actual finished weight considered for the measurement f or pa yment) sha ll be subj ected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight an d uniform through out. Cu tting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edg es shall be ground sm ooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the c overed compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di -oxide mixture shall be avoided. 308L and 315L electrodes/fillers sh all be used for the weldi ng of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the En gineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall b e subjected to cold fo rming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type o f electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure w ork shall depend upon correct dimensions and alignm ent, absence of di stortion in th e structure, satisfactory results from the inspection and testing of the welded structure joints and the

test specim ens, general workmanship being good m eeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with m irror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad su rfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the p ad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of f riction. T hese b earings shall be designed as per the performance requirements. The beari ng shall be of repu ted m ake and manufacturer as approved by Engineer, fo r required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficien t of friction between th em sh all be less than 0.06 at 55 kg/cm². In order to pr event cold flow in the PT FE surf ace it sha ll be rigidly bonded by a special high tem perature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall cons ist of m ultiple layers of ligh tweight fabric impregnated with a high quality elastomer com pound vu lcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (com pressive) load not less than 500 kg/cm² and sh ear loads upto 40 kg/cm².

c) Installation

The seating area f or PTFE bearing shall be prepared ac curately level and furnished with a thin l ayer of e poxy resin m ortar. The bearing will be placed on this layer while it is still workable and the bearing i s levelled. The bearing should not be displaced as the beam is lowered into position. When th e mortar and adhesive are fu lly set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient th ickness of epoxy resin m ortar so that wh en the beam is lowered on to th e tem porary supports it comes into full contact

with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof sha ll be realised from the Contractor. The Contractor shall m aintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other m aterials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If requ ired by the Engin eer, the m aterials m ay have to be sto red under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrode s f or electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinct ly m arked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gu nny bags o r compartments according to diam eter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control pro cedures for different item s of work and m aterials to the e xtent he deem s ne cessary to ensure that all w ork i s performed in accordance w ith this specif ication. In addition to the Contractor's quality control p rocedures, materials and workmanship at all tim es shall be subj ected to inspec tion by the E ngineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at th e Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to prov ide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this S pecification m ay be rejected at any time during the p rogress of the work.

The quality con trol procedure shall c over but not b e limited to the following items of work

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer’s certificate, physic al i nspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniform ity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dim ensions, forms, weights and tole rances of all rolled shape s rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, w herever applicable, conform to the requirem ents of the latest relevant Indian S tandards, w herever they exist, or, in the abse nce of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The cont ractor shall w ithin thirty (30) da ys after the award of the Contract submit to the Engineer the Schedule of Fa brication and erection of structu ral Steelworks, for approval. Within one week after receipt of approval on design of any steel structur e (part or full) ba sed on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection sche dule. The above-m entioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirem ents as well as sp ecifications. The approval of drawing however shall not relieve the c ontractor of his sole responsibility in carrying out the wo rk cor rectly and fu lfilling the com plete requirem ents of contract documents.

The fabrication drawings shall include but not limited to the following:

a) Assembly drawings gi ving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed dr awings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the nec essary inform ation for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various com ponents of the steelwork,

including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary inform ation adequately. Notes on the fabrication drawings sha ll indica te those joint s or groups of joints in which it is particularly i mportant that the welding sequence and tec hnique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding sym bols used shall be in acco rdance with the require ments of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. W eld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be re sponsible for and shall ca rry out at his cost any alterations of the work due to any disc repancies, errors or om issions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All wo rkmanship shall be equal to the best practice in m odern structur al shops, and shall conform to the provisi ons of the Indian Standard IS: 800 - Code of Practice for general constructi on in steel and o ther relev ant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled m aterials bef ore bei ng l aid off or worked, m ust be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Stan dard Specification on IS : 1552 - Specificatio n for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by m echanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as m easured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawi ng shall affect cutting. Use of a m echanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel m ay also be permitted provided special care is take n to leave sufficient metal to be rem oved by machining, so that all metal that has been hardened by flam e is rem oved. Gas cutting without a m echanically controlled torch m ay be permitted if special care is taken an d done under expert hand, subject to the approval of the Engineer.

To de termine the effective size of m embers cut by gas, 3 m m shall be deducted f rom each c ut edge. G as c ut e dges, which will be subjected to substantial stress or w hich are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more th an 4 mm deep w ill be perm itted. G ouges greater than 4 mm that remain from cutting shall be removed by grinding. A ll re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut w ith a m echanically c ontrolled torch sh all not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surf ace. Surface cut with hand-flam e shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to stee l shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater cle arance is necessary, su itably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through m ore than one th ickness of m aterial f or m embers, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assem bly, if the thic kness of t he m aterial is not gre ater than the nominal diameter of rivet or bolt plus 3 m m subject to a m aximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for ri vets or black bolts shall be not m ore than 1.5 m m or 2.0 m m (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 m m) larger in diam eter than the nom inal diameter of the rivet or black bolt passing through them.

Holes for turned and f itted bolts sha ll be drilled to a diam eter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by

tacking welds or clam ps and the holes drilled throug h all the thicknesses in one operation and subsequently reamed to size. Holes not drilled throug h all thickness in o ne operation shall be dril led to a smaller size and re amed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unm atching holes sh all not generally be permitted. In case drifting is permitted to a slig ht extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to adm it the rive ts or bolts sh all be reamed. Poor matching of holes shall be cause for rejection .The com ponent parts shall be so assem bled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall or dinarily be hot driven, in which case their f inished heads shall be approxim ately h emispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125 °C they shall not be drive n after their temperature has fallen below 540°C.

Rivets shall be driv en by power riveters, of either com pression or manually operated type, em ploying pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unl ess in exc eptional cases specif ically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surf ace. In case of countersunk rivets, the countersinking shall be f ully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members sh all have all parts firmly drawn an d held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspec t all single riv eted connections. Special care shall also be taken in heating and driving long rivets . The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the E ngineer. No extra paym ent will be m ade to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If th e ratio is belo w 75%, all the rivets in the particular section or gro up sh all be cut, rem oved and r eplaced an d tested again at the

Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be perm itted onl y in case of field connections if called f or on the Drawings and is subjected to the lim itation of pa rticular connections as may be specified. In special cases, h owever, shop b olt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or oth erwise suitably shape d, w here nece ssary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project trough the nut at least one thread. In all cases th e bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be prov ided for each bolt for connections subjected to vibr ating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in ac cordance with relevant Indian Standards and as supplemented in the Specification. W elding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be w elded shall be f ree from loose scale , slag, rust, grease, pa int, and any other foreign m aterial except that m ill scale, whic h withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by m ore than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the am ount of the separation. Th e fit of joints at contact surf aces, which are not completely sealed by, welds, shall be close en ough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 m m shall be corrected and in m aking the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up m embers, the procedure and sequence o f welding shall be suc h as wi ll a void needl ess distortion and m inimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In th e fabrication of cover-plated beams and built-up members, all shop splices in each com ponent part shall be made before such com ponent part is welded to oth er parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing m aterial not m ore than 8 m thick with root opening not less than one-half the thickne ss of the thinner part joined, shal l have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the sa me material, as the base m etal shall have the weld metal thoroughly fused with the b acking material. Backing strips need not be rem oved. If required, they may be rem oved by gouging or gas cutting after welding is com pleted, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be term inated at the ends of a joint in a m anner that will ensure their soundness. W here p ossible, th is should be done by use of extension bars or run-off pl ates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, autom atic submerged arc process shall be preferred. The t echnique of welding em ployed, the appearance and quality of welds made, and the m ethods of correc ting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall no rmally be done on parent material at a temperature below (-) 5 °C. However, if welding is to undert aken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When

the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0 °C, the surface around the joint to a distance of 100 m m or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is m ore than 40 m m thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regard ing preheating of the parent m aterial shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where requi red, interm ediate layers of m ultiple-layer welds may be pe ened with light blows from a power hammer, using a round-nose tool, peening shall be don e after the weld has cooled to a t emperature wa rm to th e ha nd. Care shall be exercised to prevent sc aling or flaking of weld and base m etal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator m ay produce satisfactory welds. The welding m achine shall be of a type and capacity as recom mended by the m anufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the end s of shaf ts together with the a ttached gussets, angles, ch annels etc; afte r welding/rivetin g togeth er, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecti ng angles of channe ls are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and ca ps f abricated out of ste el slabs, e xcept when c ut m aterial with true surface, shall be accurately machined over the be aring surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes sha ll be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in con crete, in wh ich case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be m ade fo r all necess ary steel bearing p lates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size a nd spacing of beari ng bars and cross bar s shall be as approved in detailed drawings. Alternatively diam ond p attern grating if approved may be used.

The grating shall be m ade in pan el uni ts designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free fro m warps, twists, o r any other defects. Grating work shall include cutouts and clearance op enings for all columns, pipes, ducts, condui ts etc. The gratings sh all be n otched, trimmed, and neatly finish ed around com ponents of the steel structures encou ntered. Binding strip shall be provided on the grat ing to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 m m thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thick ness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cu t edges properly g round. Sti ffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherw ise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carry ing brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork sh all be temporarily shop-erected complete or as dir ected by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a s ufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchangeability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all othe r steelwork shall be given one coat of shop pa int, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordanc e with the f ollowing pa ragraph, by brush, spray, roller coating, flow-coating or dipping as m ay be approved by the Engineer.

After inspection and appr oval and before leav ing the shop, all steelwork specified to be painted sha ll be clean ed by hand-wire brushin g or by other methods of loose m ill scale, loose rust , weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop pain t shall, after fabrication , be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessi ble af ter asse mbly, shall re ceive two coats of shop paint, Positively of differe nt colours to prove application of two coats before assem bly. This does not ap ply to th e interio r of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in acc ordance with sub-clau se 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surf aces sha ll be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection o r which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise prov ided for, sur faces within 50 of any f ield weld location shall be f ree of m aterials that would prevent proper welding or produ ce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract sh all be hot dip galvaniz ed in acc ordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel struc tures are require d to be galvanized the f ield connection m aterials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be ga lvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, pro vided th at th e pi ckling t ime is adjusted accordingly.

The pickling process shall be com pleted b y thoroughly r insing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniform ity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The thre ads of bo lts shal l not be m achined after galvanizing and shall not be clogged with zinc. The th reads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adverse ly affect the mechanical properties of the m aterials to be galvanized. W here m embers are of suc h le ngths as to pre vent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has b een damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on ga lvanized surfaces during transport, handling, and

erection. Damages, if occur, shall be m ade good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specif ied otherwise , inspection to all, work shall be m ade by the or Engineer's rep resentative at the place of manufacture prior to deli very. The Engineer or his representative shall have free access at all reasonable times to those parts of the m anufacturer’s wo rks wh ich ar e concerned with the fabrication of the steelwork und er this Contract and he shall be afforded all reasonable f acilities f or satisf ying him self that the fabri cation is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instrum ents as may be required by the Engineer to carry ou t in spection and /or tests in accordance with the Contract. The Contractor sh all gua rantee compliance w ith the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor sha ll carry out sam pling and te sting in accordanc e with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall ge t the specimens tested in a laboratory approved by th e Engineer and sub mit to the E ngineer the te st results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor sh all co nform, to th e relevant Indian Standards. Except otherwis e m entioned in the contra ct, only te sted quali ty steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be f ree from all im perfections, mill scales, slag intrusions, laminations, fittings, rusts etc . that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be clea ned with steel wire brush to rem ove spatter metal, slag etc. and 100% of weld s shall be inspected vi sually for size, length of weld ment and external defe cts. Weld g auges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

i) 10% at random on fillet-joints.

ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like im proper roo t penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rew elded. All defects shall be rect ified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed m anufacturers with test c ertificates. The correct grade and size o f electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the pro visions of the relevant Indian Standard s or other equivalents. For every 50 tones of welded fabrication, the Engineer m ay ask for 1(one) test-destructive or non-destructive including X -ray , ultrasonic te st or sim ilar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procu red from M/s. Gu est Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in acco rdance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and prim ers shall be of standard q uality and procured from approved m anufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Metho d for testing u niformity of coating o n Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dim ensions of individual rolled steel components shall be as specified in IS : 1852 - specif ication for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolera nces on straig htness, len gth etc. of various fabricated com ponents (such as beams and girders, colum ns, crane gantry girder etc.) of the steel struct ures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be l iable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in ca ses w here the Enginee r considers the def ects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelw ork will be accepted forthwith and th e En gineer will issue acceptance certificat e, upon receipt of which, the item s will b e shop painted, packed and dispatched. No item to be delivered unless an acceptance c ertificate for the sam e has been issued. The satisfactory completion of these tests or the issue of the c ertificates shall not bind the Ow ner to accept the w ork, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all ne cessary f ield connection m aterials in such sequence as will perm it the most efficient and econom ical performance of the erection work. The Owner may prescribe or control the sequence of deliv ery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos

as applicable.

vi) Fabrication and shipping of al l other rem aining steelwork in cluding miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tendere r's f abrication workshop giving details of equipment, manpower, the total capacity, and the capacity that w ill be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication dra wings, m aterial li sts, cut ting lists, rive and bolt lists, field welding schedules base d on th e approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessa ry photographs in six (6) copies to reach the Engineer on or before the 7th day o. each m onth, giving the up-to-date status of preparat ion of detailed shop dr awings, bill of m aterials, procurement of materials, actual fabr ication done, shippin g and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the W ork done and rep orted in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of item s shall be read in conjunction with these specifications includ ing amendments a nd additio ns, general conditions of contract, special conditions of contracts, and other tender docum ents, if any. For each item of Sc hedule of Item s, the bidder's rates shall in clude the activities covere d in the descripti on of the item a s w ell as all necessary

operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not ha ve been included in the description in these documents but are essentia l f or t he satisf actory com pletion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates f or all items of schedule of item s shall include complete cost towards plant, equipm ent, erection and dism antling of scaffolding, m en, materials and consum ables, skilled and unskilled labour, levies, taxes, royalties, dut ies, transport , storage , repa ir/rectification/maintenance unti l handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be ente rtained, if the de tails shown on the `R eleased f or Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder' s rates f or Structural Steel shall in clude for fabrication and erection, transportation to site, preparation checking collecting and distributing o f the fabrication dr awings and design calcu lations, erection scheme, alignment, welding, including pr eheating and post heating, testing of welders, inspection of weld s, visual inspection, non destructive and special testing, rectification and correction of defective welding works, pro duction test plate, inspection and testing, erection scheme, protection against dam age in transit, stabil ity of structures, etc . The rate s shall also be inclusive of providing and installing tem porary structures, transport of Own er issue material f rom store, return of surplus/waste steel m aterials inc luding cut pieces/waste steel, provi sion of add itional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall incl ude fabrication, threading, heat treatm ent, erection, in stallation, and alignm ent of complete bolt assem bly with nuts, locknuts, anc hor plates, stiffene r plates, pr otective tape, et c. This shall a lso inc lude t he cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidders rates for ap plication of inorganic prim er shall include surface preparation to near white m etal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning a nd abra sives used, and getting appro val of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates forapplication of finish painting system shall include surface preparation, application of inte rmediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder' s rates f or electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load i ntensifies, preparation of d esign and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall inc lude the application of hot dipped galvanization as finish over the f abricated gratings and the treatment to be g iven for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates f or perm anent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washer s in positio n, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’ s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washer s in positio n, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder’srates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc ., as mentioned in the tec hnical spe cification. Unutilised stee l pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder' s rates f or re-erection of erec tion m arks a fter additions to, alterations in and/or m odifications shall be incl usive of all op erations mentioned in technical specification for the calculated weight of the rectified/modified e rection m ark rejected at site. This sha ll not incl ude the weight of temporarily dismantled/supported members, connected member. All the operations mentioned a bove for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been m odified/rectified before erection sh all not be paid under this item but shall be paid under relevant item of fab rication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning et c. along with any taxes, duties thereon etc.

6.01.17 The bidde r's rates f or S tainless S teel ho pper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and desig n calculations, all other operations m entioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bo lting, assem bly, edge preparation, welding including pre-heating, post-heati ng, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structure s e tc. The ra tes sha ll also be inclusive of providing and installing temporary structures, transport of Owner issue material f rom store, return of surplus / waste steel m aterials in cluding cut pieces/waste steel, provi sion of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. com plete alo ng with any taxes, duties thereon etc.

6.01.19 The bi dder's rates f or St ainless S teel H and R ail (if spe cified) shal l include complete Hand Ra il incl uding, m aterials, fabr ication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the c ost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of found ation bolts assembly including that of nuts; lo cknuts shall be based on the calculated we ight of ste el i nstalled in

Metric Tonne, corrected to second place of decimal. The weight of the foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted from the assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contr actor after final welding for m embers. Erection boltholes left after rem oval of erection b olts shall be suitably plugged with welds.

6.02.12 The m easurement f or th e item of application of inorganic prim er in cluding blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of de cimal. The weight shall be the weight as approved, for erection m ark/element of the m ark pa inted, for paym ent o f th e it em of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish prim er system shall be based on the weight on which the epoxy ba sed finish primer is applied in Metric Tonne, corrected to third place of d ecimal. The weight shall be the weight as approved, for erection mark/element of the m ark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of de cimal, as supp lied by the Contractor, and accepted by the En gineer. Nothi ng extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, co rrected to second place of decim al of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the C ontractor and a ccepted by the Engineer, and as pe r the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual wei ght in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The m easurement f or the item of the work of dism antling, addition s, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unm odified weight of the ac tually dism antled erection marks shall only be measured.

6.02.20 For th e work of addition to, alteration in and / or m odification of 'erection marks' either in erected position or in the fabrication yard, m easurement of

weight for paym ent purpo se shall be ca lculated as the arithmetic sum of weight of steel cut and rem oved from the e rection mark, weight of stee l reutilised out of such cut and removed pieces and weight of add itional new steel pieces added to the erection mark.

6.02.21 For re- erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be ar rived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the ite m of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by th e Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for th e item of stainless steel hopper shall be based on the actual finished weight of ho pper weight in Kgs, corrected to second place of decimal. The ho pper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The m easurement f or the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. B ellow S traps shall be s upplied as per the requirem ent of the approved drawings. Th e m easurement shall be done for the inner circumference of the bunker on which ne oprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight o f handrail in Kgs corrected to sec ond place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless S teel cleats e tc. The w eight sha ll be the f inished weight of Hand Rail, as accepted by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erec tion of structural steelwo rk in cluding receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all com plete as per D rawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provid ed for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consum ables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, c hecking, a nd moving to storage yard at Site including prompt atten dance to all in surance matters as necessary for all fabricated stee l m aterials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging , assem bling, riveting , bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If n ecessary suitable tem porary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, lev els of all foundation blocks including ch ecking line, level, position and plum b o f all bo lts and pockets. An y defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structure s on the foundation blocks.

e) Aligning, plum bing, leveling, rive ting, bolting, welding and securely fixing the fabricated stee l structures in cluding floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the

Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts dam aged beyond repair durin g transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts om itted during fabrication by e rror, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/o r replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erec t the e ntire f abricated steel struc ture, align all the members, complete all field connections and grout the foundation s all as per the provisions of this specification and the sequen ce and the design criteria laid down by the Engineer. All work shal l conform to th e provisions of th is specification and /or instruc tions of the engineer. The te sting and acceptance of the ere cted structures shall be in accordance with the provisions o f this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the C ontractor to the site . The Contractor shall take delivery from railway wagons or trucks at site, and unload th e materials and perform all formalities like checking of m aterials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All m aterials required to be su pplied by the Co ntractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the w orks. A ny material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be rem oved im mediately from the site, f ailing whic h, the engineer shall be at liberty to get the m aterials rem oved by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site fo r storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy eq uipments. The yard shall be fenced all around with secu rity arrangement and shall be of sufficiently large area to permit systematic storage of the f abricated steel structure s without overcrowding an d with suitab le access f or c ranes, trailers and othe r equipm ent f or use in ere ction w ork in proper sequence in accordance with the approved Programme of work.

The Tenderer m ust visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be ca rried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection m aterials, paints, cement etc. shall be stor ed on well

designed racks and platform s off the ground in a properly cov ered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and m aintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure com pliance w ith the provisions of th e Contract an d shall submit the records of th e sam e to the Engineer . The quality control op eration shall include but not be limited to the Following items of work :

i) Erection: Lines, levels, grades, plumbs, jo int characteristics in cluding tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and nece ssary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall subm it claim s to insurance or oth er authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the sam e are erected in place and accepted. The C ontractor shall salva ge, c ollect, and de liver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and ade quacy of all erection tools and plant and equipm ent proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in go od working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erecrtion shall install, free of cost to the Owne, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracing and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and /or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of colum n shall be plum bed and maintained i n a true ve rtical position subject to the limits of tolerance under this Specification.
No perm anent field connections b y rive ting, bolting or shall be carr ied out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated an d driven with pneumatic t ools. Hand passing or "throwing" of rivets are desirable. Any other m ethod of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All ot her requ irements of riveting in cluding quality and acc eptance crite ria shall be in accordance with the relevant portions of the Specification for Fabric ation of Structural Steelwor k of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of S tructural St eelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible m aterials. W hen asse mbled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, w hen all f asteners in the joint are tight, the required m inimum bolt tension by an y of the following methods.

a) Turn-of-nut Method

When the turn-of-nu t m ethod is used to provide the bolt ten sion, there shall first be en ough bolts brought to a "snug tight" condition to ensure that the parts of th e Joint are brought into good contact with each other. 'Snug tigh t" is defined as the tightness attained by a few im pacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts sha ll be plac ed in any rem aining holes in the connection and broug ht to snug tightness. All bolts in the joint shall then be tight ened additionally by the applicable am ount of nut rotation speci fied in Table-I w ith t ightening progressing system atically from the most rigid part of the joint to its free edges. During this operation

there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt r egardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be in stalled without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tighten ed by the turn-o f-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thu s affording the inspector visual means of noting the actual nut rotation. Such marks can be m ade by the wrench opera tor by suita ble means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specif ied in TABLE-II (See Note below the Table). Nuts sh all be in tightening m otion wh en torque is measured. When using torque wrenches to install several bolts in a single joint, the w rench shall be returned to touch up bolts previously tightened, which m ay have been loosened b y the tightening of subsequent bo lts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) of IS:1367	Torque to be applied (Kg.M) for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14.

7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torqu e wr ench shall be ca librated at least once daily to find out the actual to rque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wre nches if used shall be of adequate c apacity and suff iciently supplied w ith air to pe rform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the f it of the bol ts shal l be in ac cordance w ith relevant Indian Standard Specifications. All other requirements regarding asse mbly and bolt tig htening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly a nd w elding shall be carrie d out in accordanc e with the requirements of the sp ecification for fabrication work applicable to the project, excepting such provisions therein which m anifestly apply to shop conditions only. W here the fabricated structural steel m embers have been delivered painted, the pa int shal l be rem oved before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, we lds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or othe rwise alter the work of other trades, unless such w ork is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete inf ormation as to size, loc ation and num ber o f alterations prior to carrying out any work. The Contractor shall not be entitled for any paym ent on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasona ble amount of reaming and cutting of excess stock from rivets will be consid ered as perm issible. F or this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to m ake connections. Reaming, that we akens the member

or makes it impossible to fill the holes properly or t o adjust accurately after reaming, shall not be allowed.

Any error in shop wo rk which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of th e Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cem ent and one (1) part sand and just enough water t o make it workable . The posi tions to be grouted shall be cleaned thoroughly with com pressed air je t and wetted with water and any accumulated w atershall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may b e added to the above noted cem ent-sand grout m ix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is em ployed, the o peration shall not be carried out u ntil the steelwork has been finally levelled and plumbed, the stanchion bases being sup ported m eanwhile by steel wedges, and i mmediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Eng ineer, certain admixtures like alum inium powder, “ironite” or equivalent, may be required to be ad ded to the gro ut to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength m ay also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting sh all only be done after the structure is erected, levelled, plumbed, aligned and grouted in its f inal position, tested and acce pted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and m asonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirem ents of t he spec ification for fabricatio n of structu ral

steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abr asions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall re ceive the full, specified protective trea tment before Bolts and f abricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coat s of Synthetics En amel painting or Aluminium paint of approved m anufacture as per the app roved “Schedule of Painting”. T he shades shall also be as per the appro ved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Tem porary W orks resulting in connection with th e perform ance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be ca rried out on er ected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dism antled and replaced with suitable member as per the C ontract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contr actor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the En gineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing o perations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural m ember under consideration shall be loaded with its actual dead load for as long a tim e as possible before testing and the tests shall be conducted as in dicated in th e following sub-clauses 4.01.01, 4 .01.02 and 4.01.03. Th e m ethod of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or m ember shall be subjected, addition to its actua l dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shal l be maintained for 24 hours. The m aximum deflection attained during the test shall be within the permissible limit. If, after removal of the test loa d, the member or structur e does n ot show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or stru ctural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specif ied superimposed load, and this load sha ll be m aintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and m aintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a w hole. Complete tests u nder both con ditions m ay be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure show s a recovery of at leas t 20 pe r cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures a re built to th e same d esign and it is considered unnecessary to test all of them, one structure, as a pro totype, shall be fu lly tested, as described in previous Sub-clauses, but in addition, during the first application of the test lo ad, particular note shall be taken of the strain or deflection when t he t est lo ad 1.5 times the specified superimposed load has been maintained for 24 hours. This inform ation is requir ed as a b asis of comparison in any check test carried out on samples of the structure.

When a structure of the sam e type is selected f or a che ck test, it shall be subjected, in additi on to its actual de ad l oad, to a supe rimposed test load, equal to 1.5 time the specified li ve loa d, in a m anner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory , provided that the maximum str ain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subseque ntly to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted m embers and has subsequently satisfied the 'S tiffness T est' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deem ed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances fo r the p rofile dimensions perm itted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the-least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm

	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all part s of the structu re unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Su b-clause 4. 01.00, 4.0 1.01, 4.01 .02, 4.01. 03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treate d as a pproved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall subm it a tentative programme based on the inform ation available in the Tender Docum ent and vi sit t o sit e indic ating the structure-wise erection schedule proposed to be m aintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipm ent like cranes , derricks, winches, weldin g sets, erection tools etc. along with their m ake, m odel, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Ten der. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage sp ace for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of er ection equipments and other facilities. The Engineer shall have the right to modify the arrangem ent and location of the proposed yard to suit site conditions and the Contractor shall com ply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the C ontract for completion of the work in time in accordance with the C ontract. This will show the target p rogramme, with details of erection p roposed to be carried out in each fortnight, details of m ajor equipment required, and an assess ment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall su bmit fortnigh tly progress reports in tripl icate t o the Engineer showing along with nece ssary photographs, 125 m m x 90 mm size, and all details of actual achievements against the ta rget programme specified in Sub-clause 5.02.01 above. Any shortfa ll in the achievement in a particular fortnight must be made up within the next fortnight. Along with th is report, the Contractor shall also fu rnish details of fabricated materials in ha nd at site and the strength of his workers.

VOLUME: II B

SECTION - D

SUB-SECTION – D19

ROOF DECKING

SPECIFICATION NO. PE-TS-999-600-C019

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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4.00.00	ACCEPTANCE CRITERIA	6
5.00.00	IS CODES	6
6.00.00	RATES AND MEASUREMENTS	7

ROOF DECKING

1.00.00 Scope

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deareator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and centre to centre of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 150 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labo ur, equipment and m aterials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets,

fixtures, flashings and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and de tails, and the C ontractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the su itability of the details. Manufactu re of roo f decking sheets shall not com mence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing

3.02.01 Sequence of Manufacture/Erection

Cutting Schedules, delivery to site a nd stacking arrangements in store shall ensure that sheets are erected in a sequence which f ollows that for the manufacture. The decking sheets shall be erected using an arra ngement of sheets a nd joi nts to c onform with t he re quirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a m anner as to provide the m aximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where po ssible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be o btained before the roof decking sheets a re c ut a t site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.

3.02.06 Laps

End laps and side laps to roofing sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. The se self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self -drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's

recommendations using tools approved by the m anufacturer which do not damage the coating of the decking sheets.

3.03.00 Protection during Construction

Precautions sha ll be taken during the ere ction of the roof de cking toensure that partially e rected decking a re protected during inclem ent w eather and damage at all times.

3.04.00 Damage

Any damage to coating & prim er during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

a) Side and end laps

b) Absence of damage in the sheeting.

c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the f ollowing or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered b y Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS : 513 - Specification for cold rolled carbon steel sheets.

IS : 3618 - Specification for phosphate treatm ent of iron and steel for protection against corrosion.

IS : 4431 - Specification for carbon & carbon manganese free cutting steel.

IS : 1573 - Electroplated Coatings of zinc on iron and steel.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rat e for complete item described in the Sch edule of Item s and shall include all wastage.

6.02.00 Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be m easured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be p aid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.

VOLUME: II B

SECTION - D

SUB-SECTION – D20

FALSE FLOORING

SPECIFICATION NO. PE-TS-999-600-C020

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

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FALSE FLOORING

1.00.00 General

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supply of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL

2.01.00 Supporting structure

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of $\pm$ 0.2mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of $\pm$ 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.

2.02.01 Strength

Each 610mm x 6 10 m m floor panel m ust be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shallbe capable of carr ying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the sam ples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be pr ovided under floor st ringer alon g front panel area of each control board fo r taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All rem ovable panels shall have the top surface finished with 2 m m thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall b e 150 m m high and 2 mm thic k, c ompletely m atching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer’s installation instructions.

3.00.00 INSTALLATION

3.01.00 Base

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from com ing in con tact with cables an d to minimise dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of th e false flooring system

shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be prote cted by two c oats of polyurethane paint over a compatible p rimer and any damage to the pa int during instal lation shal l be made good. In case the loads exerted by the weight of machines are above the stated cha racteristics of f loor finish m aterial, the floor sh all be p rotected by overlaying hard board during installation of machine or equipment.

All inst allation work of the f alse flooring system shall be supervised by the manufacturer's authorised representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be take n during the erec tion of the f alse f looring to ensure that partially erected floo ring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the sim ilar type of coating as per the m anufacturer’s specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks :

a. Level

b. Alignment of joints

c. Thickness of joints

d. Surf ace finish

e. Colour and texture

f. Details of edges, junctions etc.

g. Performance

h. Criteria specified for strength.

5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the follo wing or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered b y Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0 RATES AND MEASUREMENTS

6.01.00 Rates

Rates shall be unit rat e for complete item described in the Sch edule of Item s and shall include, bu t not lim ited to, su pply & installation of floor panels, supporting systems, paintings atc.

6.02.00 Method of Measurement

False flooring shall be m easured in Sq .M for net area of the work done. No deduction shall be made for openings m easuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in m aking opening and cutting to size.

VOLUME: II B

SECTION - D

SUB-SECTION – D21

BORED CAST-IN-SITU RCC PILES

SPECIFICATION NO. PE-TS-425-600-C002

Bharat Heavy Electricals Limited
Power Sector - Project Engineering Management
PPEI Building, Plot No. 25
Sector – 16A, NOIDA (U.P.) - 201301

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TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED CAST-IN-SITU PILES

1.00.00 SCOPE

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out carrying capacities.

2.00.00 GENERAL REQUIREMENTS

2.01.00 This specification along with technical requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carry out the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carry out all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pull-out for various pile diameters are given in Annexure-A.

2.05.00 In case the piles does not meet the desired capacity due to structural failure of pile or rejected due to any other reason, the Contractor shall redesign, install and test additional piles at no extra cost to the Owner.

2.06.00 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.07.00 The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (RL) of these locations with respect to the benchmark indicated by the Engineer.

Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specification and drawings.

2.08.00 The contractor shall assure the quality of piling work including quality of concrete and integrity of piles, etc.

2.09.00 **AVAILABLE SUB-SOIL DATA**

An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder.

3.00.00 MATERIALS

3.01.00 General

All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.

3.02.00 CONCRETE

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01 Technical Specification for Cement Concrete (Plain and Reinforced) works along with IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticiser to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02 Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 kg/m³ of concrete.

3.02.03 Slump of concrete
The slump of concrete shall be between 150mm and 180 mm.

3.03.00 REINFORCEMENT

3.03.01 Longitudinal and lateral reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise.

3.03.02 The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.03 The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing. The laterals may in the form of links or spirals. The minimum diameter of the links or spirals shall be 8mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm.

3.03.04 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall preferably be assembled before lowering into casing tube/pile bore by providing necessary laps as per IS: 456.

3.03.05 The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.

3.03.06 The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.

3.03.07 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

3.03.08 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.

3.03.09 Minimum clear cover to the longitudinal reinforcement shall be 50 mm, unless otherwise mentioned.

3.03.10 Bundling of bars is not permitted.

4.00.00 PILE INSTALLATION

4.01.00 Equipment and Accessories

4.01.01 The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.

4.01.02 List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

4.01.03 The capacity of the rig shall be adequate so as to reach the specified founding level.

4.01.04 Provision shall be kept for chiselling within the pile bore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.

4.02.00 WORKMANSHIP

4.02.01 Bored cast in-situ piles should be installed by installation technique, covering,

a) Borehole stabilization, that is, use of casing and/or use of drilling mud;

b) Concreting which shall be by use of tremie

c) Choice of boring tools in order to permit satisfactory installation of a pile at a given site.

4.02.02 Piles shall be installed as accurately as possible according to the design and drawings either vertically or to the specified batter. Greater care should be exercised in respect of installation of single pile or piles in pile group. As a guide, an angular deviation of 1.5 percent in alignment for vertical piles and a deviation of 4 percent for raker piles should not be exceeded. Piles should not deviate more than 75 mm or D/6 whichever is less for pile having diameter less than 600mm and 75 mm or D/10 whichever is more in case of piles having diameter more than 600 mm from their designed positions at the working level. In the case of single pile under a column the positional deviation should not be more than 50 mm or D/6 whichever is less for pile having diameter less than 600mm and 75 mm in case of piles having diameter more than 600 mm.

4.02.03 For piles to be cut-off at a substantial depth below the working level, the design shall provide for the worst combination of the above tolerances in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by redesign of the pile cap or pile ties, the piles shall be replaced or supplemented by additional piles. In case of piles, with non-circular cross-section 'D' should be taken as the dimensions of pile, along which the deviation is computed. In such cases the permissible deviation in each direction should be different depending upon the dimension of the pile along that direction.

4.02.04 Temporary casing as specified/as required shall be provided for stabilization of pile bore. Permanent liner shall be provided if specifically called for in the bill of quantities.

4.02.05 In case a borehole is stabilized by use of drilling mud, the specific gravity of the mud suspension should be determined at regular intervals by a suitable slurry sampler. Consistency of the drilling mud shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud.

4.02.06 Cleaning of Bore hole

If a borehole is stabilized by drilling mud, the bottom of the hole shall be cleaned of all loose and undesirable materials before commencement of concreting in the following manner:

a) Boring done with normal bailor and chisel with temporary/permanent liner — First heavier material to be removed with cleaning tools, such as, bailor and then reinforcement cage and tremie pipe to be lowered. Flushing then to be continued with water/drilling fluid under pressure through tremie pipe.

b) Boring done with bentonite slurry — Procedure given in (a) above to be followed. However, flushing shall be done with fresh bentonite slurry.

c) Boring done by rotary drilling rigs — cleaning bucket attached to the kelly shall be used for cleaning the bore. Wherever bentonite slurry is used, after using cleaning bucket, the bore shall be flushed with fresh bentonite slurry.

In case of flushing with water or bentonite slurry, the pump capacity shall be suitably decided depending on depth and diameter of bore so that sufficient pressure is built to lift the material up along with the fluid. Flushing should be continued till coarse materials cease to come out with the overflowing fluid. The finer materials will normally remain suspended in the fluid but they do not pose any problem. Alternatively, air lift technique may be used for cleaning of bore hole, if required.

On completion of boring and cleaning the bottom of each pile bore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pile bore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer

4.03.00 Concreting

4.03.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the

Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.03.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile.

4.03.03 Concreting for bored piles shall be done by Tremie method. The following requirements are particularly to be followed for tremie concrete work:

a) The concrete should be coherent, rich in cement (not less than 400 kg/m3) and of slump between 150-180 mm;

b) The tremie should be water-tight throughout its length and have a hopper attached to its head by a water-tight connection;

c) The tremie pipe should be large enough in relation to the size of the aggregate. Tremie pipe should be of diameter not less than 150 mm. All piling above 600 mm diameter piles, should, however preferably be done with 200 mm diameter tremie pipe;

d) A steel plate or a ball is placed at the bottom of the hopper and the hopper is filled with concrete. The first charge of concrete is sent down through the tremie by removal of this plate or ball. Additional concrete is then added into the hopper and by surging action concreting is pushed down through the tremie and into the pile bore to the bottom of the pile. Theoretically, a small part of the first charge which gets contaminated is supposed to be the top of the rising concrete within the bore;

e) The tremie pipe should always be kept full of concrete and should always remain at least one meter into the concrete in the bore hole with adequate margin against accidental withdrawal of tremie pipes;

f) The pile should be concreted wholly by tremie and the method of deposition should not be changed midway to prevent laitance from being entrapped within the pile;

g) All tremie pipes should be cleaned before and after use; and

h) A sliding plug of polystrene or similar material lighter than water and approved by the Engineer-in-charge or his representative shall be placed in the tremie pipe to prevent direct contact between the first charge of concrete in the tremie and the bentonite slurry.

4.03.04 Normally concreting of the piles should be uninterrupted. In exceptional cases of interruption of concreting, it shall be resumed within 1 or 2 hours, but the tremie shall not be taken out of the concrete; instead it shall be raised and lowered from time-to-time to prevent the concrete around the tremie from setting.

4.03.05 In case of withdrawal of tremie out of the concrete, either accidentally or to remove a choke in the tremie, the tremie may be introduced 60 cm to 100 cm in the old concrete and concreting be resumed within the specified duration in clause as mentioned in clause 4.03.04. The fresh concrete will emerge out of the tremie displacing the laitance and scum and prevent impregnation or laitance of scum in the fresh concrete.

4.03.06 The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level. The reinforcing cages shall be left with adequate protruding length above cut-off level for proper embedment into the pile cap.

4.03.07 Where cut-off level is less than 2.5 m below the ground level, concrete shall be cast to a minimum of 600 mm above cut-off level. For each additional 0.3 m increase in depth of cut-off level beyond the initial 2.5m depth, additional coverage of minimum 50 mm shall be allowed. Higher allowance may be necessary depending on the length of the pile. When concrete is placed by tremie method, concrete shall be cast up to the ground level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut-off level. In the circumstances where cut-off level is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure should be observed and accordingly length of extra concrete above cut-off level shall be determined.

4.03.08 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

4.03.09 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

4.03.10 Concreting shall be done by tremie method as specified by IS: 2911 (Part I /Sec.2). The level of drilling mud shall be maintained sufficiently above the ground water level.

4.03.11 Consistency of the drilling mud suspension shall be controlled throughout the concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

4.03.12 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

4.03.13 The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.

4.03.14 The concreting operations should not be taken up when the density of bottom slurry is more than 1.12. The slurry should be maintained at 1.5 m above the ground water level.

4.04.00 Cut off level (COL)

4.04.01 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.

4.05.00 Building up of Piles

4.05.01 If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using at least one grade higher concrete than that used for concreting of the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.

4.06.00 Breaking off of Piles

4.06.01 If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.

4.07.00 Preparation of Pile head

4.07.01 The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space, sufficient enough to place shuttering, reinforcement, concreting and any other related operations.

4.07.02 The exposed part of concrete above the COL shall be removed/chipped off and made to a uniform level at COL, but not before seven days of casting of pile.

4.07.03 The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.

4.07.04 The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.

4.07.05 All loose material, like debris due to chipping/breaking of pile head to the desired level, shall be removed and disposed off as directed by the Engineer.

4.08.00 Rejection and Replacement of Defective Piles

4.08.01 The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.

4.09.00 Recording of Piling Data

4.09.01 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix F of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D as well. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.

5.00.00 SAMPLING, TESTING AND QUALITY ASSURANCE

5.01.00 Facilities required for sampling and testing of materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

5.02.00 The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shell be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.

5.04.00 Quality Assurance Programme

a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results.

b) Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to meet all the specified requirements before acceptance at manufacturer's premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.

5.05.00 Testing of Concrete

5.05.01 Concrete and other materials shall be tested for quality, strength and other properties. Details of testing shall be as specified under technical specification for Cement concrete (Plain and Reinforced).

5.05.02 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

5.05.03 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 10 piles shall be tested for the 7-days & 28-days cube strength.

5.05.04 In preparation of test cubes or specimens, vibrators shall not be used.

5.05.05 Concrete shall be tested for slump at every 1-hour interval during concreting of piles.

5.05.06 The frequency of sampling and testing of concrete and materials shall be done as per technical specification for cement concrete (Plain & Reinforced).

5.05.07 The acceptance criteria shall be as mentioned in Table-1.

5.06.00 Testing for position and alignment

5.06.01 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

5.06.02 Permissible limits for deviation shall be as specified under clause no. 4.02.02.

5.07.00 Properties of Drilling mud

5.07.01 Properties of drilling mud shall be checked as per requirement under Annexure C. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified elsewhere with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.

5.07.02 Density of the drilling mud shall be checked in each pile before concreting.

5.08.00 Check for Pile bore

5.08.01 On completion of boring and cleaning the bottom of each pile bore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.

5.08.02 For sampling of drilling mud from the pile bore the following method or any other suitable method shall be adopted.

a) A solid cone shall be lowered by a string to the bottom of pile bore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.

5.09.00 Pile Integrity test

5.09.01 Low strain integrity test shall be conducted on all test piles and job piles or as directed by Engineer. The testing shall be done as per IS 14893. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.

Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.

5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the results with specific regard to piling. This test is limited to testing the integrity of the shaft and is not intended to replace the use of static load testing.

5.09.03 Low Strain Integrity Test Methodology:

a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.

b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis.

c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections, which will be added to the return signal.

d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.

e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete.

f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile.

g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile.

6.00.00 PILE TESTING

Pile load test shall be carried out as per IS: 2911 Part-4 (latest edition) or as directed by Engineer.

6.01.00 INITIAL LOAD TEST

Initial load test shall be carried out on piles for confirmation of estimated pile capacities and to fix a more accurate installation criteria.

6.02.00 ROUTINE LOAD TEST

Routine load tests shall be carried out on job (working) piles as specified. Maximum test load shall be 1.5 times the design safe load capacity. Piles showing unsatisfactory results as per load test results shall be treated as defective piles. Defective piles shall be removed or left in place and replaced by additional piles as directed by Engineer at no extra cost to the owner. Any additional cost towards design implications, if any, due to above shall be born by the contractor.

7.00.00 CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 432 (Part 1 & 11)	-	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 456	-	Code of practice for plain and reinforced concrete.
IS: 1200 (Part 23)	-	Measurement of Building and Civil Engineering works Piling.
IS: 1786	-	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.

IS: 1892	-	Code of practice for Subsurface Investigation for foundation.
IS: 2131	-	Method of Standard Penetration Test for Soils
IS: 2911 Part I/Sec 2	-	Code of practice for design and construction of pile foundations - Bored cast-in-situ concrete piles.
IS: 2911 Part IV	-	Code of practice for design and construction of pile foundation - Load test on piles.
IS: 6926	-	Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects.
IS: 10262	-	Recommended guidelines for concrete mix design.

8.00.00 RATES AND MEASUREMENTS

8.01.00 Rates

8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements.

8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions, local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer.

8.01.03 The quoted rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work.

8.01.04 The quoted rate for piling for a particular diameter shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification.

8.01.05 The quoted rate for piling shall be inclusive of making observations, establishing the ground level and coordinates at each location of pile by

carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner.

8.01.06 The quoted rate for piling shall be inclusive of bailing out all the pile bore spoil from the pile bore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pile bore, transporting to laboratory, testing and reporting of results.

8.01.07 The quoted rate for piling shall include shifting of plant and equipment from one pile location to another pile locations, providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials, equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc.

8.01.08 The quoted rate for the piling shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer.

8.01.09 The quoted rate for piling shall also include welding, placing the reinforcement cage in pile casing/bore and other cost of tools and plants as required etc.

8.02.10 Plasticiser/Admixture when used as directed by the Engineer shall be included in piling rates.

8.01.10 The quoted rate for piling shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc.

8.01.11 Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not have been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.

8.02.00 Measurement

8.02.01 Piling length shall be measurement by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter and capacity of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be

considered for reconciliation of cement consumption. No separate payment shall be made for the length above cut-off level to ground level.

8.02.02 Reinforcement steel shall be measured by weight in tones, up to third place of decimal in the following manner:

i) The weight shall be arrived at by multiplying the actual length measured along with standard hooks, rings or spirals, spacers, cranks, bends, authorized laps, etc. by sectional weight. These shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS code's sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.

ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.

iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.

ANNEXURE-A

Technical Requirements

Al.0 Minimum cement concrete grade M-30

Minimum cement content 400 kg/m³ of concrete

A1.1 Safe load

Diameter of Pile (mm)	Cut off level below finished ground level (m)	Vertical/ Compression (MT)	Horizontal/ Lateral (MT)	Pull-out/Tension (MT)
*	*	*	*	*
*	*	*	*	*

A2. Installation criteria

In soil/weathered rock

Minimum length of the pile shall be ---------- *m below Cut off level.

A3. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria

Socketing depth

Density of bentonite before concreting

Slump of concrete

Time interval between end of boring and start of concreting

* Values shall be indicated separately depending upon sub soil strata of the site.

ANNEXURE-B

List of Equipments

SI.No	Description	Quantity
1.	Piling Rig	
3.	High pressure Mud Pumps	To be filled by PSSR
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.
2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.

ANNEXURE-C

The bentonite powder and bentonite suspension used for piling work shall satisfy the following requirements:

a) The liquid limit of bentonite when tested in accordance with IS 2720 (Part 5) shall be 400 percent ormore.

b) The bentonite suspension shall be made by mixing it with fresh water using a pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.03 and 1.10 g/ml depending upon the pile dimensions and the type of soil in which the pile is to be bored. The density of bentonite after contamination with deleterious material in the bore hole may rise up to 1.25 g/ml. This should be brought down to less than or equal to 1.12 g/ml by flushing before concreting.

c) The marsh viscosity of bentonite suspension when tested by a marsh cone shall be between 30 to 60 stoke; in special cases it may be allowed up to 90 s.

d) The pH value of the bentonite suspension shall be between 9 and 11.5.

ANNEXURE-D

PILE DATA

1. Reference No. Location (Co-ordinates)_____area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:

    i) Freshly supplied mud:
    Liquid limit -

    Sand content -

    Density -

    Marsh viscosity -

    Swelling index -

    pH value -

    ii) Contaminated mud -

Sand content-
Density-

14. Date and time of start and completion of concreting.

15. Method of placing concrete

16. Concrete quantity
    a) Actual
    b) Theoretical

17. Ref. Number of test cubes

18. Grade and slump of concrete

19. Results of test cubes

20. Reinforcement details:

Main Reinforcement	Stirrups: Type
No._____	No._____
Dia._____	Dia._____
Depth_____	Spacing _____

21. Any other information regarding obstructions, delay and other interruption to the sequence of work.

TABLE -1

FREQUENCY OF SAMPLING AND TESTING

SI. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pile bore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit, Marsh Viscosity, Specific gravity, sand content, swelling index, pH value. Density, sand content	in lab in lab	As per Cl. 5.07 Each Pile	As per Annexure C As per Annexure C
3.	Position and Alignment	-	Physical or any approved method	Each Pile	As per Cl. 4.02.02
4.	Cleaning of Pile bore	-	As per Cl. 5.8	Each Pile	Pile bore be free from bored Material debris/sludge
5.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design
6.	Concrete a) Workability b) Cubes	Slump cone test Compressive Strength test	Each pile As per spec.	As per Cl. 5.05.00 As per Cl. 5.05.00	As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	As per technical specification for concrete and relevant IS codes			
9.	Pile head		Physical	each pile	

VOLUME: II B

SECTION - D

SUB-SECTION – D22

SITE LEVELLING & GRADING WORKS

SPECIFICATION NO. PE-TS-999-600-C022

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	GENERAL	3
2.00.00	SCOPE	3
3.00.00	MATERIALS	4
4.00.00	QUALITY CONTROL	6
5.00.00	EXECUTION	6
6.00.00	RATES AND MEASUREMENTS	15

GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for **"Site Levelling and Grading Works including Slope Protection"** etc for the enti re plant and associated areas. The specif ied f ormation level(s) shall be achieved eit her by excavation or by raisi ng with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works i nvolved in le velling the site to the lines, grades, cross secti ons and di mensions as shown on the appr oved dr awings and/or as directed by the engineer including site clearance, set ting out, earth wor k in excavation, st acking, loadi ng, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus ear th etc. It al so i nclude supplying and providing all labour, materials, supervision, services, equipm ents, tools and plant s, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works, Part-1: Earthwork

IS: 2720 Method of test for soils (Relevant parts)

IS: 3764 Excavation work- Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground Blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

a) Materials from swamps, marshes and bogs
b)Expansive clays
c)Peat, logs, sod and perishable materials
d)Materials susceptible to combustion
e) Any material or industrial and domestic produce which will adversely affect other materials of work
f) Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with

the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and

rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**
The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to

transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officerin-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine. Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

♦ not to put their feet on the clean floor unless the magazine shoes on.

♦ not to touch the magazine shoes on ground outside the clean floor.

♦ not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities. Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed

from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be

present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as for as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as

determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720**,** part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed

layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, crosssections
and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any

debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughned** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.

VOLUME – II B

SECTION – D

SUB SECTION – D23

ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-999-600-C023

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

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TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to set up a c hemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.
All necessary work to ensure unifo rm distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.
Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following che micals (conforming to relev ant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly ov er the area treated.

Chemicals		Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for co lumn pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by

rodding the earth at 150 mm centres close to the wall surface and spray ing the chemicals in the specified dose.

2.02.02 **Treatment of Top Surface of Plinth Filling**

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface o f compacted plinth fill. Chemical emulsion at the rate of 5 litres / M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 **Treatment of Expansion Joints**

These shall re ceive special attent ion and shall be treated in a manner approved by the Engineer.

2.02.05 **Treatment at Junction of the Wall and the Floor**

Special care shall be take n to esta blish continuity of the vertical chemical barrier on inner wall surfaces from gr ound lev el up to the level of the filled earth surface.
A small channel 30 x 30 mm shall be mad e at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm a part and the chemical emulsion poured a long the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 **ACCEPTANCE CRITERIA**

The Contractor shall giv e a 10- year service guarantee in writ ing supplemented by a separate and unilate ral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.00.00 **RATES**

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00 **METHOD OF MEASUREMENT**

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations , walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation an d like beyond plinth limit shall be the part of complete work.

6.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings
Pre-constructional c hemical treatment measures.

VOLUME: II B

SECTION - D

SUB-SECTION – D31

LANDSCAPING WORK

SPECIFICATION NO. PE-TS-999-600-C001

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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STANDARD TECHNICAL SPECIFICATION FOR LANDSCAING

1.01.00 SCOPE

The landscape contractor shall from the date of commencement of contract, furnish all materials, labour, and related items necessary to complete the work indicated and specified herein.

The scope of work for the above mentioned work shall include following and shall be carried out as per BOQ, Specification & Landscaping Layout drawings:

1. Lawns
2. Plantation Works for Service Building along with decorative pebbles.

The landscape contractor will be generally responsible for the entire site but in particular to works listed below. Along with site management, the responsibilities will include landscaping works and arboriculture works and maintaining the same.

After planting, all planted areas that have exposed soil will have to be mulched with straw or hay. Mulching will be evenly spread to cover any exposed soil.

In addition, the contractor will also be responsible for filling gaps, thinning and transplanting, or replanting where plants may need to be replaced. Along with other planting, the contractor will also be responsible for improving soil conditions for planting. This may include import /export of sand/soil to/from site. The contractor will also clear vacant area from existing grasses, debris and unwanted materials keep the site clean and maintain the already planted areas free of weeds, pests or insects that cause diseases. All weeds, unwanted grasses and plant material will be cleared up to 1000 mm from the edge of planting of newly created and already existing horticultural works (such as boundary trees). The contractor will also be responsible for protection of the plants from salt spray that may occur during the monsoons.

1.01.01. Specifications and Planting Techniques for Trees

Sapling to be at least 1.5m in height as specifically approved and planted in pits of size 750mm X 750mm X 750mm forplantation

along material movement road. Refilling the pits (after the sapling) shall be with standard mixture of soil, organic mixture in the ratio of 1 Existing Black Soil: 1 Existing Red top soil : 1 Good Quality Red Soil : 1 Farm Yard Manure (i.e 1:1:1:1). Supply and maintaining the sapling from the day of planting to the day of its handing over are included in the scope**.** The requirement of individual species may however be varied by Owner as per site conditions.

1.01.02 Plantation Techniques

The ideal time to plant trees is during when the weather conditions are cool which allow plants to grow roots in the new location. Planting shall not carry out during rains and summer heat. However, trees properly developed in the nursery, and given the appropriate care during transport to prevent damage, can be planted throughout the growing season. In tropical climates where trees grow round the year, any time is a good time to plant a tree, provided that sufficient water is available. In either situation, proper handling during planting is essential to ensure a healthy future for new trees and shrubs.

1.02.00 Storage Shed

No storage area will be provided at site by BHEL. Security of materials at site will be the responsibility of the contractor. Any temporary sheds or structures may be built as working space at the area shown at site and on the approval of the Site Engineer.

1.03.00 Watering

Water will be made available at only one source at site on chargeable basis. If the water on site is insufficient or saline or unacceptable, then the contractor shall be responsible for importing water in water tankers for the general upkeep of the plants. No plants shall be allowed to wither or die due to lack of proper watering.

1.04.00 Replacement of Plants

Those plants that are not up to the standards, and do not meet specifications shall be replaced by the contractor at no extra cost to the Employer.

When the plants are to be replaced either for filling gaps or poor quality, then the contractor shall replace with plants of equal height , size and age of the plants in that area. For this purpose, extra numbers of plants of those used in the project will have to be maintained in the Nursery.

Survival Guarantee (99%) for all trees & plants shall be assured for the entire contract period. If any shortfall in survival rate occurs in the trees & plants during this period, it shall be replaced within one week and maintained free of cost.

The contractor shall be responsible for any thefts of plants already planted. While the Employer will provide security at entry and exit points, plants removed by theft shall be the responsibility of the contractor.

1.05.00 Plant Requirements

Plants and shrubs shall be sourced by the contractor from available nurseries, unless otherwise specified. Seeds shall be acquired from reputed organizations and hybrid seeds will be used where possible – particularly for flower varieties. No plant material shall be changed without the consent of the Engineer

Plants shall be typical of their species and variety with well-developed branches, well foliated with fibrous root system.

Plants shall be free of defects and injuries.

Plants shall not be pruned before planting.

The Contractor shall source 50% of total saplings (approximate quantity required to be planted in the first year of the development Contract period) from approved nurseries. Balance 50% Plants shall be grown in the nursery to be developed at site by the Contractor before taking up plantation in the second year.

Barks shall be free from abrasion

All trees soon after planting shall be properly supported by tripod stacking with bamboo / wooden sticks to ensure their safety against winds or any other factor which may affect it adversely.

1.06.00 Weekly Report

The contractor shall also maintain a work report for work completed each week. The same report in English, will be sent to the Engineer In Charge. The Engineer In Charge shall verify completed work as per the report. Contractor will be responsible for meeting deadlines for the completion of the job.

1.07.00 Responsibilities

a) The contractor's work shall not hinder other work, either underground or over ground, such as electrical, phone lines, water or sewage lines, etc. In areas of overlap, the contractor shall work in coordination with other related contractors. Any damage by the landscape contractor's team to such utilities will be penalized and contractor shall be responsible for cost for such damages.

b) The contractor shall abide by the Security rules / procedures of the Employer, and shall obtain gate pass, issue I.D. badges to all their employees on site, etc. as prescribed by the Employer.

1.08.00 Material and Labour

All the materials which are required for the progress of the Landscaping works shall be supplied by the contractor. The required numbers of Labour are to be provided by the contractor.

1.09.00 Planting

Whenever planting, the following specifications will be followed by the contractor. Wherever sand is to be removed, the following specifications shall be followed after refilling the area with good soil.

1.09.01 Digging of pits

Tree pits of 600mm x 600 mm x 600 mm (approx. 2'x2'x2') shall be dug a minimum of two weeks prior to back filling. The pits for shrubs shall be 600 mm in depth and 300mm diameter. For ground cover, the land will be prepared by digging up to 300 mm (1') and soil loosened. While digging the pits the top soil may be kept aside, and mixed with the rest of the soil as specified.

If the soil quality is poor, it shall be replaced with soil mixture acceptable to the Consultant. If the soil quality is satisfactory, then it shall be mixed with manure and river sand. The soil condition will have to be approved by the Engineer In Charge. Pest/termite prevention chemicals or any other approved chemical to be applied into the soil before planting as per supplier's specification. When planting is in more than one row, then pits will be dug in a zig-zag fashion ensuring a diagonal planting in each row.

1.09.02 Planting Mixture

The topsoil will be mixed with 15% farm yard manure, 40% red soil, 20% river sand and 20 % excavated earth (topsoil). This mixture will be filled in pits before and after planting.

1.09.03 Backfilling

The soil is back filled, watered thoroughly and gently pressed down a day previous to planting, to make sure that it may not further settle down after planting.

1.09.04 Planting

No tree pits shall be dug until a final tree position has been pegged out for approval. Care shall be taken that the plant sapling when planted is not buried beyond the level of the pot containing it. Planting should not be carried out in waterlogged soil.

1.09.05 Stacking

If necessary, a single vertical stake 1 meter (approx. 3 ft) longer than the clear stem of the plant, driven 300 mm to 450 mm (approx.1ft to 1'6") into the soil shall be used. Each plant should be secured to the stake so as to prevent excess movement.

1.09.06 Watering

The landscape contractor shall allow for the adequate watering of all newly planted trees, shrubs and groundcover immediately after planting and during the following growing season, shall keep the plant material well watered.

1.09.07 Mulching

All planted areas including around trees which have open soil that is exposed will have to be mulched with straw or hay. Rates indicated in the Bill of Quantities shall include such mulching costs. No separate compensation will be paid for mulching.

1.09.08 Planting along the edge of the Building

All plants proposed to be planted by edge of building in front façade of building should be planted with special care so as to ensure the following:

a) The painting/cladding of walls is not soiled and kept clean at all times.

b) Watering is done with care so as to ensure water is not entering windows or muddy water is not splashed on walls.

c) All plants growing over the height of windows should be trimmed below window height.

1.09.09 Protection

The contractor will be responsible and should take measures to protect the planted saplings from cattle, salt spray and high wind pressure. Rates indicated in the Bill of Quantities shall include such costs of protecting the plants including any physical construction such as walls, tree guards, etc. that may be required for the same.

1.10.00 Shrub Planting and Ground Cover

Same specification as for trees, except where specified otherwise.

1.11.00 Lawns

1.11.01 Preparation

During period prior to planting the lawn, the area shall be maintained free from weeds, whatever the nature of soil, complete surface shall be trenched over to a depth of 300 – 450 mm. Grading and final levelling of the lawn shall be completed at least 2 weeks prior to the actual sowing.

1.11.02 Soil

The soil itself shall be ensured to the satisfaction of Consultant to be a good fibrous loam, rich in humus. Pest/termite prevention chemicals to be mixed if required. Top soil shall be mixed with farm yard manure or coco-peat and mixed with river sand in ratio of 15% manure, 25% river sand, 35% red soil and 25% excavated earth and levelled to maintain positive drainage or specified slopes.

1.11.03 Execution

Nodes of specified grass shall be dibbled not more than 50mm apart on above mentioned soil conditions. Wherever specified, carpet lawn will used. The carpets will be laid next to each other in an even pattern to ensure that all

lawn area is covered. After lying of carpet, it should be lightly pressed into the ground to ensure that it is does not shift, and to ascertain that the roots are in soil. Positive slopes will be maintained to ensure that there will be no low lying areas in centre where water logging or pools are created.

1.11.04 Maintenance

In the absence of rain, lawn shall be watered daily - heavily, soaking the soil thoroughly to a depth of at least 150 mm.

1.11.05 Cutting

The scythe must continue to be used for several months until the grass is sufficiently secure in the ground to bear the mowing machine.

1.11.06 Edgings

These shall be kept neat and must be cut regularly with the edging shears.

1.11.07 Fertilizing

The lawn shall be fed once a month with liquid fertilizer by dissolving 45 gms of Ammonium Sulphate in 5 litres of water.

1.11.08 Weeding

Prior to regular mowing, the contractor shall carefully remove unsightly weeds.