

SECTION - 3

ENCLOSURES TO THE SPECIFICATION (Customer's Specification)

- 1 Document Number 6987-000-16-48-4201 R0
- 2 Document Number 6987-00-16-48-DB01 R1
- 3 Document Number 6987-046-16-48-JS01 R0- Part A
- 4 Document Number 6987-046-16-48-JS01 R0- Part B
- 5 Document Number 6987-00-19-40-5000 R0

JOB SPECIFICATION
FOR
BIPOLAR CONCRETE PENETRATING
CORROSION INHIBITING ADMIXTURE
TO
PROTECT EMBEDDED STEEL
REINFORCEMENT IN CONCRETE

PROJECT : DAHEJ PETROCHEMICALS COMPLEX

OWNER : ONGC PETRO additions LTD.

PMC : ENGINEERS INDIA LTD.

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1.0 SCOPE

- 1.1 This specification prescribes the requirements and test methods of physico – chemical characteristics including performance test for evaluating the efficiency of the product in the laboratory for protecting steel reinforcement embedded in concrete from corrosion.
- 1.2 This standard prescribes the requirements and methods of test for the material known as Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA). The CPCIA shall be concrete penetrating type which upon addition into the concrete matrix inhibits the corrosion process. It need not be in direct contact with the steel. Its vapours penetrate through fissures, honeycomb structure of concrete, pure water solution added in concrete and seals steel reinforcement at both anodic & cathodic sites, for inhibition. This is due to the bipolar mechanism property of the system. Non-concrete penetrating, nitrite & nitrate corrosion inhibitors are excluded from this scope. The product shall be suitable to protect embedded steel reinforcement bars used in concrete structures from corrosion.

2.0 TERMINOLOGY

- 2.1 For the purpose of this standard the definitions as given in latest versions of ASTM-G1, ASTM-G3, ASTM-G109, ASTM-C 1202, JIS-Z-1535, AASHTO T259, IS:101(Part1/sec.5)-89, IS:456-2000, IS:1202-97, IS:1448-67, IS:1786-85, IS:9103-99 etc. shall apply.
- 2.2 Rounding off, of observed values on different tests shall be in accordance with IS: 2-1960.

3.0 SAMPLING

- 3.1 The representative samples of the material shall be drawn by the purchaser or the Inspecting authority as per the table given below:

Scale of Sampling for CPCIA

No. of containers lot (N)	No. of containers to be selected for sampling (N)
Up to 50	1
51-100	2
101-200	3
201-300	3
301-500	4
501-800	5
801-above	6

4.0 PROPERTIES

- 4.1 The material shall comply with the requirements specified in Clause 5.0, Table-I and Table-II of this specification.
- 4.2 Unless otherwise specified, the following testing conditions shall apply.
- 4.2.1 All the tests shall be conducted at room temperature $27 \pm 2^\circ\text{C}$ and relative humidity at $65 \pm 5\%$ in a well ventilated chamber free from draught and dust.

5.0 REQUIREMENTS

- 5.1 The admixture shall be supplied in one pack.
- 5.2 There are two types of requirements that the material should meet in order to be considered for usage.
- 5.2.1 Properties which can be evaluated in short duration as laid down in Table –I. It can be performed at a laboratory or at sites with proper testing facilities.
- 5.2.2 Properties which can be evaluated by performing long duration tests as laid down in Table–II.
- 5.2.3 All the tests performed under Indian Tropical Conditions mentioned in Table-I & Table-II are mandatory requirement for the approval of product.
- 5.2.4 Approving authorities certificate for long term tests and Suppliers test certificate meeting the short term requirements may be accepted by the purchaser. However, short term tests may be cross checked with NABL accredited laboratory if desired.
- 5.3 The recommended dosage of CPCIA in concrete shall be preferably 1% (w/w of Cement) or as recommended by the manufacturer.
- 5.4 Tests specified in Table II shall be performed in triplicate.

TABLE –I

**REQUIREMENT OF BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING
ADMIXTURE (Short Term Tests)**

Sr. No .	Characteristics	Requirements	Methods of Tests
1.	Appearance	Brownish Liquid free from any visible residual deposits	Visually
2.	Odour	Mild Ammonical Odour	By smell
3.	Skin irritation	No irritation	By applying on reverse of the palm for 05 minutes.
4.	pH i) As in supplied condition ii) 1% dilution ,w/w	i) 9.0-11.0 ii) 9.0-11.0	pH meter / Standard pH paper
5.	Specific Gravity at $27 \pm 2^\circ\text{C}$	1.04-1.06	IS 1448-1967

Sr. No .	Characteristics	Requirements	Methods of Tests
6.	Viscosity of the material as in supplied condition, by Ford cup No 4, at $27 \pm 2^\circ\text{C}$	10 -20 sec.	IS: 101(Pt. 1/Sec.5)1989
7.	Accelerated Corrosion Test, for 21 hrs. i) Raw water without CPCIA ii) ii) Raw water with CPCIA	i) Excessive corrosion spots. ii) There shall not be more than 1-2 corrosion spots.	Modified accelerated corrosion test (Based on Japanese standard JIS Z 1535)

TABLE –II

REQUIREMENT OF BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING
ADMIXTURE (Long Term Tests)

Sr. No .	Characteristics	Requirements	Methods of Tests
1.	Immersion test for 720 hrs. (Rebar weight loss method) i) With out CPCIA* ii) With 1% CPCIA*	i) 40.00 mpy, max. ii) 2.00 mpy, max.	Immersion Test (Rebar weight loss test)[as / ASTM G 1]
2.	Effect of Concrete admixture on compressive strength i) Wth out CPCIA* ii) With 1% CPCIA*	Concrete strength in sample with CPCIA* should be \geq concrete strength in sample without CPCIA*	Test for effect on compressive strength by addition of CPCIA [IS 9103-1999]
3.	Polarization test by Tafel polarization with 3.5% Sodium Chloride, for 20 days i) With out CPCIA* ii) With 1% CPCIA*	Rate of corrosion shall be i) 45 mpy, max. ii) 9 mpy, max.	Electrochemical polarization test conducted on steel rebars embedded in concrete [ASTM-G 3 and IS 9103-1999]
4.	Effect of CPCIA* on corrosion of embedded steel rebars exposed to chloride environments after 09 cycles (14 days wetting and 14 days drying) as per ASTM G109. i) With out CPCIA* ii) With 1% CPCIA*	Rate of corrosion shall be i) 25.00 Coulombs, max. ii) 0.50 Coulombs, max.	Long term corrosion test [ASTM G-109-2005]

Sr. No.	Characteristics	Requirements		Methods of Tests
5.	Chloride Migration profile properties of concrete with & without CPCIA i) Chloride % in concrete at 30 mm depth after 90 days. (For all types of cements e.g. OPC, PPC, PSC, SRC) ii) Ability to resist chloride ion penetration (RCPT) (For all types of cements e.g. OPC, PPC, PSC, SRC) a) Concrete grade M-30, Water cement ratio: 0.45 b) Concrete grade M-40, Water cement ratio: 0.40	With out CPCIA* Chloride % shall be 0.025%, max.	With 1% CPCIA* Nil Resistance to chloride ion penetration shall be 1650 Coulombs, max. 1000 Coulombs, max.	AASHTO T-259 i) Chloride ion penetration (Salt ponding test) [IS:456-2000] ii) Electrical indication of Concrete ability to resist Chloride Ion Penetration (Rapid Chloride Permeability test) [ASTM C-1202 1997]

Note

- 1 CPCIA* : Bipolar Concrete Penetrating Corrosion Inhibiting Admixture. The CPCIA shall be used as 1% w/w of cement or as recommended by the manufacturer for conducting the tests mentioned in Table-II except Immersion test for 720 hrs mentioned at S. No. 1 where it shall be used as 1% w/w of water or as recommended by the manufacturer.
- 2 Wherever required , rebars conforming to IS: 1786-1985 shall be used for testing purposes

6.0 SAFETY TO CONSTRUCTION MATERIAL

CPCIA should not degrade, or damage the construction materials.

- Concrete
- Aggregates
- Steel reinforcement
- Form work/Shuttering

7.0 SAFETY FOR FABRICATION

The CPCIA should not cause harm to personnel by mean of inhalation or skin

contact. All precautionary measures shall be intimated by the manufacturers clearly in writing along with instructions of usages. However final decision about adoption of such measures shall lie with the EIL or client and shall depend upon the conditions prevailing at the site.

8.0 WASTE WATER DISCHARGE

The waste discharge shall be in accordance with the laws of pollution control in force from time to time.

9.0 PACKING

The material shall be packed in suitable air tight polyethylene containers preferably of capacity 20 kg / 200kg or as agreed by purchaser and supplier.

10.0 MARKING

10.1 Each container shall be legibly and indelibly marked with the following:

- a) Name of the material
- b) Name of the manufacturer
- c) Volume / weight of material
- d) Specification number
- e) Batch No. or Lot No. in code or otherwise
- f) Month and year of manufacture

11.0 INSPECTION

11.1 At the time of initial approval of the product or firm, full testing as mentioned in clause 5.2.3, shall be carried out.



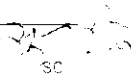
11.2 In case of acceptance testing, Inspecting Authority shall draw the sample as per clause 3.1, from the batch under consideration and the material shall be tested for the tests stipulated in Table-I.

11.2.1 Long duration tests need substantial amount of time. The testing facilities for these tests may not be available in each and every laboratory, therefore, Approving authority's certificate for long term tests as stipulated in Table-II & Supplier's test certificate/NABL accredited laboratory test certificate meeting the short term tests as stipulated in Table-I may be accepted by the Purchaser for the acceptance of the material. However if desired by the purchaser, long term tests may also be organized to be carried out at any IITs/NABL accredited laboratory.

ENGINEERING DESIGN BASIS DESIGN PHILOSOPHY

6.6 STRUCTURAL & ARCHITECTURAL

REV. 1 - Cl. 4.1 e Wind Load revised.

1	18.11.2009	REISSUED FOR ENGINEERING	 DS	 PJS	 SC
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PART – I : STRUCTURAL

(FROM PAGE 3 TO 20)

PART –II : ARCHITECTURAL

(FROM PAGE 21 TO 40)

PART-I: STRUCTURAL

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1.0 REFERENCED STANDARDS & PUBLICATIONS

(BIS codes of Practice shall be applicable)

S.No.	CODES	
1.	Code of practice for plain & reinforced concrete	IS: 456
2.	Code of practice for general construction in steel	IS: 800
3.	Code of practice for use of cold formed light gauge steel structural members in general building construction	IS:801
4.	Code of practice for use of structural steel in overhead transmission line towers	IS:802
5.	Code of practice for use of steel tubes in general building construction	IS:806
6.	Indian Standard on Dimension s of Hot Rolled Steel Beams, Columns, Channel and Angles	IS: 808
7.	Scheme of Symbols for Welding	IS: 813
8.	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel	IS:814
9.	Code of practice for use of metal arc welding for general construction	IS:816
10.	Code of practice for design loads	IS: 875
11.	Common burnt clay building bricks-specification	IS: 1077
12.	Steel tubes for structural purposes-specifications	IS: 1161
13.	Technical Supply Conditions for Threaded Steel Fasteners	IS: 1367
14.	Code of practice for construction of stone masonry	IS: 1597
15.	Fillers for expansion joints	IS: 1838
16.	Criteria for earthquake resistant design of Structures	IS: 1893 (Part -1& 4)
17.	Code of practice for design & construction of Foundations in soils	IS: 1904
18.	Code of practice for structural use of unreinforced masonry	IS:1905
19.	Steel for General Structural Purposes- Specification.	IS: 2062
20.	Recommended practice for hot dipped galvanising on iron and steel	IS:2629
21.	Methods for testing uniformity of coating of zinc coated articles	IS:2633
22.	Code of practice for Design and construction of Pile foundations	IS:2911
23.	Code of practice for design & construction of raft foundations	IS:2950
24.	Code of practice for design & construction of machine foundations	IS:2974

25.	Code of practice for concrete structures for storage of liquids	IS:3370
26.	Steel Chequered Plates – Specification	IS: 3502
27.	Code of practice for design and construction of foundation for transmission line towers and poles	IS:4091
28.	Code of practice for earthquake resistant design and construction of buildings	IS:4326
29.	Criteria for blast resistant design of structures for explosions above ground	IS:4991
30.	Criteria for design of RCC chimneys	IS: 4998
31.	Method of test for determination of dynamic property of soil	IS: 5249
32.	Code of practice for anti-termite measures in buildings	IS: 6313
33.	Code of practice for determination of bearing capacity of shallow foundations	IS: 6403
34.	Code of practice for design & construction of steel chimney	IS:6533
35.	Method for determination of mass of zinc coating	IS: 6745
36.	Code of practice for calculation of settlement of foundations	IS: 8009
37.	Chlorpyrifos emulsifiable concentrates	IS: 8944
38.	Recommendations for metal arc welding of carbon and carbon manganese steel	IS:9595
39.	Two parts polysulphide based sealants	IS: 12118
40.	Indian Standard on Hot Rolled Parallel Flanged Steel sections for Beams, Columns and Bearing Piles	IS:12778
41.	Pulverized fuel ash-lime bricks-specification	IS: 12894
42.	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces	IS:13920
43.	Control Room Safety (a publication of Oil Industry Safety Directorate)	OISD-STD-163
44.	Fire Proofing in Oil and Gas Industry (a publication of Oil Industry Safety Directorate)	OISD-STD-164
45.	Fire Protection System for Electrical Installations	OISD-STD-173

Note The above list is suggestive and not exhaustive. Apart from these basic codes any other related codes shall also be followed wherever required.

2.0 GENERAL

- 2.1 This specification defines the design criteria and loads that shall be taken in to account for the design of all industrial plant and non-plant structures and buildings for a pipeline project. The design considerations given hereunder establish the minimum basic requirements of reinforced concrete structures, structural steel works and masonry structures. However, all structures shall be designed for the satisfactory performance of the functions for which the same are to be constructed.

3.0 MATERIALS OF CONSTRUCTION

- 3.1 All shed type structures such as Compressor house, Ware house etc. shall be in structural steel.
- 3.2 Pipe supports, cross over, access way, service platform shall completely be of steel construction. All other buildings shall be as per Architectural Design Basis.
- 3.3 All buildings shall be of RCC Frame type construction with brick masonry walls.
- 3.4 Boundary wall shall be of Stone masonry.
- 3.5 Bricks for masonry works shall be of the class conforming to IS: 1077 which is locally available.

4.0 DESIGN LOADS

- 4.1 These loadings shall be applicable to all structures irrespective of the material employed for construction.

a. DEAD LOADS

The weight of all permanent construction including walls, fire proofing, floors, roofs, partitions, stairways and fixed service and other equipments excluding their content.

b. EQUIPMENT LOADS

The empty weight of process equipment including all fixtures, platforms, ladders and attached piping but excluding contents shall be considered. If piping weight is not indicated separately or included in the weight of the equipment, the same shall be taken as 10% of the weight of the equipment.

For horizontal equipments the weight on two supports shall be calculated based on the total weight and C.G. of the equipment.

c. LIVE LOADS

Live loads shall, in general, be as per IS: 875. However, the following minimum live loads shall be considered in the design of structures to account for maintenance and erection as well.

i.	<u>Process Building/Technological Structure (Open/Enclosed type)</u>		
	Operating area	-	5.0 kN/m ² (including 2.0 kN/m ² for Piping)
	Maintenance area	-	7.5 kN/m ²
ii.	<u>Compressor House/TG house</u>		
	Operating area	-	7.5 kN/m ²
	Maintenance area	-	7.5 kN/m ² (or as specified by machine vendor)
iii.	<u>Service Platform</u>		
	Vessel/Tower	-	3.0 kN/m ²
	Isolated platform (for valve operation)	-	2.5 kN/m ²
	Access way	-	2.5 kN/m ²
	Cross over	-	2.0 kN/m ²
iv.	<u>Substation/Control Room</u>		
	Panel floor	-	10.0 kN/m ²
	Partitions	-	1.0 kN/m ²
v.	<u>Office building</u>		
	Office area	-	3.0 kN/m ²
	Lobby	-	5.0 kN/m ²
	Exit way	-	5.0 kN/m ²
	Partitions	-	1.0 kN/m ²
vi.	<u>Laboratory</u>		
	Upper floors	-	4.0 kN/m ²
vii.	<u>Staircase</u>		
	Office	-	5.0 kN/m ²
	Substation/Control Room	-	3.0 kN/m ²
	Laboratory	-	3.0 kN/m ²
	Service platform	-	2.5 kN/m ²

vi. Walkway

Gantry girder - 3.0 kN/m²

Live load on various types of roofs shall be as per the requirements given in IS: 875.

d. **OPERATING LOADS**

Operating loads shall include the maximum designed equipment inventory in the operating cycle of the plant.

e. **WIND LOADS**



Wind loads shall generally be as per IS: 875. The basic wind speed for all the stations/terminals shall be taken as 44 m/sec.

Values of coefficients k_1 , k_2 , k_3 shall be as:

k_1 (Probability factor, risk coefficient) = 1.00 for permanent structures and
 = 0.90 for temporary structures
 = 0.70 for barricading structures/ Boundary Wall

k_2 (Terrain, height & structure size factor) = this shall be taken for relevant class of structure with **category 2** terrain w.r.t. actual height of the structure

k_3 (Topography factor) = As per site

The design life span of all structures shall be taken as 50 years. Temporary structures shall be designed for a design life span of 25 years. Design life span for boundary wall/barricading structure shall be as per IS: 875.

To account for surface area of piping, platforms and other attachments fixed to the equipment the surface area of the equipment (vessel/column) exposed to wind shall be increased by 20% or as specified in the mechanical data sheet of the equipment.

f. **SEISMIC LOADS**

Seismic forces shall be as per site specific seismic spectra 6987-00-16-54-DB-01 for Seismic Zone III.

g. **IMPACT & VIBRATORY LOADS**

Structures subjected to impact or vibratory loads shall be designed as per the provisions of IS: 875 & IS: 2974.

h. **BLAST FORCES**

Blast resistant control room or any other specified structure subjected to blast forces generated due to accidental blasts from hydrocarbon ignitions shall be designed to withstand all such forces. Design blast loads and blast resistant construction shall conform to OISD-STD-163.

i. **BUNDLE PULL**

Bundle pull for different types of Exchangers shall be taken for design of their supports unless it is made clear that bundle extractor is to be used.

Total Bundle Pull shall be considered on fixed pedestal alone.

j. **OTHER LOADS**

Apart from the specified live loads, any other equipment load or possible overloading during construction/hydro-test/ maintenance/erection shall also be considered in the design. Under hydro test condition the wind force shall be taken as 25% of normal loading.

Design of all structures shall also consider any other relevant and consequential load/stress imparted to the structure.

All liquid retaining/storage structures shall be designed assuming liquid up to the full height of wall irrespective of provision of any over flow arrangement. Pressure relief valves or similar pressure relieving devices shall not be made in underground water retaining/storage RCC structures.

All buildings/structures shall be designed to resist the worst combination of the above loads. However wind loads shall not be considered in combination with loads due to maintenance cranes in workshop, comp. House etc.

5.0 SOIL AND HYDROSTATIC PRESSURE

Pressure on basement walls: - In design of basement walls and similar approximately vertical structure below grade, provision shall be made for the lateral pressure of adjacent soil. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or whole of adjacent soil is below free water surface, computations shall be based on the weight of the soil diminished by buoyancy (submerged weight of soil) plus full hydrostatic pressure.

Uplift on floor: - In the design of basement floor and a similar approximately horizontal construction below grade, the upward pressure of water, if any, shall be taken as the full hydrostatic pressure applied over the entire area. The Hydrostatic head shall be measured from the underside of construction. Factor of safety against uplift shall be 1.2. For the purpose of calculating downward load due to over burden; the weight for the same shall be calculated for volume over projected plan area only.

6.0 FOUNDATION DESIGN

6.1 Minimum Requirements

Foundation design shall be as per Geo-Technical Data as specified in bid document.

6.1.1 Minimum depth of foundation for all structures shall be as per Geo-Technical Data. Factors of safety against overturning and sliding shall be as per values given in Table-1. Component of soil backfill weight over foundation slab shall be appropriately covered as foundation dead load. For stability checks the weight of soil as overburden shall be as per Table-1.

6.1.2 The design ground water level shall be as per the Geo-Technical Data and the hydrostatic pressure shall be adequately accounted for in design.

6.1.3 Allowable net bearing capacity of soil shall be based on the following settlement criteria for dead plus imposed load conditions:

- | | |
|--|------------------|
| - Foundations in unit areas, utility areas
and foundations for Plant buildings. | 25mm settlement. |
| - Non Plant buildings. | 40mm settlement. |
| - Raft Foundations | 40mm settlement |

For transient loadings, e.g. wind/seismic, settlement shall not be the design criteria and the SBC (safe bearing capacity) based on shear criteria shall be considered.

6.1.4 Permissible increase in SBC/Pile capacities (for compressive, shear and uplift/tension) shall be as per the Geo-Technical Data.

6.1.5 Under blast (due to hydrocarbon explosion load combinations the design bearing pressure of soil shall not exceed 2 (two) times the allowable static bearing pressure of soil. Pile capacity shall be similarly increased in blast condition to 1.5 times the permissible capacity under compression, tension and shear modes.

6.1.6 Grade of concrete to be used shall in general be as per the philosophy adopted for the entire project. However, minimum cement content, type of cement & any remedial actions required for foundation due to aggressiveness of sub soil water shall be as per the Geo-Technical Data.

6.2 Anti Termite Treatment

No anti termite treatment shall be provided inside the unit areas. All buildings shall be provided with anti termite treatment as per IS: 8944 and IS: 6313.

6.3 Minimum Cover to Foundation Bolts

Minimum distance from the centerline of foundation/anchor bolt to edge of pedestal shall be the maximum of the following:

- i) Clear distance from the edge of the base plate/base frame to the outer edge of the pedestal shall be minimum 50mm.

- ii) Clear distance from the face of pocket to the outer edge of the pedestal shall be 100mm.
- iii) Clear distance from the edge of the sleeve or anchor plate to the edge of pedestal shall be 100mm.

6.4 Height of Pedestals

The minimum projection of pedestals supporting any steel structure/stanchion bases shall be 300/150mm above the high point of pavement/ finished grade/finished floor level whichever is higher, for outdoor and indoor located pedestals respectively. The maximum projection of pedestals for staircase/ladder shall be 200mm.

6.5 Grouting & Minimum Grout Thickness

The minimum thickness of grout shall be **25 mm** and not more than 50mm.

All anchor bolt sleeves/pockets and spaces under column bases, shoe plates etc. shall be grouted with free flow, non shrink (premix type) grout with 28-day minimum cube crushing strength of 40N/mm². Ordinary cement sand (1:2) grout shall only be used under the base plates of cross-overs, short pipe supports (not exceeding 1.5 m height) and small operating platforms (not exceeding 2 m height) not supporting any equipment.

Grouting requirement for machines and equipments are not covered here. The same shall be governed by equipment vendor's requirement.

7.0 FLOORING DETAILS FOR BUILDINGS & SHEDS

The specifications given hereunder shall be adopted for the non-suspended ground floor slabs for buildings & sheds as categorised in Table-2 only.

For outdoor pavements, Design basis of Gen. Civil shall be referred.

8.0 SPECIAL CONSIDERATIONS FOR RCC STRUCTURES

8.1 General/Design Methods

- a) All buildings, structures, foundations, machine/equipment foundations, liquid retaining/storage structures, trenches, pits etc. shall be of RCC and designed based on the following IS Codes (latest revision with all amendments issued there to) in general and other relevant IS Codes applicable: IS: 456, 875, 1893, 1904, 2911, 2950, 2974, 3370, 4091, 4326, 4995, 4991, 4998, 5249, 6403, 8009, 13920.
- b) Only limit state method as per IS: 456 shall be followed in the design unless otherwise specified elsewhere in this document for special structures.
- c) Where the specified design depth of groundwater table so warrants all underground pits, tunnels, basements etc. (excluding appurtenances of storm water/effluent collection system, cable trench, pipe trench) shall be of leak-proof RCC construction using waterproofing compounds.
- d) All liquid retaining/storage RCC structures shall be leak-proof and designed as uncracked section as per IS: 3370. However, the parts of such structures not

coming in contact with the liquid shall be designed according to IS:456 except ribs of beams of suspended floor slabs & counter forts of walls (located on the side remote from the liquid) and roof which shall be designed as uncracked section. No increase in permissible stresses in concrete and reinforcement shall be made under wind or seismic conditions for such structures.

- e) The walls and base slabs of liquid retaining/storage structures shall be provided with reinforcement on both faces for thickness greater than or equal to 150mm. In all liquid retaining structures, PVC water bars (minimum size 230mm wide, 5mm thick) shall be provided at each construction joint.
- f) Hot/cold water basin and other primary framing members of Cooling towers or similar liquid retaining structures which remain constantly in contact with water (stored/sprayed) shall be designed as uncracked sections.

8.2 REINFORCEMENT BARS

High Strength Deformed TMT steel bars of grade Fe 500 (with corrosion inhibitors in concrete) conforming to IS: 1786 shall be used for all structures.

8.3 CONCRETE

Minimum grade of reinforced cement concrete to be used for different structures and foundations shall be **M30**. From Durability considerations the minimum cement content and maximum water-cement ratio shall be as under. However, the maximum cement content shall not exceed 450 kg/m³.

For all stations/terminals

Type of cement	Plain concrete (M20)		Reinforced concrete (M30)		Exposure Condition
	Minimum cement content (kg/m ³)	Maximum water-cement ratio	Minimum cement content (kg/m ³)	Maximum water-cement ratio	
OPC/Fly ash based PPC/SRC(*)	250	0.50	320	0.45	Severe

OPC: Ordinary Portland cement, PPC: Portland Pozzalana Cement

*SRC: Sulphate Resistant Cement (if required as per soil recommendation for respective site)

75mm thick lean concrete of grade 1:5:10 shall be provided under all RCC foundations except under base slab of liquid retaining structures where **100 thick** concrete of mix 1:3:6 shall be used. The lean concrete shall extend **50mm** beyond the foundation for normal foundations and **75mm** under liquid retaining structures.

Plain Cement Concrete (PCC) of grade M15 of minimum 150mm thickness shall be provided under all masonry wall foundations.

Plain cement concrete of grade M20 of minimum 40mm thickness shall be provided as damp proof course at plinth level of all masonry walls and to be coated with 3mm thick bitumen emulsion.

8.4 MINIMUM COVER TO MAIN REINFORCEMENT

The following minimum clear cover shall be provided for RCC works.

- Slab (roof & floor), Canopy, Cantilever, Waist slab 45mm
- Beam (roof, floor & tie), lintel 45mm
- Column, Pedestal 50mm
- Retaining Wall, Basement and Pit Wall.
 - a) Face in contact with earth 50mm
 - b) Free face 45mm
- Liquid retaining structure
 - a) Face in contact with liquid 45mm
 - b) Face away from liquid but in contact with earth 50mm
 - c) Free face 45mm
- Foundation slab, base slab, plinth beam 50mm
- Pile Cap
 - a) Bottom face 100mm
 - b) Top face 50mm

8.5 MINIMUM THICKNESS OF STRUCTURAL CONCRETE ELEMENTS

The following minimum thickness shall be followed:

- Footings (All types, with or without beams) 300mm
(Note: Tapered footings shall not have thickness less than 150mm at the edges. Minimum average thickness shall not be less than 300mm)
- Pile Cap 500mm
- Basement
 - a) Walls 150mm
 - b) Base slab with beams 200mm

c)	Base slab without beams	300mm
-	Slab thickness in Raft foundations with beam & slab construction	150mm
-	Floor/Roof Slab, Walkway, Canopy Slab	120mm
-	Cable/Pipe Trench/Launder Walls & Base Slab	125mm
-	Parapet	75mm
-	Louvre / Fin.	100mm
-	Precast Trench Cover/Precast Floor Slab	125mm
-	Louvre (in contact with liquid)	125mm
-	Liquid Retaining / Leak proof Structure	
a)	Walls	150mm
b)	Base slab with beams	200mm
c)	Base slab without beams	300mm
-	Underground Pit	
a)	Walls	150mm
b)	Base slab with beams	200mm
c)	Base slab without beams	300mm
-	Blast resistant construction	AS/OISD-STD-163

9.0 SPECIAL CONSIDERATIONS FOR STEEL STRUCTURES

9.1 General/design methods

- a) Design, fabrication and erection of the above work shall be carried out in accordance with the following IS Codes as applicable to the specific structures, viz. IS: 800, 801, 802, 806, 814, 816, 875, 1893, 9178, 9595, 6533, etc. Basic consideration of structural frame work shall primarily be stability, ease of fabrication/erection and overall economy satisfying relevant Indian Standard Codes of Practice. Simple and fully rigid design as per IS: 800 shall be used. Where fully rigid joints are adopted they shall generally be confined to the major axis of the column member
- b) Structural elements continuously exposed to temperatures above 200⁰ C shall be designed for reduced stress as per IS:800.
- c) Crane gantry girders shall generally be of welded construction and of single span length. Chequered plate shall be used for gantry girder walkway flooring.
- d) Steel staircases for main approaches to operating platforms shall have channels provided as stringers with minimum clear width of 750mm and slope of app. 41 degree. The vertical height between successive landings shall not be less than 2.6m

nor exceed 4.0 meters. Treads shall be minimum 230mm wide made of grating (with suitable nosing) spaced equally so as to restrict the rise to maximum 200mm.

- e) Hand rails, 1000mm high, shall be provided to all walkways, platforms, staircases. Toe plate (100mmx5mm) shall be provided for all hand railing (except for staircases). Spacing of uprights shall be 1500mm (maximum). Two types of hand railing shall be provided.
 - i) For Tech. structures, walkways, platforms (except platform around/on circular/horizontal vessels), and staircases: Top rail, mid-rail and upright shall be 32mm dia (NB) galvanised MS tubes.
 - ii) For platforms around circular vessels: Top rail shall be 32mm dia (NB) galvanised MS tubes but mid rail and upright shall be of structural steel.
- f) Electro-forged hot dip galvanised MS Gratings shall be minimum 25 deep. The maximum size of voids in the grating shall be limited to 30mm x 100mm. The minimum thickness of galvanising shall be 120 microns.
- g) Welded connections shall be adopted as far as practicable except for the removable members where bolted connections are required viz. (Galvanised) electrical switchyard structures and transmission towers. Structural connections shall have minimum two bolts of 16mm dia. unless otherwise limited by the size of members.
- h) Minimum two nuts shall be used for all anchor bolts except for ladder, stair and handrail.
- i) Structural section shall be conforming to IS:808 and/or IS:12778. RHS/SHS section conforming to IS:4923 shall be used. CHS section shall be conforming to IS:1161.

9.2 GRADE OF STEEL

Structural steel shall be of yield stress of 250 MPa conforming to grade A of IS: 2062. RHS/SHS/CHS shall conform to Yst 310/240.

9.3 FIREPROOFING OF STEEL STRUCTURES

Fire proofing of steel structures shall be by concrete (for structures supporting transfer line & two phase flow line above 6" diameter) and vermiculite (for other structures), wherever required as per OISD-STD-164 and shall be done for 2 hours fire rating as per EIL specification or as required as per TAC rules. Guniting method of fire proofing shall be applied for equipment skirts

9.4 Limiting permissible Stresses

- Permissible stresses in structural members shall be as specified in:

IS: 800	Hot rolled sections (excluding transmission towers and switchyard structures).
IS: 801	Cold formed light gauge sections
IS: 802	Code of practice for use of structural steel in overhead Transmission line towers & switchyard structures
IS: 806	Tubular structures

- Permissible stresses in bolts shall be as specified in:

IS: 800	Hot rolled sections
IS: 801	Cold formed light gauge sections.
IS: 802	Transmission towers & switchyard structures.

- Permissible stresses in welds shall be as specified in:

IS: 801	Cold formed light gauge sections.
IS: 816	Metal Arc Welding

9.5 Limiting Deflection

- a) The limiting permissible vertical deflection for structural steel members shall be as specified below:

- Gantry girder for electric overhead crane (Capacity up to 50T)	: L/750
- Gantry girder for electric over head crane (Capacity over 50T)	: L/1000
- Gantry girder for manually operated crane	: L/500
- Girder/beam for supporting dynamic equipment/hoist	: L/450
- Grating/Chequered plate	: L/200 or 6mm whichever is minimum
- Purlins supporting any type of roofing material under (dead load+live load) or (dead load+wind load) conditions	: L/200
- Other structures/structural components	: As specified in Relevant IS Codes

Where 'L' represents the span.

- b) The limiting permissible horizontal deflection for multi storied steel structure/ building including flare stack shall be Height/325.

9.6 Minimum Thickness

The minimum thickness of various structural components (Hot rolled sections) shall be as given:

a) General Construction:	
Trusses, purlins, side girts & bracings	6mm
Columns, beams	7mm
Gussets in trusses & girders	
i) upto and including 12m span	8mm
ii) above 12m span	10mm
Stiffeners	8mm
Base plates	10mm

Chequered plate
Grating

6mm (on plain)
3mm

Structural members exposed to marked corrosive action shall be increased in thickness or otherwise suitably protected against corrosion.

The minimum thickness of structural components (except gratings & chequered plates) which are directly exposed to weather and inaccessible for repainting shall be 8mm.

b) Transmission Towers & Switchyard Structures:

The minimum thickness of various structural components shall be as per IS: 802.

The minimum thickness for rolled beams and channels shall be mean flange thickness regardless of the web thickness.

The minimum thickness of tubes shall be as specified in IS: 806.

9.7 PAINTING

Painting including shop primer to Structural Steel shall be as per painting specification attached elsewhere.

10.0 SPECIAL CONSIDERATIONS FOR MASONRY WORKS

10.1 General

Masonry works shall be of the class which is locally available in accordance with IS: 1077, IS: 1905, IS: 1597, IS: 12894 and other relevant IS Codes as applicable. All external brick masonry walls shall be of minimum 230mm thickness except for fire walls.

10.2 Cement Mortar

All masonry work shall be constructed in cement sand mortar 1:6 except half brick partition walls which shall be constructed in 1:4 cement sand mortar with two numbers of 6mm diameter MS bars provided at every fourth course properly anchored with cross walls or pillars.

11.0 DESIGN REQUIREMENTS FOR SPECIFIC APPLICATIONS

11.1 PIPE RACK & PIPE SUPPORTS

Design of pipe rack & pipe supports shall be as per document no. 8-76-0020

11.2 MACHINE FOUNDATIONS

Machine foundations shall satisfy the requirements of IS: 2974 and any other parameter as per machine vendor.

12.0 SPECIFIC REQUIREMENT

Maintenance platform below Coolers shall be full RCC platform.

Sand Filling for Ring Wall foundation shall be either by river sand or crushed Stone Sand.

TABLE-1

FOUNDATION DESIGN - FACTORS OF SAFETY

Type Of Structure	Minimum Factor Of Safety Against Overturning		Minimum Factor Of Safety Against Sliding		% Weight Of Overburden Over Projected Plan Area Of Footing
	With Wind Or Seismic	Without Wind Or Seismic	With Wind Or Seismic	Without Wind Or Seismic	
All Buildings/ Structures/Eqpts. in Units	1.5	2.0	1.5	1.5	100
Pipe Rack (Offsite)	1.5	2.0	1.5	1.5	50 ^{\$}
Flood Light Mast	1.5	-	1.5	-	50 ^{\$}
Retaining Wall	1.5	2.0	1.5	1.75	100
Over Head water Tank	1.5* / 2.0	-	1.5	-	50 ^{\$}
Flare Supporting Structure	1.5	-	1.5	-	50 ^{\$}
Blast Resistant Structures	1.5	2.0/1.2 [#]	1.5	1.5/1.5 [#]	100

* Empty condition

With blast pressure

\$ In case area is paved, overburden shall be based on NGL (for area under filling) or 600mm below HPP whichever is lower. In case of unpaved area, it shall be w.r.t. FGL.

Minimum Factor of safety against UPLIFT shall be 1.2 for all structures. (Note: In case of sumps, lining weight shall not be included)

TABLE – 2

FLOORING DETAILS FOR BUILDINGS & SHEDS

S No	Description		Flooring Type		
			I	II	III
1(a)	Sub Grade	Earth fill base compacted to 95% dry density.	✓	✓	✓
1(b)		Compacted layer of sand/boulder packing over thoroughly compacted Earth fill (in mm)	200 THK.	200 THK.	150 THK.
2(a)	Strl Grade Slab	Lean concrete 1:5:10 over sand layer (in mm)	50 THK.	50 THK.	50 THK.
		Strl. non suspended slab in M20 Grade concrete (Reinforced with 8mm dia bars @200 c/c both ways) over lean concrete.	150 THK.	150 THK.	100 THK.
2(b)		R/F placement	R/F placed centrally	R/F placed in two layers at top & bottom	No R/F required.
3	Finish	Floor finish	As per Arch Detail	As per Arch Detail	As per Arch Detail

Type I: Plant Buildings such as Sub-Stations, Control Rooms, Pump Houses, Utility Compressor Houses, Parking Areas, Stores, Porches.

Type II: Ware Houses, Workshops, Cement Godowns, Fire Stations, Process Compressor Houses.

Type III: Non Plant Buildings (viz. Administration, Laboratory, Canteen, Time Office, Gate House, Training Centre, Guest House, Residential buildings).

Notes:

- 1) Reinforcement steel shall be as per clause 8.2.
- 2) For Ware Houses & Work shops non suspended ground floor slabs with above specifications shall be provided using vacuum dewatering concrete system.

PART –II : ARCHITECTURAL

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ENGINEERING DESIGN BASIS

1.0 REFERENCED PUBLICATIONS

1. National Building Code of India
2. Factory Law
3. Local Municipality or any other Authority's Bye-laws as applicable.
4. TAC (Tariff Advisory Committee) Rules.
5. Bye-laws of Town & Country Planning Organisation
6. OISD Norms
7. BPE Norms
8. BIS Codes
9. Indian Electricity Rules
10. Any other applicable Law, Rules, Standard as referred in respective clause.

1.1 STANDARD SPECIFICATIONS CODES & PRACTICES

EIL Engineering design incorporates Codes and Standards as referred in the design philosophy of respective engineering disciplines as well as applicable EIL standards specifications.

2.0 DESIGN PHILOSOPHY/ CRITERIA

2.1 ARCHITECTURAL DESIGN

Architectural design of the buildings shall be in accordance with this design basis and references as stated above to meet the functional requirements.

2.2 BUILDING REQUIREMENTS

2.2.1 List of buildings:

Following buildings are envisaged in this project.

2.2.1.1 Non-Plant Buildings

1. Security Barracks and Guard Houses
2. Product Ware House
3. Central Ware House
4. Guest House
5. Construction Office Building
6. Canteen Building
7. Emergency DG House
8. Health Centre
9. Administrative/Training/ Medical centre
10. Central Laboratory Building
11. Polymer Service Building
12. NCU/GCU Service Building
13. Central Workshop
14. Central Warehouse
15. Weigh Bridge
16. Chemical Storage Building

17. Gate Houses

The above list of Non Plant Building is subjected to finalization during detail engineering

Spatial requirement for non-plant buildings. shall be finalized looking into the functional requirements and its occupancy which shall be governed by Owner's specific requirement. Design shall be in accordance with Factory Act, NBC etc.

Requirement of services/utilities such as air conditioning, LAN etc. shall be finalized as per Owner's specific requirement.

2.2.1.2 Plant Buildings

1. Main Control Room
2. Satellite Rack Room
- 3 Sub Stations

The above lists of Plant Buildings are subjected to finalization during detail engineering.

Spatial requirements of these Plant Buildings shall mainly be decided based on the equipment/panel layout, activities to be performed in the building and consequent occupancy pattern. Sizes of various type of spaces shall be decided based on occupancy/ equipment/Panel layout, clearances, maintenance & safety requirements. The objective of spatial arrangement shall be to satisfy functional requirements, physical comfort, and safety regulations as well as aesthetics.

- (a) Control Room Buildings & Satellite Rack Rooms for Process Units shall be designed as per OISD-STD 163, TAC building bye-laws and Factory Act. Control Room Buildings shall be centrally air-conditioned, single storied construction, designed to fully meet the Instrumentation, Electrical, HVAC, safety and other requirements.

Control Room Buildings shall broadly consist of Console Room, Rack Room, EC/ PLC Room, Computer Room, UPS Room, Battery Room, Operators' Rooms, Shift-in-Charge Rooms, Supervisor's Office accommodation, Instruments Calibration Room, Operators' Check and Change Room, Toilets (Ladies & Gents), A.C. Plant/ AHU Rooms, Clean Agent Storage Room etc.

Satellite Rack Rooms shall broadly consist of Rack Room, Room, UPS Room, Battery Room, A.C. Plant/ AHU Rooms, Clean Agent Storage Room etc. Operators' Rooms, Toilets (Ladies & Gents) may be provided if required.

Requirement of Blast resistant design and construction shall be finalized during detail engineering stage.

- (b) Sub-Station buildings shall be designed as per OSID –STD 149; 173; IEA;IER; TAC building bye-laws, Factory Acts etc. Sub Stations shall be double storied having Cable Cellar at ground floor or single storied (having trenches for the cables) as per the Electrical requirements and Electrical Design Basis. Sub Station Buildings shall broadly consist of Switchgear Room, Operator's Room, Battery Room, Other Electrical Panels' Room, Pressurization Room etc. as per functional requirements and Electrical design basis. Toilets shall be provided as per requirement.

2.2.1.3 Units

1. Process buildings/ sheds of DFCU unit (plant/equipment sheds, analyzer room etc. As required)
2. Process buildings/ sheds of PGHU unit (plant/equipment sheds, analyzer room etc. As required)
3. Process buildings/ sheds of BzEU unit (plant/equipment sheds, analyzer room etc. As required)
4. Process buildings/ sheds of BdEU unit (plant/equipment sheds, analyzer room etc. As required)
5. Process buildings/ sheds of LLDPE unit (additive house, extruder house, Bagging & palletization building, catalyst storage, teal house, storages, Analyzer room etc. As required)
6. Process buildings/sheds of HDPE unit (additive house, bagging building, extruder house, analyzer room, etc. As required)
7. Process buildings/ sheds of PP unit (polymerization building, catalyst/ mineral oil storage, extruder house, bagging/palletization & bulk loading building, warehouse, valve house, analyzer room etc. As required)
8. Process buildings/ sheds of BUTENE -1 unit (plant/equipment sheds, analyzer room etc. As required)

The above lists of buildings/sheds are subjected to finalization during detail engineering.

Buildings/ Sheds of Process Units shall be designed as per Factory Act & NBC incorporating special requirements of Licensors if any.

Ventilation and day-lighting shall be ensured by means of louvers/ window & ventilators and roof monitors. Necessary lifting devices shall be provided.

2.2.1.4 Utility Facilities

1. Buildings/ sheds for power receiving and distribution system utility package (as required for utility package)
2. Buildings/ sheds for raw water system utility package (as required for utility package)
3. Buildings/ sheds for DM water system utility package (as required for utility package)
4. Buildings/ sheds for cooling water system utility package (as required for utility package)
5. Buildings/ sheds for compressed air (instrument & plant) system utility package (as required for utility package)
6. Buildings/ sheds for fuel gas system utility package (as required for utility package)
7. Buildings/ sheds for Inert gas system utility package (as required for utility package)
8. Buildings/ sheds for Steam generation system utility package (as required for utility package)

9. Buildings/ sheds for condensate & condensate polishing system utility package (as required for utility package)
10. Buildings/ sheds for emergency power system utility package (as required for utility package)
11. Buildings/ sheds for utility & product distribution piping utility package (as required for utility package)

The above lists of buildings/sheds are subjected to finalization during detail engineering.

Buildings/ Sheds of Process Units shall be designed as per Factory Act & NBC incorporating special requirements of Licensors if any.

Ventilation and day-lighting shall be ensured by means of louvers/ window & ventilators and roof monitors. Necessary lifting devices shall be provided.

2.2.1.5 Offsite Facilities

1. Buildings/ sheds for tankage/ storage facility (as required for offsite package)
2. Buildings/ sheds for resin silos and bagging facility (as required for offsite package)
3. Buildings/ sheds for effluent system (as required for offsite package)
4. Buildings/ sheds for chemical storage (as required for offsite package)
5. Buildings/ sheds for catalyst storage (as required for offsite package)
6. Buildings/ sheds for fire fighting system (as required for offsite package)
7. Buildings/ sheds for security & surveillance system (as required for offsite package)
8. Buildings/ sheds for loading and unloading system (as required for offsite package)

The above lists of buildings/sheds are subjected to finalization during detail engineering.

Buildings/ Sheds of Process Units shall be designed as per Factory Act & NBC incorporating special requirements of Licensors if any.

Ventilation and day-lighting shall be ensured by means of louvers/ window & ventilators and roof monitors. Necessary lifting devices shall be provided.

2.2.2 Day Lighting

Established level of illumination shall be maintained for all parts of the buildings by means of windows, ventilators etc. Provision of referenced publications like NBC part-VIII; Section-1; IS-2440-1975; IS-3646 (part II-1996); IS-7662 (part I-1974), Factory rule or other relevant rules etc. shall be adhered to in this regard. Openings shall be provided with shading devices to avoid glare. For the purpose of illumination, day lighting shall also be supplemented by artificial illumination particularly at fire-exit.

2.2.3 Ventilation

2.2.3.1 Natural Ventilation

Established level of ventilation in terms of air changes per hour shall be maintained for all spaces as per the provision of referenced publications like State Factory rules,

NBC part-VIII Section-1, IS:3101-1975 (Industrial building), IS:3362-1975 (Residential buildings), IS:7662 (Part I-1974) or other relevant code/ rules. Natural ventilation shall also be supplemented by mechanical or electrical means of ventilation in all human occupied areas. Sufficient no. of Glazed/Louvered windows/Ventilators shall be provided and supplemented by exhaust fans.

2.2.3.2 Mechanical ventilation

In addition to natural ventilation, if required Mechanical or electrical ventilation is provided depending on the type of building and its use. Refer Design Basis of Packaged Equipment for its requirement and applications.

2.2.4 Safety Requirement

Safety from fire and like emergencies shall be taken into account in building design as per NBC-Part IV; State Factory Rules and other relevant code/ rules. The buildings shall be provided with exits sufficient to permit safe escape of occupants in case of emergency. The exits shall be in terms of doorway, corridors, etc. to internal/ external staircase or to areas having access to the outside.

2.2.5 Site planning & Landscaping

Site planning of building shall take into account aspects like inter-relationship of the buildings with the whole system, movement pattern, traffic and road net-work, safety regulations, service network, fire safety, climatic and environmental aspects, site conditions like site dimension, contour, drainage, noise level, view, future expansion, visual aspects etc.

Main and service/ maintenance entrances of buildings shall be provided with vehicular access. All exit points shall also be provided with footpath/ vehicular access. Truck movement space in accordance with traffic pattern shall be provided for the building as per the location of hoisting bay/loading, unloading platform. Road network and open space around the buildings shall be designed considering movement and functioning of Fire tenders and cranes etc.

Suitable Landscaping treatment shall also be done around the important buildings. Such treatment shall generally consist of lawns, road side plantation and beautification of building entrance areas. Standard landscape elements such as earth contours, pavings, flower beds, hedges, shrubs, ground cover and ornamental trees shall be incorporated in landscape treatment. Necessary water supply/sprinklers shall also be provided.

2.3 BUILDING SERVICES

Following services shall be provided for all buildings as essential services.

2.3.1 Water Supply, Distribution and Drainage, Sanitary Services.

This service is essential for all human occupied buildings. The building shall have toilet and drinking water facility and accordingly water supply, distribution and drainage, sanitary services as per NBC- Part-IX: Section 1&2, Factory rules and or referenced publication. Drinking water provisions shall be provided within an enclosure separated from the toilets. Space for janitor shall be provided in the toilets. All service pipes showing on the external wall shall be suitably concealed or shall be provided within a shaft.

2.3.2 Electrical Services

This service shall be provided as essential service for all the buildings. Electrical services for building shall consist of electrical supply, and distributions, electrical lighting installations, telephone network, fans, exhaust fans, lighting protection system etc., all accessories, cabling etc. including Emergency power supply, all as defined under Engg. Design Basis of Electrical.

2.3.3 Air Conditioning and Heating

Control Room Building, Administration Building, etc. shall be centrally air-conditioned. Accordingly A.C. Plant/ AHU etc. of the require capacity (depending on the requirement) shall be provided and suitably housed. Some designated rooms (as per Electrical requirement) in the Sub Station Buildings may be required to be air-conditioned. For this suitable window/ split/ package type units may be provided as per requirement w.r.to the Design Basis of Packaged Equipment.

2.4 AESTHETICS

Apart from the fulfillment of functional & safety requirement, aesthetic requirement of the building shall be taken care of in the design. Preliminary drawings indicating Architectural scheme shall be submitted for Owner's approval.

Architectural scheme shall be based on general principles of Aesthetics. Building facades shall reflect such principles like symmetry, balance, proportion, rhythm, light and shade etc.

Building Elements like canopies, overhangs & shading devices, gutters, roof projections, parapets, door; window/ ventilator composition, External wall/ facade shall be considered as contributory elements to aesthetics.

Architectural scheme including design of above mentioned elements shall be subjected to Owner/ PMC approval.

Minimum two alternative Architectural scheme of buildings as desired by PMC/ Owner shall be prepared and submitted for approval.

2.5 STRUCTURAL AND CONSTRUCTION ELEMENTS

The structural system shall be as specified in Engineering Design Basis (Structural).

2.6 BUILDING ELEMENTS

2.6.1 Plinth Protection

The building shall be provided with minimum 900 mm wide (100mm high from top of Approach Road Level) plinth protection around the building.

2.6.2 Finished Floor Level (FFL)

In general, FFL of the Building shall be determined with respect to top of approach road or pavement. Following schedule shall be adhered to for FFL of the building:

- A. Control Room Building (Buildings having false flooring):
Top Road level of Approach road + 150 mm + Height of false flooring

- B. Sub Station Buildings:
- (i) Top of approach Road level +300 mm (Cable Cellar floor)
 - (ii) Top of approach Road level +150 mm (Transformer bays) with pebbles
 - (iii) F.G.L. (+) approx. 1000 mm high from top of road (in case of single storey Substation Building with trenches as per electrical requirement.
- C Plant Buildings (Unit area) floors (HPP) shall be maintained as per Design Basis of General Civil.
- D. Other Buildings:
Top of approach Road level +300 mm to 450 mm and or as per functional requirement.

Notes:

1. In case of approaches with different top levels, the highest top level of approach road/ pavement shall be considered.
2. FFL shall be same throughout in a building.
3. FFL of external loading/unloading bays/ platforms, toilet, pantry, and kitchen shall be 10-15 mm lower than that of the building FFL to check ingress/spillage of water.

2.6.3 Steps/ ramps/ Stairs

Steps/ ramps shall be provided for access to the Building for pedestrian/ vehicular, equipment entry as per relevant code. Minimum 1000 mm wide platform shall be provided in between entrance door and steps/ramps. Following dimensions of the steps/ ramps shall be adhered to.

- | | | |
|----|--------------------------|--|
| A | Stairs width | = 1500mm minimum |
| B. | Tread | = 300 mm minimum |
| C. | Riser | = 150 mm maximum |
| D. | Slope of Ramp | = Not steeper than 1:6 or as per requirement |
| E. | Ratio of Tread & Riser | = 2 Riser + Tread= 600 to 650 mm |
| F. | No. of risers per flight | = 15 Nos. |
| G. | Landing width | = 1500. minimum |

2.6.4 Walls

Following schedule shall be adhered to for wall material and thickness:

- | | | |
|----|---------------------------------|--|
| A. | External, walls | = 230 mm. thk. Brick wall |
| B. | Internal partition wall | = 230/115 mm thk. Brick wall depending on the overall length and height of the wall (refer note below) |
| C. | Transformer Walls | = 200 thk. RCC or 355 thick (including plastering) fire walls as per Electrical requirements. (IER) |
| D. | Concrete wall (Blast resistant) | = As per structure design basis |

Notes:

1. 115 mm thk. brick partition walls (with nominal steel requirement as per structure design) shall be provided with 230 mm thk. brick pillars for stability.
2. Wherever conduits or pipes are required to be concealed within partition wall, the wall thickness shall be increased suitably.
3. Wherever, bricks are not commonly available, suitable alternative material shall be used after obtaining owner's approval.

2.6.5 Doors

Doors shall be provided for access, security and safety at all entry & exits of rooms, functional areas & the buildings. Air tight door shall be provided in pressurized area and in gaseous protection area. Fire check doors shall be with minimum two hours rating as per statutory requirement. Sizes of the doors shall be determined on the basis of the following schedule:

- A. Equipment, Panel area: Size of max. equipment including packing.
- B. Other areas: Volume of movement through door.
- C. W.C., Bath Cubicle Door: 800 mm x 2100mm (wall opening size)
- D. Minimum size of other doors: 1000mm x 2100mm (wall opening)

Notes:

1. Rolling shutters shall be provided for equipment entry for Switchgear Room/ Electrical Room, A.C. Plant Room etc.
2. Motor operated Rolling Shutters shall be provided in the main equipment entry door.

2.6.6 Windows/ ventilators

Windows/ ventilators shall be provided in all areas for natural lighting, ventilation and visibility at working level.

For the purposes of natural ventilation, total openable area of the windows/ventilators shall be as per Factory Act subjected to a minimum of 15% of the floor area to be ventilated.

For the purpose of natural lighting total glass area shall be minimum 15% of the floor area. However, in case of offices, work places etc. windows shall be provided for the full length of walls as per approved Architectural scheme. Areas accommodating panels/eqpts. shall be normally provided with ventilators at high level for unobstructed distributed lighting.

Wherever due to limitation of external wall area or any other reasons, stipulated area of window/ ventilation for ventilation cannot be provided, suitable mechanical devices shall be provided. For Workshop/Warehouse sheds etc. with roof sheeting etc. suitable monitor to be provided for ventilation.

Transparent roof light sheeting shall be provided in roofing of shed type structures for day lighting.

2.6.7 Canopy/ Overhang

Canopy/overhangs shall be provided at all entries & exits for rain & sun protection. Size of the canopy/ porch shall be decided w.r.to utility of the building and other aesthetic. Blast proof Control Rooms shall not have any projections with outer face of its walls except with false treatment for aesthetics of the building.

2.6.8 Shading Devices

Shading devices shall be provided over all windows, openable ventilators for rain & sun protection. These devices shall be in form of horizontal projections, vertical projected fins or combination of both as per building facade treatment. Minimum projection shall be 600 mm.

2.6.9 Parapet

Parapets shall be of RCC for all buildings with minimum 500 mm high for non-approachable roof and 900 mm high for approachable roof.

2.6.10 Roof Gutter

Gutter with rain water pipes or R.C.C. shafts shall be provided for all the building for roof water drainage. Sizing of the gutter shall be based on area to be drained and number of outlets. Gutters shall be of RCC. For Workshop/ Warehouse shed with precoated roof sheeting, precoated sheets gutters may be provided and for big size of workshops/warehouse RCC shaft may be provided at the end of gutter.

2.6.11 Rain Water Pipes, Spouts

Rain water pipes shall be provided for roof water drainage. Number of rain water pipes shall be decided on the basis of roof area, slope and rainfall intensity as per NBC-IX Section 2. Rain water pipes shall be embedded in concrete. RCC or GI spouts may be used for drainage of chajja/small canopies of ground floor.

2.6.12 Air Lock Lobby

This shall be provided for all entries with centrally air-conditioned spaces.

2.6.13 Emergency Exits

Emergency exits shall be provided for the building as per State Factory Rules, NBC-Part IV and for individual functional spaces such as Console area, Electrical room etc. Emergency exits shall be located in such a manner that escape route is direct, unobstructed & without passing through any other functional areas to safe area.

2.6.14 Staircases

Staircases shall be provided for vertical circulation & emergency exits. Number of staircases shall be based on building sizes more than 500 Sq.M ground covered area shall have two stairs (NBC-Part IV). Emergency exit requirements shall be as per safety distance requirement. At least one no. staircase/ladder shall be provided for access to the flat roof top for maintenance.

2.6.15 Railings

Railings shall be provided in stairs, and in all unprotected openings in slabs as a safety device. Steel railings in loading/ unloading bay of shall be of removable type.

2.6.16 False Ceiling

False ceilings shall be provided in the all air-conditioned areas for the purpose of reducing room volume and to hide air conditioned ducting etc. and also to maintain acoustic level inside any space.

2.6.17 False/Cavity flooring

False/ cavity flooring shall be provided to accommodate under floor cabling in Instrumentation areas like Console Room, Rack Room, Computer Room etc. Extent of false/ cavity flooring shall be as per Instrumentation requirements.

2.6.18 Transformer Gate

Steel gate of suitable size in front of transformer bays in substations building may be provided as per electrical requirement.

2.7 SCHEDULE FOR ARCHITECTURAL FINISHES

2.7.1 GENERAL

For the purposes of schedule of Architectural finishes, buildings are categorised into following types. colour Scheme for all Architectural items shall be as approved by the Owner.

Type	Buildings
Type A	Important buildings like Administration Building / Training / Medical centre, Main Gate/ Guard House
Type B	Control Rooms, Satellite Rack Room, Sub Stations
Type C	Non plant buildings like Guest house, Canteen Building, Health Centre, Central Laboratory Building, Gate House (other than main gate/ guard house) etc.
Type D	Non plant buildings like Service Buildings, Security Barracks, Product Ware House, Central Ware House, Construction Office Building, Central Workshop, Central Warehouse, NCU/GCU Service Building, Weigh Bridge, Chemical Storage Building etc. & other non plant buildings not categorized under any other group
Type E	Utility/ storage/ Process Buildings/ Sheds like DG Shed, Pump Houses, Compressor House, Process Building/Sheds, Cement Godown, Storage Shed, Analyzer Room etc.

Note:

In case of conflict between licensor/ process/ safety/ statutory requirement and this schedule of Architectural finishes, the former shall override.

2.7.2 EXTERNAL FINISHES

2.7.2.1 External wall, RCC Surfaces

A. Type "A" Buildings

- Composite Aluminum Panel & structural glazing

B. Type "B" Buildings

- Sand stone cladding

C. Type "C" Buildings

- Plain cement plaster and texture coating ('Heritage' or 'Spectrum')

D. Type "D" Buildings

- Plain cement plaster and Acrylic paint

E. Type "E" Buildings

- Plain cement plaster and waterproof cement paint

2.7.3 INTERNAL FINISHES

2.7.3.1 Floor finishes:

A. Entrance Lobby, Reception, lounge, Waiting area etc :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone	○ Granite stone	○ Vitrified tiles	○ Kota stone	○ Kota stone

B. Office and associated areas like records/ storage, meeting/ conference room etc.:

Type-A	Type-B	Type-C	Type-D	Type-E
○ Vitrified tiles	○ Vitrified tiles	○ Vitrified tiles	○ Ceramic Tiles	○ Kota stone

C. Circulation area (Corridor, passage, etc.):

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone	○ Granite stone	○ Vitrified Tiles	○ Kota stone	○ Kota stone

D. Kitchen, Pantry & Dining hall etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Vitrified Tiles	○ Vitrified Tiles	○ Vitrified Tiles	○ Ceramic Tiles	○ Kota stone

E. Toilet, Drinking water area etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite Stone	○ Granite Stone	○ Vitrified Tiles	○ Ceramic Tiles	○ Ceramic Tiles

Note: In Sub Station building flooring of Toilet/ drinking water shall be of Ceramic Tiles

F. Staircase.

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite Stone	○ Granite Stone	○ Marble Stone	○ Kota Stone	○ Kota Stone

Note: In Sub Station building flooring of staircase shall be of Kota stone

G. Battery Room & Chemical Handling areas (All type of Buildings):

- Chemical resistant Epoxy coating

H. Electrical Room, Pressurisation Room, AC Plant, Loading / Unloading bays, Equipment handling areas, Storage areas, Switchgear, MCC, Ware House, Work Shop, Process/ utility Sheds etc. (All type of buildings):

- Heavy duty cement concrete flooring.
(Vacuum dewatering flooring in large Rooms/ areas)

I. Console, Rack room , UPS Room , areas housing instrumentation equipments requiring under-floor cabling (All type of buildings):

- Raised Access/ cavity/ false flooring :
With High pressure laminate finish

2.7.3.2 Internal wall finishes:

A. Entrance Lobby, Reception , lounge, Waiting area etc :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone cladding	○ Granite stone cladding	○ Marble stone cladding	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

B. Office and associated areas like records/ storage, meeting/ conference room etc.:

Type-A	Type-B	Type-C	Type-D	Type-E
○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

C. Circulation area (Corridor, passage, etc.) :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone cladding up to 1500mm height, POP punning & Plastic emulsion paint above	○ Granite stone cladding up to 1500mm height, POP punning & Plastic emulsion paint above	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

Note : In Sub Station building wall finish of Circulation area shall be Oil bound distemper

D. Kitchen, Pantry & Dining hall etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado

E. Toilet, Drinking water area etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Granite stone dado	○ Granite stone dado	○ Ceramic tile dado	○ Ceramic tile dado	○ Ceramic tile dado

Note: In Sub Station building cladding in Toilet etc. shall be of Ceramic Tile dado

F. Staircase.

Type-A	Type-B	Type-C	Type-D	Type-E
○ Textured coating	○ Textured coating	○ Plastic emulsion paint	○ Plastic emulsion paint	○ Oil bound distemper

Note: In Sub Station building Staircase wall finish shall be Oil bound distemper.

G. Battery Room & Chemical Handling areas (All type of Buildings):

- Acid resistant tiles/ epoxy coating over cement plaster up to 2500 height & oil bound distemper above 2500 height.

H. Electrical Room, AC Plant, Loading / Unloading bays, Equipment handling areas, Storage areas, Switchgear, MCC, Ware House, Work Shop, Process/ utility Sheds etc. (All type of buildings):

- Oil bound distemper.

I. Rack room , UPS Room (All type of buildings):

- POP punning with plastic emulsion paint

J. Console Room :

- Granite stone dado

2.7.3.3 Internal ceiling finishes:

A. Entrance Lobby, Reception , lounge, Waiting area etc :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Gypsum board panel false ceiling	○ Aluminum panel/ strip false ceiling	○ Gypsum board panel false ceiling	○ Gypsum board panel false ceiling	○ Oil bound distemper

B. Office and associated areas like records/ storage, meeting/ conference room etc.:

Type-A	Type-B	Type-C	Type-D	Type-E
○ Mineral fibre false ceiling	○ Aluminum panel/ strip false ceiling	○ Mineral fibre false ceiling	○ Mineral fibre false ceiling	○ Oil bound distemper

C. Circulation area (Corridor, passage, etc.) :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Gypsum board panel false ceiling	○ Aluminum panel/ strip false ceiling	○ Gypsum board panel false ceiling	○ Gypsum board panel false ceiling	○ Oil bound distemper

D. Other AC areas etc., where false ceiling required :

- Gypsum board false ceiling

E. Other area not indicated above etc. :

Type-A	Type-B	Type-C	Type-D	Type-E
○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ POP punning & Plastic emulsion paint	○ Oil bound distemper

F. Electrical Room, AC Plant, Loading / Unloading bays, Equipment handling areas, Storage areas, Switchgear, MCC, Ware House, Work Shop, Process/ utility Sheds etc. (All type of buildings):

- Oil bound distemper

2.7.4 DOORS

A. Entrance/ exit Doors

Type-A	Type-B	Type-C	Type-D	Type-E
○ Powder coated Aluminium glazed shutter	○ Powder coated Aluminium glazed shutter	○ Powder coated Aluminium glazed shutter	○ Powder coated Aluminium glazed shutter	○ Pressed steel

B. Doors in circulation area of all type of Buildings

- Glazed, powder coated Aluminum door

C. Office area doors

Type-A	Type-B	Type-C	Type-D	Type-E
○ TW frame, block board TW veneer finish flush shutter	○ Powder coated Aluminium glazed shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter

D. All Electrical Room, A.C. Plant Room, Battery Room doors of all type of Buildings

- Pressed steel frame with Pressed steel shutter

E. Toilet doors

Type-A	Type-B	Type-C	Type-D	Type-E
○ TW frame, block board TW veneer finish flush shutter	○ TW frame, block board TW veneer finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter	○ Pressed steel frame block board laminated finish flush shutter

F. Fire check/ resistant doors

Irrespective of above schedule, Fire check doors (minimum 2 hours rated) shall be provided wherever required as per OISD/ Statutory requirements.

1. Fire check doors In Control Room / Satellite Rack Room Building
 - A. Main entrance/ entry to Console :
 - Glazed steel Fire check door
 - B. Other Rooms :
 - Solid type steel fire check door (with 300x300 vision panel)
2. Fire check doors In Administration Building
 - A. Main entrance/ entry/ circulation area :
 - Glazed steel Fire check door
 - B. Other Rooms :

- Wooden, TW veneered fire check door (with 300x300 vision panel)

3. Fire check doors In other Buildings

A. Main entrance/ entry/ circulation area :

- Glazed steel Fire check door

B. Other Rooms :

- Solid type steel fire check door (with 300x300 vision panel)

Rolling shutters shall be provided in equipment areas like Switchgear/ MCC Room, Workshop, Ware House etc. where opening size for door exceeds 3000 x 3000mm. Doors/windows/ventilators shall be complete with all fittings & fixtures for easy smooth operation & locking facility.

2.7.5 WINDOWS & VENTILATORS

Type-A	Type-B	Type-C	Type-D	Type-E
○ Glazed, Powder coated Aluminium	○ Glazed, Powder coated Aluminium	○ Glazed, Powder coated Aluminium	○ Glazed, Powder coated Aluminium	○ Glazed, steel

2.7.6 ROOF TREATMENT

- Atactic Polypropylene modified bituminous waterproofing membrane .

2.7.8 ROOFING / CLADDING (sheds/workshop)

- Precoated, profiled colour coated galvanised steel sheet roofing/ cladding

2.7.9 SANITARY FITTINGS & FIXTURES

A. Water Closet (European type) :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Wall hung type, coloured (premium luxury model)	○ Wall hung type, coloured (premium luxury model)	○ Wall hung type, coloured (premium luxury model)	○ Pedestal type, coloured	○ Pedestal type, coloured

B. Wash Basins :

Type-A	Type-B	Type-C	Type-D	Type-E
○ Round, coloured, with electronic sensor over granite counter (premium luxury model)	○ Round, coloured, with electronic sensor over granite counter (premium luxury model)	○ Round, coloured, with electronic sensor over granite counter (premium luxury model)	○ Round, coloured, over granite counter	○ Wall hung type

C. Urinals :

Type-A	Type-B	Type-C	Type-D	Type-E
○ With electronic sensor (premium luxury model)	○ With electronic sensor (premium luxury model)	○ With electronic sensor (premium luxury model)	○ Standard Wall hung type	○ Standard Wall hung type

D. Plumbing fixtures (stop/ bib / pillar cocks, flash valves etc.):

Type-A	Type-B	Type-C	Type-D	Type-E
○ Stainless steel (premium luxury model)	○ Stainless steel (premium luxury model)	○ Stainless steel (premium luxury model)	○ CP Brass	○ CP Brass

JOB SPECIFICATIONS & DATA SHEETS (STRUCTURAL & ARCHITECTURE)

PART: A (STRUCTURAL)

STEAM & POWER GENERATION SYSTEM PACKAGE

PROJECT : DAHEJ PETROCHEMICALS COMPLEX

OWNER : ONGC PETRO additions LTD.

PMC : ENGINEERS INDIA LTD.

JOB NO. : 6987

0	30-06-2009	ISSUED WITH BID PACKAGE	PM	AS	SC
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

STRUCTURAL

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1.0 GENERAL

1.1 The design considerations given hereunder establish the minimum basic requirements of reinforced cement concrete (RCC) structures, structural steel works and masonry structures. All structures shall be designed for satisfactory performance and functions for which the same are to be constructed.

- a) All codes referred in this document pertain to BIS (Bureau of Indian Standards) publications and bearing the prefix IS.
- b) Whenever any reference to BIS code is made, the same shall be taken as the latest revision (with all amendments issued there to) on the notified date of submission of tender.
- c) Apart from the BIS codes mentioned in particular in the various clauses of this document, all other relevant codes related to the specific job under consideration and/or referred to in the above-mentioned codes, shall be followed wherever applicable. Reference to some of the codes in the various clauses of this document does not limit or restrict the scope of applicability of other relevant codes.
- d) In case of any variation/contradiction between the provisions of BIS codes and the requirements given hereunder, the provisions given in this document shall have precedence over all others. In absence of relevant BIS codes, reference to corresponding British/American codes may be made (in that order of preference).

All designs, detailing and construction shall strictly conform to the enclosed standards, specifications and 'Specific Requirements'. Only if relevant information is not available in this document, reference to relevant BIS code shall be made.

1.2 The Contractor shall do the structural designing of all structures and prepare complete set of civil and structural drawings needed for correct and accurate construction. The design shall be strictly in accordance with 'Design Criteria' given herein.

1.3 Detailed list of drawings/documents [including design calculations, design drawings, bar bending schedules (for RCC works) and fabrication drawings (for structural steel works)] and structure-wise quantity statements (showing anticipated, released and balance quantities of concrete, structural steel and piles) shall be prepared by the Contractor and submitted monthly for review by Owner/Owner's representative. This list shall also indicate the document/drawing category (approval, review or information as applicable) together with the scheduled and actual dates of submission of the documents.

1.4 Before proceeding with design and drawing preparation the Contractor shall submit detailed general philosophy of design of various parts of (all) the structures and equipment foundations along with explanatory sketches for review by Owner/Owner's representative. Only after the review and incorporation of comments on the general philosophy, as offered during the review, the Contractor shall submit any design document and/or drawing for review or

information or issue the same for construction. Design and detailing of the structures and foundations shall fulfill all functional requirements for which the same is intended and it shall be ensured that adequate accesses, clearances, clearing of interferences, provision of cutouts, etc. have been provided to make the structure/foundation fully operational.

- 1.5 The design and AFC drawings shall strictly adhere to the reviewed design basis and architectural/ structural general arrangement and shall incorporate all the comments/ suggestions given by Owner/Owner's representative without any extra cost to the Owner and any implication of time-schedule for completion of works.
- 1.6 Construction of units/structures identified for design/drawing review (as referred in Specific Requirements attached in this document) by Owner/owner's representative shall not be taken up at the site till these documents are reviewed by Owner/owner's representative and comments/suggestions given by Owner/owner's representative are incorporated. For all other foundations and structures the Contractor shall directly submit the AFC drawings to Engineer-in-Charge and construction of such works shall be taken up immediately. Requisite number of prints of design and drawings for such foundations/ structures shall also be simultaneously sent to Owner/owner's representative for their information and record. In the event Owner/owner's representative offers any comment on documents/drawings of *Information category* it shall be ensured by the Contractor that these comments are duly incorporated in the documents/ drawings and revised set of document/drawing is issued to site for construction and simultaneously to Owner/owner's representative for records.

Wherever review is carried out the same shall be restricted to following:

- a) Conformance of general arrangement of the structure to already reviewed design philosophy and design basis.
- b) Overall framing of the building/conceptual foundation system.
- c) Detailed design and drawings including input/ output of computer analysis and design vis-à-vis actual drawing.

Irrespective of the identified structures requiring review, the Contractor shall submit complete sets of design and drawings of all structures/foundation systems.

- 1.7 (i) Structural design/ drawings for any structure/ foundation shall be submitted for review only if referenced input (e.g. architectural drawing, piping GAD, equipment data sheet, vendor drawing, etc.) have been reviewed by the concerned Owner's specialist in approval/review code-2 or code-1.
- (ii) To facilitate an overall systematic review the Contractor shall submit the design and drawings for each independent building/structure, together with a copy of the referenced reviewed input data, in one lot.
- 1.8 Submission of all identified documents including design calculations and drawings for review and/or information/record to the Owner/Owner's

representative by the Contractor shall be in requisite (as mentioned elsewhere) number of prints. To ensure accuracy, correctness and completeness of documents before submission to Owner/Owner's representative, the Contractor shall ensure that all such submitted designs and drawings are complete in all respects, thoroughly checked, stamped **APPROVED FOR CONSTRUCTION (AFC)**, and signed APPROVED by the Contractor's own responsible Civil/structural graduate (minimum) engineer (irrespective of the fact that the same are prepared in the Contractor's own design office or by an approved agency).

Incomplete, unchecked, unsigned and unstamped documents/drawings and designs shall not be accepted for review/construction and shall be returned forthwith.

- 1.9 The accuracy/correctness of all designs and drawings shall be the sole responsibility of the Contractor and any delay/loss/damage incurred by the Owner in respect of any mistake/discrepancy/anomaly in such designs and drawings shall be entirely borne by the Contractor.
- 1.10 Owner/Owner's representative reserves the right to review any/all or none of the designs and drawings. Review by Owner/Owner's representative shall not relieve the Contractor of his responsibility for correct design and execution of the works.
- 1.11 All revisions shall be clearly marked and clouded for easy identification. Subsequent review of such revised documents shall be limited to revision as clouded.
- 1.12 All fabrication/erection drawings and bar bending schedules shall be prepared by the Contractor and shall be directly issued for construction to his work site. Also, six copies of such drawings together with design calculations for all splices, joints and gusset plates shall simultaneously be submitted to Owner/owner's representative at site (Resident Construction Manager) for review. The Owner/owner's representative at site at his discretion may review all or some or none of these designs & drawings.

Wherever such review is carried out the same shall be restricted to the following:

- a) Structural layouts, orientation, elevation of structural members.
 - b) Section/size of members.
 - c) Adequacy of few critical connections and joints for their required strength.
- 1.13 Internationally accepted commercial software viz. STAAD, STAADPRO, COSMOS, GT STRUDL, NISA only shall be permitted for analysis and design. STAAD shall not be allowed for use in dynamic analysis of machine foundations.

In case software packages other than listed above are intended to be used for analysis and design, the same shall be informed in writing to Owner/owner's representative. Calculations and relevant computer files containing input and detailed output (also refer clause 1.14) shall be submitted by the Contractor for checking and validation of the software package. Only after getting written

approval from Owner/owner's representative, to this effect, such intended software be put to use for detailed analysis and design.

1.14 Soft copies of all input files and the following documentation as hard copy shall be submitted for computer aided analysis and design:

- (i) Complete print out of input and output files.
- (ii) Relevant sketches with node and member numbering, loading, etc.
- (iii) Summary of member end forces, support reactions, stress ratio, deflections, etc.

Verification of the foundation loading data for all equipments/ structures/ stacks etc., which form part of the comprehensive packages supplied by respective vendors, shall be entirely the responsibility of contractor. Contractor shall ensure that wind/ seismic loadings are strictly in line with the basic wind pressure/ site spectra curves enclosed with this Bid package.

Reviewing of designs/ drawings is not obligatory on the part of Owner/ Owner's representative and complete correctness/ soundness of the designs/drawings and their execution at the site shall be the sole responsibility of the Contractor irrespective of the fact whether the same has been reviewed by Owner/ Owner's representative or not. Any defect observed during construction or till the defect liability period of works' shall be rectified and removed by the Contractor. The Contractor shall carry out whatever modification or reconstruction is needed for the purpose, to the entire satisfaction of the Engineer-in-Charge/ Owner without any extra cost and/or time implication to the Owner.

2.0 DESIGN CRITERIA - GENERAL

Offsite Pipe Rack shall be completely in structural steel construction with bolted (machined holes) connections and subsequently welded. Unit Pipe Rack and Technological structures¹ shall have RCC framed construction up to first deck level. However, Unit Pipe Rack and Technological structure supporting Air Coolers shall have RCC framed construction up to the Air Cooler support level. Unit Pipe Rack in Pre-cast concrete may be used with cast in situ foundations. Top tier supporting Electrical/ Instrument trays and Flare line supports to be in structural steel. Compressor sheds shall completely be of steel construction and shall not have Fire Proofing. The balance structures shall be in structural steel with Fire proofing as per OISD-STD-164. All other buildings shall be of RCC (frame-type) construction with brick walls. However, Blast proof Control Room shall be completely in RCC.

All structures shall be checked and designed to satisfy the worst load combination (refer IS:875) that produces maximum forces and effects and consequently maximum stresses. Wind and earthquake (or blast) loads shall not be considered to act simultaneously.

The design and detailing of all structures, whether concrete or steel, shall suffice a minimum fire rating of greater of 2 (two) hours or as specified by licensor. Norms as defined in OISD-STD-164 and IS: 456 shall be strictly adhered to for structural steel and concrete works, respectively.

2.1 FOUNDATIONS

- 2.1.1 NGL (Natural ground level) and FGL (Finished ground level) shall be marked on all drawings showing foundation/sub-structure details and related design documents.
- 2.1.2 Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.
- 2.1.3 Foundations and structures for machines subject to vibrations shall be so proportioned that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).
- 2.1.4 Structures supported on RCC strip footings shall be provided with suitable tie beams connecting all footings at foundation level. Minimum width of footing shall be 1000 mm.
- 2.1.5 Raft foundations shall be designed as per IS: 2950.
- 2.1.6 Masonry walls shall be supported on continuous plain cement concrete mats/plinth beams. Top of plinth beams shall be located minimum 300mm below

¹ Uncladded-open type structure housing process equipments.

the finished grade level. Fouling of plinth beams with cable trenches, drains, pipe ducts, service lines etc. shall not be acceptable.

- 2.1.7 For the design of foundations for vertical vessels and process columns under hydro test condition minimum 25% wind load shall be considered acting on the equipment.

3.0 DESIGN REQUIREMENT FOR SPECIFIC APPLICATIONS

3.1 PIPE RACK LOADING

(Doc. No. 8-76-0020, wherever mentioned shall be replaced by following portion)

The pipe rack and its foundation shall be designed for the worst combination of following loads and forces

- 1) Piping loads
- 2) Thermal loads
 - Sliding friction force : Longitudinal & Transverse
 - Anchor, Cross Guide and Guide restraint forces
- 3) Electrical cable loads
- 4) Instrumentation cable loads
- 5) Live loads
- 6) Wind force
- 7) Seismic force
- 8) Equipment loads
- 9) Maintenance loads

3.1.1 Piping Loads

- 3.1.1.1 Piping loads shall consist of the weights of pipes, valves, fittings, gas / fluid contents of piping, insulation etc. This load shall be considered as equivalent uniformly distributed load (U.D.L.). Piping loads are standardized in four load categories as listed below:

Load Category	Uniformly Distributed Load (U.D.L.) in Kg/m ²
1	150 Kg/m ²
2	200 Kg/m ²
3	250 Kg/m ²
4	400 Kg/m ²

3.1.1.2 The **Uniformly Distributed Loads (U.D.L.)** indicated above include all process and utility lines of all sizes and cooling water header upto 30" dia directly placed on the pipe rack tier and flare header , overhead vapour line upto 30" dia supported on pipe rack tier or extended column/ framework upto 2m height above the top tier. However , extended portion of pipe rack column/ frame work shall also be designed locally for the flare header / vapour line load (weight of pipe including insulation , if any, plus one-third volume of pipe filled with water). Friction (30% of vertical load in both longitudinal and transverse directions acting simultaneously) and wind/ seismic loads for such pipes shall also be considered for the design of extended column/ frame work. For calculating the weight of all such pipes supported on the extended column/framework, the size, schedule and insulation thickness shall be given by piping in the beginning of the project.

3.1.1.3 For flare header and vapour lines above 30" dia not placed on pipe rack tier but located on extended column/framework upto or more than 2 m height above the top tier or supported on brackets and for any process and utility line supported on extended column/ framework 2m above the top tier, loads shall be considered separately. For flare header and vapour lines, the weight shall be taken as self weight including insulation , if any, plus one third volume of pipe filled with water. Friction (30% of vertical load in both longitudinal and transverse directions acting simultaneously) and wind/ seismic forces shall also be considered on these pipes for the design of framework/ extended column including foundation. For calculating the weight of all such pipes, the size, schedule and insulation thickness shall be given by piping in the beginning of the project.

Note : Normally, the condensate in the flare header/ vapour line is taken as 1/10th to 1/6th of the volume of pipe and friction force as 30% of vertical load in longitudinal direction and 10% of vertical load in transverse direction acting simultaneously or vice versa. To account for thermal forces which are not being considered for the pipes, the volume of condensate has been increased to 1/3rd of the volume of the pipes and the friction force as 30% of the vertical load acting in longitudinal and transverse directions simultaneously.

Density of insulation shall be taken as 260 kg/m³.

3.1.1.4 If cooling water headers above 30" size are to be placed on pipe rack due to Client's requirement, additional point loads shall be considered for such pipes besides UDL. Piping shall indicate such requirement in the beginning of the project.

3.1.1.5 Cooling water headers and other large diameter pipes shall be placed near to the rack columns (i.e. away from the centre of span).

- 3.1.1.6 The above U.D.L. does not include transfer line loads, which shall be separately considered as furnished below. Wind / seismic loads shall also be considered on these lines. For calculating the weight of all such pipes, the size, schedule and insulation thickness shall be given by Piping in the beginning of the project. In all the bays supporting transfer line, suitable plan bracing shall be provided to transfer the lateral load to the framework. At least one of the bays carrying transfer line shall have vertical bracing.

A) Transfer line with rigid support

Loading condition	Transfer line loading on pipe rack		
	Vertical load	Axial load	Lateral load
Operating condition	2.0V1	0.6V1 (Note 5)	1.2V1
Hydro test condition	V2	0.1V2	0.1V2

B) Transfer line with spring hangers

Top level

Loading condition	Transfer line loading on pipe rack		
	Vertical load	Axial load	Lateral load
Operating condition	V1	0.1V1	0.1V1
Hydro test condition	1.5V1	0.15V1	0.15V1

Bottom level :

Loading condition	Transfer line loading on pipe rack		
	Vertical load	Axial load	Lateral load
Operating condition	0.0	0.0 (Note 5)	0.5V1
Hydro test condition (non-concurrent with top level loading)	V2	0.1V2	0.1V2
Hydro test condition (concurrent with top level loading)	(V2-1.5V1)	0.1(V2-1.5V1)	0.1(V2-1.5V1)

- Notes:** 1) V1 = Self weight+Insulation weight+1/6 of water weight
 2) V2 = Self weight+Insulation weight+full water weight
 3) Axial = Along the axis of pipe
 4) Lateral = Perpendicular to the axis of pipe in horizontal plane
 5) At cross guide locations design force shall be taken as 2.5V1

- 3.1.1.7 Various units of Refineries and Petrochemical Plants shall be designed for load categories as listed in Annexure - 1 and Units not listed in Annexure - 1 shall be classified by Piping Specialist as similar to one of those listed in this Annexure.

3.1.1.8 Basis for the design of pipe racks of width less than 6m shall be same as for 6m wide racks.

3.1.1.9 Loading on Intermediate Transverse Beams

3.1.1.9.1 Intermediate transverse beams at tier level shall be designed for 40% of the piping load on one panel between two portals. However, a reduction of only 20% shall be considered for main portal beams if intermediate beams are provided.

3.1.1.9.2 Intermediate beams shall support the following :

- Lines up to 1½" size
- Lines to and from pipe rack provided with dummy.
- Bare lines of size 2" to 12" which are not provided with bottom bearing plate .
- Insulated lines up to 4".

Notes : Bare lines of size 14" and above are not to be supported on intermediate beams. These are supported only on main beams by providing bearing plates.

Bare lines of size 2" to 12" may be provided with bearing plates if specifically required by the client. However, line sizes 6" and above shall not have bearing plates at intermediate beam locations.

3.1.1.10 Loading on Longitudinal Beams

3.1.1.10.1 Longitudinal beams connecting portal columns shall be designed to sustain 25% of the load on the transverse beam(s). This load shall be assumed as two equal concentrated loads acting at 1/3rd span. This load shall be in addition to the load transferred to the longitudinal beam from intermediate transverse beam. Other longitudinal axial forces coming on it from the design of the supporting system shall also be simultaneously taken into account in the design of the longitudinal beams. These beams shall be locally checked for the loads of monorails supported from them. As all the monorails are not operative simultaneously, the loads of monorails shall not be considered for the overall analysis and design of the structural system. However the longitudinal beams at bends shall be designed for the same load as the main frame beam of the branch rack.

3.1.1.10.2 Longitudinal beam at the centre of transverse beam shall be designed for axial tension equal to 50% of longitudinal friction on transverse beams in addition to axial force due to lateral restraint to transverse beams (as per IS:800) . No vertical load other than self weight shall be considered for design. Size of this beam shall be restricted as per clause 4.4.2.

3.1.2 Thermal Loads

3.1.2.1 Thermal loads are forces caused by thermal expansion or contraction of the piping. These forces are in the form of Sliding Friction force , Anchor / Cross guide / Guide restraint force etc.

3.1.2.2 Sliding Friction Force

- 3.1.2.2.1 Horizontal force shall be taken as 10% of vertical load at each tier on every portal both in longitudinal and transverse directions acting simultaneously to cater for the sliding friction and the guide forces due to the bends / tappings.
- 3.1.2.2.2 Horizontal force on longitudinal beams of unit pipe rack shall be taken as 10% of the vertical load on these beams and this shall be considered in transverse direction only. However, this friction force shall not be considered for the design of portals. (While considering this load effective length of the compression flange shall be taken with lateral restraint at load points).
- 3.1.2.2.3 Sliding friction force on intermediate transverse beams shall be taken as 10% of the vertical load on these beams and this shall be considered in longitudinal direction only.

3.1.2.3 Anchor / Cross Guide / Guide Restraint Forces

- 3.1.2.3.1 Anchors, cross guides and guides for various pipes shall be staggered by Piping on different portals and also at various tiers, so as to avoid concentration of these forces. Since pipes generally have straight run on pipe rack, staggering of above restraints shall enable balancing of thermal forces largely. However, some residual unbalanced forces may still be present due to different lengths of pipes and branching off of various pipes and hence following percentages of vertical load shall be considered as Anchor / Cross Guide / Guide Restraint forces in addition to the sliding friction forces :
- 2.5% of vertical load on each tier in transverse and longitudinal direction simultaneously. This unbalanced force due to above restraints shall be applied on all portals except for the last two portals at each battery limit end.
 - 15% of the vertical load in the longitudinal direction and 5% of the vertical load in the transverse direction on last two portals at the battery limit ends. At these two portals a higher thermal load is considered as large numbers of pipes are likely to be restrained or anchored on these portals.

3.1.3 Electrical Cable Loads

Electrical cable loads shall be considered as 85 kg/meter length for each cable tray of width up to 750mm. The support for trays shall be provided at a maximum spacing of 3.0m c/c. In addition to the cable load, the tray support shall also be designed for a man's weight equal to 75 kg considered at the extreme end of the support. Electrical dept. shall furnish detailed drawing showing number of trees and tiers, platform etc. to Piping department for space allocation on pipe rack and to Structural department for design of pipe rack.

3.1.4 Instrumentation Cable Loads

- 3.1.4.1 Instrumentation deptt. shall furnish a drawing showing number of ducts and their sizes etc. to Piping department for space allocation on pipe rack and Structural department for design of pipe rack. Weights of various duct sizes shall be considered as under :

Duct Size (W X H) in mm	Weight (Kg./m)
1200 x 400	800
1000 x 400	650
800 x 300	400
600 x 300	300
400 x 200	200

3.1.4.2 Instrument cable ducts shall be supported continuously along their length.

3.1.5 Live Loads

3.1.5.1 Live loads on pipe rack platforms are imposed loads such as personnel loads, tools and tackles loads etc. Live loads on pipe rack platforms, including the interconnection with technological structures, shall be 300 Kg/m². However for the platform for safety valve 500Kg/m² live load shall be considered.

3.1.5.2 Live load on the floor below air fin cooler shall be considered as 500 Kg/m² for the design of slab and 300 Kg/m² for beam / column / foundation design.

3.1.6 Wind Force

3.1.6.1 Transverse wind loading shall be calculated depending on the width of the pipe rack as per the following table. This load shall be considered on each tier irrespective of the level difference between two consecutive tiers.

WIDTH OF PIPE RACK	WIND FORCE AT EACH TIER LEVEL (N)
Upto 4m	1.25 x PxS
Above 4m but upto 6m	1.50 x PxS
Above 6m but upto 10m	2.00 x PxS
Above 10m	H x PxS

Where P : Horizontal wind pressure as per IS:875 (N/m²)
S : Spacing of Portals (m)
H : Projected Height (m)

= 0.8 x Diameter of Largest pipe (Including insulation)(m) + width of rack(m) x
tan

However , the value of H shall not exceed the distance between two consecutive tiers. Diameter of largest pipe shall be taken as 30". In case the same is more than 30", it shall be given by Piping.

3.1.6.2 Wind load on extended framework above top tier to support flare/ vapour/ transfer lines shall be as per IS:875. (Refer Clause 4.1e of Doc. No. 6987-00-16-48-DB01)

3.1.7 Seismic Force

Seismic forces shall be as per site specific seismic spectra (Refer Doc. No. 6987-00-16-54-DB-01)

3.1.8 Equipment Loads

3.1.8.1 Equipment loads of surge drums, deaerators, silencers, etc. when supported on pipe rack shall be considered on actual load basis derived from the data sheets for the design of foundation and super structure.

3.1.8.2 Following loading may be considered for the design of foundations of pipe rack in case the data sheets for Air fin coolers are not available.

EQUIPMENT	VERTICAL LOADING (operating condition)
Air Fin Cooler	1000 kg/m ² (max.) on plan area occupied by Air fin cooler
Air fin cooler inlet/outlet piping	500 kg/m ² on balance plan area occupied by piping, (minimum 2.5m on both sides of the air cooler) acting at 10m (max.) above cooler structure support level.

However, actual load of each air cooler as furnished by **HMTD** shall be considered for the design of super structure.

3.1.9 Maintenance Loads

Maintenance loads such as loads due to the use of monorail, davit etc. shall be considered in design only on specific requirement furnished by the user group.

Note:

Structural AFC drawings shall be released based on aforesaid loads and other inputs as per this guide line. However, during detailed piping analysis of transfer lines, flare lines & O/H vapour lines, if Piping specialist comes across any load heavier than the loads given in this guide line, the same shall be conveyed to the Structural specialist for local checking and strengthening, if required.

3.2 RCC AND STEEL CHIMNEYS

RCC and Steel chimneys shall be designed as per the requirements of IS:4998, IS:6533 and Standard specification no. 6-68-0053.

3.3 MACHINE FOUNDATIONS

Machine foundations shall satisfy the following requirements:

- a) The minimum grade of concrete to be used shall be as per clause 8.3 of Doc. No. 6987-00-16-48-DB01.
- b) Minimum reinforcement as per requirements of IS:2974 shall be provided unless required otherwise by design.
- c) All units of the foundation system, except foundation raft shall be provided with symmetric reinforcement on opposite faces, even if not required by design considerations.
- d) The soil stress below foundations under dead loads shall not exceed 80% of the allowable soil bearing capacity, or safe load on pile, for static loading.
- e) The combined center of gravity of the machine and foundation system shall, as far as possible, pass through the center of area of the foundation raft or centroid of the pile group. Where unavoidable, eccentricity shall be less than 5% for block foundations and 3% for frame foundations.
- f) Foundations shall be so designed that natural frequency of the foundation system shall not resonate with the following:
 - i) Operating speed of the motor.
 - ii) Operating speed of the machine.
 - iii) 2 x Operating speed of the machine.
 - iv) Critical speed of the machine (for centrifugal machines).

Natural frequency of the foundation shall preferably be $\pm 20\%$ away from the above-mentioned frequencies. However, amplitudes of vibration of the foundation block shall always be checked to be within permissible limits.

- g) Amplitudes of vibration shall be less than values specified by the machine manufacturer. If not specified, provision of IS:2974 shall be followed.
- h) The foundation and its superstructure shall be separated from adjacent foundations and platforms. Clear air gaps shall be provided in the superstructure to avoid transmission of vibration to adjacent structures. Special note shall be given on the drawing in this respect, and suitable details shown as required.
- i) Foundations resting partly on rock and partly on soil shall preferably be avoided. However, if unavoidable, the soil area shall be replaced by lean concrete (1:4:8). However, Owner/owner's representative concurrence shall be obtained for such cases.
- j) Foundations shall not rest on previously backfilled or sensitive soils.

- k) For frame foundations, base raft shall be cast in a single concreting operation. A properly designed construction joint shall be provided between the base slab and columns. The entire superstructure of columns and upper deck shall be cast in a continuous concreting operation.
- l) If height of the frame columns above raft level exceeds 8.0m, an additional construction joint at the junction of columns/top-deck may be provided.
- m) Block foundations shall be cast in a single concreting operation.

3.4 **BLAST RESISTANT CONTROL ROOMS**

- a) The structure shall be designed on shear wall concept with roof acting as a diaphragm that transfers the transverse loads to the side shear walls and columns in proportion to their stiffness. Internal partitions and division walls shall not be designed as shear walls.
- b) Thickness of reinforced concrete walls shall be 230mm (to meet the criteria of Tariff Advisory Committee).
- c) RCC wall shall be taken up to 1.5m below FGL or up to top of footing whichever is shallower, maintaining the wall thickness and R/F same as in superstructure.
- d) All superstructure members shall be designed for reversal of stresses.
- e) Minimum R/F in wall in each face shall be 1% (as total % in both directions) of gross cross sectional area as calculated from structural design considerations. The maximum R/F in each face however shall not exceed 2%.
- f) Roof slab shall be doubly reinforced. Minimum R/F on top and bottom shall be 1% of gross cross sectional area (as total % in both directions).
- g) Maximum spacing of bars in walls and roof slab shall not exceed 150mm c/c. Minimum bar diameter shall be 12mm.
- h) In addition to load combinations of IS:875, the structure shall also be checked for:
 - (i) 1.0 (Dead load + Blast load) for flexure considerations
 - (ii) 1.2 (Dead load + Blast load) for shear considerations
- i) For blast load combinations the design bearing pressure of soil shall not exceed twice the allowable static bearing pressure of soil. For piles under blast conditions, the permissible increase shall be one-and-a-half times the allowable capacity of pile in horizontal and vertical (compression and uplift) directions.

3.5 TANK FOUNDATIONS

Storage tanks shall be supported on ring wall type/ sand pad foundations as per approved foundation recommendation.

3.6 SUPPORTING ARRANGEMENTS FOR TRANSFER LINE

Structures supporting transfer lines and other two phase flow lines:

A list of piping with two-phase fluid flow shall be developed by the Contractor. Pipe routing and structures supporting such lines shall be drawn. Only piping with diameter more than 6" shall be considered critical and governed by this clause. Smaller diameter piping shall be governed by relevant clauses for pipe rack.

3.6.1 Design loads

Horizontal force not less than 50% of the pipe weight (empty and contents) shall be considered, acting simultaneously in two orthogonal directions (along the pipe and across it) at that support.

3.6.2 Piping supported on Pipe racks

3.6.2.1 Pipe racks supporting two phase flow lines above 6" diameter shall have all portals and longitudinal beams encased in structural grade concrete. Encasing shall be in all shapes (excluding profile shapes) with a minimum 50mm cover over the largest dimension of the steel section. Minimum reinforcing steel as shrinkage/temperature reinforcement shall be provided as welded wire fabric conforming to IS:1566 with mesh size of 50mm x 50mm and wire thickness 3mm.

3.6.2.2 Between all successive portals supporting such lines, plan bracings shall be provided. These shall be provided at least at their supporting elevation (bottom level in case of a line with spring hangers). Longitudinal bays connecting portals shall be braced vertically, from supporting level downwards, at least in one bay.

3.6.2.3 If the level difference between two phase fluid piping support and normal pipe supporting tier of pipe rack is 3 metres or more, additional vertical bracing shall be provided above the pipe rack level in all such transverse frames.

3.6.3 Isolated trestles

Vertical bracing shall be provided on all faces and horizontal bracing at least at pipe support level. All members including bracing shall be encased in concrete for the entire height of the trestles and the fundamental frequency of the structure shall be isolated from the most critical range which is 4 to 7 Hz. The weight of pipe shall not be considered for dynamic analysis. Encasing details shall be same as mentioned in clause 4.6.2.1.

3.6.4 Supports from technological structures

Structural members supporting transfer lines from technological structures shall be adequately braced. Floors shall have plan bracing to effectively transfer horizontal forces to vertical frames of the structure.

Supports on/from cantilevers shall be avoided. However, if unavoidable, adequate plan bracing shall be provided.

3.6.5 Permissible stresses

No increase in permissible stresses shall be allowed except in load combination with wind and seismic, as permitted by IS codes.

3.6.6 Permissible deflections

The deflection at the top of the structure, with all the horizontal forces acting together, shall be limited to 25mm or height/325, whichever is less.

3.7 COMPRESSOR HOUSE, PUMP HOUSE AND OTHER SHED TYPE STRUCTURES

Roofs of all shed type structures shall have 1:3 slope. MS wind ties (40mm x 6mm)

painted as per painting specifications shall be provided over roof sheeting on the last purlin towards eaves and the first purlin at ridge, on each slope of the roof. Cladding shall be provided on all sides starting at 3 metre height from FFL/HPP and continuing up to roof level. Provision for equipment entry and drop out area shall also be made as per approved equipment layout.

Daylight, natural ventilation and rain protection shall be ensured by providing continuous louvers and roof monitors along the longitudinal sides of the shed. Louvers shall be provided at various levels of the cladding to act as necessary air inlet/outlet, and for daylight and rain protection. One louver shall be provided at 3.5metre height from FFL/HPP, for rain protection of the opening below. Similarly, one louver shall be provided at eaves level for ventilating the stagnant air, at that level. Sufficient number of louvers shall also be provided at all intermediate working and equipment levels for achieving proper day-lighting and ventilation in the sheds as per Factory Act and National Building Code of India.

Continuous steel ventilator consisting of fixed glass and weld mesh with bird screen net and sufficient overhang shall be provided on the longitudinal sides of the roof monitor. Rain water gutters and PVC pipes shall be provided for proper roof drainage. Gutters shall be of Mild Steel sheets (minimum 3mm thick) painted as per painting specifications.

3.8 Floor gratings shall be fabricated from mild steel and shall be minimum 25mm thick. These shall be made from electro-forging process. The maximum size of voids in the grating shall be limited to 30x100mm. Deflection shall not be more than 6mm or span/200, whichever is lower. Floor gratings shall be hot dip galvanised in accordance with IS:2629 and tested as per IS:2633 and IS:6745. Quantity of zinc coating shall be minimum 900 g/m² of surface area (0.12mm uniform thickness).

It shall be mandatory that a prototype of the grating fulfilling the following is demonstrated satisfactorily to the Owner/owner's site representative prior to placement of bulk order(s):

- a) above defined requirements.
- b) the unfused joints are not in excess of 5% of the total joints. If unfused joints found are in excess of 5%, the prototype shall stand rejected and a fresh prototype shall be prepared with revised welding parameters clearing the requirement of unfused joints limited to 5% of the total joints.
- c) the projection of secondary member above the main member is not more than 1.5mm.
- d) the unfused 5% joints of b) above are welded by SMAW/GMAW process.
- e) the joints are able to sustain a minimum pull out load of 1.2 times the allowable shear capacity of the secondary member.
- f) gratings shall be subjected to a third party inspection as per Owner/owner's representative approval.

4.0 MATERIAL REQUIREMENTS

4.1 General

4.1.1 The minimum requirements of various materials to be used in Civil and Structural works are as below:

4.2 Water

4.2.1 Water used in construction for all civil & structural works shall be clean and free from injurious amounts of oil, acids, alkalies, organic matters or other harmful substances which may be deleterious to concrete, masonry or steel. The pH value of water sample shall be not less than 6. Potable water will be considered satisfactory. All requirements of IS:456, have to be met.

4.2.2 Tests on water samples shall be carried out in accordance with IS:3025 and these shall fulfill all the guidelines and requirements given in IS:456.

4.2.3 Water for curing shall be of the same quality as used for concreting and masonry works.

4.3 Aggregate (For Concrete)

4.3.1 General

- Coarse and fine aggregates for Civil and Structural Works shall conform in all respects to IS:383 (Specification for coarse and fine aggregates from natural sources for concrete). Aggregates shall be obtained from an approved source known to produce the same satisfactorily. Aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or a combination thereof. These shall be chemically inert, hard, strong, dense durable, clean and free from veins, adherent coatings, injurious amounts of alkalies, vegetable matter and other deleterious substances such as iron pyrites, coal, lignite, mica, shale, sea shells etc.
- Aggregates which may chemically react with alkalies of cement or might cause corrosion of the reinforcement shall not be used.
- The maximum quantities of deleterious materials in the aggregates as determined in accordance with IS:2386 - Part II (Methods of Test for aggregates for concrete), shall not exceed the limits defined in IS:383.

4.3.2 Coarse Aggregates

- Coarse aggregates are the aggregates, which are retained on 4.75mm IS Sieve. It shall have a specific gravity not less than 2.6 (saturated surface dry basis).
- These may be obtained from crushed or uncrushed gravel or stone and may be supplied as single sized or graded. The grading of the aggregates shall be as per IS:383 or as required by the mix design, to obtain densest possible concrete.

4.3.3 Fine Aggregates

- Fine aggregates are the aggregates which pass through 4.75mm IS sieve but not more than ten percent (10%) pass through 150 micron IS sieve. These shall comply with the requirements of grading zones I, II and III of IS:383. **Fine aggregates conforming to grade zone IV shall not be used for reinforced concrete works.**
- Fine aggregates shall consist of material resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies, or crushed stone sand or gravel sand. Sand from sea shores, creeks or river banks affected by tides, shall not be used for filling or concrete works.

4.3.4 Sampling and Testing

The Contractor shall carry out all tests including mix designs of concrete, at the start of work as well as during any stage of construction as per the requirement. Tests shall be carried out in accordance with IS:516-Methods of test for strength of concrete and IS:2386-Methods of test for aggregates for concrete. The method of sampling shall be in accordance with the requirements given in IS:2430.

4.3.5 Storage of Aggregates

- Storage of all types of aggregates at the site of work shall be as specified in IS: 4082. Aggregates shall in no case be stored near excavated earth or directly over ground surface.
- Fine aggregates delivered at the site in wet condition or becoming wet due to rain or any other means, shall not be used for at least 24 hours. For the use of such aggregates the contractor shall adjust the water content in accordance with IS:2386 to achieve the desired mix.

4.4 Sand (For Masonry & Filling)

4.4.1 Sand for Masonry Mortars

- The sand shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified in IS:2116
- The sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shells in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar.
- The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand, when tested in accordance with IS:2386, shall not be more

than 5% by mass in natural sand, or crushed gravel sand or crushed stone sand. For organic impurities, when determined in accordance with IS:2386, colour of the liquid shall be lighter than that indicated by the standard solution specified in IS:2386.

4.4.2 Grading of Sand

The particle size grading of sand for use in mortars shall be within the limits as specified below:

Grading Of Sand For Use In Masonry Mortars

IS Sieve Designation IS:460 (Part I)	Percentage Passing By Mass	Reference To Method
4.75 mm	100	IS:2386 (Part-I)
2.36 mm	90 to 100	
1.18 mm	70 to 100	
600microns	40 to 100	
300 microns	5 to 70	
150 microns	5 to 15	

In case of sand whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles, this shall be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of natural sand particles or crushed stone screening which are by themselves unsuitable. The various sizes of particles of which the sand is composed shall be uniformly distributed throughout the mass.

4.4.3 Sampling and Testing

The method of sampling shall be in accordance with IS:2430. The amount of material required for each test shall be as specified in relevant parts of IS:2386. All tests shall be carried out in accordance with the relevant parts of IS:2386.

If further confirmation as to the satisfactory nature of the material is required, compressive test on cement mortar cubes (1:6) may be made in accordance with IS:2250 using the supplied material in place of standard sand and the strength value so obtained shall be compared with that of another mortar made with a sand of acceptable and comparable quality.

4.4.4 Sand for Filling

Sand for filling shall meet the requirements of IS:383 and shall be natural sand, hard, strong, free from any organic and deleterious materials. Sand obtained from sea shores, creeks or river banks affected by tides, shall not be used for filling. Fine aggregates suitable for concreting works shall be suitable for filling also. No sand below grading zone-III as per IS:383 shall be allowed for filling.

4.5 **Cement**

Unless otherwise specifically called for, cement² for RCC and PCC/lean concrete works shall be one of the following:

53 grade ordinary Portland cement	IS:12269
43 grade ordinary Portland cement	IS:8112
Portland slag cement	IS:455
Portland Pozzolana cement (fly ash based)	IS:1489 (Part-1)
Portland Pozzolana cement (calcined clay based)	IS:1489 (Part-2)
Sulphate resisting Portland cement	IS:12330
High alumina cement	IS:6452

4.6 **Steel**

4.6.1 **General**

All steel bars, sections, plates, and other miscellaneous steel materials, etc. shall be free from loose mill scales, rust as well as oil, mud, paint or other coatings. The materials, construction specifications such as dimensions, shape, weight, tolerances, testing etc, for all materials covered under this section, shall conform to respective BIS codes.

4.6.2 **Reinforcement Bars**

High strength deformed (HSD) steel bars of minimum grade Fe 500, conforming to IS:1786 T.M.T.(with corrosion inhibitors in concrete) bars shall be used for all structures. 16 gauge SWG wire shall be used for binding reinforcement bars.

4.6.3 **Structural Steel**

Structural steel sections shall conform to following BIS codes:

Steel tubes for structural purposes	IS:1161
Mild Steel Tubes, tubular and other wrought steel fittings	IS:1239
Steel for general structural purposes (Grade A).	IS:2062

²

The type of cement selected shall be appropriate for the intended use.

Hollow steel sections for structural use. IS:4923

4.6.4 **Miscellaneous Steel Materials**

Miscellaneous steel materials shall conform to the following BIS codes:

Expanded Metal Steel Sheets for General purposes.	IS:412
Steel for General Structural Purposes- Specification.	IS: 2062
Hexagonal head bolts, screws & nuts of product Grade C.	IS:1363
Cold formed light gauge structural steel sections.	IS:811
Technical supply conditions for threaded steel fasteners.	IS:1367
Plain washers	IS:2016
Steel wire ropes for general engineering purposes	IS:2266
Thimbles for wire ropes.	IS:2315
Bulldog grips.	IS:2361
Mild Steel Tubes, tubular and other wrought steel fillings. (For Hand rail tubular sections)	IS:1239
Drop forged sockets for wire ropes for general engineering purposes.	IS:2485
Steel chequered plates.	IS:3502
Hexagonal bolts and nuts (M42 to M150).	IS:3138

4.6.5 **Anchor Bolts**

Material for Anchor Bolts such as MS bars, washers, nuts, pipe sleeves and plates etc. shall be as per relevant BIS codes mentioned above under Clauses 4.6.4.

4.7 **Brick**

4.7.1 **General**

Bricks for masonry works shall conform to IS:1077 - Specification for common burnt clay building bricks and shall be variety of class 5.0 (with minimum compressive strength of 5.0 N/mm^2). Physical requirements, quality, dimensions, tolerances etc. of common burnt clay building bricks shall conform to the requirements of IS:1077.

Bricks shall be hand-moulded or machine-moulded and shall be made from suitable soils. The bricks shall have smooth rectangular faces with sharp corners

and shall be well burnt, sound, hard, tough and uniform in colour. These shall be free from cracks, chips, flaws, stone or humps of any kind.

Testing of the bricks shall be done as per IS:5454 and IS:3495. Water absorption shall not be more than 20% by its dry weight when soaked in cold water for 24 hours.

Locally available bricks of non modular size (230x115x75mm) in place of bricks of modular size (190x90x90mm) can be used in case the bricks satisfy the other requirements of IS:1077 (corresponding class as defined above).

4.8 Stone

4.8.1 General

All Stones used for masonry works shall conform to the requirements of following BIS codes.

Method of identification of natural building stones IS:1123

Recommendations for dimensions and workmanship
of natural building stones for masonry work IS:1127

Recommendations for dressing of natural building stones IS:1129

4.8.2 Quality of Stones

Stones shall be hard, dense, strong, sound, durable, clean and uniform in colour. They shall also be free from veins, adherent coatings, injurious amounts of alkalies, vegetable matters and other deleterious substances such as iron pyrites, coal, lignite, mica, sea shells etc. As far as possible stones from one single quarry shall be used for anyone work. The strength of stones should be adequate to carry the imposed load and shall meet all the requirements of IS:1905, taking into account the appropriate crushing strength of stone and type of the mortar used. The percentage of water absorption, when tested in accordance with IS:1124, shall not exceed 5 percent.

The length of the stone shall not exceed 3 times the height. Width of stone on base shall not be less than 150mm and in no case exceed $\frac{3}{4}$ th thickness of the wall. Height of the stone shall not be more than 300mm.

4.9 Admixtures

4.9.1 General Requirements for Admixtures

- All concrete admixtures shall comply with the following Indian standards:

Specification for integral cement water proofing compounds. IS:2645

Specification for other admixtures for concrete. IS:9103

In case of non-availability of any IS code for testing and acceptability criteria,
relevant American, British or German Code shall be applicable.

- No admixture shall impair the durability of the concrete nor combine with the ingredients to form harmful compounds nor increase the risk of corrosion of reinforcement. Use of admixtures shall not reduce the dry density of concrete. Once the proportion of admixtures have been established, strict check shall be maintained not to alter the proportions of ingredients and water-cement ratio of the Design Mix during execution.
- The chloride contents in admixtures shall not exceed 2% by mass of the admixture or 0.03% by mass of the cement.
- Admixtures which do not meet the requirements stipulated in this document shall not be used.

4.9.2 Water Proofing Compounds

- The permeability of the specimen with the admixture shall be less than half of the permeability with a similar specimen without the use of these compounds. These compounds shall be used in such proportion as recommended by manufacturer but in no case it shall exceed 3% by weight of cement.
- The initial setting time of the cement with the use of these compounds shall not be less than 30 minutes and final setting time shall not be more than 10 hours. Tests shall be carried out in accordance with IS:4031.
- Compressive strength of the specimen at 3 days shall not be less than 160kg/cm^2 nor 80% of the 3 days compressive strength of mortar cubes prepared with same cement and sand only, whichever is higher. Similarly compressive strength at 7 days shall not be less than 220kg/cm^2 nor less than 80% of the 7 days compressive strength prepared with the same cement and sand only, whichever is higher. The test to determine the compressive strength shall conform to IS:4031.

4.9.3 Bipolar Concrete Penetrating Corrosion Inhibiting Admixture

Refer Doc. No. 6987-000-16-48-4201

4.10 Water Bars (Water Stops)

- 4.10.1 PVC water bars shall be used in reinforced concrete construction of liquid retaining structures or any other structure to safeguard them from hydrostatic pressure and water leakage and any relative movement between two parts of the structure due to thermal loading shrinkage or differential movement of foundations. These shall be preformed and shall provide a permanent water tight seal along the entire joint in the poured concrete structures. These shall also be flexible enough to withstand deflection/ displacements at joints arising due to variation of temperatures or settlement of foundations.

4.10.2 Performance requirements of PVC water bars shall meet the requirements of IS:12200. These shall be of an approved make and of ribbed/serrated/plane type with a bulb at the centre. The thickness and width of water bars shall in no case be less than 5mm and 150mm respectively. However, for concrete sections greater than 300mm thick, the width of water bars shall not be less than 230mm.

4.11 **Bitumen/bituminous Materials**

Bitumen to be used for various types of work shall meet all the requirements of relevant BIS codes as given below:

Specification of Paving Bitumen.	IS:73
Specification for bitumen mastic for flooring (Grade IV)	IS:1195
Specification for Bitumen felts for water proofing and damp proofing.	IS:1322
Specification for Bituminous compounds for water proofing and caulking purposes.	IS:1834
Specification for preformed fillers for expansion joint in concrete pavements and structures.	IS:1838
Specification for bitumen mastic for use in water proofing of roofs	IS:3037
Specification for bitumen primer for use in water proofing and damp proofing.	IS:3384
Specification for Bitumen Mastic for Tanking and Damp proofing.	IS:5871
Specification for Glass fibre base coal tar pitch & bitumen felts	IS:7193
Code of practice for damp proofing using bitumen mastic	IS:7198
Specification for bitumen Mastic, Anti Static and electrically conducting grade.	IS:8374

Tests and acceptable criteria shall be as per relevant BIS codes.

4.12 **PVC Pipes**

PVC Pipes shall conform to the requirements of IS:4985.

4.13 **Wood/timber**

4.13.1 Wood recommended for platforms of cold vessels or below cold vessels/exchangers shall be hard and shall be of group A, grade I, and shall have safe permissible stress of 7N/mm^2 in compression, perpendicular to grains on outside location as per IS:883. General characteristics like durability, treatability etc. shall conform to IS:883 and IS:3629.

- 4.13.2 Timber required to be used for form work shall be fairly dry before use. It should maintain its shape during the use and even when it comes into contact with moisture from the concrete. Storage of Wood/Timber shall be as per the requirements of IS:4082.

For proper identification and selection of suitable timber for form work, following codes shall be referred.

Classification of commercial timbers and their zonal distribution	IS:399
Specification for ballies for general purposes	IS:3337
Specification for Ply wood for concrete shuttering work	IS:4990

4.14 Anti-termite Compounds

- 4.14.1 Chloropyrifos emulsifiable concentrates (1%) conforming to IS:8944 shall be used for treatment of soil for protection of buildings against attack by subterranean termites.

4.15 Polysulphide Sealants

- 4.15.1 All Polysulphide Sealants shall conform to IS:12118. Test conditions and requirements shall be as given in the above referred BIS code.

5.0 CONSTRUCTION REQUIREMENTS

5.1 Construction

- 5.1.1 All concrete works shall be carried out as per the provisions of IS:456, IS:3370, IS:2974 and other relevant BIS Codes. Concrete mix proportioning and design mix; sampling and strength test of concrete, production and control of concrete, tolerances and placing of reinforcement and for cover; transporting, placing, compacting and curing etc, inspection and testing of structure (including requirement of non-destructive testing) shall be as specified in IS:456.
- 5.1.2 Continuous concreting shall be done for structures supporting dynamic equipment as per the provisions of IS:2974.
- 5.1.3 The damp proof course shall be laid in two layers of equal thickness and each layer given two coats of hot bitumen on top (grade A90/S90 conforming to IS:73) at the rate of 1.7 kg/m². Dry sharp sand shall be sprinkled evenly over the top layer of bitumen before hardening.
- 5.1.4 Form work and stripping of form work shall be as per the provisions of IS:456.
- 5.1.5 Assembly of reinforcement in RCC structures shall conform to IS:456.
- 5.1.6 Fabrication of all structural steel works shall be carried out as per the provisions of IS:800/801/802/806 and other relevant BIS codes. Fabrication shall include cleaning, straightening, cutting, bending, holding, bolting, welding, machining, painting, marking, assembling, erecting, inspecting and testing etc. Welding procedure and welder qualification shall be as per IS:800 and/or referenced BIS codes only.
- 5.1.7 Erection of all structural steel works including supply of plant & equipment, storing and handling, setting out, field connections, field welding and security during erection shall conform to IS:800/801/802/806.
- 5.1.8 All masonry works shall be carried out as per the provisions of IS:1597/2212/4326 and other relevant BIS codes.
- 5.1.9 Necessary embedment like insert plates, anchor fasteners, bolts, rungs etc. are to be done in concrete, wherever required.
- 5.1.10 The limits of dimensional tolerances for all works shall be as given below:

For Plain and Reinforced Cement Concrete Structures:

- | | | |
|-----|--|----------------|
| (a) | Deviation from specified dimensions of cross section of columns and beams. | - 6mm to +12mm |
| (b) | Deviation from dimensions of footings (see Note below) | |
| (i) | Dimensions in plan | -12mm to +50mm |

- | | | |
|-------|----------------------------|---|
| (ii) | Eccentricity
footing in | 0.02 times the width of the

the direction of deviation but not
more than 50 mm. |
| (iii) | Thickness
thickness. | ± 0.05 times the specified |

Note: Tolerances apply to cast-in-situ concrete dimensions only, not to positioning of vertical reinforcing steel or dowels.

- (c) Deviation in length (major dimension of single unit)
- | | |
|--|-------------------|
| up to 3m | $\pm 6\text{mm}$ |
| 3m to 4.5m | $\pm 9\text{mm}$ |
| 4.5m to 6m | $\pm 12\text{mm}$ |
| additional deviation for every subsequent 6m | $\pm 6\text{mm}$ |
- (d) Deviation in straightness or bow (deviation from specified line) for a single or continuous member), e.g, beam, column or slab edge.
- | | |
|------------------------------------|------|
| Up to 3m | 6mm |
| 3m to 6m | 9mm |
| 6m to 12m | 12mm |
| additional for every subsequent 6m | 6mm |
- (e) Deviation in squareness shall be measured taking the longer of two adjacent sides as the base line.
- The shorter side shall not vary in its distance from a perpendicular so that the difference between the greatest and shortest dimensions exceeds 6mm. For this purpose, any error due to lack of straightness shall be ignored. Squareness shall be checked with respect to the straight lines that are most nearly parallel with the features being checked. When the nominal angle is other than 90 degrees, the included angle between check lines shall be varied accordingly.
- (f) Deviation in twists shall be within a limit such that any corner shall not be more than the limit given below from the plane containing other three corners:
- | | |
|---|------|
| Up to 600mm wide and up to 6m in length | 6mm |
| over 600mm wide and for any length | 12mm |
- (g) Maximum deviation in flatness from a 1.5m straight edge placed in any position on a nominally plain surface shall not exceed 6mm.

For Steel Structures:

- (a) Columns and tower-type structures
- Deviation of column axes at foundation top level with respect to true axes.
 - i) In longitudinal direction $\pm 5\text{mm}$
 - ii) In lateral direction $\pm 5\text{mm}$
 - Deviation in the level of bearing surface of columns at foundation top with respect to true level. $\pm 5\text{mm}$
 - Out of plumb (verticality) of column axis from true vertical axis measured at top:
 - i) Up to and including 30m height $\pm H/1000$ or $\pm 25\text{mm}$ whichever is less.
 - ii) Over 30m height $\pm H/1200$ or $\pm 35\text{mm}$ whichever is less.
 - Deviation in straightness in longitudinal & transverse planes of column at any point along the height. $\pm H/1000$ or $\pm 10\text{mm}$ whichever is less
 - Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance. $\pm 5\text{mm}$
 - Deviation in any bearing or seating level with respect to true level $\pm 5\text{mm}$
 - Deviation in difference in bearing levels of a member on adjacent pair of columns both across & along the building $\pm 5\text{mm}$
- Note 1) Tolerance specified for out-of-plumbness should be read in conjunction with 'Deviation in straightness....' & 'Difference in the erected positions.....'.
- Note 2) 'H' is the column height in mm.
- Note 3) Tolerance limits as given under clause (a) above for steel structures are applicable to concrete columns/pedestals also.
- (b) Trusses
- Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord.

- $\pm 1/250$ of height of truss in mm at center of span or ± 15 mm whichever is less
- Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss
 $\pm 1/1500$ of span of truss in mm or ± 10 mm whichever is less
- Lateral shift in location of truss from its true position. ± 10 mm
- Lateral shift in location of purlin from true position. ± 5 mm
- Deviation in difference of bearing levels of truss from the true level
 $\pm 1/1200$ of span of truss in mm or 20 mm whichever is less.
- (c) Gantry girders and Rails
 - Shift in the centre line of crane rail with respect to centre line of web of gantry girder
 $\pm \left[\frac{\text{web thickness of girder (mm)}}{2} + 2 \text{ mm} \right]$
 - Shift of alignment of crane rail (in plan) with respect to true axis of crane rail at any point ± 5 mm
 - Deviation in crane track gauge with respect to true gauge.
 - i) For track gauge upto and including 15 m ± 5 mm
 - ii) For track gauge more than 15 m $\pm [5 + 0.25(S - 15)]$ subject to maximum ± 10 mm, where S in metres is true gauge.
 - Deviation in the crane rail level at any point from true level ± 10 mm
 - Difference in level between crane track rails (across the bay) at
 - i) Supports of gantry girders 15 mm
 - ii) Mid span of gantry girders 20 mm
 - Relative shift of crane rail surfaces 2 mm

(at a joining) in plan and elevation

- 5.1.11 Construction of all other items of works shall conform to relevant Indian Standards and sound engineering practices.
- 5.1.12 The Contractor shall be responsible for the complete safety pertaining to all construction works.
- 5.1.13 Before starting the piping work over the pipe rack, the contractor shall provide a hanging scaffolding, about one meter below the entire pipe rack first tier elevation, to provide an elevated working platform leaving the ground free, to provide protection from the falling material and to act as a safe working platform for the mechanical work at the first tier

6.0 SPECIFIC REQUIREMENTS

6.1 GENERAL

- 6.1.1 Apart from the conditions mentioned in the Design requirements given in the document, the following shall be strictly adhered to.
- 6.1.2 Cable/pipe trenches & precast slab covers shall be designed to withstand the load of hydra-crane. Seating surface of the slab shall be at least 100mm wide with structural ISA50x50x6 edge protection embedded through out the length of the trench.
- 6.1.3 Only steel shuttering shall be used for civil construction.
- 6.1.4 Contractor shall make necessary arrangement for placing the anchor bolts in position before concreting. Whenever there are more than four foundation bolts, these shall be fixed by using template. In case bolts are not available at site at the time of casting of foundation, proper pockets shall be left as per direction of the Engineer-in-charge.
- 6.1.5 Contractor to ensure isolation of structures/equipments with difference of temperature for free expansion while providing interconnecting platform and for connection to the stair structure.
- 6.1.6 Contractor shall ensure lateral stability by providing box/built up sections for columns wherever it is not feasible to provide vertical bracing in either direction.
- 6.1.7 Buildings shall be provided with anti termite treatment.
- 6.1.8 All designs, detailing & construction shall strictly conform to enclosed standards, specifications & drawings. However drawings marked "Issued for Information only" are for only guidance to the contractor.
- 6.1.9 Contractor shall furnish the BULK MTO for cement and High Strength Deformed TMT bars (*diameter wise*) and Structural Steel (*section wise*) within 45 days from the date of receipt of LOI/TOI. It shall also be updated at 50% & 90% stages of engineering progress and shall be submitted to owner/owner's representative for information.
- 6.1.10 Sequence of construction is to be shown on the AFC drawings by indicating construction joints wherever required.
- 6.1.11 The minimum diameter of reinforcement bar for slabs, beam stirrups and column ties shall be 8 mm and for footing slabs and vertical walls it shall be 10 mm. The maximum spacing of these bars shall be restricted to 300 mm c/c.
- 6.1.12 No equipment shall be directly supported on suspended floor slab. Suitable arrangement of beams shall be provided underneath to support the equipments.
- 6.1.13 The foundation design shall be based on approved Geotechnical investigation recommendations. Geotechnical investigation shall be in scope of the bidder.

However, boreholes of nearby areas are enclosed for reference only for the bidder.

- 6.1.14 Contractor shall depute his concerned Civil-Structural design engineer to owner/owner's representative review office as and when required for review of his documents. During such reviews involving computer aided analysis/design/drafting of structures, the Contractor shall make his own arrangement of Personal Computer (PC) in the form of Lap-top in the premises of owner/owner's representative review office. This is required to expeditiously resolve all the comments including those involving the use of PC by Contractor in his submission. The Contractor shall ensure that these PC's are fully operational along with necessary software already loaded including the input/output/drawing files of the structures being reviewed. The Contractor shall revise and re-submit the analysis/design and drawings as required during review.

6.2 REVIEW OF DESIGN AND APPROVED FOR CONSTRUCTION (AFC) DRAWINGS

- 6.2.1 Complete structural design and AFC drawings for the structures mentioned in section A-5.2.2 shall be got reviewed by owner/owner's representative in detail before taking up any construction activity at the work site:

For all other works/buildings/structures, requisite number of prints (as mentioned elsewhere) of design calculations and AFC drawings shall be sent simultaneously to owner/owner's representative for information and to site for construction.

Submission of typical review category documents shall be taken up prior to corresponding information category documents. Owner/owner's representative comments on typical review category documents shall be duly taken care in information category documents as well before issuing them for construction.

- 6.2.2 The contractor shall furnish the quantities of different grades of concrete, reinforcement and structural steel in the respective AFC drawings. Bar Bending schedule for all RCC drawings shall be submitted by the contractor along with the AFC drawings.

6.3 HANGER SCAFFOLDING

Before starting the piping work over the pipe rack, the contractor shall provide a hanging scaffolding, about one meter below the entire pipe rack first tier elevation, to provide an elevated working platform leaving the ground free, to provide protection from the falling material and to act as a safe working platform for the mechanical work at the first tier.

The scaffolding shall be light weight, easy to remove when the work is complete. The deck planks may be perforated sheets suitably folded at the ends and open web ladder type of beams may be used to support them. These beams shall be supported on the hangers provided from the beams of the pipe rack.

The design load under the working condition shall be 120kg per sqm and that for the limit state of collapse shall be twice the same. However individual panel shall

be designed for the concentrated loads of 120kg at spacing of 1m and double that load for the limit state of collapse. Deflection of individual planks shall be maximum span/100. For the beam, the deflection shall be controlled as per IS: 800-2007. The design shall be supported by the properly testing of the checking for the specified loads.

After completion of work over the pipe rack, the contractor shall remove the hanging scaffolding from the pipe rack and take back the Scaffolding material.

JOB SPECIFICATION (STRUCTURAL & ARCHITECTURAL)

PART-B (ARCHITECTURAL)

STEAM AND POWER GENERATION SYSTEM PACKAGE

PROJECT : DAHEJ PETROCHEMICAL COMPLEX
OWNER : ONGC PETRO additions LTD.
PMC : ENGINEERS INDIA LIMITED
JOB NO. : 6987

0	06.07.09	ISSUED FOR BIDS	AG	SD/JKB	VK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

CONTENT

- 1.0 SPECIFIC DESIGN REQUIREMENT**
- 2.0 ARCHITECTURAL FINISHES**
- 3.0 SPECIFICATION OF ARCHITECTURAL FINISHES**
- 4.0 LIST OF APPROVED MANUFACTURERS**

1.0 SPECIFIC DESIGN REQUIREMENT

A. Design basis

The Buildings shall be designed on the basis of following documents. In case of any irrevocable conflict, the most stringent provision or Owner/ PMC's decision shall be followed.

1. Licensor's recommendations/ guidelines
2. Engineering design basis (6987-00-16-48-DB-01, Part-II)
3. National Building Code of India
4. State Factory Rules
5. TAC (Tariff Advisory Committee) recommendations
6. OISD (Oil Industry safety Directorate) Standards
7. BPE (Bureau of Public Enterprises) norms
8. BIS (Bureau of Indian Standards) Codes
9. Indian Electricity Rules
10. Local Municipality/ any other Authority Bye-Laws as applicable.

B. Requirement of Buildings

The Contractor shall finalise the list of buildings such as:

STG shed
Control Rooms/ Rack Rooms
Sub Stations
Operator Cabin
DG Shed
Other buildings/ sheds etc. as required for the package on the basis of Owner's and Licensor's requirement.

C. Space requirement of Buildings

Each building shall accommodate space/ group of space required to meet the functional requirements as well as health/ safety/ Environment / maintenance/ statutory (stairs, fire exits etc)/ utilities & services (Toilets, Air-conditioning, LAN etc.) requirements.

D. Sizing of building spaces

1. Sizing of building spaces shall be adequate to meet functional/ operational/ maintenance/ safety and human comfort requirement.
2. Sizing of office spaces such as Cabins/ Cubicle/ Workstations shall be finalised considering Owner's requirement.

E. Building lay-out

1. Required spaces in the buildings shall be arranged to generate efficient building design/ lay-outs considering functional/ health/ environment/ safety/ statutory / maintenance aspects by means of efficient circulation system.

Contractor shall prepare alternative designs (minimum 2 numbers) for Control Rooms, Rack Rooms, and Office Buildings and submit drawings for review / approval by Owner/ PMC

These alternative drawings shall include 3-D rendered perspective of all external sides of buildings.

Alternative as chosen by Owner/PMC shall be taken up for further detail engineering after incorporating comments by Owner/PMC

2. Buildings shall have one main entry (preferably with a lobby) and minimum one emergency exit connected by un obstructed corridor.
3. Building lay-out shall meet the requirements of fire and life safety as stipulated in NBC, State Factory Rules and recommendations/ guidelines of Licensor.
4. Each Room/ spaces inside buildings shall have independent access without having to pass through other rooms. However, if required functionally, interconnectivity between rooms shall be kept.
5. Each room/area of the building shall have direct access to at least two alternative emergency exits.
6. Each individual Fire Zones shall be segregated from other fire zones/ areas by means of fire rated wall/ partition/doors/ windows etc.

All openings/ penetrations in boundary walls of these zones/ areas shall also be sealed suitably, so that fire integrity is maintained.

F. Building utilities & services

1. Building utilities/ services as required and finalised on the basis of Owner's requirement shall be provided.
2. Toilet & drinking water facility shall be provided in manned buildings. Toilet blocks shall consist of Gents & Ladies toilet, drinking water facility, Janitor's space & ventilation / pipe shaft.
3. Any space housing equipments / machines / instruments etc., which require conditioned environment, shall be suitably conditioned.

G. Building aesthetics

1. Contemporary Architectural style shall be reflected in the design.
2. Contractor shall develop and incorporate Architectural control schemes covering all the buildings. Purpose of Architectural control scheme shall be to achieve unified Architectural style of buildings across the complex. Various building elements and their aesthetic treatment shall be demonstrated in the scheme. Aesthetic treatment shall cover shape, form, material, colour etc. of key building elements such as building shape, entrance, entrance lobby/ reception area, canopy, stairs, windows, shading devices, roof line etc.
3. Contractor shall submit (during detail engineering stage) minimum 2 alternative Architectural schemes for finalized Control Rooms, Rack Rooms, and Office Buildings supported by 3-D rendered walkthroughs (interior as well as exterior) indicating decorative patterns/ features in floor/

wall/ ceiling and other Architectural features. Scheme approved by Owner/ PMC (after incorporation of comments if any) shall be incorporated in the final design drawing to be issued for construction of the buildings. contractor shall also make presentation to Owner/PMC for finalisation of design at Owner's Head Office/ site

H. Specific requirement of Building elements

1. STG & other sheds

STG shed shall be Galvalume/Zincalume sheet roof and side cladding (generally at 3000 mm height) shall be provided along external periphery.

Roof monitor/ static ventilator, louvers, windows/ ventilators shall be provided to ensure required ventilation & day light

STG Shed shall be designed in accordance with GA drawings reviewed/ approved by Owner/ PMC

Ventilation system of the Shed shall be as reviewed/ approved by Owner/ PMC

In case of natural ventilation, Continuous louvers, roof monitor/ static ventilators shall be provided.

Poly carbonate sheets shall be provided in Cladding and roofing for natural lighting, in addition to windows/ ventilators.

Configuration of windows/ ventilators, polycarbonate sheets, louvers, cladding including colour scheme of the roofing/ cladding sheets shall be finalised considering aesthetics/ ventilation and natural lighting.

2. Control Room / Rack Rooms

Control Room / Rack Rooms shall be RCC framed structure with RCC roof.

These buildings shall be designed in accordance with OISD-STD-163, other references as per engineering design basis and GA drawings reviewed/ approved by Owner/ PMC

Other than basic functional and utility spaces, office and office related spaces shall also be provided as per Owner's requirement.

3. Sub Stations

Sub Stations shall be RCC framed structure with RCC roof and brick masonry walls.

These buildings shall be designed in accordance with as per OSID –STD 149; 173; IEA; IER; other references as per engineering design basis and GA drawings reviewed/ approved by Owner/ PMC

I. Fire and explosion safety

Walls/ doors/ windows/ ceilings of required fire & explosion resistance shall be provided as per Licensor's requirement and other safety/ statutory requirements as listed in clause 1.0.A

2.0 ARCHITECTURAL FINISHES

A. All the buildings/ Sheds shall be provided with Architectural finishes such as floor finishes, plastering & painting on walls & ceilings, doors / windows / ventilators, Roofing treatment, plinth protection etc.

B. Architecture finishes shall be as per following schedule of Architectural finishes, Approved Engineering Design Basis and licensor's requirement.

In case of any irrevocable conflict, Owner/ PMC's decision shall be followed.

C. Any item not indicated in the bid document shall be as per the direction of the Owner/ Consultant with out any extra cost.

D. Architectural finishes shall be in accordance with specification of Architectural Items in the bid document or Licensor's specification.

In case of any irrevocable conflict, Owner/ PMC's decision shall be followed.

E. Make of Architectural items shall be as per approved vendor list.

F. Wherever, options are indicated for Architectural finishes, Owner/ Consultant's choice shall be final and binding.

G. Colour scheme shall be as approved by Owner/ PMC

H. Schedule of exterior finishes

Note:

In case of composite/ combined buildings comprising of different type of buildings, only one exterior finish shall be provided. In that case, superior finish amongst the finishes of different type of buildings shall be provided.

1. Control Room, Sub Stations and similar type buildings

- Plain cement plaster and sand stone cladding

2. Operator Cabins and similar type buildings

- Plain cement plaster and Texture Coating

3. STG Shed and similar type Sheds

- Plain cement plaster and water proof cement paint (over RCC/ Brick)

4. Metal sheet roofing and cladding in Sheds

- Galvalume/ Zinalume sheet

I. Schedule of interior finishes

1. Control Room, Sub Stations, Rack Rooms and similar type buildings :

Area	Flooring	Wall	Ceiling
Entrance/ Exit/ Air Lock lobby : Control Room, Rack Room	Granite stone	Granite stone cladding	Aluminum panel false ceiling
Entrance lobby : Sub Station	Kota Stone	Oil Bound Distemper over cement plaster	Oil bound distemper over cement plaster
Circulation area (Corridor, passage etc.): Control Room, Rack Room	Granite stone	Granite stone cladding up to 1500 mm height, POP punning & plastic emulsion paint	Aluminum panel false ceiling
Circulation area (Corridor, passage etc.): Sub Station	Kota Stone	Oil Bound Distemper over cement plaster	Oil bound distemper over cement plaster
Office and associated areas like records/ storage, meeting/ conference room etc.	Vitrified Tiles	Plastic emulsion paint over cement plaster & POP punning	Aluminum panel false ceiling
Switch Gear, AHU, Clean Agent Room, Pressurization, CO ₂ Cylinder Room, MCC. Loading unloading & Other areas housing equipments etc.	Heavy duty flooring	Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Cable Cellar	Granolithic flooring	Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Battery Room & Chemical handling area	Chemical resistant epoxy coating	Chemical resistant epoxy coating up to 2500 high Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Rack Room, UPS Room	False flooring with High pressure laminate	Plastic emulsion paint over cement plaster & POP punning	Aluminum panel false ceiling

Area	Flooring	Wall	Ceiling
Console Room	Partly Granite stone flooring partly False flooring with High pressure laminates	Granite Stone cladding Textured coating in selected areas	Aluminum panel false ceiling
Toilets, Drinking water area, Hand wash area: Control Room ,Rack Room	Granite stone	Granite stone	Aluminum panel false ceiling or Plastic emulsion over cement plaster & POP punning
Toilets, Drinking water area, Hand wash area: Sub Station	Ceramic tile	Ceramic tile	Aluminum panel false ceiling or Plastic emulsion over cement plaster & POP punning
Stair : Sub Station	Kota stone	Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Stair : Control Room ,Rack Room	Granite Stone	Textured coating	Plastic emulsion over cement plaster & POP punning
Pantry / Dining Hall	Vitrified Tiles	Ceramic tile	Aluminum panel false ceiling

2. Operator Cabins and similar type buildings :

Area	Flooring	Wall	Ceiling
Entrance lobby, lounge, Reception etc	Vitrified Tiles	Marble Stone cladding	Gypsum board false ceiling
Circulation area (Corridor, passage etc.)	Vitrified Tiles	Plastic emulsion paint over cement plaster & POP punning	Gypsum board false ceiling
Office and associated areas like records/ storage, meeting/ conference room etc.	Vitrified Tiles	Plastic emulsion paint over cement plaster & POP punning	Mineral fiber false ceiling

Area	Flooring	Wall	Ceiling
Battery Room & Chemical handling area	Chemical resistant epoxy coating	Chemical resistant epoxy coating upto 2500 high Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Instrumentation Panel/ console, UPS Room	False flooring with High pressure laminate	Plastic emulsion paint over cement plaster & POP punning	Aluminum panel false ceiling
Stair	Marble Stone	Plastic emulsion paint over cement plaster & POP punning	Plastic emulsion paint over cement plaster & POP punning
Toilets, Drinking water area, Hand wash area	Vitrified Tiles	Ceramic Tiles	Gypsum board false ceiling Or Plastic emulsion paint over cement plaster & POP punning
Pantry / Dining hall	Vitrified Tiles	Ceramic tile	Gypsum board false ceiling Or Plastic emulsion paint over cement plaster & POP punning Plastic emulsion over cement plaster & POP punning

3. STG shed, and similar type buildings/ Sheds

Area	Flooring	Wall	Ceiling
Process , utility & similar type area	Architectural finishes shall be as per licensors's requirement. If nothing is specifically mentioned :		
	Heavy duty flooring	Oil bound distemper over cement plaster	Oil bound distemper over cement plaster for RCC roof
Entrance lobby	Kota Stone	Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Circulation area (Corridor, passage etc.)	Kota Stone	Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Office and associated areas like records/ storage, meeting/ conference room etc	Kota Stone	Oil bound distemper over cement plaster	Mineral fiber false ceiling or oil bound

Area	Flooring	Wall	Ceiling
			distemper over cement plaster
Battery Room & Chemical handling area	Chemical resistant epoxy coating	Chemical resistant epoxy coating upto 2500 high Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Instrumentation Panel/ console, UPS Room	False flooring with High pressure laminate	Plastic emulsion paint over cement plaster & POP punning	Aluminum panel false ceiling
Stair	Kota Stone	Oil bound distemper over cement plaster	Oil bound distemper over cement plaster
Toilets, Drinking water area, Hand wash	Ceramic tiles	Ceramic tile	Gypsum board false ceiling or Oil bound distemper over cement plaster
Pantry/ Dining Hall	Kota Stone	Ceramic tile	Gypsum board false ceiling or Oil bound distemper over cement plaster

Notes:

1. Skirting shall be of same finish as that of floors.
2. Counters and window sills in Pantry, Dining Hall etc. shall have granite finish with moulded edges.
3. Granite stone cladding shall have moulded border on top.
4. Decorative patterns involving colours combination and decorative shapes shall be provided in floors and ceiling finishes of office buildings, laboratories, control room, rack room etc.
5. False ceiling and under deck insulation shall be provided in all Air-conditioned areas irrespective of above schedule
6. False flooring shall be provided in areas having extensive under-floor cabling irrespective of above schedule
7. Granite store thresholds shall be provided wherever floor finishes in adjoining area changes.

J. Doors, Windows, Ventilators

Note:

1. Fire check doors of required rating (minimum 2 hours) shall be provided in Console Room, Rack Room, Battery Room, UPS Room, AC Plant/ AHU/ Electrical Rooms (when accessible from inside the buildings) of all type of buildings.

2. Irrespective of following schedule, fire check doors/ windows/ ventilators of required fire rating shall be provided wherever required in accordance with OISD Standards, Licensor's recommendations, Factory Rules, National Building Code of India and other statutory requirements.
3. Motor operated Rolling shutters shall be provided in equipment area like Switchgear/ MCC Room, Workshop, Warehouse etc. where opening size for door exceeds 3000x 3000 mm.
4. Doors /windows/ ventilators shall be complete with all fittings & fixtures for smooth operation & locking facility
 - a. Control Room, Rack rooms, Sub Stations and similar type buildings :
 1. Entrance /Exit doors
 - Powder coated Aluminum glazed (5.5mm thk. Toughened glass) doors
 2. Circulation area doors
 - Powder coated Aluminum glazed (5.5mm thk. Toughened glass) doors
 3. Office area doors
 - Powder coated Aluminum glazed (5.5mm thk. Toughened glass) doors
 4. AC Plant, Battery room, Electrical room doors
 - Pressed steel frame with pressed steel shutter doors (powder coated)
 5. Toilet doors
 - TW frame, block board TW veneer finish flush doors
 6. Window& Ventilators
 - Powder coated Aluminum glazed (5.5mm thk. Toughened glass) window & ventilators. Ventilators shall have aluminium louvers also.
 - b. Operator Cabins and similar type buildings
 1. Entrance /Exit doors
 - Powder coated Aluminum glazed (5.5mm thk. Toughened glass) doors
 2. Circulation area doors
 - Powder coated Aluminum glazed (5.5mm thk. Toughened glass) doors
 3. Office doors
 - Powder coated pressed steel frame block board laminated finish flush shutter doors
 4. AC Plant, Battery room, Electrical room doors
 - Pressed steel frame with pressed steel shutter (powder coated)
 5. Toilet doors
 - Powder coated pressed steel frame block board laminated finish flush shutter doors
 6. Window& Ventilators

– Powder coated Aluminum glazed (5.5mm thk. Toughened glass) window & ventilators. Ventilators shall have aluminium louvers also.

c. STG building and similar type buildings/ Sheds

1. Entrance /Exit doors
– Pressed steel frame with pressed steel shutter doors (powder coated)
2. Circulation area doors
– Pressed steel frame with pressed steel shutter doors (powder coated)
3. Office area doors
– Powder coated pressed steel frame block board laminated finish flush shutter doors
4. AC Plant, Battery room, Electrical room doors
– Pressed steel frame with pressed steel shutter (powder coated)
5. Toilet doors
– Powder coated pressed steel frame block board laminated finish flush shutter doors
6. Window& Ventilators
– Steel, glazed (5.5mm thk. Toughened glass) window & ventilators. Ventilators shall have steel louvers also (powder coated)

d. Fire Check/ resistant Doors (minimum 2 hours fire rated)

1. Console Room, Rack Room, Main entrance – Glazed steel fire check door
2. Office area – Wooden fire check door with vision panel
3. Other rooms – Solid type steel fire check door with vision panel

K. Water proofing treatment

- a. Roof water proofing shall done with Atactic polypropylene modified bituminous waterproofing membrane
- b. Rain water pipes shall be of CI/UPVC

L. Plinth protection

- a. Minimum 900 mm wide plinth protection shall be provided all around the buildings.

M. Sanitary fittings/ fixtures

- a. Control Room, Rack Rooms and similar type buildings
 1. Water Closet (European type) :
– Wall hung type, coloured (premium luxury model)
 2. Wash Basins :
– Round coloured, with electronic sensor over granite counter (premium luxury model)

3. Urinals :
 - With electronic sensor (premium luxury model)
4. Plumbing fixtures (stop/bib/pillar cocks, flash valves etc.) :
 - Stainless steel (premium luxury model)
- b. Sub Stations
 1. Water Closet (European type) :
 - pedestal type, coloured
 2. Wash Basins :
 - Round coloured, over granite counter
 3. Urinals :
 - Standard wall hung type
 4. Plumbing fixtures (stop/bib/pillar cocks, flash valves etc.) :
 - CP brass
- c. Operator Cabins and similar type buildings
 1. Water Closet (European type) :
 - Wall hung type, coloured (premium luxury model)
 2. Wash Basins :
 - Round coloured, with electronic sensor over granite counter (premium luxury model)
 3. Urinals :
 - With electronic sensor (premium luxury model)
 4. Plumbing fixtures (stop/bib/pillar cocks, flash valves etc.) :
 - Stainless steel (premium luxury model)
- d. Process buildings, Utility buildings like STG, Analyser room and similar type buildings
 1. Water Closet (European type) :
 - pedestal type, coloured
 2. Wash Basins :
 - Wall hung type
 3. Urinals :
 - Standard wall hung type
 4. Plumbing fixtures (stop/bib/pillar cocks, flash valves etc.) :
 - CP Brass

Note: a. Granite slab partition with moulded edges shall be provided between urinals.

3.0 SPECIFICATION OF ARCHITECTURAL FINISHES

Note:

1. In case of any conflict with specifications mentioned elsewhere, specifications as indicated in this clause shall prevail.
2. For specifications not covered herewith shall be prepared by contractor and submitted for Owner/ PMC approval. The work shall be executed in accordance with approved specifications.

3.1 GENERAL

- (a) For any aspect of item not covered in the document, the contractor shall follow instructions of the engineer-in-charge and execute the work as per relevant IS codes/ recommendations of approved manufacturer/ good engineering practice without any cost or time implication to Owner/PMC. Contractor shall refer only to the relevant part of the specifications given below as per the Building Finishes described before.
- (b) All materials shall be of first quality conforming to the specifications & IS or equivalent with IS marks and shall be obtained from the approved Manufacturer. The Contractor shall get the materials approved by the Engineer - In - Charge before ordering & procurement. The Contractor shall furnish necessary certificates etc. as asked by the Engineer - In - Charge. Further to that he shall get the materials tested from approved test house if asked by the Engineers - In - Charge & submit the test certificate at his own cost for which no extra payment shall be made to him. The Engineer - In - Charge shall have the right to reject all or any of the materials intended to be used and such materials shall be immediately removed from the site by the Contractor at his own cost without any claim for compensation etc. due to such rejection.
- (c) Workmanship shall be to the satisfaction of the Engineer- In- Charge. The contractor shall follow the specifications, relevant Codes & Manufacturer's guidelines for achieving desired level of workmanship as per specification & good engineering practice. Any executed work not conforming to the specification or not to the satisfaction of the Engineer -In-Charge shall be rectified by the Contractor as directed by the Engineer -In-Charge. No extra payment shall be made to the Contractor for such rectification. The contractor shall use only first quality approved material for all items.
- (d) All specifications of various finishing items include construction supervision; supply of all materials, labours, tools tackles, scaffoldings etc. and are applicable for all heights, locations etc.
- (e) For specifications of construction water, sand, cement, bricks/ stone, aggregates etc. reference shall be made to the Civil/ Structural specifications attached in the bid document.
- (f) All specialised items of work (e.g. Composite Aluminium panel, Structural/ Curtain Glazing, Aluminium Doors and Windows, Waterproofing, Insulation, Pre-coated roof sheeting/ cladding, False ceiling, False Flooring, Partitioning and Panelling,

Expansion joint sealing etc.) shall be got executed by the Contractor only through authorised applicators/ sub contractors of approved manufacturer/ vendor. The

contractor shall submit list of such authorised applicators/ sub contractors for approval before execution of such items.

3.2 FLOOR FINISHING

Reference shall be made to the following Indian Standards for any further information etc. not covered in the specification. In case of any conflict/contradiction, provision of specification shall override.

IS: 4971	Recommendations for selection of Industrial floor finishes.
IS: 1237	Specification for Cement concrete flooring tiles.
IS: 777	Specification for glazed earthenware wall tiles.
IS: 2571	Code of practice for laying in situ cement concrete flooring.
IS: 4631	Code of practice for laying of epoxy resin floor toppings.
IS: 5491	Code of practice for laying in situ granolithic concrete floor topping.
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 mortar.

3.2.1 Cement Concrete Flooring

Cement concrete flooring shall be laid in average 25mm thickness over sub base (as per structural drawings/ specifications) and shall generally conform to IS: 2571. The flooring shall be laid in panels and shall consist of:

(a) 25 mm thick base course of M-20 grade cement concrete (with 6mm and down size stone aggregate) laid on the sub-base in panels (each panel not exceeding 1 Sq. Mtr. in area) in desired shape and pattern. The panels shall be bound by 3x20mm PVC strips panel dividers; fixed in position with their top at proper level maintaining the required levels, slopes, linearity etc. as required. Base course shall be laid in alternate panels. Before laying the base course, neat cement slurry @ 2.75Kg. of cement per Sq. Mtr. of area shall be applied (brushed) over the prepared sub base surface. Cement concrete shall be placed in position and beaten with trowel, including tamping and finishing smooth. Finishing of the surface shall follow immediately after completion of laying of base. The bed for flooring shall be prepared either level or sloped as per drawings and as instructed by Engineer-in-charge.

(b) Neat cement @ 2.75Kg. per Sq. Mtr. mixed with water to form a thick slurry applied over the base course (when the concrete is green), spread over the surface, pressed twice by means of iron floats; once when the slurry is applied and second time when the cement starts setting. The junction of floor with wall plaster, cladding, skirting shall be rounded off uniformly upto a radius of 25mm unless otherwise mentioned.

Each finished portion of floor, on completion shall be kept wet with ponding for a minimum period of 7 days.

3.2.2 Cement Concrete Granolithic Flooring

Cement concrete granolithic flooring shall be laid in overall **40mm** thickness over sub base (as per structural drawings/ specifications) and shall generally conforming to IS:5491 in workmanship. The flooring shall be laid in panels and shall consist of:-

(a) 25mm base Course (Under layer) of M-20 grade Concrete (shall generally conform to Civil structural specifications) laid over sub base in panels (each panel not exceeding 1 Sq. Mtr. in area) in desired shape and pattern. The panels shall be bound by 3x30 PVC strips panel dividers; fixed in position with their top at proper level maintaining the required levels, slopes, linearity etc. as required. Base course shall be laid in alternate panels. Before laying the base course, neat cement slurry @ 2.75Kg. of cement per Sq. Mtr. of area shall be applied (brushed) over the prepared sub base surface. The borders of the panels shall have mitred joints at the corners of the room and intermediate joints shall be in straight line with panel joints. Cement concrete shall be placed in position and beaten with trowel and finished smooth. Beating shall cease as soon as surface is found covered with cream of mortar. Necessary slope shall be provided.

(b) 15mm thick Wearing top layer of cement mortar 1:3 (1 cement: 3 course sand by volume) which shall be laid within 15 minutes of laying the first layer. The cement and aggregates for the top layer shall be mixed dry. After mixing, sufficient quantity of washed sand and water shall be added to make the mix plastic but not flowing. The top and bottom layer shall firmly grip together. The base course shall be free of excessive moisture before starting the floor finishing. Use of dry cement, cement sand mixture sprinkled on the surface to stiffen the concrete or absorb excessive moisture shall not be permitted.

(c) While the concrete is still green, cement @ 2.75 kg per Sq.M of floor area shall be mixed with water to form a thick slurry and spread over the surface. It shall be pressed twice by means of iron floats, once when the slurry is applied and second time when the cement starts setting. The junction of floor with wall plaster, cladding, skirting shall be rounded off uniformly upto a radius of 25mm unless otherwise mentioned.

Each finished portion of floor, on completion shall be kept wet with ponding for a minimum period of 7 days.

3.2.3 Heavy Duty Cement Concrete Flooring

Heavy duty Cement concrete flooring shall be laid in overall 50mm thickness over sub base (as per structural drawings/ specifications); shall generally conform to IS: 5491 in workmanship. The flooring shall be laid in panels and shall consist of:-

(a) Base Course (Under layer) 35mm thick of cement concrete (1 cement: 1.5 coarse sand: 3.5 stone aggregates of 10mm to 6mm size by volume) laid over sub base in panels (each panel not exceeding 1 Sq. Mtr. in area) in desired shape and pattern. The panels shall be bound by 3x40mm PVC strips panel dividers; fixed in position with their top at proper level maintaining the required levels, slopes, linearity etc. as required. Base course shall be laid in alternate panels. Before laying the base course, neat cement slurry @ 2.75Kg. of cement per Sq. Mtr. of area shall be applied (brushed) over the prepared sub base surface. The borders of the panels shall have mitred joints at the corners of the room and intermediate joints shall be in straight line with panel joints. Cement concrete shall be placed in position and beaten with trowel and finished smooth. Beating shall cease as soon as surface is found covered with cream of mortar. Necessary slope shall be provided.

(b) Wearing Top layer/ Finishing layer shall be of cement, hardener and stone aggregate mix of 15mm thickness laid over the base course. Unless otherwise mentioned, one part of approved quality hardener and four parts of cement by weight shall be mixed dry. This dry mixture shall be mixed with stone grit of 6mm and down size in the ratio of 1 hardener and cement mixture : 2 stone grit by volume. Just enough water shall then be added to the mix.

The mixture so obtained shall then be laid on the base course within 2 to 4 hours of latter's laying. It shall be firmly pressed into bottom concrete so as to have a good bond with it. After the starting of initial setting, the surface shall be finished smooth and true with steel floats.

Each finished portion of floor, on completion shall be kept wet with ponding for a minimum period of 7 days.

3.2.4 Cement Plaster Skirting

Cement plaster skirting shall be laid with cement mortar (1 cement:3 coarse sand by volume) shall be of 18mm thickness. The surface on which the skirting is to be applied shall be prepared and skirting shall be laid. The junction between flooring and wall shall be rounded off to a radius of 25mm if not otherwise mentioned.

While the mortar is still green, cement @ 2.75Kg per square metre shall be mixed with water to form a thick slurry and applied over the mortar. It shall be pressed twice by means of iron floats, once when the slurry is applied and second time when the cement starts setting. The flooring shall be cured for 7 days.

3.2.5 Tile Work (Glazed/ Ceramic/Vitrified Porcelain)

Glazed ceramic tiles shall conform to IS: 13753. Ceramic tiles for flooring shall be matt finished and non slip type. All tiles shall be decorative type of approved shade, pattern, texture and design and of approved manufacturer. The sizes of the ceramic tiles shall generally be 300x300x8mm for flooring and 100x200x6mm or 300x200x6mm for walls (dado). Vitrified tiles shall conform to EN 176. The sizes of Vitrified Porcelain tiles shall be as per approved manufacturer's standards/ as approved by owner. Pigments to be admixed with mortar for grouting the joints shall conform to Table -1 of IS: 2114. The tiles shall be laid over a coating of approved neoprene based adhesive (as per manufacturers specification) laid on base floor/ wall plaster. The joints of the tiles shall be flush pointed with cement paste (white cement and pigment conforming to IS:2114, Table-I) matching the shade of colours. The tile work shall be suitably cured.

3.2.6 Kota Stone Flooring/ skirting/ dado

Stone Flooring shall be laid in minimum 40mm overall thickness over sub base (as per structural drawings/ specifications). The Kota Stone slabs shall be of selected quality and shade, hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flakes. These shall be machine cut to the requisite size and thickness and chisel dressed. For flooring and skirting/ dado/ riser the thickness of the stone slabs shall be 25mm and 18mm respectively. Skirting shall normally be 125mm high unless specified otherwise.

The slabs shall have smooth top (exposed) face before being laid. Before starting the work, the contractor shall get the samples of slabs approved by Engineer-in-charge.

Each slab shall be machine cut to the required size and shape and fine chisel dressed at all edges to full depth and machine rubbed to a smooth surface finish. All angles and edges of the slabs shall be true square and free from chippings giving a plane and smooth surface.

For steps, joints in Kota stone shall be permitted only when width/ length is more than 0.6/ 2 metre. For flooring minimum size of Kota stone slab shall be 450mm x 450mm and shall be of uniform size.

Preparation of base shall include making it rough, cleaning thoroughly and applying neat cement slurry @ 2.75 kg of cement per Sq.M. of area to receive the mortar. Cement mortar shall be 15mm thick 1:6 (1 cement: 6 Coarse sand by volume) for flooring and 12mm thick 1:3 (1 cement: 6 Coarse sand by volume) for skirting. The mortar shall be laid for fixing one slab at a time. The slab shall be washed clean before laying. It shall be laid over cement mortar bedding on top, pressed, tapped gently to bring it in level. It shall be then lifted and laid aside. Top surface of the mortar then shall be corrected by adding fresh mortar at hollows and depressions. The mortar then shall be allowed to harden and cement slurry of honey like consistency @ 4.4.kg of cement per Sq. M shall be spread over the mortar. The edges of the slabs shall be buttered with white cement (with necessary pigment) grout to match the shade of the slabs. The slabs shall then be gently placed in position and tapped with wooden mallets till it is properly bedded in level. The joints shall be as fine as possible. Surplus cement on the surface of the slab shall be removed. The slabs in flooring shall continue for not less than 10 mm under the plaster/skirting. The finished surface shall be true to levels and slopes as instructed by the Engineer-in-Charge. Cut size may be used along periphery as required. Curing, as required shall be done.

Grinding shall be commenced when the joints are properly set. Unevenness at the meeting edges of slabs shall be removed by fine chiselling. Grinding shall be done by machines except for skirting and small areas. First grinding shall be done with Carborundum stones of 48 to 60 grade grit fitted in the machine. Water shall be properly used during grinding. When the floor has been uniformly rubbed, it shall be cleaned with water baring all pin holes. It shall then be covered with a thin coat of cement mixed with pigments to match with colour of the Kota stone. This grout shall be kept moist for a week. Thereafter the second grinding shall be started with Carborundum stone of 120 grit. Grinding and curing shall follow again.

Final grinding shall be with Carborundum of grade 220 to 350 grit using water in abundance. The floor shall be washed clean with water, oxalic acid powder shall then be dusted at 35 gms/sq. m. on the surface rubbed with machine fitted hessian bobs or rubbed hard with woollen rags. The floor shall then be washed clean and dried with a soft cloth or linen. If any stone slab is disturbed or damaged, it shall be refitted or replaced and properly jointed and polished.

3.2.7 Marble Stone Flooring & cladding

The Marble Stone slabs shall be minimum 18-19mm thickness of selected quality (grade- I) in approved design, pattern and shade and shade of **Indo Italian Marble** (20%) in combination with **White Makrana Marble** (80%). It shall be hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flakes. The slabs shall be machine cut to the requisite dimensions. Dimension of slabs shall be

700mm to 2500mm in length and 300mm to 1000mm in width. Skirting shall normally be 125mm high unless specified otherwise. Pigments, wherever required, to be admixed with mortar or position and tapped with wooden mallets till it is properly bedded in level. The joints shall be as fine as possible. Surplus white cement on the

surface of the slab shall be removed for grouting the joints shall conform to Table -1 of IS: 2114.

The slab shall be washed clean before laying. 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.

Laying in floor :

Marble Stone Flooring shall be laid in minimum 40mm overall thickness over sub base (as per structural drawings/ specifications). Preparation of base shall include making it rough, cleaning thoroughly and applying neat cement slurry @ 2.75 kg of cement per Sq. Mtr. of area to receive the mortar. It shall be laid over cement mortar (20mm thick 1:6 ,1 cement: 6 Coarse sand by volume) bedding, pressed, tapped gently to bring it in level. It shall be then lifted and laid aside. Top surface of the mortar then shall be corrected by adding fresh mortar at hollows and depressions. The mortar then shall be allowed to harden and cement slurry of honey like consistency @ 4.4.kg of cement per square metre shall be spread over the mortar. The edges of the slabs shall be buttered with white cement with or without pigment grout to match the shade of the slabs. The slabs shall then be gently placed in position and tapped with wooden mallets till it is properly bedded in level. The joints shall be as fine as possible. Surplus cement on the surface of the slab shall be removed. The slabs in flooring shall continue for not less than 10 mm under the plaster/skirting. The finished surface shall be true to levels and slopes as instructed by the Engineer-in-Charge.

The slabs shall be laid in patterns as per drawings and size. Cut size may be used along periphery as required. The joints shall be uniform and in perfect line.

Laying in skirting/ dado/ risers :

The slabs shall be held in position by suitable temporary measure such as wooden/ bamboo supports, temporary hook etc. as approved by Engineer-In- Charge. The outer face of the slabs shall be checked for plane and plumb and corrected. The joints shall be as fine as possible and shall be filled with neat cement paste/ grout with white cement and pigment to match the colour of the slabs. The joints shall thus be left to harden and then the rear gap between the slabs and backing surface shall be packed with cement mortar of specified mix and thickness. Temporary supports shall be removed after the mortar filling in the gap has acquired sufficient strength. The top line of the skirting/ dado/ risers shall be truly horizontal and joints truly vertical.

Polishing and Finishing :

Unevenness at the meeting edges of slabs shall be removed by fine chiselling.

The day after the tiles are laid all joints shall be cleaned with a wire brush 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 shade of the stones.

Grinding shall be commenced after a minimum period of 7 days when the stones and the joints are properly set. Grinding shall be done by machines. First grinding shall be done with carborundum stones of 60 grade grit fitted in the machine. Water shall be profusely during grinding. When the chips show up and the floor has been uniformly rubbed, it shall be cleaned with water baring all pin holes. The second grinding shall be done with carborundum stone of 120 grit. Final grinding shall done the day after the second grinding with carborundum stone of 320 grit using water in abundance. The

surface shall be washed clean with water, oxalic acid powder shall then be dusted at 33 gms/sq. m. on the surface rubbed with machine fitted hessian bobs or rubbed hard with woollen rags. The surface shall then be washed clean and dried with a soft cloth or linen. If any stone is disturbed or damaged, it shall be refitted or replaced and properly jointed and polished.

3.2.8 Italian Marble slab Flooring and cladding

The Italian Marble slabs Flooring and cladding shall be pre-polished (mirror-polish), hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flakes minimum 18-19mm thickness of selected premium quality (grade- I) and shade owner's choice.

Laying, finishing of Granite stone shall be similar to Marble stone laying & finishing

3.2.9 Granite Stone Flooring and cladding

The Granite Stone slabs shall be pre-polished (mirror-polish), hard, sound, dense, homogenous in texture, free from cracks, decay, weathering and flakes minimum 18-19mm thickness of selected premium quality (grade- I) and texture/ shade of owner's choice.

Laying, finishing of Granite stone shall be similar to Marble stone laying & finishing

3.2.10 Epoxy Coating:

Epoxy floor coating shall be pigmented (approved shade) made of a solvent based, two pack system with epoxy resins and amine curing agents, chosen to withstand high degrees of chemical and abrasive action as per approved manufacturer's specification and shall consist of:-

Screed:

The screed shall be provided in flooring and shall consist of a solvent free combination of epoxy resin, modified amine hardeners filled with specially graded and selected chemically inert aggregates of high strength. The system shall include an epoxy resin

primer and screed which are both supplied in pre-weighed units ready for on-site mixing and application. The thickness of screed shall be minimum 3mm thick. The primer shall be applied by brush and shall be allowed to become tacky. The screed shall be prepared as per manufacturers specification and laid evenly over the base floor by trowel. In case of flooring, the finished, cured screed shall have a slightly granular texture.

Finishing Coat:

An epoxy resin sealing coat in two coats @ 125 gms./sq.m. (minimum) per coat shall form the topping coat over the screed in case of flooring and over plastering in case of vertical surfaces. The epoxy resin topping shall be applied at least 24 hours after the laying of the screed. This topping shall be applied by brush or sprayed to a specified thickness in two coats with 3-5 hours interval between them. Care shall be taken to finish the topping perfectly smooth and devoid of any bubbles and unevenness. The newly laid floor shall be protected from dust or moisture and allowed to be used only after a minimum lapse of 48 hours.

The surface on which the epoxy coating is to be done shall be sound, clean and dry in order to achieve maximum adhesion with the primer coating of epoxy resin as per approved manufacturer's specification.

3.3 DOORS AND WINDOWS

3.3.1 Aluminium Glazed Doors, Windows And Ventilators

Aluminium glazed doors/ windows/ ventilators shall be made of extruded tubular electrostatically powder coated (min. 30 microns) Aluminium sections conforming to IS : 733 and IS : 1285 of 'INDAL' or approved equivalent manufacturer with 5.5mm toughened glass conforming to I.S.: 2553 fixed with rubber lining or EPDM gasket and extruded anodised aluminium beading.

Extruded aluminium sections used for various application shall have minimum weights as under.

a. Doors

1. For fixed frames

i) Sides & Top members	:	1.975 Kg/RM
ii) Lock rail	:	1.594 Kg/RM
iii) Bottom rail	:	3.495 Kg/RM

2. For shutter frame	:	1.202 Kg/RM
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3. Glazing clips (beading)	:	0.182 Kg/RM
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a. Window/Ventilator

1. For fixed frames	:	0.639 Kg/RM
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2. For shutter frame	:	0.636 Kg/RM
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3. Glazing clips (beading)	:	0.165 Kg/RM
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4. Coupling bars	:	0.933 Kg/RM
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b. Member for fixing the frame	:	0.463 Kg/RM
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The frames shall be fixed to masonry by means of Aluminium lugs fixed to the frame by counter sunk brass machine screws and grouted with M-20 grade concrete in minimum 150 x 150 x 50 mm sized hole in the masonry. In case of RCC, the frames shall be fixed with 12mm dia dash fasteners in case of concrete. Any steel item coming in contact with Aluminium shall be galvanised.

Aluminium glazed doors shall be provided with cup pivots (of aluminium alloy conforming to IS designation NS-4 of IS 737 and IS designation of A-5-M of IS : 617) riveted to outer and inner frames to permit to swing through an angle of 85 degree.

Following hardware shall be provided for the doors.

1. Heavy duty & hydraulically operated double or single action adjustable door closer conforming to IS : 6315
2. 250mm and 150mm long, 10mm dia Aluminium tower bolts as per IS: 204 one each for each shutter.

3. Brass body 6 lever mortise lock as per IS : 2209
4. Aluminium door handle for each shutter for each side.

(Note: All Aluminium fittings/ fixtures shall be of same finish as that of doorframe & shutter)

Side hung window shutters shall be fixed to the frame with Aluminium alloy friction hinges and shall be complete in all respects including accessories, fittings fixtures of same finish as that of window frame & shutter, handles of cast aluminium conforming to IS designation A-5-M of IS : 617 mounted on a handle plate riveted to opening frames, Aluminium Tower bolts, peg stays for ventilators etc. Wherever specified, decorative aluminium safety grills of approved design shall be provided which shall be screwed to the main frame.

3.3.2 Steel Doors

Steel doors shall consist of :

(a) Pressed steel door frame of overall 125x 65mm size conforming to IS : 4351 and made of 16 SWG pressed steel sheet bent to required shape using bending machine to form solid/ true mitred edges/ corners, stiffened with 50 x 5mm thick MS flat spacers welded to the frame facing the wall/ column @ 600mm c/c maximum vertical spacing. The frame shall be fixed to the masonry by means of 300 x 25 x 6 mm thick MS hold fast welded to the spacer and grouted with M-20 concrete in minimum 350 x 100 x 100 mm sized hole in the masonry. In case of concrete, the frames shall be fixed by 96mm long, 12 mm dia metallic counter sunk type dash fasteners through the frame & spacers. Provision for hinges, locking arrangement and other hardware shall be provided in the frame by machine cutting of required size cutouts in the frame and welding/ screwing to 3 mm thick MS pad plates already welded over the cutout from behind. The frame shall be thoroughly cleaned of rust, mill scale, dirt, oil etc. and then finished with 2 or more coats of approved quality synthetic enamel paint of approved shade over a priming coat of approved red oxide zinc chromate primer. The hollow frame shall be packed with PCC to fill the cavity without gap.

(b) Pressed steel door shutter shall be made with 18 gauge steel sheets formed by machine bending in the form of hollow box (overall 40mm thick) welded at meeting of the sheets with pad plate of 3mm thick MS flat all along the perimeter. The shutter

shall be braced with channel shaped 35mm wide horizontal stiffeners by folding 16 gauge MS sheets @ 500mm c/c fixed by flush riveting. 3mm thick MS pad plates shall be welded inside at required locations for fixing of hardware. The cavity inside shall be packed with rigid PU foam/ phenolic foam or glass wool insulation to fill into the box cavity without gap.

For double shutters, an MS angle (25x 45x 3mm thick) shall be welded to one of the shutter providing a minimum 25mm wide rebate for the other shutter at the meeting point.

The shutters shall be fixed to the door frame by means of heavy duty MS butt hinges of 150mm size conforming to IS : 1341 @ 500mm c/c maximum.

Each door shutter shall have following accessories.

1. Spring loaded pressure die cast zinc alloy door stopper.

2. Heavy duty, MS aldrop 400mm long for double shutter & 300mm long for single shutter.
3. 12mm dia, 300mm long pressure die cast zinc alloy handles on both sides.
4. 12mm dia, 250mm long MS tower bolt at top and 12 mm dia 150mm long at bottom.
5. 3- way spring loaded locking & latching system.
6. 150mm x 300mm Vision panel with 16 gauge MS beading bent to 'Z' shape & 4mm thick plain glass conforming to IS : 2853.
7. All steel doors shall be provided with heavy duty overhead door closer with adjustable spanners, metal screws etc confirming to IS:3564

The entire shutter including all accessories, fittings & fixtures etc. shall be painted with 2 or more coats of approved quality synthetic enamel paint of approved shade over a coat of approved quality red oxide zinc chromate primer.

3.3.3 Wooden Flush Doors

Flush doors shall consist of:-

Frame :

Pressed steel door frame of overall 125x 65mm size conforming to IS : 435 and made of 16 SWG pressed steel sheet bent to required shape using bending machine to form solid/ true mitred edges/ corners, stiffened with 50 x 5mm thick MS flat spacers welded to the frame facing the wall/column @ 600mm c/c maximum vertical spacing. The frame shall be fixed to the masonry by means of 300 x 25 x 6 mm thick MS hold fast welded to the spacer and grouted with M-20 concrete in minimum 350 x 100 x 100 mm sized hole in the masonry. In case of concrete, the frames shall be fixed by 96mm long, 12 mm dia metallic counter sunk type dash fasteners through the frame & spacers. Provision for hinges, locking arrangement and other hardware shall be provided in the frame by machine cutting of required size cut outs in the

frame and welding/ screwing to 3 mm thick MS pad plates already welded over the cut out from behind. The frame shall be thoroughly cleaned of rust, mill scale, dirt, oil etc. and then finished with 2 or more coats of approved quality synthetic enamel

paint of approved shade over a priming coat of approved red oxide zinc chromate primer). The hollow frame shall be packed with PCC to fill the cavity without gap.

Shutter:

Flush door shutters shall be factory made and overall 35mm thick consisting of solid core block board bonded with phenol formaldehyde synthetic resin conforming to IS : 848. The shutters shall be faced on both sides with 3 mm thick Teakwood veneering conforming to IS: 303, BS: 476 part-7/ 1 mm thick approved quality melamine faced lamination shall be provided on both sides in case of toilet doors. 35 x 20mm second class Teakwood lipping shall be provided all around the shutter by means of approved quality neoprene based adhesive and nailing @ 300mm (maximum).

Teakwood veneering along with lipping shall be french polished (lacquer finish) as per specifications. The shutters shall be fixed to the frame by means of 125mm long MS butt hinges conforming to IS: 1341 @ 600mm c/c maximum.

Teakwood used for lipping, beading etc. shall be second class Indian teakwood (conforming to IS : 4021) of good quality, well seasoned and free from defects such

as cracks, dead knots, sapwood etc. and shall be with no individual hard & sound knots more than 15 Sq.CM in area and the aggregate area of such knots not exceeding 2% of area of the piece. The wood shall be fairly closed grains having not less than 2 growth rings per Cm. Width in cross section.

Following hardware of approved quality and shade shall be provided in each shutter:-

1. Heavy duty, overhead hydraulically operated door closer conforming to IS: 3564.
2. Anodised aluminium tower bolts as per IS : 204, 10mm dia 250mm long (at top) and 150mm long (at bottom), one each for each shutter on either side.
3. Brass body 6 lever mortise lock as per IS : 2209 including pair of handles of pressure die cast zinc alloy (satin finished)
4. 3mm thick plastic kick/push plate (150mm high at bottom for entire width & 200mm x 100mm at handle location).
5. Zinc alloy pressure die cast chromium plated spring loaded door stopper with heavy duty rubber shoes.
6. 150mm x 300mm Vision panel with of 4mm thick plain glass conforming to IS: 2853 fixed with second class Teakwood beading (not for toilet doors).

3.3.4 Steel Rolling Shutter

MS rolling shutters shall conform to IS: 6248 and shall be constructed with interlocking lath sections formed out of cold rolled 0.9mm thick, 80mm wide steel strips for shutter width upto 3.5 M, or 1.25mm thick, 80mm wide steel strips for shutter width beyond 3.5 M, jointless MS channel section of 3.15mm thickness for guide, MS girders & bottom rail, shutter suspension stud with pulley & cage, top rolling springs, locking arrangement etc. all complete as per manufacturers approved drawings. The entire shutter including all accessories shall be painted with 2 or more

coats of approved quality & shade synthetic enamel paint over a coat of approved quality red oxide zinc chromate primer. All the damaged surfaces of wall, columns, plastering etc. shall be made good.

Electrically operated Rolling shutters with all accessories, electrical motor, cabling etc. as per approved manufacturers design shall be provided in Substations equipment entry.

Wherever specified the Rolling shutters shall be grill type or partly grill & partly solid type or fully solid type depending on ventilation requirement.

3.3.5 FIRE & SMOKE CHECK DOORS

a. General

The Fire & smoke Check Doors/ Fire resistant Doors (hereinafter termed as FCD) and Fire resistant / Fire check windows (hereinafter termed as FCW) shall not collapse during the rated period of fire under the specified fire conditions and shall provide safe access to the escape route. The Doors shall not allow passage of hot gases or the flames through the rebate or the gap between the door frame and shutter for the duration of fire rating. The mean temperature of the doors on unexposed side shall not exceed 140 degree C above ambient temperature for the duration of fire rating.

b. Fire rating

The complete assembly of the doors i.e. frame, shutter, vision glass and hardware shall have fire rating as required and shall confirm to:

1. BS:476,Part-20 & 22,
2. IS : 3614, Part-II
3. IS : 3809

The FCD & FCW shall be UL listed/ FM approved/ VDS approved / CBRI Roorkee approved or approved by any other any other national or international reputed approved test house. The Contractor shall furnish prototype test certificate from UL/FM/VDS/CBRI ROORKEE or from any other national or international reputed approved test house to this effect.

c. Fire Check Doors & Windows

i. Composition of the Doors

All materials, items, hardware etc. shall be subjected to approval by Engineer-In-Charge. Necessary documentation/ test certificates shall be furnished by the Contractor for such approval. FCD & FCW shall be fabricated only after approval of materials etc, by Engineer-In-Charge.

Each FCD & FCW shall be provided with a small metal identification plate in suitable location indicating Fire rating, name of the Manufacturer, date of installation and approval of approved test house.

Each vision panel shall carry a stamp of the manufacturer.

Unless otherwise mentioned elsewhere, all FCD & FCW shall be of two hours (120 Min.) fire integrity. The FCD shall be broadly classified as per material of construction, in the following category:

1. Fire Check Wooden Door
2. Fire Check Steel Door
3. Fire Check Glazed Door
4. Fire check glazed window

ii. Fire check wooden door

Fire Check Wooden door shall be of proprietary design of the manufacturers as per the valid fire test certificate from UL/FM/VDS/CBRI ROORKEE or from any other national or international reputed approved test house.

Frame :

Door frame shall be a steel door Frame 160mm x 60mm 1.6mm.

To ensure insulation across the door frame, both jambs and the head shall be filled with a sand cement mortar mix. The frame- work arrangement shall be in accordance with the pattern of the Door leaf

Shutter :

Shutters shall be fire rated proprietary non-metallic and asbestos free type having over all thickness of 42mm and shall be composed of approved autoclaved, non-asbestos, non-metallic Calcium Silicate square edged, non combustible boards of approved thickness each side. Fire rated insulation ceramic fiber blankets 30mm thick, minimum density 95 kg/m³ with fire resistant acrylic sealant 1mm thick on both sides. The boards will be fixed to the Perimeter stile and rails 100mm x 30mm.

Calcium silicate board shall have following properties:

Density nominal 95 kg/m³, Resistant to vermin, mould growth, minor impact, abrasion and short term water attack. Smooth surface suitable for receiving most forms of decoration.

Material class: Non-combustible, in accordance with DIN 4102: Part 1, BS 476: Part 4 and AS 1530: Part 1

Surface spread of flame: Class 1 to BS 476: Part 7 and AS 1530: Part 3 Building regulations classification: Class 0

Alkalinity (approx.): pH 9

Thermal conductivity (approx.) at 20°C: 0.210 W/m⁰k

Nominal Moisture content (air-dried): 4-10%

Water absorption capacity (average): 0.49 g/cm³

Expansion under water, 100% saturation (maximum): 0.39 mm/m

Shutters shall be faced with 4mm thick teak ply ("DONEAR" or "DURIAN" or approved equivalent) on both sides with heat activated intumescent fire seal of 10mm x 4mm size encased in PVC casing and CP teakwood lipping on all sides except at bottom.

The total assembly shall ensure fire and smoke integrity as per the fire rating.

Finishing :

The Door frames and shutters shall be provided with approved quality fire resistant primer (one coat) and fire resistant polishing to provide class-I surface of flame confirming to BS:476 Part-7, IS:12777 in desired shade & finish.

iii. Fire check steel door

Fire Check Steel door shall be of proprietary design of the manufacturers as per the valid fire test certificate from UL/FM/VDS/CBRI ROORKEE or from any other national or international reputed approved test house.

Frame :

Door frame shall be of 1.6mm thick galvanized steel sheet pressed form to double rebate profile of nominal size 160mm x 60mm. The frame size may vary as per manufacturer's approved design. They shall be provided with stiffeners for hardware/ lock mounting and holdfast for grouting. To ensure insulation across the door frame, both jambs and the head shall be filled with a sand cement mortar mix. The frame-work arrangement shall be in accordance with the pattern of the Door leaf .

Shutter :

Shutter shall comprise of single / double pressed steel shutter (The shutter width may vary as per manufacturer's approved design) with two outer skin panels of 1.25 mm thick galvanized sheet with infill of either 9mm calcium silicate board on either side with 30mm thick 96 kg/m³ ceramic fibre insulation or mineral wool or ceramic fibre or

any other fire rated proprietary insulation filler with lock seam joinery and internal reinforcement for high strength and fire resistant acrylic sealant (overall shutter thickness shall not be less than 43 mm) for maintaining overall fire integrity.

The total shutter assembly shall ensure fire and smoke integrity as per the fire rating.

Finishing :

The Door frames and shutters shall be provided with approved quality fire resistant primer (one coat) and approved fire resistant poly-urethane paint or fire resistant polishing to provide class-I surface of flame confirming to BS:476 Part-7, IS:12777 in desired shade & finish.

iv. Fire check glazed door

Fire Check Glazed door with steel frame shall be of proprietary design of the manufacturers as per the valid fire test certificate from UL/FM/VDS/CBRI ROORKEE or from any other national or international reputed approved test house.

Frame :

Door frame shall be manufactured of 1.6mm thick galvanized steel sheet pressed form to double rebate profile of nominal size 154mm x 77mm. The frame size may vary as per manufacturer's approved design. They shall be provided with stiffeners for hardware/ lock mounting and holdfast for grouting. The door frame shall be finished with etch primer for scratch resistance and shall be powder coated. The frame- work arrangement shall be in accordance with the pattern of the Door leaf .

Shutter :

Shutter shall comprise of single / double pressed steel shutter (The shutter width may vary as per manufacturer's approved design) with two outer skin panels of 1.2 mm thick galvanized sheet with infill of fire rated proprietary insulation filler on both faces with lock seam joinery at stile edges and internal reinforcement for high strength at top, bottom and stile edges for required fire rating. The door shutter shall consist of a top rail and side rail of nominal size 100mm x 48mm and a bottom rail of 200mm x 48mm and finished with etch primer for scratch resistance.

The glass panels shall be 13mm thick, clear, 120 min. rated, 15 min. insulated, non wired toughened glass of make "SAINT GOBAIN CONTRAFLAM LITE" or equivalent, complied to BS476 Part22. The glass shall be complied to Class A Category of Impact Resistance to BS6206:1981 safety Glazing Material. The Glass shall have a light transmission ratio of approx. 87% according to EN410 standards. The glass shall be held in position with G.I. beading, matrix mineral boards, intumescent putty and fire resistant acrylic sealant for maintaining overall fire integrity.

The total shutter assembly shall ensure fire and smoke integrity as per the fire rating.

Finishing :

The Door frames and shutters shall be finished with etch primer for scratch resistance and shall be powder coated.to provide class-I surface of flame confirming to BS:476 Part-7, IS:12777 in desired shade & finish.

v. Hardware & vision panel for FCD

Fire Check doors of all type shall be provided with Hardware and vision panel (wherever applicable) as per following. All Hardware and vision panel shall have same fire rating (wherever applicable) as the doors.

Hardware :

Each FCD shall be provided with following Hardware as a minimum. All Hardware shall have same fire rating (wherever applicable) as the doors.

Sr. No	Hardware	Nos
1	SS 304 satin finish double ball bearing hinges per panel of 100 x 75 x 2.5mm complete with SS Screws	4 Nos
2	Approved type UL listed "push to open" horizontal panic bar - single / double leaf panic exit devices tested in accordance with BS 476 Part 20, 22 having 5 years manufacturers warranty and tested with complete assembly offered by manufacturer	1 No.
3	Openable locks / trims for horizontal Panic Bars to operate panic bar from outside with necessary screws as required. The lock and handle should be an amalgamated single motion piece from the same manufacturer as that of Panic Bar	1 No.
4	Approved type UL listed fire rated heavy duty door closer tested in accordance with BS: 476 Part – 22: 1987 having 10 years manufacturers warranty and tested with complete assembly offered by manufacturer	1 No.
5	SS 304 grade, satin/ brass finish twin rubber heavy duty Door Stopper with SS screws	1 No.

For Internal fire doors opening to the rooms adjoining corridor (defined as escape route), the doors need not have panic bar assembly and shall have the following Hardware as a minimum. All Hardware shall have same fire rating (wherever applicable) as the doors.

Sr. No	Hardware	Nos
1	SS 304 satin finish double ball bearing hinges per panel of 100 x 75 x 2.5mm complete with SS Screws	4 Nos
2	Approved type UL listed fire rated heavy duty door closer tested in accordance with BS: 476 Part – 22: 1987 having 10 years manufacturers warranty and tested with complete assembly offered by manufacturer	1 No.
3	Heavy duty mortice lock (with D type handle on both face) with 90mm cylinder in SS finish along with necessary screws as required.	1 No.
4	SS 304 grade, satin/ brass finish twin rubber heavy duty Door Stopper with SS screws	1 No.

Vision Panel :

Vision panel shall be of 120 minutes fire rated (conforming to BS 476 part 22), UL listed or FM approved, 6mm thick Borosilicate or other special substrate clear, Non Wired, toughened float glass. The Glass shall be compliant to Class A Category of

Impact Resistance to BS 6206:1981 Safety Glazing Material. Glass shall be fixed with necessary beading so as to maintain the integrity of the shutter with respect to fire rating.

vi. Fire check window

Fire Check Windows shall be fixed, glazed with steel frame and shall be of proprietary design of the manufacturers as per the valid fire test certificate from UL/FM/VDS/CBRI ROORKEE or from any other national or international reputed approved test house.

Window frame shall be manufactured of 1.2mm thick galvanized steel sheet pressed form to double rebate profile of nominal size 40mm x 50mm having Glass Panes with size not more than 1.22sqm for each panel. The frame size may vary as per manufacturer's approved design. The window frame shall be finished with etch primer for scratch resistance and shall be powder coated to provide class-I surface of flame confirming to BS:476 Part-7, IS:12777 in desired shade & finish. The frame- work arrangement shall be in accordance with the pattern of the window.

The glass panels shall be double glazed with 6mm thick, clear, 120 min. rated, non wired toughened glass of make "SAINT GOBAIN PYROSWISS EXTRA" or equivalent, complied to BS476 Part22. The glass shall be complied to Class A Category of Impact Resistance to BS6206:1981 safety Glazing Material. The Glass shall have a light transmission ratio of approx. 87% according to EN410 standards. The glass shall be held in position with G.I. Glazing beads and fastened with steel clip-on screws. Ceramic Intumescent Tape with dimensions 20 x 5mm shall be using for sealing between the glass and steel frame on either sides, for maintaining overall fire integrity. Gaps shall be filled with ceramic wool of minimum 80kg/cum density.

The total WINDOW assembly shall ensure fire and smoke integrity as per the fire rating.

vii. Installation

Shop drawings of the doors in accordance to the prototype door profile used to obtain fire test certificate by CBRI Roorkee or other approved test house shall be prepared and submitted for approval by the Engineer-In-Charge. The shop drawings shall include all details of construction, anchoring, connections, fastenings etc. Any suitable modification in fittings, fixtures as required for project specific installations shall have to be incorporated in door profile and approval obtained prior to the installation of the door.

viii. Testing

Along with all material tests the complete system along with the framing shall be tested in accordance with the criteria of BS 476: Part 22 1987 and Report 212 (1)/FR/2003; insulation at door leaf only. The door system shall be tested using a steel Mortise latch set with a steel knob set. The ACRYLIC sealant and the Intumescent door strip shall be tested in accordance with Bs 476: Part 20 and AS 1530: Part 4 and AS 4072: Part1.

ix. Deliverables by the Contractor

Following documentation/ drawings shall be furnished along with the Doors

1. Prototype Test Certificate by CBRI, ROORKEE or other approved test house.
2. Shop drawings

3. Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items intended to be used.
4. Certificate indicating that design and installation of Doors and hardware confirms to norm laid down by CBRI ROORKEE and BIS. or other approved test house.
5. Guarantee in prescribed format in manufacturer's stationery.

x. Guarantee

The doors including all hardware (excepting door closer) shall be guaranteed for a period of 12 months from the date of installation against any manufacturing defect.

Guarantee period for Door Closer shall be 10 years. In case of any such defect within the guarantee period, the defected part shall be replaced by the Contractor.

3.4 PLASTERING & WALL CLADDING

3.4.1 Plain Cement Plaster

Plain Cement plaster shall be provided in following thickness:

- a. 12mm thick in 1:4 cement mortar for all plumb of the internal masonry walls & RCC Columns coming in line (flush) with this side of wall.
- b. 15mm thick in 1:4 cement mortar for rough side of internal masonry walls RCC Columns coming in line (flush) with this side of wall.
- c. The external plastering shall be with waterproof compound (cement mortar mixed with approved acrylic waterproof compound @ 1 Kg. per 50 Kg. of cement) 18mm thick cement plaster in 1:4 cement mortar for all external surfaces as indicated.
- d. 6mm thick in 1:4 cement mortar for all RCC ceiling, beam etc. However if the undulation in ceiling is beyond 6mm thick plaster, extra thickness of plaster shall be applied without any extra cost to give a smooth and fair surface to the satisfaction of Engineer-In-Charge.

3.4.2 Sand face plaster

The plastering work shall include preparation of background surface which shall consist of cleaning of all dust, loose mortar droppings, traces of algae, efflorescence or any other foreign matter by water or by brushing, roughening up of smooth surfaces by wire brushing or hacking, trimming of projections whenever necessary. The surface shall be washed off and well wetted before applying the plaster.

For external plaster, the plastering shall be started from top floor and carried downwards. Internal plastering shall start with ceiling. Plastering shall be applied evenly in specified thickness. The entire surface shall be finished smooth by means of trowel or wooden float.

All the brick/stone masonry and RCC joints shall be provided with 20 gauge chicken wire mesh stretched tight and fixed with G.I. type nails before plastering.

20mm x 10mm grooves (horizontal and vertical) shall be provided in perfect straight line & plumb in plastering as per drawings and instructions of Engineer- In - Charge.

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period the plaster shall be suitably protected from all damages at the contractor's expense by such means as approved by the Engineer-in-charge. The date of execution of plastering shall be marked on the plastering to ensure the proper duration of curing.

The plastering shall include all scaffolding, damage rectification etc. complete.

3.5 ROOF TREATMENT/ WATERPROOF COATING

3.5.1 APP Bituminous membrane Water proofing

Material:

The water proofing membrane shall have a non-woven polyester membrane coated on both side with APP (Atactic polypropylene) modified bitumen. It shall have a Black finish with a very thin polyethylene foil on both sides It shall be in rolls of 1x10m for continuous laying on large lengths. When installed, it shall form an impervious, flexible blanket, which accepts normal structural movement without breaking or cracking.

Workmanship:

Preparation of surface:

The roof surface (or screed) shall be thoroughly cleaned with a wire brush and all foreign matter etc. shall be removed. Well-defined cracks on the surfaces shall be cut to a 'V' section, cleaned and filled up flush with a paste of filling compound and cement in the ratio of 1:2. The finished surface shall be perfectly dry and any dampness should be allowed to evaporate.

Laying:

The membrane shall be laid on the perfectly dry prepared surface by torching-on method with a gas torch. All joints shall have an overlap of 75mm which shall be torch sealed. The overlap shall be done in a manner, which does not hinder water flow along the roof slope. The membrane shall be finished with bituminous base aluminium paint. The waterproofing shall be continued up to the parapet/wall for a minimum of 600mm over the finished roof surface. It shall be continued into rain water pipes by at least 100mm.

Cement Screed:

Plain cement concrete (1:2:4) of 25mm min. thickness with 24 SWG chicken wire mesh shall be laid to slope in panels not exceeding 6 m.sq. area per panel over the roof slab. The joints between panels shall be raked out neatly (after stipulated curing period) to a min. 6mm x 6mm V-groove and filled up with an approved quality sealant compound. Drain outlet shall be provided for all spouts/ rain water pipes by suitable rounding, filling and sloping of PCC. At the junction of the roof and parapet or any other vertical surface, a fillet of 75mm radius shall be formed in cement mortar (1 cement: 4 coarse sand).

A guarantee of 10 years shall be provided by the manufacturer against the performance of the finished waterproof coating.

3.6 WHITE/ COLOUR WASHING, PAINTING, POLISHING ETC.

Reference shall be made to the following Indian Standards for further information etc. not covered in the specification. In case of conflict/ contradictions provisions of the specification shall override.

IS : 6278	:	Code of practice for white washing and colour washing.
IS : 2395	:	Code of practice for painting concrete, masonry and plaster surfaces.
IS : 712	:	Specification for building limes.
IS : 55	:	Specification for Ultramarine blue for paints.
IS : 63	:	Specification for whiting for paint and putty.
IS : 5411	:	Specification for plastic Emulsion paint for interior use.
IS : 2338	:	Code of practice for finishing of wood, and wood based materials.
IS : 5410	:	Cement paint, colour as required.
IS 384	:	Brushes, paints and varnishes, flat.
IS 486	:	Brushes, sash, tool, for paints and varnishes.
IS 110	:	Ready mixed paint, brushing, grey filler enamels for use over primers.
IS 426	:	Paste filler for colour coats.
IS 345	:	Wood filler, transparent liquid.
IS 3585	:	Ready mixed paint, alum. brushing priming water resistant for woodwork.
IS 426	:	Paste filler for colour coats.
IS 106	:	Ready mixed paint, brushing, priming for enamels, for use on metals.

All materials required for the execution of painting work shall be obtained direct from approved manufacturers and shall be brought to the site in makers drums, bags etc. with seals unbroken.

In case of ready mixed paints, thinning if necessary, the brand of thinner shall be as per recommendations of the manufacturer.

Paint shall be applied by brushing or spraying. Spray machine used may be of high pressure type or low pressure depending on the nature and location of work. The paint containers, when not used shall be kept close and free from air.

After the finishing of work, the adjacent surfaces not intended to be washed/ distempered/painted/polished, shall be thoroughly cleaned of all paint patches and shall be finished in accordance with surface finishing of such surfaces.

3.6.1 Oil Bound Distempering

The oil bound distempering work shall consist of:-

Preparation of surface :

The surface shall be thoroughly brushed free from dust, dirt, grease, mortar droppings, other foreign matter and shall be made smooth by sand papering. In case of distempering over existing distempered surface, the existing distempering shall be scrapped by steel scrappers leaving a clean surface. All nails shall be removed. Pitting in plaster shall be made good with plaster of paris mixed with distemper of colour to be used. The surface then shall be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395. Any unevenness shall be made good by applying putty made of plaster of paris mixed with water including filling up the undulation and then sand papering the same after it is dry. Scaffolding wherever required shall be erected in such a way that no part of the scaffolding shall rest against the surface to be painted.

The primer coat :

The primer coat shall be alkali resistant primer or distemper primer and shall be of the same manufacture as oil bound distemper.

Base preparation

After the Primer coat, the base preparation shall include applying two or more coatings of oil based putty in paste form made from chalk powder mixed with linseed oil, white zinc, varnish etc. as per manufacturers recommendations. After each coat of putty, sandpapering of the surfaces shall be done.

Application of Distemper

After the base preparation coats have dried, the surface shall be lightly sand papered and dusted off avoiding rubbing off of the primer coat. The distemper shall conform to IS: 428 and shall be diluted with water or any other prescribed thinner recommended by the manufacturer. Minimum two coats of distemper shall be applied with brushes in horizontal strokes followed by immediate vertical strokes, which together shall constitute one coat. The subsequent coats

shall be applied after at least 24 hours between consecutive coats to permit proper drying of the preceding coat. The finished surface shall be even and uniform without patches, brush marks drops etc. Application of a coat in each room shall be finished in one operation. 14 cm double bristled distemper brushes shall be used. After each days work brushes shall be thoroughly washed in hot water with soap solution and hung down to dry.

Surfaces of doors, windows, floors etc. shall be protected from being splashed upon. Such surfaces shall be cleaned of distemper splashes.

3.6.2 Plastic Emulsion Paint

The Plastic Emulsion paint work shall consist of

Preparation of surface :

The surface shall be thoroughly brushed free from dust, dirt, grease, mortar droppings, other foreign matter and shall be made smooth by sand papering. In case of plastic emulsion paint work over existing distempered/ emulsioned surface, the existing distempering/ emulsion shall be scrapped by steel scrappers leaving a clean surface. All nails shall be removed. Pitting in plaster shall be made good with plaster

of paris mixed with plastic emulsion of colour to be used. The surface then shall be rubbed down again with a fine grade sand paper and made smooth. A coat of plastic emulsion shall be applied over the patches. The surface shall be allowed to dry thoroughly. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395. Any unevenness shall be made good by applying putty made of plaster of paris mixed with water including filling up the undulation and then sand papering the same after it is dry. Scaffolding wherever required shall be erected in such a way that no part of the scaffolding shall rest against the surface to be painted.

The primer coat :

The primer coat shall be alkali resistant primer or emulsion primer and shall be of the same manufacture as plastic emulsion paint.

Base preparation :

After the Primer coat, the base preparation shall include applying two or more coatings of oil based putty in paste form made from chalk powder mixed with linseed oil, white zinc, varnish etc. as per manufacturers recommendations. After each coat of putty, sandpapering of the surfaces shall be done.

Application of Plastic Emulsion Paint :

After the base preparation coats have dried, the surface shall be lightly sand papered and dusted off avoiding rubbing off of the primer coat. The plastic emulsion paint shall conform to IS: 5411 (Part- I) and shall be diluted prescribed thinner recommended by the manufacturer. Minimum two coats of plastic emulsion paint shall be applied with brushes in horizontal strokes followed by immediate vertical strokes, which together shall constitute one coat. The subsequent coats shall be applied after at least 24 hours between consecutive coats to permit proper drying of the preceding coat. The finished surface shall be even and uniform without patches, brush marks drops etc. Application of a coat in each room shall be finished in one operation. 14 cm double bristled distemper brushes shall be used. After each days work brushes shall be thoroughly washed in hot water with soap solution and hung down to dry.

Surfaces of doors, windows, floors etc. shall be protected from being splashed upon. Such surfaces shall be cleaned of splashes.

3.6.3 Plaster Of Paris Punning

Plaster of Paris punning shall be applied over roughened plastered surfaces. Superior quality Plaster of Paris of approved make shall be mixed with water to obtain paste like consistency and shall be applied on walls, ceiling etc. in sufficient thickness to give an absolutely smooth, plumb and straight surfaces.

3.6.4 Painting Of Wood Surfaces (Synthetic Enamel Paint)

Preparation of wood surface shall conform to IS: 2338 (Part-1) in general. All woodwork shall be dry and free from any foreign matter. Nails shall be punched well below the surface. The surface shall be smoothened off with abrasive paper

used across the grain prior to painting, with the grain prior to the staining. Any knots, resinous, or bluish sap wood, cutting out of which is not justified shall be covered with red lead conforming to IS: 103.

Plywood and block board shall be treated in the same manner as for wood work.

Particle boards surface shall be filled with a thin brushable filler and finished as for solid wood. Painting of wood surfaces shall consist of :

Priming :

Priming shall be in accordance with IS: 2338 (Part I and II). Dirt or any other extraneous material on the surface shall be removed and the priming shall be applied by brushing. Priming shall be done on all exposed and unexposed surfaces. Unless specified otherwise all joinery work intended to be painted shall receive at least 2 coats of primer. Type of primer shall be in accordance with Table-1 and Table-2 of IS: 2338 (Part-II).

Stopping and Filling :

Stopping and filling shall be done after priming. Stopping shall be made to the consistency of stiff paste and shall be used to fill holes and cracks. Filler shall be used to level up slight irregularities of the surface. Filler shall be applied with a putty knife and subsequently rubbed down to a level surface with abrasive paper. The filler coat shall be allowed to fully flatten and harden before subsequent coat is applied.

Application of Undercoat :

Under coat shall be applied after the surface has been primed, stopped and filled, and rubbed down to a smooth surface. Under coat may be brushed or sprayed. After drying the coat shall be carefully rubbed down and wiped clean before the next coat is applied. The type of undercoat shall be depending upon the finishing and in accordance with Table 1 and Table-2 of IS: 2338 (Part II).

Finishing :

The finishing paint shall be two or more coats of synthetic enamel paint and shall be applied either by the brush or by spraying to give a uniform, smooth and glossy finish. Reference shall be made to the Table-1 and Table-2 of IS: 2338 (Part-II)

3.6.5 Painting of Steel and Other Metal Surface

Reference shall be made to IS :2524 and IS:1447.

The surface, before painting, shall be cleaned of all rust, scale, dirt and other foreign matter with wire brushes, steel wool, scrappers, sand paper etc. The surface shall then be wiped finally with mineral turpentine which shall then be removed of grease etc. The surface then shall be allowed to dry.

In case of GI surface, surface so prepared shall be treated with Mordant solution (5 litre for about 100 sq.m.) by rubbing the solution generously with brush. After about half an hour, the surface if required shall be retouched and washed down thoroughly with clean cold water and allowed to dry.

Approved quality primer and paint in specified numbers of coats shall be applied as per manufacturer's recommendations either by brushing or spraying. Each subsequent coat shall be applied only after the preceding coat has dried.

3.6.7 Waterproof Cement Paint

The surface shall be thoroughly cleaned of all dirt, dust, mortar dropping and other foreign matter before paint is to be applied. Surfaces already white/colour washed shall be broomed down to remove all dust, dirt, loose scales of lime wash or other foreign matters.

Scaffolding, Preparation of Surface shall be same as white wash. The surface so prepared shall be thoroughly wetted with clean water before the paint is applied.

Waterproof cement paint of approved make shall be mixed with water and stirred to obtain a thick paste, which shall then be diluted to brushable consistency. The proportion of mixture shall be as per manufacturer's recommendation. The paint shall be mixed in such quantity, which can be used up within an hour of mixing to avoid setting and thickening of the paint.

The surface shall be treated with minimum two coats of waterproof cement paint. No less than 24 hours shall be allowed between two coats and subsequent coats shall be applied only after the preceding coat has become hard to resist marking by subsequent brushing. The finished surface shall be even and uniform in shade without patches, brush marks, paint drops etc. Cement paints shall be applied with a brush with relatively short stiff hog or fibre bristles.

Curing shall be started after the paint has hardened. Curing shall be done by sprinkling with water two or three times a day. This shall be done between coats and for at least two days following the final coat.

Surfaces of doors, windows, floors etc. shall be protected from being splashed upon. Such surfaces shall be cleaned of paint splashes.

3.6.8 Acrylic Copolymer Aggregate Finish

Material :

Material shall be acrylic based textured wall coating consisting of quartz and silica aggregate, inorganic pigment and other additives to form a crack-free, flexible, tough, waterproof coating.

Preparation of Surface :

The surface to be coated shall be cleaned and all dirt, dust, grease and loose particles shall be removed. Any old textured surface shall be removed with removing agent as per manufacturer's instructions.

Application :

Bonding agent and water shall be mixed first. Then flakes/ granules shall be added and mixed thoroughly and kneaded till no lumps are found. The dough shall be left for 20-30 minutes before starting application. The bonding agent, flakes/ granules and water shall be mixed in different ratio for different finishes as per manufacturer's specifications.

The first application shall be steel trowel. It shall be smoothened, if the specified finish requires, by a plastic trowel.

3.7 ROOFING

3.7.1 Precoated Zinc Aluminium Steel Sheet Roofing/ Cladding

The base metal of the roofing shall be Cold Rolled Steel Sheet conforming to IS:513. It shall be zinc aluminium coated by Hot-dip process as per AS:1397 / IS:277,. The bottom unexposed surface shall then be coated with alkyd backer of minimum 5 microns over a 5 micron coat of primer. Top exposed surface shall have primer of minimum 5 microns followed by SMP / Super Polyester top coat of minimum 20 microns of specified colour.

The precoated zinc aluminium steel sheets shall meet the following performance standards.

Pencil Hardness	:	Min. HB
T-Bending Test	:	5 T
Impact Resistance	:	Min. 10J
Salt Spray Test	:	1000 hours (Exposed top side)
QUV – Wealterometer Test	:	1000 hours
Humidity Test	:	1000 hours
Temperature Resistance	:	100 deg C for 24 hours
Fire Performance	:	Class-I

The profiles shall have a depth of not less than 28 mm at a pitch of 195 to 255mm (with intermediate ribs). Overall total coated thickness shall be minimum 0.55mm having base metal thickness of 0.50mm. Minimum weight (supply width) shall be 5.00 Kg/ SqM

All roofing accessories like ridge, flashing, north light curves etc. shall be fabricated out of the approved pre-coated sheet as per drawing. Metallic self drilling self tapping fasteners for fixing shall be corrosion proof meeting performance standard as per AS : 3566, Class-III having neoprene washers. Sealants shall be neutral cure type and cold setting variety.

Wind ties shall be of 40 mm x 6 mm flat iron section and other size as specified. These shall be fixed at the two eaves end of the sheet. Fixing shall be done with the same loose bolts which secure sheets to the purlins. Slot holes shall be cut in the wind ties to allow for temperature variations. The wind ties shall be painted with two or more coats of synthetic enamel paint of same shade as that of sheeting over a coat of approved primer.

3.7.2 C.I. Rain Water Pipes

C.I. rain water pipes shall be 100mm dia or 150mm dia (as specified/ indicated in drawings); shall conform to I.S:1729. The pipes shall be provided complete with necessary clamps, connections, bends, Tees, other accessories (as per approved manufacturers specifications) and shall be jointed with spurn yarn and cement mortar 1:2 (1 cement: 2 fine sand by volume). Embedded rain water pipes shall be suitably embedded/ encased in masonry/ cement concrete (M-20) with nominal reinforcement.

3.8 SANITARY FITTINGS AND FIXTURES

Reference shall be made to the following Indian Standards for any further information etc. not covered in the specification. In case of any conflict/ contradiction provisions of specification shall override.

- IS-2556 : Specification for Vitreous Sanitary appliances (Vitreous- China, Part 1- 15).
- IS-774 : Specification for Flushing Cistern for Water Closets and Urinals.
- IS-781 : Specification for Cast copper alloy screw down bib taps and stop valves for water services.
- IS-2064 : Code of Practice for Selection, Installation and Maintenance of Sanitary appliances.

All glazed earthen ware shall be of approved make, colour and of one piece construction. All metallic fixtures like taps, stop cocks, soap holders etc. shall be CP brass and approved make. All wall fittings shall be fixed with nylon sleeve and CP brass screws and washers.

3.8.1 Indian Type Water Closet

Squatting Pan shall be 550mm x 440mm Orissa Pan conforming to IS: 2556 Part-III with integrated footrests. The closet shall be fixed in the floor with 150 mm thick sand cushion and shall be connected with 100 mm dia CI 'S' or 'P' trap. The closet shall also be fitted with 10 litres valve less syphonic type glazed earthenware flushing cistern, conforming to IS: 774, and complete with all accessories like 15 mm dia. PVC inlet connection pipe 450mm long (with 15mm dia CP Brass stop cock and brass union), PVC ball valves, C.P Brass handle, telescopic 32 mm dia GI telescopic flushing pipe with union, 15 mm dia GI overflow pipe with mosquito proof net and fixed with glazed earthenware cover.

The cistern shall be fixed on MS brackets. All exposed metallic surface shall be painted with two coats of synthetic enamel paint of approved quality over a coat of red oxide zinc chromate primer (primer is not required for GI pipes).

One number heavy grade approved quality CP Brass bib cock conforming to IS: 781 (with necessary connections) shall be provided with each WC.

The work shall include providing and fixing water-closet and flushing cistern with all accessories, breaking wall and floors and making good the same, all inlet and outlet connections of cistern and water closet, finishing of solder joints, painting and testing of all connections etc. complete.

3.8.2 Wash Down (European) Type Water Closet

Wash down water closet shall conform to IS:2556 Part-II. Water Closet shall be of one piece construction, double trap syphonic type. This shall be fixed with plastic seat and cover as per IS:2548 of approved make and colour, fixed with CP brass hinges and rubber buffers and an integral 100 mm dia 'S' or 'P' trap with antisiphonage vent horn.

A low level earthenware cistern conforming to IS:774 of about 10 litres capacity, with 15mm dia PVC inlet pipe (with 15mm dia CP Brass stop cock) and brass union with wiped solder joint, internal overflow arrangement, 40 mm dia CP brass flushing pipe. CI or MS supporting brackets shall be fixed with the water closet. All exposed metallic surfaces shall be painted with two coats of synthetic enamel paint of approved quality over a coat of red oxide zinc chromate primer. The clearance between top of pan and bottom of cistern shall not exceed 300 mm.

One number heavy grade approved quality CP Brass bib cock conforming to IS: 781 (with necessary connections); one number approved quality CP Brass Toilet paper holder (fixed to wall with wooden cleats, CP Brass screws) shall be provided with each WC.

The work shall include providing and fixing of all fittings, breaking floors and wall, making good the same, making inlet and outlet connection to the cistern and the closet, testing of joints, painting the exposed metallic surface with two coats of synthetic enamel paint over a coat of primer etc. complete.

3.8.3 Urinals

Urinals shall be integrated photocell operated flushing system type (Integrated EFS of “ Parryware” or approved equivalent) conforming to IS:2556 Part VI. Urinals shall be of single piece construction with integral flushing box rim. These shall be mounted on walls. The flushing inlet pipe shall be of CP brass 15 mm dia and waste pipe 32 mm dia GI, 750 mm long shall be embedded in wall. Necessary unions and CP bottle trap shall be provided in the waste line.

Rawl plugs with CP brass screws shall be used for fixing the urinal. Fixing shall ensure that no liquid is left over in the pan after flushing. Unless otherwise indicated height above finished floors shall be 600 mm.

The work shall include urinals inlet and outlet pipes, flushing cistern, breaking and making good the walls and flooring, making inlet and outlet connections including all related G.I. piping work (embedded in wall), painting exposed brackets and exposed metallic parts with two coats of synthetic enamel paint of approved quality over a coat of red oxide zinc chromate primer etc. all complete.

All The Urinals shall be separated by Marble partitions (of minimum 19mm thick White Makrana marble/ granite slab each partition in one piece) of minimum size 1000mm x 600mm. These partitions shall be inserted upto 100mm depth in the wall and fixed with cement mortar 1:3 (1 cement: 3 coarse sand by volume) and suitable sized M.S. Channel (embedded in wall with grouting) at bottom. The M.S. Channel at bottom shall be finished with two coats of synthetic enamel paint of approved quality over a coat of red oxide zinc chromate primer.

3.8.4 Wash Basins

Wash basins shall be counter top type and shall be provided with granite counter top with require number of tap holes and conforming to IS: 2556 Part-IV. of size 550mm x 480mm size. Each wash basin shall be provided with 15mm dia pillar cock of approved make, rubber plug with CP brass chain, 32mm CP Waste fitting of standard pattern with 32mm dia G.I. pipe, CP Brass bottle trap, CP Brass 15mm dia stop cock etc. complete with all related accessories, fittings and fixtures. The top of rim of the wash basin shall be fixed at 800 mm above finished floor level, unless otherwise specified.

The work shall include provision and fixing of wash basin with all accessories, providing stop cocks and pillar cocks, breaking and making good walls, fixing and making inlet and outlet connections for stop cock, pillar cock and waste pipe, providing & fixing MS brackets painted with two coats of synthetic enamel paint of approved quality over a coat of red oxide zinc chromate primer etc. complete.

Following fixtures of approved quality shall be provided for each Wash Basin.

- | | |
|--------------------------|---|
| 1. Mirror | : Full length beveled edged Mirror of 5.5mm thick float glass with 6mm thick water proof plywood or A.C sheet backing |
| 2. Glass Shelf | : 600mm x 120mm x 4mm thick Glass shelf with CP brass bracket & guard rails fixed on wall. |
| 3. Towel Rail | : Chromium plated brass towel rail of 20 mm dia, 600mm length & 1.25mm thickness. |
| 4. Liquid soap container | : Chromium plated Liquid soap container. |
| 5. Hand drier | : Fully automatic "no touch" ("KOPAL" or approved equivalent) |

All the fixtures shall be fixed to the wall at identified locations with wooden cleats and CP Brass screws including cutting walls, making good the same etc. complete.

3.8.5 Stainless Steel Sink

The stainless steel Kitchen/Laboratory sink shall be of approx. size 610mm x 450mm x 200mm and made of min. 1mm thick stainless steel sheet of 'Salem Steel' or equivalent. It shall be supported on M.S. brackets conforming to IS: 775. One 15mm dia C.P brass long body bib cock (if fixed to wall) or swivel type pillar cock (if fixed to counter) shall be provided. 15mm dia PVC/ G.I. connections to floor trap with unions shall be provided. All exposed metallic surfaces shall be painted with min. 2 coats of synthetic enamel paint of approved make and shade over a coat of red oxide zinc chromate primer. All necessary cutting of floor, walls, counter etc. shall be made and then finished etc. all complete.

3.8.6 Glazed China ware Sink

This shall be white glazed vitreous china Lab sink/kitchen sink of 610mm x 450mm x 250mm size conforming to IS : 2556, Part-V. It shall be fixed with approved quality M.S./C.I. brackets conforming to IS : 775. One 15mm dia CP brass bib-cock, 15mm dia PVC connection, C.P. brass chain with 40mm dia GI pipe connected to floor trap with unions shall be provided. All exposed metallic surfaces shall be painted with 2 coats of approved shade and quality synthetic enamel paint (ICI or approved equivalent) over a priming coat of approved quality red oxide zinc chromate. All necessary cutting of floor, walls, counter etc. shall be made and then finished etc. all complete

3.9 FALSE CEILING, FALSE FLOORING, PARTITIONING, UNDERDECK INSULATION ETC.

3.9.1 False Ceiling

This false ceiling system shall consist of:-

Panel carriers/ runners :

These shall be rows of 0.6mm thick pre coated galvanised steel runners in profiles of size 32mm x 39mm. These shall be suspended from roof structure by means of G.I. suspension angles, ceiling brackets and hold on clamps @ maximum 1200mm c/c all complete as per approved manufacturer's specifications.

Ceiling Panel :

Ceiling panels shall be 150mm wide, 15mm deep roll formed out of 0.50mm thick aluminium alloy AA3105. Top coat of the panels shall have 20 micron (minimum) coil coated polyester finish and 5 micron back coat of Alkyd primer.

3.9.2 False Flooring

The False flooring system shall be of approved make ("USG" or approved equivalent) and shall consist of

- (a) Pedestal base plate made of galvanised Mild steel and shall be of 100 mm x 100mm size and 8mm thick.
- (b) Pedestal stud 20 mm dia, 2.5mm thick made of galvanised mild steel seamless pipe and having threads at top and bottom for attaching the top head attachment and fixing to base plate.
- (c) Top head attachments made of pressure die cast aluminium alloy of shape and thickness as per drawing; and shall be provided with check nuts at bottom portion for attaching the top head threads in the stud allowing for adjustment upto 25mm up & down.
- (d) Channel stringers made of galvanised, machine cut, cold rolled mild steel channels of size 30 mm x 20 mm and 1.6 mm thickness.
- (e) Floor panels of size 600 mm x 600 mm in general and of lightweight cementitious core having 36 weld points (9 x 4 sides) and additional 12 protrusion points; finished on top with 2mm thick high pressure laminate and along four sides with integral hard PVC lipping.

False flooring pattern shall be as per approved drawing. Pedestal base plates shall be fixed to the base floor by 6mm dia, 40mm long dash fasteners as per the grid.

The pedestal stud locations shall ensure the grid work as per flooring pattern which in general shall be of 610 mm x 610 mm dimension. The length of the pedestal studs shall be such that clear cavity between false flooring and base flooring is of desired depth.

The top head attachments shall be inserted into the studs and shall be adjusted to obtain proper level of the finished floor panels by means of the adjustment nuts.

Stringer channels then shall be fitted onto the top heads in position to form the supporting grid work for the floor panels checking the level once again by adjusting the nut position if necessary. Now the check nut shall be finally tightened to secure the final level. Floor panels as specified shall be placed over the stringer channels.

Each floor panel shall be marked with positional numbering on the underneath. The finished floor panels shall be perfectly leveled, aligned without any gaps in between the panels.

Each individual panel shall be removable maintenance purpose.

Necessary cut-outs shall be made in the panels for cable routing, control panel fixation etc. as per drawing.

Necessary ramps, slopes, steps etc. shall be also provided for as per drawing. Around a control panel/ rack, the residual space left out shall be filled up with cut

panels of uniform size as required to fully close the gap between the adjacent full panel and the control panel base channel. In this case the part floor panel shall extend upto the full width of the base channel and the cut size shall be determined accordingly. An additional row of jack pedestals shall be provided along the cut out on which the edge of the floor panel shall rest and over which the base channel of control panel shall be placed. It shall not directly rest on the jack head pedestal or grid channels.

The cavity between false flooring and base floor shall be properly cleaned and made dust free. The floor shall be finally coated with polyurethane based coating.

The finished false flooring shall be able to serve for a distributed load of 1250 kg/Sq.M.

3.9.3 Partitions

Partitioning work shall consist of:-

(a) MS frame made of horizontal & vertical members of 18 SWG, 52mm x 38mm MS hollow box sections. The members shall be welded to each other at maximum 600mm c/c both ways. The frame shall be fixed to the floor/ ceiling/ wall with suitable dash fasteners/ GI rawl plug, screw and washers & 300mm maximum c/c. The members shall be provided with one coat of approved quality red oxide zinc chromate primer.

The frame-work arrangement shall be in accordance with the pattern for partition including doors/windows etc.

(b) Boards for partitioning shall be 12mm thick Medium Density Fiber (MDF) Boards (manufactured from agro based lignocelluloses fibers conforming to IS-12406, exterior grade bonded with synthetic resin conforming IS: 848, BWP type) or Gypsum boards conforming to IS : 2095, both categorized as class-I for 'Surfaces of very low flame spread' as per BS-476

Partitions shall be double skin type with boards fixed on both sides of the framework. Frame work along the edges shall be concealed with panel boards. Necessary cutouts for electrical, AC, return air etc. and other fixtures shall be provided as required in the framework as well as boards. For glazed portions within the partitions, M.S. Frame spacings shall be adjusted for exact location of the glazing with additional Teakwood frame to be provided. Glass shall be 5.5mm thick toughened glass and shall be fixed with putty and wooden beadings.

Necessary arrangement for LAN and other wire/ cable management shall be provided in the partitions.

3.9.4 Phenolic Foam Underdeck Insulation

Phenolic Foam Underdeck insulation shall be of rigid slab of 40mm thickness and approx. 1000mm x 500mm size as specified and shall conform to IS: 13204. It shall have density of 32 kg / M3 and K Value 0.016 KCal/hr M C as per BS 4370, Part 2. The insulation shall be classified as 'Non Combustible' as per BS 476, part 5 and 'Class I' for surface spread of flame as per BS 476 ,part 7. It shall be prelaminated on both sides with Kraft paper.

The entire soffit of slab and beams shall be thoroughly cleaned. Bituminous primer or zinc chromate primer shall be applied evenly @ 0.5 kg/m² over the entire surface. Hot bitumen or CPRX adhesive shall then be applied on the insulation panel @ 1.5 kg/Sq.M. The panels shall be pressed in position and further secured by dash fasteners.

The underdeck insulation shall be fixed only after all fixtures like hooks, clamps, cleats etc. for light fixtures, ducts etc. have been fixed in the ceiling.

3.10 MISCELLANEOUS ITEMS

3.10.1 Transformer Gates/ Fencing

Transformer gates/ fencing shall be made of 50mm x 50mm x 6mm M.S. Angle frame, 50mm x 50mm x 6mm M.S. Tee stiffeners, 50mm x 50mm x 8mm welded mesh fixed to the frame by 20mm x 3mm M.S. flat beading. The gate/ fencing shall be fixed to the masonry/ R.C.C. by M.S. hinge arrangement (consisting of 65mm x 65mm x 6mm M.S. angle, bolt, washers etc.) with M.S. holdfast grouted with M-20 concrete block. The gate shall have M.S. pivot arrangement (ensuring smooth operation of the gate), one heavy duty 450mm long M.S. aldrop, heavy duty M.S. tower bolts etc. complete. The entire gate/ fencing with fittings/ fixtures/ accessories shall be finished with two or more coats of synthetic enamel paint of approved make and shade over a coat of approved red oxide zinc chromate primer. All embedded metallic parts shall be provided with primer.

3.10.2 Plinth Protection

The plinth protection shall consist of a layer (150mm thick) of compacted sand and over that 100mm thick M-20 grade concrete top layer laid to slope. The top concrete layer shall be trowel finished, cured etc. complete. The work also includes carrying out the necessary excavation, disposal of surplus earthwork etc.

3.10.3 Cinder Filling

All the sunk R.C.C slabs shall be provided with cinder filling comprising of:-

- (a) Plastering the R.C.C. slab top, sides etc. with 18mm thick cement plaster 1:6 (1 cement: 6 sand by volume) mixed with approved waterproof compound @3% of cement by weight and finishing with a floating coat of neat cement slurry @ 2.75 kg. per sq. Mtr, finishing, curing etc. The work includes preparation of base surface as described in Plastering item.
- (b) Filling with Cinder concrete 1:10 (1 cement : 10 cinder of 12mm and down grade) including consolidating, finishing, curing etc. complete.

3.10.4 Sealing of Expansion Joints

All expansion joints (25mm wide) of the building shall be sealed with premium grade Silicon sealant (SILPRUF of GE Silicons or equivalent) consisting of the following:-

- (a) The surfaces over which it is to be applied shall be totally dried and cleaned of all dirt, oils, mortar droppings, all loose material etc. by vigorous wire brushing and wherever necessary by grinding and blast cleaning (sand or water).

(b) A backup material or joint filler tapes (as per approved manufacturers specifications) shall be fixed in the expansion joint.

(c) A coat of primer as per approved manufacturers specifications (specially developed for use with Silicon sealant material) shall then be applied over the surface.

(d) Silicon sealant shall be applied by means of cartridge- type caul gun, either hand or air pressure activated. The sealant shall be applied in a continuous operation, horizontally in one direction and vertically from bottom to top of joint opening. The sealant shall be applied in excess so that a positive pressure adequate to properly fill and seal the joint is created. The sealant shall be struck with light pressure to spread the material against the back up material and the joint surfaces properly. The sealant shall be tooled to slightly concave surface. As the work progresses, the excessive sealant shall be removed. The masking tape shall be removed immediately after tooling. The sealant shall be cured as per approved manufacturers recommendations.

Entire work shall be carried out as per as per approved manufacturers specifications and recommendations.

3.10.5 Anti Termite Coating

All woodwork (frames, panels etc. including hidden/ embedded portions of wooden members shall be provided with anti- termite coatings of approved quality aldrine-chlorinated phenol compound conforming to IS: 401. Three or more coats as required @ 3 Sq. Mtr. per coat per Kg. covering capacity shall be applied before applying the finishing (painting, polishing, lamination etc. as specified) coats.

4.0 LIST OF APPROVED MANUFACTURERS

GENERAL NOTES

1. ONLY '**FIRST**' QUALITY MATERIALS SHALL BE USED.
2. **OWNER/ EIL** RESERVES THE RIGHT TO CHOOSE ANY OF THE APPROVED MAKE/ VENDORS AS PER THIS LIST.
3. IN CASE OF PRODUCTS NOT INDICATED IN THIS LIST, ONLY BIS MARKED PRODUCTS SHALL BE USED.
4. SPECIFICATION OF MANUFACTURER'S ITEM SHALL BE CHECKED AGAINST TENDER ITEM/ SPECIFICATIONS BEFORE SELECTING ANY PRODUCT OR BRAND NAME. IN CASE OF ANY DISCREPANCY, TENDER ITEM/ SPECIFICATIONS SHALL PREVAIL, AND ANY SUCH BRAND OF ITEM SHALL NOT BE USED WHICH IS NOT CONFORMING TO TENDER SPECIFICATIONS EVEN IF IT IS LISTED IN THIS LIST.
5. IN CASE OF NON-AVAILABILITY OF ANY ITEM/ MATERIAL AMONG APPROVED MANUFACTURERS/ BRANDS AT A PARTICULAR SITE/ REGION, ALTERNATE MANUFACTURERS/ BRANDS CONFORMING TO BIS/ BS ETC. SHALL BE USED SUBJECT TO APPROVAL BY **OWNER/ EIL HO**.
6. IN CASE OF NON-AVAILABILITY OF ANY MANUFACTURER AMONG APPROVED MANUFACTURERS AT A PARTICULAR SITE/ REGION, ALTERNATE MANUFACTURER'S NAME SHALL BE PROPOSED ALONGWITH REQUIRED CREDENTIALS FOR **EIL'S** APPROVAL.
7. IN CASE OF ANY ITEM/ PRODUCT NEITHER COVERED IN THIS LIST NOR HAVING A BIS SPECIFICATIONS, THE CONTRACTOR SHALL SUBMIT THE PROPOSED ITEM/ PRODUCT ALONGWITH TECHNICAL LITERATURE/ SPECIFICATIONS (AS PER BID), TEST CERTIFICATES ETC. AND OTHER CREDENTIALS OF THE MANUFACTURER FOR **EIL'S** APPROVAL.

SL.	ITEM/ NAME OF MANUFACTURER	PLACE	BRAND NAME
4.1	FLOOR FINISHING		
4.1.1	TERRAZZO TILES		
A	NITCO	DELHI	NITCO
B	HINDUSTAN TILES	DELHI	HINDUSTAN TILES
4.1.2	CERAMIC TILES		
A	REGENCY CERAMICS LTD.	HYDERABAD	REGENCY
B	KAJARIA CERAMICS LTD.	DELHI	KAJARIA
C	ORIENT CERAMICS & INDUSTRIES LTD.	DELHI	ORIENT
D	BELL CERAMICS	VADODARA	BELL
F	SPL LTD.	DELHI	SOMANY
G	H & R JOHNSON (I) LTD.	MUMBAI	JOHNSON
H	SPARTEK CERAMICS	CHENNAI	SPARTEK
I	MURUDESHWAR CERAMICS LTD	HUBLI	NAVEEN
4.1.3	VITRIFIED TILES		
A	REGENCY CERAMICS LTD.	HYDERABAD	REGENCY
B	ORIENT CERAMICS & INDUSTRIES LTD.	DELHI	ORIENT
C	SPL LTD.	DELHI	SOMANY
D	H & R JOHNSON (I) LTD.	MUMBAI	JOHNSON
E	MURUDESHWAR CERAMICS LTD	HUBLI	NAVEEN
F	KAJARIA CERAMICS LTD.	DELHI	KERROGRES
4.1.4	ACID RESISTANT TILES		
A	REGENCY CERAMICS LTD.	HYDERABAD	REGENCY
B	H & R JOHNSON (I) LTD	MUMBAI	ENDURA
4.1.5	PVC TILES/ ROLLS		
A	RESPONSIVE POLYMERS LTD.	MUMBAI	TUSKER
B	ARMSTRONG WORLD INDUSTRIES INDIA (P) LTD.	MUMBAI	EXCELEN
C	RMG POLYVINYL INIDA LTD.	DELHI	WONDER FLOOR
D	PREMIER POLYFILM LTD.	DELHI	POLY FLOOR
E	BHOR INDUSTRIES	DELHI	MARBLEX
F	SHYAM VINYL	CHENNAI	SHYAM VINYLES
4.1.6	PVC TILES/ ROLLS (ANTI-STATIC)		
A	RESPONSIVE POLYMERS	MUMBAI	ELECTRA
B	ARMSTRONG WORLD INDUSTRIES INDIA (P) LTD.	MUMBAI	SOLIDLG1
C	PREMIER POLYFILM LTD.	DELHI	ANSTAT
4.1.7	EPOXY COATING		
A	STP	KOLKATA	SHALIDECK SL
B	FOSROC CHEMICAL (I) PVT LTD	BANGALORE	NITOFLOOR SL 2000/1000
C	SIKA	KOLKATA	SIKA FLOOR
D	BUILDTech PRODUCTS (I) PVT LTD	DELHI	BUILDPOXY-SL
E	ANUPAM INDUSTRIES	KOLKATA	-
F	CICO TECHNOLOGIES	DELHI	CICO ARMOURCOAT-525
4.1.8	FLOOR HARDENER		
A	CICO TECHNOLOGIES LIMITED	DELHI	CICO SURFACE HARDENER
B	SAMCOCK CHEMICALS (P) LTD.	AHMEDABAD	SAMHARD STD
C	PEE ESS PROCESSOR AND TRADERS	KOLKATA	DORONITE
4.2	WOODWORK		
4.2.1	PLYWOOD/ BLOCK BOARD/ FLUSH DOOR		
A	KITPLY PRODUCTS	KOLKATA	KITPLY
B	GOYAAL INDUSTRIAL CORPORATION	DELHI	GOYAAL
C	SOLAR TIMBER PVT.LTD.	DELHI	JANNET

SL.	ITEM/ NAME OF MANUFACTURER	PLACE	BRAND NAME
D	GALAXY PLYWOOD INDIA (P) LTD.	DELHI	GALAXY
E	ARCHID PLY INDUSTRIES	BANGALORE	ARCHID
F	WOODCRAFT PRODUCTS	KOLKATA	WOODCRAFT
G	SITAPUR PLYWOOD	SITAPUR, UP	SITAPUR
H	INDIAN PLYWOOD MFG. CO. LTD	DELHI	ANCHOR
I	SWASTIK PLYWOOD	DELHI	SWASTIK
4.2.2	LAMINATES		
A	SAFE DÉCOR PVT. LTD	DELHI	SAFE DÉCOR
B	BAKELITE HYLAM LTD.	SECUNDRABAD	DELOLAM/ DECOLITE
C	GREENPLY INDUS. LTD.	DELHI	GREENLAM
D	THE BOMBAY BURMAH TRADING CORPN.	DELHI	FORMICA
E	HORIZONS LAMKRAFT PVT LTD	AHMEDABAD	SIGNATURE
F	RAMMICA INDUSTRIES	DELHI	RAMMICA
4.2.3	MDF BOARDS		
A	NUCHEM LIMITED	DELHI	NUWUD
B	MANGALAM TIMBER PRODUCTS LIMITED	DELHI	DURATUFF
C	WESTERN BIO SYSTEMS LTD.	PUNE	ECOBORD
D	BAJAJ ECO-TEC PRODUCTS LIMITED	NOIDA	BAJAJ
4.2.4	PARTICLE BOARD (Plain/ Veneered/ Pre-laminated)		
A	BHUTAN BOARD	BHUTAN	BHUTAN BOARD
B	BEST BOARD	DELHI	HIBOND
C	NOVOPAN INDIA LIMITED	HYDERABAD	NOVOPAN
D	THE BOMBAY BURMAH TRADING CORPORATION LIMITED	DELHI	NOVATEAK/ EASYLAM
E	BAJAJ ECO-TEC PRODUCTS LIMITED	NOIDA	BAJAJ
F	ARCHID PLY INDUSTRIES	BANGLORE	ARCHID
4.3	STEEL/ ALUMINIUM/ FIRE RATED DOORS, WINDOWS, VENTILATORS		
4.3.1	PRESSED STEEL DOORS/ WINDOWS		
A	SKS STEEL IND.	DELHI	-
B	DHIMAN STEEL	DELHI	-
C	SUPER STEEL WINDOWS CO	DELHI	-
D	RDG ENGINEERING	MUMBAI	-
E	ANAND INDUSTRIES	DELHI	-
F	RAYMUS ENGINEERING	GURGAON	-
4.3.2	ALUMINIUM/ DOORS/ WINDOWS' SECTIONS		
A	JINDAL ALUMINIUM LIMITED	BANGALORE	-
B	HINDALCO	MUMBAI	-
4.3.3	FIRE PROOF DOORS		
A	NAVAIR INTERNATIONAL	DELHI	VIPER
B	RDG ENGG.	BOMBAY	RADIANT
4.4	DOORS/ WINDOWS FITTINGS		
4.4.1	MORTICE LOCKS WITH HANDLES		
A	GODREJ & BOYCE	MUMBAI	GODREJ
B	EVERITE AGENCIES (P) LTD.	DELHI	EVERITE
C	GOLDEN INDUSTRIES	DELHI	GOLDEN
4.4.2	HYDRAULIC DOOR CLOSER (Overhead/ Floor Mounted)		
A	DOORKING INDUSTRIES	DELHI	DOORKING
B	EVERITE AGENCIES (P) LTD.	DELHI	EVERITE
C	HARDWYN TRADERS	MUMBAI	HARDWYN
4.4.3	MISC. DOOR FITTINGS e.g. Hinges, Tower Bolts, Latches, Stoppes etc.		
A	EVERITE AGENCIES (P) LTD.	DELHI	EVERITE
B	EBCO INDUSTRIES	DELHI	EBCO
C	ECIE (P) LTD.	MUMBAI	ECIE

SL.	ITEM/ NAME OF MANUFACTURER	PLACE	BRAND NAME
D	NU-LITE INDUSTRIES	DELHI	NULITE
E	HARDWYN TRADERS	MUMBAI	HARDWYN
4.5	ROOF TREATMENT (WATER-PROOFING)		
4.5.1	P.U. BASED WATERPROOFING (ONE COMPONENT)		
A	LLOYD INSULATIONS (I) LTD.	DELHI	ISOTHANE EMA
B	CICO TECHNOLOGIES LTD.	DELHI	CORCHEM 206 I
C	FOSROC CHEMICAL (I) PVT. LTD.	BANGALORE	NITOPROOF 600
4.5.2	P.U. BASED WATERPROOFING (TWO COMPONENT)		
A	SHIVALIK AGRO POLY PRODUCTS PVT. LTD.	DELHI	SHIVABOND 903
B	INDUSTRIAL PRODUCT MANUFACTURING COMPANY	PUNE	EZECOAT
C	FOSROC CHEMICAL (I) PVT. LTD.	BANGLORE	BRUSHBOND
D	SIKA	KOLKATA	SIKALASTIC 450H
E	SIP INDUSTRIES LIMITED	CHENNAI	SIPGUARD
4.5.3	APP MEMBRANE		
A	LLOYD INSULATIONS (I) LTD.	DELHI	LLOYD PLASTOLAY
B	BUILDTech PRODUCTS PVT (I) LTD.	DELHI	BUILDWRAP P
C	CICO TECHNOLOGIES LTD.	DELHI	CICO SHIELD
D	FOSROC CHEMICAL (I) PVT. LTD.	BANGALORE	PROOFEX TORCHSEAL
E	SIKA	KOLKATA	SIKA WP SHIELD
F	STP LTD.	KOLKATA	SUPER THERMOLAY
G	IWL INDIA LTD.	CHENNAI	HYPERPLAS
H	PURE LEATHERS PVT LTD	DELHI	ROOFSEAL
4.6	PAINTING WORKS		
4.6.1	PLASTIC/ ACRYLIC EMULSION PAINT (INTERNAL AND EXTERNAL), DISTEMPER ETC.		
A	ICI PAINTS/ ICI INDIA LTD.	KOLKATA	-
B	BERGER PAINTS	KOLKATA	-
C	ASIAN PAINTS	MUMBAI	-
D	SHALIMAR PAINTS	MUMBAI	-
E	NEROLAC PAINTS	MUMBAI	-
F	ACROPAINTS LIMITED	DELHI	-
G	GODAVARI PAINTS PVT. LTD.	MUMBAI	-
H	N.E PAINT UDYOG	SIVASAGAR (ASSAM)	-
4.6.2	SYNTHETIC ENAMEL PAINT (for Building Works)		
A	ICI PAINTS/ ICI INDIA LTD.	KOLKATA	-
B	BERGER PAINTS	KOLKATA	-
C	ASIAN PAINTS	MUMBAI	-
D	SHALIMAR PAINTS	MUMBAI	-
E	NEROLAC PAINTS	MUMBAI	-
F	GODAVARI PAINTS PVT. LTD.	MUMBAI	-

SL.	ITEM/ NAME OF MANUFACTURER	PLACE	BRAND NAME
G	N.E PAINT UDYOG	SIVASAGAR (ASSAM)	-
4.6.3	WATERPROOF CEMENT PAINT		
A	KILLICK NIXON LTD	MUMBAI	SNOWCEM
B	GODAVARI PAINTS PVT. LTD.	MUMBAI	SUPEREMCEM
C	ACRO PAINTS	DELHI	ACROCEM
D	SNOW WHITE INDUSTRIAL CORPN.	CHENNAI	SUPERCEM
E	RAJDOOT PAINTS	DELHI	Xtracem 76 Superior Cement Paint
4.6.4	DECORATIVE TEXTURED COATING		
A	LUXTURE SURFACE COATINGS PVT. LTD.	AJMER	LUXTURE
B	BAKELITE HYLAM LTD.	SECUNDRABAD	HERITAGE
C	NCL ALLTEK AND SECCOLOR LTD.	HYDERABAD	ALLTEK
D	ACRO PAINTS LTD.	DELHI	ACROTEXTURES
E	UNITILE	DELHI	UNITILE
F	SPECTRUM PAINTS	DELHI	SPECTRUM
4.6.5	POLISHING (for Woodwork)		
A	ASIAN PAINT	MUMBAI	ASIAN PAINT
B	SHALIMAR PAINTS	MUMBAI	MELLAC
4.7	ROOFING SHEETS & ACCESSORIES		
4.7.1	PRECOATED PROFILED G.I./ GALVALUME/ ZINCALUME SHEETS		
A	LLOYD INSULATION (I) LTD.	DELHI	LLOYDECK
B	INTERARCH BUILDING PRODUCTS (P) LTD.	NOIDA	TRACDEK
C	MULTI COLOUR STEEL (I) PVT. LTD.	DELHI	MULTI CLAD
D	HARDCASTLE & WAUD MFG CO. LTD.	MUMBAI	FERO COLOUR
E	SPECOTECH ROOFING & CEILING SYSTEM PVT. LTD.	DELHI	SPECO
F	MG INDUSTRIES	FARIDABAD	SONEX
G	JAPAN METAL BUILDING SYSTEMS PVT. LTD.	BANGALORE	JMBS
H	TATA BLUESCOPE STEEL LIMITED	PUNE	TRIMDECK
I	ERA BUILDING SYSTEMS LIMITED	DELHI	ERA
J	SHREE PRECOATED STEELS LIMITED	MUMBAI	METACOLOUR
4.7.2	C.G.I. SHEET		
A	ISPAT INDUSTRIES LTD	DELHI	EVEREST
B	STEEL AUTHORITY OF INDIA LTD	-	SAIL
C	TATA STEEL	-	TISCO
4.7.3	ALUMINIUM SHEET		
A	JINDAL ALUMINIUM LIMITED	BANGALORE	-
B	HINDALCO	MUMBAI	-
4.7.4	FIBER GLASS SHEET & PANELS		
A	SIMBA FRP (P) LTD	DELHI	SIMCRYL
4.8	SANITARY, PLUMBING FITTINGS & FIXTURES		
4.8.1	SANITARY FITTINGS		
A	HINDUSTAN SANITARY WARE & INDUS. LTD.	KOLKATA	HINDUSTAN
B	PARRYWARE SANITARY	CHENNAI	PARRYWARE
C	MADHUSUDAN CERAMICS	DELHI	CERA
D	NYCER CERAMICS	CHENNAI	NYCER
4.8.2	PLUMBING FITTINGS AND FIXTURES		
A	JUPITER AQUA LINES LTD.	MOHALI	JUPITOR
B	OTHELLO FAUCETS PVT. LTD.	DELHI	MAYUR
C	ORIENT CERAMICS	DELHI	ORIENT
D	GEM INTERNATIONAL	FARIDABAD	GEM
E	PARKASH BRASSWARE INDUSTRIES	DELHI	PARKO

SL.	ITEM/ NAME OF MANUFACTURER	PLACE	BRAND NAME
F	JAQUAR & COMPANY LTD.	DELHI	JAQUAR
G	PLASTOCRAFT SANITARY INDIA PVT. LTD.	DELHI	KINGSTON
4.8.3	MIRROR/ GLASS		
A	ATUL GLASS	DELHI	ATUL
B	GUJARAT GUARDIAN LTD.	DELHI	MODIGUARD
C	TRIVENI GLASS	KOLKATA	TRIVENI
D	CONTINENTAL FLOAT GLASS	DELHI	CONTINENTAL
E	HINDUSTAN SAFETY GLASS	KOLKATA	HINDUSTAN
4.9	FALSE CEILING		
4.9.1	ALUMINIUM STRIP/ TRAY TYPE		
A.	INTERARCH BUILDING PRODUCTS (P) LTD	NOIDA	TRAC
B.	HUNTER DOUGLAS	DELHI	LUXALON
C.	MASCOT OVERSEAS	DELHI	METACIL/ TRULON
D.	M.G. INDUSTRIES	FARIDABAD	SONEX
E.	LLOYD INSULATION (I) LTD.	DELHI	LLOYD LINEAL CEILINGS
4.9	GYPSUM BOARD		
A.	SAINT-GOBAIN GYPROC INDIA LTD.	MUMBAI	GYPCBOARD
4.10	FALSE FLOORING		
A	UNITED INSULATION	MUMBAI	-
B	LLOYD INSULATIONS (I) LTD.	DELHI	-
C	MULTI FLOORS	DELHI	-
D	A.R & BROTHERS	CHENNAI	-
E	BESTLOCK SYSTEM & CONCEPTS	MUMBAI	-
4.11	INSULATION		
4.11.1	UNDERDECK INSULATION		
A	BAKELITE HYLAM LTD.	SECUNDRABAD	PHENOTHERM
B	LLOYD INSULATIONS (I) LTD.	DELHI	ISOLLOYD NILFLAME
C	UP TWIGA FIBRE GLASS LIMITED	DELHI	TWIGA
4.11.2	OVERDECK INSULATION		
A	LLOYD INSULATIONS (I) LTD.	DELHI	LLOYAD SPRAY FOAM
B	BEST PLASTRONICS LTD	DELHI	BESTPLASTRONIC S
4.12	MISCELLANEOUS ITEMS		
4.12.1	WATER PROOFING COMPOUND IN PLASTER		
A	CICO TECHNOLOGIES LTD.	DELHI	CICO NO 1
B	PIDILITE INDUSTRIES	MUMBAI	PIDIPROOF LW
C	AMIT CHEMICALS (P) LTD	DELHI	CRETO ADMIX
4.12.2	CPRX BITUMAN MASTIC		
A	SHALIMAR TAR PRODUCTS	DELHI	SHALIMAR TAR
4.13	CONCRETE ADMIXTURES		
4.13.1	WATER PROOFING COMPOUND		
A	CICO TECHNOLOGIES LTD.	NEW DELHI	CICO NO. 1 CICO SUPER CICO ACRYL
B	FAIRMATE CHEMICALS PVT. LTD.	VADODARA	FAIRCRETE RMW
C	KRYTON BUILDMAT CO. PVT. LTD.	DELHI	KIM
D	SIKA INDIA PVT. LTD.	KOLKATA	PLASTOCRETE PLUS NOLEEK
4.13.2	WATER REDUCING COMPOUNDS		
A	CICO TECHNOLOGIES LTD.	DELHI	CICOPLAST SUPER
B	FAIRMATE CHEMICALS PVT. LTD.	VADODARA	FAIRCRETE N FAIRFLO

SL.	ITEM/ NAME OF MANUFACTURER	PLACE	BRAND NAME
C	SIKA INDIA PVT. LTD.	KOLKATA	FAIRFLO S PLASTIMENT BV/40 PLASTIMENT R1 SIKAMENT 170 SIKAMENT FF SIKAMENT NN SIKAMENT NN(BWSL) SIKAMENT NNSP3 SIKAMENT HE200/HE220 SIKARAPID 1 SIKAVISCOCRETE 20HE SIKAVISCOCRETE R550 (I) SIKA AER
4.14	CONSTRUCTION CHEMICALS		
4.14.1	POLYSULPHIDE SEALANT		
A	CHOWKSEY CHEMICALS PVT.LTD.	MUMBAI	TECHSEAL 940/941
B	CICO TECHNOLOGIES LTD.	DELHI	CICOSEALANT T680
C	FOSROC CHEMICALS	DELHI	THIOFLEX 600
D	PIDILITE INDUSTRIES LTD.	MUMBAI	PIDISEAL PS41G PIDISEAL PS42P
E	SIKA INDIA PVT. LTD.	KOLKATA	SIKA POLYSULPHIDE (SIKALASTIC) SIKAFLEX CONSTRUCTION IGAS Ih
4.14.2	SILICON SEALANTS		
A	PIDILITE INDUSTRIES LTD.	MUMBAI	DR. FIXIT SILICON SEALANT WX
4.15	ANCHOR FASTENERS		
4.15.1	MECHANICAL ANCHOR FASTENERS		
A	HILTI INDIA PVT. LTD.	DELHI	-
B	FISCHER FIXING SYSTEMS (MICO) LTD.	BANGALORE	-
4.15.2	CHEMICAL ANCHOR FASTENERS		
A	HILTI INDIA PVT. LTD.	DELHI	-
B	FISCHER FIXING SYSTEMS (MICO) LTD.	BANGALORE	-
4.16	ELECTRO-FORGED GRATINGS		
A	GREATWELD STEEL GRATINGS PVT. LTD.	PUNE	-
B	INDIANA GRATINGS PVT. LTD.	MUMBAI	-

FORMATS FOR CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

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FORMAT NO. C1 Rev.0

RECORD OF CALBRATION OF MEASURING/TESTING EQUIPMENTS

Project :
Owner :
Name of Work :

Job No. :
EPCC Contractor :

Sl. No.	Name of Equipment/Apparatus	Model No.	Certificate No.	Calibrated By	Calibration Date	Next Calibration Due on	Remarks	Accepted EPCC Contractor	PM C
	Theodolite								
	Levels								
	Steel measurement tapes								
	Cross staff								
	Distomat								
	All balances								
	Weigh Batcher								
	Cube testing Machine								
	Pressure Gauges								
	Dial gauges								
	Dead weight tester								
	Vernier caliper/ screw gauge								
	Holiday tester								
	Universal Testing Machine								
	Charpy V-notch Impact testing machine								
	Hardness Testing Machine								
	Various Digital and Analog meters								
	Variable current, voltage and resistance generators								
	Temperature/ Pressure Recorders								
	Temperature gauges including RTDs								
	Thermocouples								
	Vibration probes								
	Decibel-meter								
	Any other								

FORMAT NO. C2 Rev.0

SURVEYING AND LAYOUT RECORD

Project :

Job No :

Owner :

EPCC Contractor :

Name of Work :

1. Reference Drawing :
2. Reference Grid Pillars :
3. Reference Bench Mark/Reduced Level :
4. Co-ordinates :
5. Reduced Level :
6. Closing error, if any :
7. Layout Sketch :

(EPCC CONTRACTOR)

(PMC)

(OWNER)

Date :

TEST REPORT FOR DETERMINATION OF DRY DENSITY & MOISTURE CONTENT OF SAND/SOIL

Project :
Owner :
Name of Work :
Location :

Job No :
EPCC Contractor :
Layer No :

S. No.	Description	Relation	Test Nos:						Remarks
			1	2	3	4	5	6	
1.	Wt. of mould + wt. of wet soil/sand	W_1 gm							
2.	Wt. of mould	W_2 gm							
3.	Wt. of wet soil/sand	$(W_1 - W_2)$ gm							
4.	Volume of mould	V cc							
5.	Density of wet soil/sand	$D_w = (W_1 - W_2)/V$ gm/cc							
6.	Wt. of wet sample taken	W_w gm							
7.	Wt. of sample after drying	W_d gm							
8.	Moisture Content (or directly by moisture meter)	$Mc = (W_w - W_d)/W_d \times 100\%$							
9.	Dry density	$D_d = D_w/(1+Mc)$ gm/CC							
10.	Laboratory Max dry density	gm/cc							
11.	Degree of Compaction	%							
12.	Required degree of compaction	%							
13.	Optimum Moisture Content (OMC)	%							

Date :

(TESTED BY/LAB-IN-CHARGE)

(EPCC CONTRACTOR)

(PMC)

FORMAT NO. C4 Rev.0

**RECORD OF APPROVAL OF SOURCE(S) FOR
AGGREGATES**

Project :	Job No :		
Owner :	EPCC Contractor :		
Name of Work :			
1.	Reference	:	
2.	Material	:	
3.	Location of Source	:	
4.	Approx. distance from the site	:	
5.	Physical Properties		
	a) Colour	:	
	b) Shape	:	Rounded/Irregular
	c) Texture	:	Glossy/Smooth/Granular
6.	Tests conducted at	:	
7.	Code of Conformance	:	IS : 383
8.	Test Report Reviewed	:	Satisfactory/Un-satisfactory
9.	Remarks	:	The source is approved/not approved
10.	Explanation if any	:	
Enclosures	:	a)	Reviewed Test Reports
		b)	Request of EPCC Contractor, if available
COMMITTEE MEMBERS	:		
APPROVED	:	i)	PMC :
		ii)	Owner :
Signature of the EPCC Contractor		:	
Date		:	
Place		:	

SIEVE ANALYSIS REPORT

FORMAT NO. C5 Rev.0

Name of Work :
EPCC Contractor :
Date on which sample taken :

Job No

Project :
Owner :
Wt. of Sample taken :

FINE AGGREGATE

S. No.	Sieve Size	Weight Retained (gm)	Percentage Retained	Cumulative % Retained	% Passing	Fineness Modulus	Zone (As per IS:383)	Remarks
1.	4.75mm							
2.	2.36mm							
3.	1.18mm							
4.	600 u							
5.	300 u							
6.	150 u							
7.	Pan							

COARSE AGGREGATE/ROAD METAL

Wt. of Sample taken				Passed/ Failed (As per IS:383/EIL Spec 6-65-00'18)		Remarks
1.	2.	3.	4.	5.	6.	
1.	125mm					90-45 (Gr-I), 63-45 (Gr-II), 13.2mm (screening) for road work
2.	90mm					
3.	80mm					
4.	63mm					
5.	53mm					
6.	45mm					40mm down for PCC
7.	40mm					
8.	22.4mm					
9.	20mm					20mm down for RCC
10.	16mm					
11.	13.2mm					
12.	12.5mm					
13.	11.2mm					
14.	10mm					
15.	5.6mm					
16.	4.75mm					
17.	2.36mm					
18.	180 u					

(TEST BY/LAB-IN-CHARGE)

Date :

(EPCC CONTRACTOR)

(PMC)

UNDERGROUND PIPING-TEST REPORT (RCC/CI) EQUIPMENTS

Project :
Owner :
Name of Work:

Job No: _____
EPCC Contractor : _____

- | | | |
|-----|-----------------------|---|
| 1. | Reference Drawing | : |
| 2. | Location | : |
| 3. | Line Designation | : |
| 4. | Type of Pipe & System | : |
| 5. | Specification | : |
| 6. | Dia of Pipe | : |
| 7. | Gradient | : |
| 8. | Type of Manhole | : |
| 9. | Test (s) Conducted | : |
| 10. | Date of Testing | : |
| 11. | Remarks, if any | : |

EPCC CONTRACTOR

Date :

PMC

OWNER

FORMAT NO. C7 Rev.0

CEMENT TESTING RESULT REPORT

Project : Job No :

Owner : EPCC Contractor :

Name of Work : Consignment No. :

Brand of Cement : Sample Collected on :

Wt. of sample taken : Room Temperature :

A. CONSISTENCY

Trial No.	Wt. of Cement (gm)	Wt. of Water Added (gm)	% of Water	Reading Of Indicator (mm)	Consistency	Remarks

B. SETTING TIME

Trial No.	Wt. of Cement (gm)	Wt. of Water Added (gm)	W/C Ratio	Time Recorded When Water Added	Time Recorded At set	Initial Set	Final Set	Setting Time	Remarks

C. FINENESS

Trial No.	Wt. of Cement Sample Used	Retained on 90 μ IS sieve in gm	% Retained	Remarks

D. COMPRESSIVE STRENGTH

Cube Size : 7.06X7.06X7.06 cm

Trial No.	Mix Proportion	Date of		Age of Specimen	Crushing Surface Area (Cm ²)	Crushing Load (Kg)	Crushing Strength (Kg/Cm ²)	Remarks
		Casting	Testing					

(TESTED BY)/LAB-IN-CHARGE

(EPCC CONTRACTOR)

(PMC)

Date :

FORMAT NO. C8 Rev.0

POUR CARD-I (PROGRAMME OF CONCRETING)

EPCC Contractor :		Owner :	
Name of work :			
1.	Reference document :		
2.	Type of structure :	Location :	
3.	Levels	From :	To :
4.	Grade of concrete/ Approved Design Mix		
5.	Brand name, Grade and Consignment no. of cement		
6.	Estimated volume of concrete :		
7.	Quantity of cement required :		
8.	Reinforcement checking details :		
		No.	Dia.
			Length
	a) Laps		
	b) Separators		
	c) Chairs		
	d) Any other		
	Remarks		
9.	Pre pour inspection details	Checked	NA
	a) Survey/ Layout		
	b) Sub soil compaction		
	c) Completion of underground works		
	d) Cleanliness		
	e) Cover to reinforcement		
	f) Anchor bolts		
	g) Sleeves/ pockets		
	h) Water stops		
	i) Formwork		
	j) Slopes		
	k) Construction/ Expansion joints		
	l) Admixtures		
	m) Any other		
	Remarks		
10.	Clearance for Electrical/ Mechanical works required/ not required :	Electrical	Mechanical
11.	The above structure is finally inspected on _____ at _____ AM/PM and found/ not found satisfactory for concreting.		
	Remarks, if any		

(EPCC Contractor)
 Name
 Designation
 Date

(PMC)
 Name
 Designation
 Date

(Owner/ Owner)
 Name
 Designation
 Date

FORMAT NO. C9 Rev.0

POUR CARD-II (OBSERVATIONS DURING CONCRETING)

EPCC Contractor :		Owner :	
Name of work :			
1.	a) Quality of coarse aggregates	Satisfactory <input type="checkbox"/>	Not satisfactory <input type="checkbox"/>
	b) Quality of fine aggregates	Satisfactory <input type="checkbox"/>	Not satisfactory <input type="checkbox"/>
	c) Bulkage of sand taken into account	Yes <input type="checkbox"/>	No <input type="checkbox"/>
2.	Quality of water	Satisfactory <input type="checkbox"/>	Not satisfactory <input type="checkbox"/>
3.	Machinery mobilization	Nos.	Stand by
	a) Mixture machine		
	b) Ready mixed concrete dumpers		
	c) Vibrators		
	d) Pumps		
	e) Hoists		
4.	Pour start time	: AM/PM ;	Date :
5.	Slump		
6.	W/C Ratio		
8.	Type of weather	Normal <input type="checkbox"/>	Abnormal <input type="checkbox"/>
	Details of abnormality : (Precautions taken for <5°C and >40°C, rainy season)		
10.	Number of cubes taken	:	
11.	Quantity of concrete poured	:	
12.	Pour completion time	: AM/PM ;	Date :
13.	Curing method :		
	<input type="checkbox"/> Traditional	<input type="checkbox"/>	Curing compound
	<input type="checkbox"/> Blankets/ foils/ gunny bags	<input type="checkbox"/>	Others (specify)
14.	Period for removal of form work	:	
15.	Any defect(s) observed during concreting :		

(EPCC Contractor)

Name
Designation
Date

(PMC)

Name
Designation
Date

(Owner)

Name
Designation
Date

FORMAT NO. C10 Rev.0

CRUSHING STRENGTH TESTING RESULTS OF CONCRETE CUBES

Project : Job No :
Owner : EPCC Contractor :
Name of Work :
Grade of Concrete : Type of Cement :
W/C Ratio : Max. size of Aggregate :

Cube No.	Id. Mark on cube	Type & Location of Structure	Date of		Age (days)	Dimensions of Cube			Vol. of Cube (m ³)	Wt. of Cube (Kg)	Unit WT. (Kg/m ³)	Surface Area (Cm ²)	Crushing Load (Kg)	Crushing Strength (Kg/Cm ²)	Remarks
			Casting	Testing		L (Cm)	B (Cm)	H (Cm)							

(TESTED BY)/LAB-IN-CHARGE (EPCC CONTRACTOR) (PMC)

STRUCTURE FABRICATION & ERECTION SHEET

Project : Job No :
Owner : EPCC Contractor :
Name of Work :
Reference Drawing : Location/Coordinates/Grids :
Layout Clearance obtained : Yes/ No

S. No.	Item No.	Material & Dimensional clearance	Shop Fit up		Shop welding		Cleaning & primer painting		Erection Fit up		Alignment & leveling		Field welding		Grouting clearance		Final Painting & thickness		Remarks
			Con	PMC	Con	PMC	Con	PMC	Con	PMC	Con	PMC	Con	PMC	Con	PMC	Con	PMC	

Abbreviations:
Con : EPCC Contractor's signature with date