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PRAGATI POWER CORPORATION LIMITED
 (A GOVERNMENT OF DELHI UNDERTAKING)

PRAGATI-III COMBINED CYCLE POWER PROJECT
1500MW (NOMINAL)

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-314-600-C001

SECTION - C
SPECIFIC TECHNICAL REQUIREMENTS

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

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PART-I : GENERAL CIVIL REQUIREMENT

PART-II : SPECIFIC DESIGN REQUIREMENTS - CIVIL

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PART-I

GENERAL CIVIL REQUIREMENT

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GENERAL CIVIL SPECIFICATIONS

1.1 INTRODUCTION

Two Volumes-Section C & Section D of this specification cover design, preparation of general arrangement drawings, construction and fabrication drawings, supply of labour, materials and construction of all civil, structural and architectural works.

Section-C covers specific technical requirements of contract and should be read in conjunction with BOQ, Section-D and other sections of the contract. In case of any conflict between the contents of BOQ and Section-C, BOQ will prevail over Section-C. In case of any conflict between Section-C and Section-D, Section-C will prevail over Section-D. Further contract document and clarifications given by BHEL to Bidder will prevail over Section C and D in case of any conflict. If during detailed engineering if there is some change in requirements, which is agreed by customer, consultant and BHEL, the same shall prevail over all and shall be ultimately binding. For that no extra compensation is payable.

This section covers technical requirements for all civil, structural and architectural works except boundary wall, therefore; the bidder shall refer only relevant portion under the scope of work of the bidder.

Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as Civil Works. Various buildings, structures, plant and systems, facilities, etc., covered under the scope are given in Volume-III, Section-VI, Part-A. Irrespective of what is stated in this document, all civil works required to complete the entire scope of work specified elsewhere within the battery limits (terminal points) of this bid document shall be deemed to be in the scope of this contract.

The Bidder shall do all works related to site clearance including levelling, grading and finishing. The formation levels of different areas are as indicated in general layout plan drawing enclosed with this specification. All survey and other related works shall be done by the Bidder as specified in scope of works. The bidder shall carry out detailed survey and soil investigation work as required for the entire plant area. The Bidder shall make the layout and levels of all structures from the nearest GSI benchmark or other acceptable benchmark of Govt. deptt. as per the directions of the Engineer. **The Bidder shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Engineer for general checking of the correctness of the civil**

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works. All the quality standards, tolerances, welding standards and other technical requirements shall be strictly adhered to. The Bidder shall fully appraise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications. In case of any conflict between stipulations in various portions of the specification, most stringent stipulation would be applicable for implementation by the Bidder without any extra cost to the Employer.

1.2 SUBMISSIONS

Material test certificates shall be submitted.

As built drawings with quantities of various items of work system wise, building wise, structure wise, etc. duly certified by Site after execution of work for information/ record.

Wherever applicable, scheme for dewatering, shoring, strutting/ sheet piling shall be provided

2. CODES AND STANDARDS

Following is a general listing of Codes and Standards to be used in the design of the Plant. Specific applicable codes and standards will be identified in System Design Descriptions/ Technical Specifications as appropriate. The latest editions/ revision of following codes and standards along with addendums/ amendments, if any, shall be followed:

All applicable standards, references, specifications, codes of practice, etc., shall be the latest edition including all applicable official amendments and revisions. A complete set of all these documents shall be available at site with Bidder.

List of some of the applicable Standards, in original Codes and references is as given in Annexure-II of this specification.

2.01.00 GENERAL

- a) Internationally accepted design Codes and Standards where Indian Codes are not available and which are equivalent to Indian Standards.
- b) National Building Code of India.

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- c) "Accepted Standards" and "Good Practice" listed in the appendix to National Building Code of India.
- d) IS 1200: Method of measurement of Building and Civil Engineering Works.
- e) IS 1256: Code of Practice for Building Byelaws.

2.01.01 Excavation and Filling

- 1. IS :2720- Methods of test for soils(relevant parts)
- 2. IS:4701- Code of practice for earth work on canals.
- 3. IS:9759 -Guide lines for dewatering during construction.
- 4. IS:10379- Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

2.01.02 Properties, Storage and Handling of Common Building Materials

- 5. IS:269 -33 grade for ordinary Portland cement.
- 6. IS:383 -Coarse and fine aggregates from natural sources for concrete.
- 7. IS:432- Specification for mild steel and medium tensile steel bars and (Part 1&2) hard drawn steel wires for concrete reinforcement.
- 8. IS:455- Portland slag cement. IS:702 Industrial bitumen.
- 9. IS:712- Specification for building limes.
- 10. IS:1077- Common burnt clay buidling bricks.
- 11. IS:1161- Steel tubes for structural purposes.

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12. IS:1239 -Mild steel tubes, tubulars and other wrought steel fillting - MS tubes. 13. IS:1363- Hexagon head bolts, screws and nuts of productions (Part 1-3) grade - C. 14. IS:1364- Hexagon head bolts, screws and nuts of productions (Part 1-5) grade-A & B. 15. IS:1367 -Technical supply condition for threaded fasteners. (Part 1-18) 16. IS:1489 -Portland-pozzolana cement. (Part-I) Fly ash based 17. IS:1542 -Sand for Plaster. 18. IS:1566- Hard drawn steel wire fabric for concrete reinforcement. 19. IS:1786 -High strength deformed steel bars & wires for concrete reinforcement. 20. IS:2062 - Steel for general structural purposes. 21. IS:2116 - Sand for masonry mortars. 22. IS : 2185 - Hollow & solid concrete blocks. (Part 1) (Part 2) Hollow & solid light weight concrete blocks. 23. IS:2386 - Testing of aggregates for concrete. (Part I-VIII) 24. IS:3819 - Specification for fly ash for use as pozzolona and admixture. 25. IS:4082- Recommendation on stacking and storage of construction materiel and components at site 26. IS:8112 - 43 grade ordinary portland cement. 26. IS:8500- Structural steel-Microalloyed (Medium and high strength qualities). 27. IS:12269 - 53 grade ordinary portland cement.			
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28. IS:12894 - Specification for fly ash lime bricks.

29. IS:13757 - Burnt clay fly ash building bricks.

2.01.03 Cast in-situ Concrete and Allied Works

1. IS:280- Mild steel wire for general engineering purpose.

2. IS:456 -Code of practice for plain and reinforcement concrete.

3. IS:457- Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

4. IS:516- Method of test for strength of concrete.

5. IS:1199- Methods of sampling and analysis of concrete.

6. IS:1791- General requirement for batch type concrete mixers.

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

8. IS:1838 -Preformed fillers for expansion joints in concrete pavement and structures.

9. IS:2438- Specification for roller pan mixers.

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

11. IS:2505- Concrete vibrators - immersion type.

12. IS:2506- General requirements for screed board concrete vibrators.

13. IS:2722 -Specification for Portable Swing weighbatchers for concrete (single and double bucket type).

15. IS:2750- Steel scaffoldings

16. IS:2751 - Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.

17. IS:3150 Hexagonal wire netting for general purposes.

18. IS:3366 Specification for pan vibrators.

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19.

IS:3370 (Part 1-4) Code of practice for concrete structures for the storage of liquids.

20.

IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.

21.

IS:4014 (Part-1&2) Code of practice for steel tubular scaffolding.

22.

IS:4326 Code of practice for earth quake resistant design and construction of buildings.

23.

IS:4656 Form vibrators for concrete.

24.

IS:4925 Concrete batching and mixing plant.

25.

IS:4990 Plywood for concrete shuttering work.

26.

IS:5256 Code of practice for sealing expansion joints in concrete lining on canals.

27.

IS:5525 Recommendations for detailing of reinforcement in reinforced concrete works.

28.

IS:6461 Glossary of terms relating to cement concrete.

29.

IS:6494 Code of practice for water proofing of underground reservoir and swimming pools.

30.

IS:6509 Code of practice for installation of joints in concrete pavements.

31.

IS:7861 Code of practice for extreme weather concreting.
(Part -1&2)

32.

IS:9012 Recommended practice for shotcreting.

33.

IS:9103 Admixtures for concrete.

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34. IS:9417 Recommendations for welding cold worked bars for reinforced concrete construction. 35. IS:10262 Recommended guidelines for concrete mix design. 36. IS:11384 Code of practice for composite construction in structural steel and concrete. 37. IS:12118 Two parts polysulphide based sealants. 38. IS:12200 Code of practice for provision of water stops at transverse construction joints in masonry and concrete dams. 39. IS:13311 Non destructive testing of concrete - methods of test. (Part 1) Ultrasonic pulse velocity. (Part 2) Rebound hammer 40. SP-16 Design codes for reinforced concrete to IS:456-1978 41. SP-23 Hand book of concrete mixes. 42. SP-24 Explanatory handbook on Indian standards code for plain and reinforced concrete. 43. (IS : 456) SP-34 Hand book on concrete reinforcement and detailing. 44. ACI-318 American Concrete Institute code for structural concrete. 2.01.04 Precast Concrete Works 1. SP:7 National Building Code - Structural (Part 6/Sec.7) Design of prefabrication and system building. 2. IS:10297 Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units. 3. IS:10505 Code of practice for construction of floors and roofs using precast reinforced concrete waffle units.			

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2.01.05 Masonry & Allied Works

1. IS:1905 -Code of practice for structural use of unreinforced masonry.
2. IS:2212-Code of practice for brick work.
3. IS:2250 -Code of practice for preparation and use of masonry mortars.
4. IS:2572 -Code of practice for construction of hollow concrete block masonry.
5. SP:20 -Hand book on masonry design and construction.

2.01.06 Sheetting Works

1. IS:277- Galvanised steel sheets (Plan & corrugated).
2. IS:513- Cold-rolled low carbon steel sheets & strips.
3. IS:730- Hook bolts for corrugated sheet roofing.
4. IS:801- Code of practice for use of cold formed light gauge steel structural members in general building construction.
5. IS:2527- Code of practice for fixing rain water gutters and down pipe for roof drainage.
6. IS:7178 -Technical supply condition for tapping screw.
7. IS:8183- Bonded mineral wool.
8. IS:8869- Washers for corrugated sheet roofing.
9. IS:12093- Code of practice for laying and fixing of sloped roof covering using plain and corrugated galvanised steel sheets.
10. IS:12436 Preformed rigid Polyurethane (PUR) and isocyanurate (PIR) foams for thermal insulation.

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11. IS:12866 Plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced).

12. IS:14246 Continuously pre-painted galvanised steel sheets and coils.

13. BS:5950 Code of practice for design of light gauge profiled (Part-6) steel sheeting

2.01.07 Fabrication and Erection of Structural Steel Works

1. IS:800 Code of practice for General Construction of steel.
2. IS:813 Scheme for symbols for welding.
3. IS:814 Covered electrodes for manual metal arc welding of carbon & carbon manganese steel.
4. IS:816 Code of practice for use of metal arc welding for general construction in mild steel.
5. IS:817 Code of practice for training and testing of metal arc welders.
6. IS:1024 Welding in bridges and substructured subject to dynamic.
7. IS:1181 Qualifying tests for Metal Arc welders (engaged in welding structures other than pipes).
8. IS:1182 Recommended practice for Radiographic examination of fusion welded butt joints in steel plates.
9. IS:1608 Mechanical testing of metals - tensile testing
10. IS:1852 Rolling and Cutting Tolerances for Hot rolled steel products.
11. IS:2016 Specification for Plain washers.
12. IS:2595 Code of practice for Radiographic testing
13. IS:2629 Hot dip galvanising of iron and steel
14. IS:3502 Steel chequered plate.
15. IS:3613 Acceptance tests for wire flux combination for submerged arc welding.

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16. IS:3658 Code of practice for liquid penetrant flaw detection.
17. IS:3664 Code of practice for ultra sonic pulse echo testing contact and immersion method
18. IS:3757 High strength structural bolts.
19. IS:4000 High strength bolts in steel structure - code of practice.
20. IS:4353 Sub merged arc welding of mild steel and low alloy steel Recommendation
21. IS:4759 Hot dip zinc coating on structural steel and other allied products.
22. IS:5334 Code of practice for magnetic particle flaw detection of welds.
23. IS:5369 General requirements for plain washers and lock washer
24. IS :6623 High strength structural nuts.
25. IS:6649 Hardened and tampered washers for high strength structural bolts & nuts.
26. IS:6911 Stainless steel plate, sheet and strip.
27. IS:7205 Safety code for erection of structural steel.
28. IS:7215 Tolerances for fabrication of structural steel.
29. IS: 7307 Approved test for welding procedures
(Part - I) Fusion welding of steel.
30. IS:7310 Approval test for welders working to approval
welding procedure. (Part-I) Fusion welding of steel
31. IS:9178 Criteria for design of steel bins for storage of (Part-1to 3) bulk material.
32. IS:9595 Recommendations for metal arc welding of carbon & carbon manganese steel.
33. IS:12843 Tolerances for erection of steel structures.

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34. SP:6 ISI Hand book for structural Engineers. (Part 1 to 7)

2.01.08 Plastering and Allied Works

1. IS:1661 Code of practice for application of cement and cement lime plaster finishes.
2. IS:2402 Code of practice for external rendered finishes.
3. IS:2547 Gypsum building plaster. (Parts 1&2)

2.01.09 Acid and Alkali Resistant Lining

1. IS:158 Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali & heat resisting.
2. IS:412 Expanded metal steel sheets for general purpose.
4. IS:4441 Code of practice for use of silica type chemical resistant mortars
5. IS:4443 Code of practice for use of resin type chemical resistant mortars.
6. IS:4456 Method of Test for chemical resistant tiles. (Part I & II)
7. IS:4457 Ceramic unglazed vitreous acid resisting tiles.
8. IS:4832 Specification for chemical resistant mortars.
(Part - 1) Silicate type
(Part - 2) Resin type
(Part - 3) Sulfur type
9. IS:4860 Acid resistant bricks.
10. IS:9510 Bitumastic acid resisting grade.

2.01.10 Water Supply, Drainage and Sanitation

1. IS:458 Precast concrete pipes (with & without reinforcement).
2. IS:554 Dimensions for pipe threads, where pressure tight joints are required on the thread.

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3. IS:651 Salt glazed stoneware pipes and fittings.

4. IS:774 Flushing cisterns for water closets and urinals.

5. IS:775 Cast iron brackets and supports for wash basins and sinks.

6. IS:778 Copper alloy gate, globe and check valves for water works purposes.

7. IS:781 Cast copper alloy screw down bib taps & stop valves for water services.

8. IS:782 Caulking lead.

9. IS:783 Code of practice for laying of concrete pipes.

10. IS:1172 Code of basic requirements of water supply, drainage and sanitation.

11. IS:1230 Cast iron rain water pipes and fittings.

12. IS:1239 Mild Steel tubes, tubulars and other wrought steel fittings (Part 1&2)

13. IS:1536 Centrifugally cast (Spun) iron pressure pipes for water.

14. IS:1537 Vertically cast iron pressure pipes for water, gas and sewage.

15. IS:1538 Cast iron fittings for pressure pipe for water, gas and sewage.

16. IS:1703 Copper alloy float valve for water supply fitting.

17. IS:1726 Cast iron manhole covers and frames.

18. IS:1729 Sand cast iron spigot and socket soil, water and ventilation pipes, fittings and accessories

19. IS:1742 Code of practice for building drainage.

20. IS:2064 Selection, installation and maintenance of sanitary appliances.

21. IS:2065 Code of practice for water supply in buildings.

22. IS:2326 Automatic flushing cisterns for urinals.

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23. IS:2548 Plastic seats and covers for water closets.

24. IS:2556 Vitreous sanitary appliances (vitreous china).

25. IS:3114 Code of practice for laying of cast iron pipes.

26. IS:3311 Waste plug and its accessories for sinks and wash basins.

27. IS:3438 Silvered glass mirrors for general purposes.

28. IS:3486 Cast iron spigot and socket drain pipes.

29. IS:3589 Seamless or electric welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).

30. IS:3989 Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories

31. IS:4111 (Part 1 to 5) .- Code of practice for ancillary structure in sewerage system

32. IS:4127. Code of practice for laying of glazed stone ware pipes.

33. IS:4764 Tolerance limits for sewage effluents discharged into inland surface waters.

34. IS:4827 Electroplated coating of nickel and chromium on copper and copper alloys.

35. IS:5329 Code of practice for sanitary pipe work above ground for buildings.

36. IS:5382 Rubber sealing rings for gas mains, water mains and sewers.

37. IS:5822 Code of practice for laying of electrically welded steel pipes for water supply.

38. IS:5961 Specification for cast iron grating for drainage purpose.

39. IS:7740 Code of practice for construction and maintenance of road gullies.

40. IS:8931 Copper alloy fancy single taps combination tap assembly and stop valves for water services.

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41. IS:9762 Polyethylene floats for float valves
42. IS:10592 Industrial emergency showers, eye and face fountains and combination units.
43. IS:12592 Specification for precast concrete manhole covers and frames.
44. IS:12701 Rotational moulded polyethylene water storage tanks.
45. IS:13983 Stainless steel sinks for domestic purposes.
46. SP:35 Hand book on water supply and drainage with special emphasis on plumbing. CPH&EEO Manual on sewage and sewage treatment Publication - as updated.

2.01.11 Doors Windows and Allied Works

1. IS:204 Tower Bolts. (Part 1) Ferrous metals (Part 2) Non - ferrous metals
2. IS:208 Door Handles.
3. IS:281 Mild steel sliding door bolts for use with padlocks.
4. IS:362 Parliament Hinges.
5. IS:420 Putty, for use on metal frames.
6. IS:451 Technical supply conditions for wood screws.
7. IS:733 Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purposes.
8. IS:1003 Timber panelled and glazed shutters (doors shutters). (Part I)
9. IS:1003 Timber panelled and glazed shutters (Part-1) door shutters.
10. IS:1038 Steel doors, windows and ventilators.
11. IS:1081 Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.

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12. IS:1285 Wrought aluminium and aluminium alloy extruded round tube & hollow section (for general engineering purposes). 13. IS:1341 Steel butt hinges. 14. IS:1361 Steel windows for Industrial buildings. 15. IS:1823 Floor door stoppers. 16. IS:1868 Anodic coatings on Aluminium and its alloys. 17. IS:2202 Wooden flush door shutters (solid core type) particle (Part-2) board face panels and hard board face panels. 18. IS:2209 Mortice locks (vertical type) 19. IS:2553 Safety glass 2.01.12 Roof Water Proofing and Allied Works 1. IS:3067 code of practice for general design details and preparatory work for dampproofing and water proofing of buildings 2 ASTM Standard specification for high solid content cold 3 C836-89a liquid applied elastomeric water proofing membrane for use with separate wearing course. 4 ASTM Standard guide for high solid content cold 5 C898-89 liquid applied elastomeric water proofing membrane for use with separate wearing course. 2.01.13 Floor Finishes and Allied Works 1. IS:5318 Code of practice for laying of flexible PVC sheet and tile flooring. 2. IS:8042 White portland cement. 3. IS:13755 Dust pressed ceramic tiles with water absorption of 3%, E 6% (Group B11a).			
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4. IS:13801 Chequered cement concrete tiles.

2.01.14 Painting and Allied Works

1. IS:162 Ready mixed paint, brushing fire resisting, silicate type for use on wood, colour as required.
2. IS:428 Distemper, oil, emulsion, colour as required.
3. IS:1477 Code of practice for painting of ferrous metals in buildings. (Part -1) Pretreatment. (Part -2) Painting.
4. IS:1650 Specification for colours for building and decorative materials.
5. IS:2074 Ready mixed paint, air drying, red oxide-zinc chrome, priming.
6. IS:2338 Code of practice for finishing of wood and wood based materials. (Part -1) Operations and Workmanship. (Part -2) Schedule.
7. IS:2395 Code of practice for painting concrete, masonry and plaster surfaces. (Part-1) Operations and Workmanship. (Part -2) Schedule.
8. IS:2524 Code of practice for painting of nonferrous metals in buildings. (Part -1) Pretreatment (Part -2) Painting.
9. IS:2932 Enamel, synthetic, exterior, (a) under coating and (b) finishing.
10. IS:2933 Enamel exterior, (a) under coating, (b) finishing.
11. IS:4759 Hot dip zinc coatings on structural steel and other allied products.
12. IS:5410 Specification for cement paint.
13. IS:5411 Plastic emulsion paint. (Part-1&2)
14. IS:6278 Code of practice for white washing and Colour washing.
15. IS:10403 Glossary of term related to building finish.
16. IS:12027 Silicone based water repellent
17. IS:13238 Epoxy based zinc phosphate primer (2 pack)

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18. IS:13239 Epoxy surfacer (2 pack)
19. IS:13467 Chlorinated rubber for paints
20. IS:14209 Epoxy enamel, two component glossy.
21. BS:5493 Code of practice for protective coating of iron and steel structures against corrosion.

2.01.15 Piling and Foundation

1. IS:1080- Code of practice for design and construction of shallow foundations on soils.
2. IS:1904 Code of practice for design and construction of foundation in Soils : General Requirements.
3. IS:2314- Steel sheet piling sections.
4. IS:2911- Code of practice for design and construction of pile foundations. (Relevant Parts)
5. IS:2950- Code of practice for designs and construction of Raft foundation. (Part-1) Design
6. IS:2974- Code of practice for design and construction of machine (Part-1 to 5) foundation.
7. IS:4091 Code of practice for design and construction foundations for transmission line towers and poles.
8. IS:6403- Code of practice for determination of Bearing capacity of Shallow foundations.
9. IS:8009 Code of practice for calculation of settlement of foundation. (Part -1) Shallow foundations. (Part -2) Deep foundations.
10. IS:12070- Code of practice for design and construction of shallow foundations on rocks.
11. VDI:2056- Criteria for assessing mechanical vibrations of machines.
12. VDI:2060- Criteria for assessing the st of balance of rotating rigid bodies.

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13. DIN:2089- Helical compression spring made of round wire and rod : calculation and design of compression .

14. DIN:2096 Helical compression spring out of round wire and rod : Quality requirements for hot formed compression spring.

15. DIN:4024- Flexible supporting structures for machine with rotating machines.

2.01.16 Roads

1. IRC:5- Standard specifications and Code of practice for road bridges, (Section-1)
2. General Features of Design.

3. SCOPE OF CIVIL WORKS

The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the civil works for the project. The Bidder should adhere to portions specific to all civil, structural and architectural works except boundary wall.

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

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

The work shall be carried out according to the design / drawings to be developed by the Contractor and approved by the Owner / Owner's authorized Consultant. The land will be given to the Contractor by the Owner as is where basis. All site investigations, surveys, grading and levelling and other additional works shall be carried out by the Contractor.

The layout and levels of all structures shall be made by the Contractor at his own cost from the general grid of the plot and the nearest GSI bench mark or other acceptable bench mark of Govt. Dept. The Contractor shall be solely responsible for the correctness of the layout and levels.

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

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

4. LAYOUT

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

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

5. WORKMANSHIP

Workmanship shall be of the best possible quality and all work shall be carried out by skilled workmen except for those which normally require unskilled persons. Welding shall be done by experienced and certified welders in proper sequence using necessary jigs and fixtures. Fabrication shall be done in shops having proper equipment for accurate edge _lanning and milling of column shaft ends, base plate surfaces etc., and shaping and dimensioning of anchor bolt assembly, inserts and other misc. items. In addition to the requirement specified above, if the bye laws of the local Govt., Municipal or other authorities require the employment of licensed or registered workmen for various trades, the Contractor shall arrange to have the work done by such registered or licensed personnel. In case of manufactured materials, the Contractor shall have, with no additional cost to the Owner, the services of the

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supervisors of the manufacturers to ensure that the work is being done according to the manufacturer's specifications.

6. TEMPORARY WORK

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

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

7. INTERFACE WITH STRUCTURES UNDER OTHER'S SCOPE

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

8. SEQUENCE OF WORK AND PROGRESS REPORT

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

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

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9. SITE LEVELLING

Earth to be used for filling purpose shall be sand, or other inorganic materials and they shall be clean and free from shingle, salts, organic, large roots and excessive amount of sod, lumps, concrete or any other foreign substances. All clods shall be suitably broken to small pieces. Sand used for filling shall be clean, medium grained and free from impurities. Fines less than 75 microns shall not be more than 20 %. In any case, the materials to be used for filling purpose shall have the prior written approval of the Engineer.

Fill shall be placed in horizontal layers not exceeding 300 mm compacted thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction / density of 95% of Standard Proctor Maximum Dry Density

Compaction shall be carried out with 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled as directed by the Engineer. Each layer shall be wetted or the material dried by aeration to a moisture content of 3-5% above the optimum. Each layer shall be watered, rammed and compacted and tested for ensuring the desired degree of compaction.

10. CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanised from the start of the work. All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines,

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shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted.

All handling of materials shall be with cranes.

Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

Grouting shall be carried out using hydraulically controlled grouting equipment.

All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed.

Compressors for cleaning of foundations and other surfaces shall be used.

Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

11. GENERAL INFORMATION

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

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

Excavation in all types of soil shall include dewatering till the backfilling is over, backfilling and disposal of the surplus earth to the areas as per the instructions of the Engineer. The material to be backfilled shall have prior approval of the Engineer

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Lean concrete 100mm thick of 1:3:6 proportion shall be provided below all structural concrete resting directly on soil/founding strata.

The compressive stress in the concrete shall not exceed 45% of the specified 28 days cube strength of the concrete as per IS:456.

Compaction of all back filled material shall be carried out as specified elsewhere in this specification.

The minimum concrete clear cover to reinforcement in all RCC structures shall be as per IS:3370, except for Columns (below and above ground level) it shall be 50mm

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

Formwork for underground work shall be of ordinary quality. For super structures all structures and concrete works Formwork Plywood with film face formwork shall be used

Formwork Plywood with film face formwork shall be used for all structures and concrete works.

All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

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PART-II

SPECIFIC DESIGN REQUIREMENTS

[CIVIL]

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DESIGN CRITERIA

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

GENERAL:

Design detailing and fabrication of steel structures shall be done as per provisions of IS: 800.

Welding shall be used for fabrication and erection.

Site connections shall generally be with welding/bolts.

For bolted connection, IS: 4000, IS: 3757, IS: 6623 and IS: 6649 shall be followed.

IS: 814, IS: 816, IS: 1024, IS: 4353 and IS: 9595 shall be followed for welding of structures.

All structures close to railway line shall have clearances conforming to Railway norms.

- Dispersion of load in any direction through soil shall be as per IS: 8009 (relevant part).
- Dispersion of load through concrete shall be considered at an angle of 45 degrees with horizontal from the edge of contact area.
- For reinforcement detailing, IS: 5525 and SP: 34 shall be followed.
- Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC I sections having thickness 150 mm or more.

LIQUID RETAINING STRUCTURE

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a) All RCC liquid retaining/ conveying structure (except water storage tanks) shall be designed in accordance with IS: 3370 by the working stress method, using limited steel stress. However, water storage tanks shall be designed as an uncracked section as per IS: 3370 by working stress method. Grade of concrete for the above structures shall be M-25 as per IS: 456.

a) Water proofing treatment shall be provided for liquid retaining/ carrying structures and basement type structures (requiring dry working condition). Dense and durable concrete with water cement ratio not more than 0.45 shall be used. Plasticiser/ super-plasticiser cum water proofing compound shall be added to the concrete. All the construction/expansion joints shall be properly treated with PVC water bar and/or chemical injection grouting as per IS: 6494. For basement type of structures, internal/external surface shall be provided with acrylic based polymer modified cementitious composite coating system for critical structures. For external application wherever the surface is in contact with the earth, fine silica/quartz sand of 0.6 mm nominal size shall be added in the coating mix for better abrasion resistance and total nominal thickness of such coating shall be minimum 1.5 mm. For non-critical structures minimum two coats of bitumen grade 85/25 as per IS: 702, mixed with 1% of anti-stripping compound meeting the requirement of IS: 6241, shall be applied. The total application of bitumen shall not be less than 1.7 kg/sq.m. Bidder shall submit a comprehensive scheme for water proofing treatment based on above or any other alternative scheme, internationally accepted for Employer's approval prior to commencement of work.

c) All liquid retaining/ carrying structures shall be tested for water tightness as per the provisions of IS: 3370 and IS: 6494 and in case of leakage, the same shall be rectified by chemical injection grouting through nozzles.

For design of all underground structures, foundations, C.W. ducts, etc. ground water table shall be assumed at the finished ground level unless specified otherwise.

Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest or co-efficient of active earth pressure, whichever is applicable, depending upon the structural configuration. However, for the design of substructure of pump houses, earth pressure at rest shall be considered. Co-efficient of passive earth pressure shall be used only in design of shear keys for stability against sliding.

Following loading conditions shall be considered in addition to the loading from super structure for the design of substructure of pump house, channels, sumps, tanks, trenches and other underground structures containing liquid.

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

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- c) Design shall also be checked against buoyancy due to the ground water during construction as well as after construction stages. Minimum factor of safety against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loadings. Provision of pressure relief valves/ flap valves, etc., shall not be permitted to counter the buoyancy in pump sumps.
- d) Base slab and piers of the pump houses shall also be designed for the condition of different combination of pump sumps being empty during maintenance stages with maximum ground water level.
- e) Intermediate dividing pier of pump sumps and partition wall (if applicable) in channel shall be designed considering water on one side only and other side being empty for maintenance.
- f) All pump houses and other substructures (wherever applicable) shall be checked for stability against sliding and overturning during construction as well as operating conditions for various combinations of loads.

Equipment Foundations :

Supporting Arrangement :

The steam Turbine Generator (TG) and Gas Turbine (GT) shall be supported over RCC deck. The bidder may support the RCC deck for TG/GT on steel helical springs/spring cum viscous dampers which in turn will be supported on RCC sub-structures resting on soil/piles. Alternatively the deck may be directly supported on RCC sub-structure/soil/piles without steel helical springs /spring cum viscous dampers.

Detailed static and dynamic analysis shall be carried out for the foundations of ST & GT etc. The static analysis shall include all operating conditions, load cases and abnormal loads like short circuit, loss of blade unbalance and seismic forces. Unbalance loads for normal operating condition as given by machine manufacturer and/or VDI 2060 whichever is more conservative shall be used for calculating dynamic response. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. Transient analysis shall be carried out for the short circuit condition with an appropriate force function. Frequency separation criteria and amplitude criteria as laid down in IS: 2974 and/or DIN 4024 and/or VDI 2056 and/or as required by the machine manufacturer, whichever is more stringent shall be satisfied. RCC design shall be done by the working stress method for all machine foundations. A fatigue factor of 2.0 shall be considered for dynamic forces. Minimum reinforcement shall be governed by IS: 2974 as well as IS: 456. However minimum reinforcement in bottom face of the foundation raft resting on soil or pile shall not be less than 0.2% of effective cross sectional area of the raft. The minimum grade of concrete for TG & TG foundation shall be M35.

In case steel helical springs are provided, the foundation arrangement shall be such that the spring units are located above the finished floor level by at least 200mm. The isolation efficiency of the foundation system comprising RCC deck and steel helical springs shall be at least 90%. The ratio of actual spring supported weight to the nominal spring capacity shall be

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at least 0.80. At least 3% to 5% of critical damping shall be provided in the form of viscous dampers.

The special requirements for concreting including grade, type of aggregate, use of admixture, temperature control, ultrasonic testing, etc., shall be as mentioned elsewhere in this specification.

The specification requirements for steel helical springs are specified elsewhere in this specification.

All block foundations supporting rotating equipment resting on soil or piles shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than three times the mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down in the relevant codes and/or by machine manufacturer, whichever, is more stringent shall be satisfied. Minimum reinforcement shall be governed by IS: 2974 and IS: 456. Minimum Reinforcement in base raft in either direction shall be as follows:

- i) At bottom face -0.2% of gross cross-sectional area
- ii) ii) At top face -0.12% of gross cross-sectional area For the foundations supporting minor rotating equipment weighing less than one tonne or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary. However, if such minor equipment is to be supported on building structure, floors, etc., suitable vibration isolation shall be provided by means of springs, neoprene pads, etc., and such vibration isolation system shall be designed suitably.

CW DUCTS

A) Design of C.W. ducts shall be done for the following conditions.

i) Internal Pressure Condition:

Following cases shall be considered for the design of pipe:

- a) Maximum design water pressure
- b) Surge or water hammer pressure
- c) Pressure, under testing condition

ii) External Pressure Condition: The pipe shall be designed for external pressure due to soil overburden, surcharge loading, vacuum condition in pipe, ground water, etc., taken together.

iii) Practical Requirements: Design shall also be checked for handling stresses. Both stresses and the deflection of pipe shall be within the limits for the above design conditions. Deflection of the pipe under worst loading condition shall be restricted to 2 (two) percent of the pipe diameter. For the concrete encased pipe, the design of pipe shall also be checked under concreting condition during construction. Moreover, temporary bracing shall be

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provided inside the pipe to limit the deflection within 2% of diameter of pipe during construction.

iii) Top of C.W. duct shall be minimum 1.5m below grade/ formation level.

B) The design of C.W. steel pipe liners with concrete encasement shall be as per "Design and Construction of Buried Thin Walled Pipes" CIRIA (Construction Industry Research and Information Association, London) report and also as per American Water Works Association (AWWA) Manual. Steel lined C.W. duct shall be designed ignoring the internal lining (if any) and external coating/ encasement. Corrosion allowance of minimum 2mm shall be kept over and above the designed thickness. Ready manufactured RCC pipes with 3mm (min.) thick steel liner shall be designed as per AWSI/AWWA C 300-89 or equivalent unless noted otherwise. Steel Hume pipes shall be designed as per AWWA manual.

All roads shall be of flexible pavements unless otherwise specified. Design of flexible pavement shall be carried out as per IRC-37. The minimum requirements as specified in IRC-37 w.r.t. surfacing base and sub base, shall be followed. The design traffic load shall be a minimum 4 million cumulative standard axle. All roads shall be designed for class 'E' of traffic, i.e, traffic intensity of 4501500 per day (heavy vehicles exceeding 3 tonnes laden weight) as per IRC-37. The road shall be designed for 30 years of life and considering a minimum traffic growth of 1% per annum. In case of concrete pavement the design shall be carried out as per IRC-58.

a) No cable/pipe trench is envisaged in outdoor areas of the plant.

b) All pipes and cable shall generally be routed above ground on structural steel trestles having minimum clear height of 3.0m.

c) A minimum clearance (clear headroom) of 8 m shall be kept for all over-ground pipe/cable trestles for all road/rail crossings. For other areas, the requirement of trestle height is specified elsewhere in the specifications. All trestles shall be provided with continuous walkway of minimum 750mm width with handrails and toe-guards all along the length of the trestle along with approach ladders near roads, passageways, etc. Before and after the road/rail crossings, a barrier of suitable height shall be constructed so as to prevent the approach of cranes (having height more than 8 m) etc, upto the pipe/cable trestles.

d) Within Main plant area, generally grating shall be provided for Mezzanine floor except for valve room area, cable spreader floor, etc. where the floor shall be of RCC. Oil equipment room shall also have RCC floor below the grating floor.

Plant storm water drainage shall be designed taking into account the finished grade levels of the plant area, drainage pattern, intensity of rainfall, etc. The storm water drainage shall cater to storm water run off resulting from one hour rainfall intensity, with a return period of 100 years. These values shall be based on the recommendations of the Indian Meteorological Department (IMD). The maximum velocity for pipe drains and open drains shall be limited to

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2.4m/sec and 1.8 m/sec. respectively. However, minimum velocity of 0.6m/sec. for self-cleansing shall be ensured. Bed slope not milder than 1 in 1000 shall be provided. The open drains shall be open rectangular drains of RCC unless required otherwise due to functional requirement. Pipe or box culverts shall be provided at rail, road or other crossings.

Sewers shall be designed for a minimum self-cleansing velocity of 0.75m/sec and the maximum velocity shall not exceed 2.4m/sec. and shall be connected by gravity or by pumping, to the sewage treatment plant to be constructed by bidder. Manual on Sewerage and Sewage treatment (published by Central Public Health Environment Engineering Organisation, Government of India) shall be followed for design purpose.

Roof decking sheets shall be designed as per IS: 801 to carry the self load, dead load due to RCC slab and finishes and imposed load. The deflection of metal deck shall be limited as per BS: 5950. In case composite action is considered in the design, suitable shear studs shall be provided as per BS: 5950.

Plant effluents shall be handled in separate drains/ pipes. The plant effluent drain shall not be mixed with storm water drain or sewer lines.

HRSG STRUCTURES

a) HRSG support structures shall be designed for:

i) Live/ Imposed loads

i) Dead loads

iii) Static and dynamic loads of piping, movable equipment, maintenance parts and possible future additions.

ii) Loads due to platforms, walkways & stairways etc.

iv Seismic and wind loads are as specified in Project Information attached in this specification.

v) The loads listed above indicate the minimum requirements.

b) HRSG supporting structures shall be so configured that the temperature of steel does not exceeds 60 deg. C unless specified otherwise and the structure shall be designed for temperature variation of 250C from atmospheric temperature.

c) The bracings in HRSG structure shall be provided such that under no circumstances normal/convenient access to all points in the HRSG is blocked or obstructed.

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d) HRSG Support structures shall be checked for differential settlement of foundation, which shall be restricted to 1 in 1000 of span or 8mm whichever is less.

e) In design of HRSG support structures, dynamic piping loads need not be considered acting simultaneously with wind or seismic loads, increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

f) Design Criteria for foundations and some other facilities/areas are covered separately in this specification.

JOINTS/CONNECTIONS IN STEEL STRUCTURES:

Steel structures shall be detailed and connection and joints provided as per the provisions of IS:800, IS:816, IS:9595, IS:1367, and IS:9178 and as per following requirements.

a) Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.

b) Size of fillet weld for flange to web connection for built up section shall be as follows:

i) For box section weld size shall be designed for 60% of full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration butt weld shall be provided.

ii) For built up I - section, weld size shall be designed for 80% of full shear capacity or actual shear, (if indicated, in drawings) whichever is more. However, weld size shall not be less than 0.5 times the web thickness. Weld shall be double fillet.

iii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6mm.

c) Shear connections shall be designed for 60% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. However, if load is more than above, the connection shall be designed for actual load.

d) Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section. This can achieved either by direct butt welding of the top flange of beam with column flange or by providing top moment plate with suitable notch for additional weld length.

e) All butt welds shall be full penetration butt welds.

f) The connection between top flange and web of crane girder shall be full penetration butt weld. Bottom flange, connection with web can be fillet weld or butt weld as directed by Engineer.

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g) Connection of base plate and associated stiffeners with the columns shall be designed considering the total load transferred through welds. However, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners.

h) Splicing: All splicing work shall be of full strength. Field splicing shall be done with web and flange cover plates for full strength. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plate.

STACKS

- a) The design of Bypass and HRSG stacks shall in general conform to the relevant Indian Standards. For design provisions not contained in the Indian Standards, reference shall be made to the relevant American and British Standards, CICIND model codes and other relevant international standards.
- b) External and internal corrosion allowances, where applicable, for the stack and its components, shall be suitably selected in line with the relevant standards for the design operating conditions and the service life of plant.
- c) Insulation for stack shall be as per the design criteria specified elsewhere in the specification. Maximum and minimum operating temperatures shall be considered while selecting materials for the stack.
- d) The stack shall be designed for vertical loading, along wind loading, cross wind loading, seismic loading, circumferential wind loading, thermal stresses, fatigue and for effects of solar gain, local loadings, rotation of the stack base, moments of second order, and other forces not specifically mentioned but pertinent for the safe design of the structure. The stack shall be designed to resist the most onerous forces resulting from all the possible combinations of various loadings.
- e) The stacks, particularly Bypass stack, which carries gases at high temperatures, should be so configured/detailed to avoid buildup of thermal stresses. This may be achieved by allowing thermal expansion between the various components through suitable expansion joints.
- f) Adequate measures should also be taken to minimize/prevent buildup of thermal stresses due to differential temperatures between the various inter connecting stack components.
- g) The cut-outs/openings in the stack shall be sized and stiffened/reinforced in accordance with the relevant standards.
- h) For dynamic response of the stack for seismic and wind loading at least the first five modes of vibration shall be used in the computations.
- i) Seismic forces, on the stack, shall be computed by the response spectrum method using the site-specific acceleration spectra as given in Project Information attached in this specification.
- j) The along wind loading shall be computed by the peak wind method and the gust factor method of IS: 875 (Part - 3) and by the method outlined in IS: 6533, and the governing case shall be adopted for design. For wind velocity and other parameters, Project Information attached in this specification shall be referred.

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- k) The cross wind analysis of the stacks shall be carried out irrespective of the value of the Scruton Number for the stack and other empirical consideration which suggest structural immunity to cross wind oscillations. To ensure that a particular vibration mode is not excited, the critical wind velocity for the structure for that mode should be at least 20% higher than the maximum wind velocity possible at the site, The strouhal Number shall be taken as 0.2.
- l) While estimating the loadings resulting from either along wind or cross wind effects, the proximity of the other stacks shall be considered. Amplification factors on account of aerodynamic interference shall be suitably estimated and included in the analysis.
- m) Along wind and cross wind moments shall be taken separately, and as a combined action, in the loading combinations to be considered.
- n) Irrespective of the magnitude of the cross wind forces, strakes, shall be provided as three start helices, at least over the top one third height of the stack or one pitch height whichever is greater, with a helix pitch of five times the effective diameter of the stack, Radial depth of strakes shall not be less than one tenth the effective diameter of the stack. The effective diameter is usually the average diameter of the top one-third height of the stack; Strakes shall be structurally designed to withstand three times the design wind pressure at the top of stack. A drag coefficient of 1.4 for the straked region and 1.12 for the unstraked region shall be considered in the analysis & design.
- o) Local moments acting on horizontal cross-section of the stack shall be considered together with forces due to the load combination of vertical and co-existing lateral loads and temperature effects.
- p) Local moments acting on vertical cross-section of the stack shall be included together with moment forces from solar gain and /or ovalisation.
- q) Since wind is principal loading on the stack, no increase in permissible stress shall be allowed for any part of the structure, foundation and soil bearing stresses/pile forces for the loading combinations with wind loading.
- r) The Stack foundation shall be designed for the most critical forces resulting from all the possible combinations of the various loadings from the stack system during all stages of construction. The effect of water table shall be considered and the foundation shall be checked for overturning for minimum and maximum vertical loads. There shall be no uplift under any portion of the foundation for any loading condition.
- s) All the loading specifications, design parameters, structural detailing detailing, structural and other materials, coatings and painting, quality, testing, workmanship, construction and safety requirements etc. Shall be in line with this specification and the relevant Indian standards. For provisions not contained in the Indian standards, reference shall be made to the American/ British standards, CICIND model codes and ASCE code on steel chimney liners.
- t) The supporting structure for the stack shall extend at least upto 2/3rd the height of the stack. The stack could be either top hung or bottom supported from the supporting structure. In case it is designed to be supported from bottom, the support location shall be kept as low as possible, however, in either cases of supporting, the stack shall be restrained horizontally at least at two levels distribute uniformly along the height.

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STEEL HELICAL SPRINGS AND VISCOUS DAMPERS

General Requirement

This part of the specification covers the requirement for the manufacturing, testing supply, transport to site, pre-stressing, erection, supervision of erection, release of pre-stress, alignment, commissioning, etc. of steel helical springs and viscous dampers.

The information about the entire range of spring units, damper units and spring-cum-damper units manufactured by sub vendor shall be furnished to owner along with appropriate type of spring units for different machines. The information to be furnished should include the load carrying capacity, stiffness (vertical & horizontal), damping resistance, dimensions of spring and damper units.

Material (Design & Supply)

Steel helical springs and viscous dampers shall consist of:

- Steel helical spring units and viscous dampers along with viscous liquid including associated auxiliaries for installation of the spring units and dampers like steel shims, adhesive pads, etc.
- Frames for pre-stressing of spring elements.
- Suitable hydraulic jack system including electric pumps, high-pressure tubes etc. required for the erection, alignment etc., of the spring units.

One set of extra hydraulic jacks, and hand operated pumps shall also be provided.

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

The spring units should have stiffness in both vertical and horizontal directions with the horizontal stiffness not less than 50% of vertical stiffness. The stiffness should be such that the vertical natural frequency of any spring unit at its rated load carrying capacity is not more than 3 Hz.

The dampers units or spring-cum-damper units should be of viscous type offering velocity proportional damping. The damper units should be suitable for temperatures

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ranging from 0 to 500C. The damping resistance of individual damper units should be such that the designed damping can be provided using reasonable number of Units. Damper Units shall have damping resistance ranging from 40 KN Sec / M to 750 KN Sec./M.

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

The steel helical springs and viscous dampers shall be designed for a minimum operating life of 30 years.

Manufacturing & Testing

Complete manufacturing and testing of the steel helical springs and viscous dampers shall be done at the manufacturing shop of the approved sub vendor/ supplier. For this purpose the contractor/sub vendor shall submit the detail programme for approval of engineer and take up the manufacturing/testing after approval of such programme. The programme shall include.

- (a) Manufacturing schedule and quality check exercised during manufacturing.
- (b) Detail of test to be carried out at the manufacturing shop with their schedule.
- (c) Special requirements, if any, regarding concreting of top deck.
- (d) Complete step-by-step procedure covering the installation and commissioning of the spring system.
- (e) Manuals for erection, commissioning, testing and maintenance of the steel helical springs and viscous dampers.
- (f) A checklist for confirming the readiness of the civil fronts for erection of steel helical springs and viscous dampers.
- (g) Checklist for equipment required at each stage of erection.
- (h) Bill of materials (data sheet) of various elements such as spring units, viscous dampers, with their rating, stiffness etc. included in the supply.
- (i) Bill of material (data sheet) for frames for pre stressing, hydraulic jack including electric pump, high pressure tubes, hand operated pump etc., with their rating and numbers.
- (j) Any other details which may be necessary to facilitate design and construction of the foundation/structures.

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

Transportation

Steel helical springs and viscous dampers shall be suitably protected, coated, covered, boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection.

The contractor shall be responsible for any loss or damage during transportation, handling and storage.

Erection and Commissioning

Complete erection and commissioning of the steel helical springs and viscous dampers including pre-stressing of elements, placing of elements in position, checking clearances on the shuttering of the RCC top deck, releasing of pre-stress in spring elements, making final adjustments and alignments etc. all by a specialist supervisor.

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

The contractor shall guarantee the performance of the steel helical springs and viscous dampers for 24 months from the date of commissioning of each machine which shall be termed as "Guarantee Period".

Supervision The supervision of installation of steel helical springs and viscous dampers including pre-stressing, placing, releasing and alignment of spring units shall be done by a specialist supervisor of sub vendor / supplier, trained for this purpose.

Realignment of Spring System

If any realignment of the steel helical springs and viscous dampers is required to be done for aligning the shaft or for any other reasons during the first one year of operation from the date of commissioning of the machine, the same shall be done by the contractor.

Acceptance Criteria

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Stiffness values shall be checked. The permissible deviations shall be as per DIN 2096.

Following acceptance criteria shall be followed:

- (a) General workmanship is being good and as recommended by the manufacturer and approved by the Engineer.
- (b) Tolerances are within the specified limit.
- (c) Material test certificate (MTC) is in compliance with the applicable codes/standards.
- (d) Bought out material is from the approved manufacturer/vendor.
- (e) Bought out material is matching with the approved sample.

Codes and Standards

Some of the relevant standards and codes, etc, applicable to this section of the specification are listed below:

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

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

DIN : 3096 Helical compression springs out of round wire and rod; quality requirements for hot formed compression springs.

VDI : 2056 Criteria for assessing mechanical vibrations of machine.

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

FOUNDATION SYSTEM AND SOIL DATA

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Soil Data

It is envisaged that the Bidder is to check the actual site topography for filling, grading, leveling purposes. Bidder shall carryout detailed soil investigation as per the scheme given at Annexure-I.

If there are changes, during detailed engineering due to any reason, in the location of important structures/equipment like GT, ST, Stack, HRSG, Cooling Towers, etc., then the Bidder shall carryout the soil investigation work at the new location of foundations for determining the soil properties. No time shall be given on account of additional soil investigation carried out by the bidder or variation of data so obtained. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by the Employer and that found by the Bidder during soil investigation or during execution of works, shall be payable.

Foundation System

General Requirements

- (a) All equipment/structures shall be supported either on suitable open foundations or on pile foundations as required.
 - (b) The roads, ground floor slabs, trenches, channels and other lightly loaded structures with foundation intensities less than 5.0 t/sq.m may be supported on open/shallow foundation resting on virgin/controlled compacted filled up soil/improved ground. All foundations shall be designed in accordance with provisions of the relevant parts of the latest revisions of Indian Standards.
 - (c) No major foundation shall rest in the filled up ground/soil.
 - (d) A combination of open and pile foundations shall not be permitted under the same equipment/structure/building.
 - (e) Foundations shall be designed to resist all loads, including those due to wind or seismic, construction loads, and any other load as applicable and as specified elsewhere in the specification.
 - (f) Foundation shall be designed for worst combination of loads as described elsewhere in the specification.
 - (g) For identifying the subsoil for founding purposes, the Bidder shall depute/post an experienced qualified geologist/geotechnical engineer so that the specified strata as conceived in the design is reached.
- Open Foundations In case, open foundations are adopted following shall be adhered to :
- (a) Minimum width of foundation shall be 1.0 m.
 - (b) Minimum depth of foundation shall be 1.0 m below NGL.

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(c) It shall be ensured that all foundations of a particular structure/ buildings facility shall rest on one bearing stratum.

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

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

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

- (i) All facilities in Main Plant area, ducts, equipment foundation -25 mm
- (ii) All foundations in switchyard, control room building including, isolated/strip Continuous/raft foundation -40 mm
- (iii) Other footings of width upto 6m -40 mm
- (iv) Other footings of width greater -75 mm than 6.0m (raft)
- (v) Footings on rock -12 mm In case the total permissible settlement is to be restricted to less than as above specified from functional requirements, then the net allowable bearing pressure shall be reduced / reviewed accordingly in consultation with Employer.

Pile Foundations

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

(a) The piles foundation shall be of RCC, Cast in situ bored piles as per IS: 2911. Pile shall be installed by using rotary hydraulic rig. Three stage & lushing of pile bore shall be ensured by air lift technique.

(b) The minimum diameter of pile shall be 600mm. The uplift and lateral load capacity shall be respectively restricted to 20% and 5% of the allowable load capacity in vertical compression. However, the pile capacities to be adopted shall be the least of the estimated design values and that obtained from the initial pile load tests.

(c) Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

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

(f) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be as under: Vertical Lateral Minimum of 3 No. in each mode. Uplift The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test the method of loading shall be cyclic as per (IS: 2911 (relevant part)).

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

(i) Vertical 0.5% of the total number of piles provided.

(ii) Lateral -0.5% of the total number of piles provided. The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. The Employer shall approve piles for routine load tests. Routine load tests may be done by conventional method as per IS:2911 (Part-4) or by means of high strain dynamic pile load testing method as per ASTM D4945.

If high strain dynamic pile load testing is adopted, site specific correlation vis-à-vis conventional test shall be established as approved by Employer. In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Bidder shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required, without additional cost to the Employer.

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

(j) Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the piles for routine load test.

Ground Improvement

(i) Soil up to a depth of 0.5 m below the existing ground level shall be stripped. Sub base shall be leveled and compacted by mechanical roller. Thereafter soil shall be compacted in layers (each layer shall not be more than 250mm thick) up to 95% of maximum dry density (MDD) at optimum moisture content (OMC). The soil shall be made free from grass, large roots, lumps, concrete or any other foreign substances.

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(ii) A 1.0 m thick soil compacted in layers not more than 250 mm thick to achieve 95% of MDD at OMC shall be placed above the existing ground level. The soil borrowed from existing site can also be used for filling.

(iii) The material to be used for filling shall be earth, sand or any other inorganic materials except clay / fly ash and shall have a unit weight of 18.5 kN/m³.

(c) The bidder shall furnish following details for employer's approval regarding improvement/treatment of ground from the consideration of liquefaction.

(i) Drawings furnishing details of treatment with all computation & back up data and construction/execution procedure of the ground treatment/improvement.

(ii) Scheme of soil investigation to establish initial soil conditions by suitable field & laboratory tests.

(iii) Procedure to carryout field (initial) trials of treatment & their evaluation. The number of field trials of treatment shall be proposed by the bidder for employer's approval.

(iv) Post-treatment soil investigation Scheme by suitable field & laboratory tests both at initial trial area as well as at the actual job site.

(v) Field instrumentation proposed.

(vi) System of quality control checks / methods in respect of ground improvement / treatment (d) Subsequent to treatment, any depth of soil remaining un-compacted below the surface shall be compacted by rolling/tamping or by suitable means to satisfy above-mentioned densification criteria.

Other Requirements

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

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

(iii) Excavation for open foundations shall be covered with PCC immediately after reaching the founding level. In case of any local loosening of soil at founding level during excavation, the same shall be removed and compensated by PCC.

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The foundation pits shall be maintained dry during the complete construction period by means of suitable dewatering systems.

- (iv) Backfilling, around foundations and bottom of pipes, thrust blocks, etc. shall be carried out with approved material in layers not exceeding 30 cm thickness and each layer shall be compacted to 90% standard proctor density for cohesive soil and to 75% of relative density for non-cohesive soils.
- (v) Excess/surplus excavated material shall be disposed off by the Bidder as per the instructions of the Employer. Shifting of excess/surplus earth with in the plant is in the scope of the bidder as per requirment.
- (vi) CBR tests for flexible pavement design shall be carried out by Bidder after earth filling has been completed, if applicable.
- (vii) The storage tanks shall rest on flexible tank pad resting on an open/ shallow foundation or pile foundation. The tank pad shall be made of two layers. The first layer shall be thoroughly compacted fill of gravel, coarse sand or other suitable material topped with minimum 75mm thick compacted crushed stone, screenings, fine gravel, clean sand or similar material mixed in hot asphalt (80 / 100 bitumen or equivalent 8 to 10% by volume), rolled and compacted. The second layer shall be with minimum 25 thick premix carpet with 12 mm and down broken stone chips and 80/100 grade hot bitumen. The tank pad shall be laid by an expert agency having wide experience in execution of similar works. The tank pad shall be made up from founding level to the required level by controlled compaction in layers of 200 mm to achieve a relative density of 85% using suitable compaction equipment approved by the Employer. In addition to the above, in case of an open/shallow foundation, a ring wall shall be provided adjacent to the tank wall for retaining the fill below tank. The foundation system shall be designed as per the provisions of IS: 803. The tank shall have a flexible bottom plate, which will establish complete bearing with the foundation fill.

After the tanks have been erected, hydro testing shall be done. Subsequent upon hydro testing of tank, the differential settlement between any two consecutive points on the periphery shall be less than $d/400$ (where 'd' is the distance between the points), with the tank periphery being divided into 8 or more equal segments depending upon the size of the tank as decided by the Employer. The procedure for carrying out hydro testing shall be submitted for the Employer's approval prior to testing.

The founding level to be adopted including the allowable bearing capacities, measures to be adopted as mentioned in the specification shall be submitted to the Employer for approval.

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CORROSION PROTECTION MEASURES

a) Structural Steel

i) All steel members of buildings and structures shall be provided with suitable protective coating. Steel structures shall have synthetic enamel paint except for corrosive area as specified elsewhere.

ii) All mild steel parts coming in contact with water or water vapour shall be hot dip galvanised. The minimum coating of zinc shall be 610 gm/ sq.m for galvanised structures and shall comply with IS:4759 and other relevant codes. Galvanising shall be checked and tested in accordance with IS:2629.

b) RCC Members (Superstructure)

i) The protection for concrete sub-structure shall be provided based on aggressiveness of soil, chemical analysis of soil/sub-soil water and presence of harmful chemical.

ii) The protection to super structure shall depend on exposure condition and degree of atmospheric corrosion. This shall require use of dense and durable concrete, control of water cement ratio, increase in clear cover, use of special type of cement and reinforcement, coating of concrete surface etc.

iii) Bidder shall furnish the details of corrosion protection measures.

iv) The following preventive measures are required to be adopted by the bidder as minimum requirement.

For Indoor RCC Members Dense and durable concrete is to be used. Water cement ratio shall generally be restricted to 0.45. Plasticizer, if required, may be used.

For Outdoor (or Exposed) RCC Members Dense and durable concrete is to be used. Water/cement ratio shall generally be restricted to 0.45. Plasticizer, if required, may be used. Clear cover to reinforcement shall be increased by minimum 10mm over and above the values specified for normal conditions in relevant IS codes.

RCC Members (Underground Sub-soil condition)

Corrosion protective measures for underground facilities/structures shall be on the basis of results of detailed chemical analysis of sub-soil and underground water. This analysis has to be carried out by the bidder by a reputed laboratory/agency to be

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approved by the owner. The type of corrosion protection measures for concrete; reinforcement steel and structural steel for underground structures/facilities shall necessarily have protective coating.

One such protective coating system for bidder's guidance is given in Table-D on Page 125 of 146 of Section-VI, Part-B Volume-IV of technical specifications. The coating system consisting of zinc or fusion bonded epoxy conforming to relevant IS Codes can also be used based upon the results of chemical analysis of sub-soil and water.

GENERAL LAYOUT PLAN

- a) The entire construction activity shall take into account the commissioning of the units in phases matching with the phased commissioning of the plant.
- b) The interface requirements with the plant construction/erection activities of other contracting agencies engaged by the Employer. These agencies engaged may be working parallelly with the Bidder within the plant premises.
- c) The area for construction/ erection facilities like lay-down, pre-assembly, offices and stores is to be managed by the Bidder. Bidder may have to share these areas with other contracting agencies engaged by the Employer. The final location and extent of area allocated to each Bidder shall be as directed by the Employer.
- d) Transportation of all equipment and materials shall be by road as envisaged. Any other mode envisaged by the bidder may be proposed. However the same may be adopted subject to approval of the Employer.
- e) No damage shall be caused to existing buildings, facilities and plantation, etc. However, if some structures are to be removed/ relocated, the same may be carried out by the bidder subject to Employer's approval or as specified in this tender document with any cost implication to the Employer.
- f) All the buildings and facilities shall be approachable by fire tenders. Bidder shall visit the project site and physically study the entire area. Entire construction and erection facilities to be deployed including the civil design and construction techniques shall be subject to the Employer's approval. Deep excavations near the existing structures shall be carried out with sheet piling.

SITE LEVELLING

Earth to be used for filling purpose shall be sand, or other inorganic materials and they shall be clean and free from shingle, salts, organic, large roots and excessive amount of sod, lumps, concrete or any other foreign substances. All clods shall be suitably broken to small pieces. Sand used for filling shall be clean, medium grained

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and free from impurities. Fines less than 75 microns shall not be more than 20 %. In any case, the materials to be used for filling purpose shall have the prior written approval of the Engineer.

Fill shall be placed in horizontal layers not exceeding 300 mm compacted thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction / density of 95% of Standard Proctor Maximum Dry Density

Compaction shall be carried out with 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled as directed by the Engineer. Each layer shall be wetted or the material dried by aeration to a moisture content of 3-5% above the optimum. Each layer shall be watered, rammed and compacted and tested for ensuring the desired degree of compaction.

Earth generated from excavation work of raw water reservoir, other foundation work/cooling tower basin etc. shall be used for site levelling purpose.

General

Water proofing admixture (plasticiser cum water proofing compound) as approved by Engineer, shall be added as per manufacture's recommendations to the concrete for basin, ducts, channels, drainage pits, hot water basin/channels.

PVC sealing strips shall be used for all expansion and construction joints where water is retained or dry working conditions are required. The minimum thickness of PVC sealing strip will be 6mm and minimum width 230mm. The expansion joint shall be as per IS:3370. At expansion joints, joint filter material with polysulphide sealing compound shall be provided through out the height of the cooling tower.

Lean concrete 100mm thick of 1:3:6 proportion shall be provided below all structural concrete resting directly on soil/founding strata.

All other civil works required to make installation of cooling towers complete, including the connection of the cooling water discharge duct shall be provided by bidder.

Excavation in all types of soil shall include dewatering till the backfilling is over, backfilling and disposal of the surplus earth to the areas as per the instructions of the Engineer. The material to be backfilled shall have prior approval of the Engineer.

Compaction of all back filled material shall be carried out as specified elsewhere in this specification.

Drain sump(s) along with sludge pit.

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The minimum cement content as specified in relevant codal provisions shall be applicable for all structures of cooling towers

R.C.C. staircases shall be minimum 1000mm wide clear and risers shall be 180mm maximum and treads 250mm minimum.

Steel Structures

These structures shall be designed, fabricated and erected as per IS:800 (latest revision) for structural steel work.

Stoplog and its lifting arrangement shall be designed for a condition when water in the basin is upto full level and not water outside. Proper rubber seal shall be provided in the stoplog so as to avoid any leakage of water.

All mild steel parts or structural steel works used in cooling towers shall be hotdipgalvanised as per IS:4759 with 750 gm/sq.m coating. Nails and all components coming in direct contact with water shall be of stainless steel of AISI 304 or equivalent.

- All welds shall be subject to 100% visual examination.
- Dye penetration test on welds shall be carried out.
- Welding shall be done as per approved procedures and by qualified welders.
- Rubber seal used in stoplogs shall be tested as per the requirements of relevant code.
- Stoplogs shall be checked in dry condition for smooth operation and wet condition for water tightness.
- Galvanising shall be checked/tested for all tests as per IS:2629.

For other detail on steel structures gates etc. refer elsewhere.

Test for water tightness The water tightness of C.T. basin, outlet channel, hot water channel, fire water pump house and all other water retaining structures shall be tested as per the provisions of IS:3370.

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C.W. SYSTEM & RAW WATER SYSTEM/OTHER PUMP HOUSE

C.W. Pump House/ Raw Water Pump Houses/Aux. Cooling Water Pump House/ Other Pump Houses

A cooling water (C.W.) pump house for housing cooling water pumps shall be provided. Separate bays shall be provided for each pump by providing intermediate dividing piers of RCC between the pumps.

a) All pump houses shall be provided with minimum two sets of stop logs for the respective pump bay dimensions along with electrically operated hoisting arrangements. Steel embedments required for stop logs shall be provided for all bays.

b) All bays of pump houses shall be provided with a removable trash rack including electrically operated hoisting arrangements and cleaning arrangements. Moreover, one spare trash rack of respective pump bay dimension shall also be supplied for each pump house.

c) Stop logs, trash racks and hoists shall be supplied in accordance with the specifications covered elsewhere, in this specifications.

The sub-structure of all pump house including their forebays shall be RCC with M-25 grade of concrete conforming to IS:456. The superstructure of all pump houses shall consist of either structural steel frames or RCC portals.

C.W. pump house and other pump houses shall be structurally separated from their forebays by providing an expansion joint. All pump houses shall be provided with a separate maintenance bay for maintenance of various equipment and an electrical switchgear room. Length of maintenance bay shall be adequate for one pump maintenance. However, minimum length of maintenance bay for C.W. pump house shall be 10 m.

The sub-structure of all pump house including their forebays shall be RCC with M-25 grade of concrete conforming to IS:456. The superstructure of all pump houses shall consist of either structural steel frames or RCC portals.

C.W. pump house and other pump houses shall be structurally separated from their forebays by providing an expansion joint. All pump houses shall be provided with a separate maintenance bay for maintenance of various equipment and an electrical switchgear room. Length of maintenance bay shall be adequate for one pump maintenance. However, minimum length of maintenance bay for C.W. pump house shall be 10 m.

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All stop logs and trash racks shall be of structural steel, which shall be hot double dip galvanised. Proper rubber seal shall be provided for the stop logs so as to avoid any leakage of water. Rubber seal provided for the stop logs shall be tested in accordance with the relevant Indian Standards. Stop logs shall be checked for water tightness and smooth operation in dry and wet conditions.

All mild steel parts used in the water retaining structures shall be hot double dip galvanised. The minimum coating of zinc shall be 610gm/sq.m for galvanised structures and shall comply with IS:4759 and other relevant codes. Galvanising shall be checked and tested in accordance with IS:2629.

The galvanising shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416.

C.W. DUCTS

CW ducts from C.W. pumps house upto condensers and from condensers upto cooling towers shall either be steel pipe encased in concrete or factory made steel hume pipes (steel pipe having cement concrete lining inside and cement mortar coating with pre-tensioned wire on the outside) or ready manufactured RCC pipes (of M-25 grade) with steel liner of minimum 3mm thickness for water- tightness like "BONNA PIPES".

For C.W. pipe liner, specifications given elsewhere in these specification shall be followed. Top of C.W. ducts shall be minimum 1.5 m below grade/formation level.

Sand filling shall be provided as back fill, minimum upto the centre of the pipe in case of steel hume pipe. For the remaining height, for steel hume pipes and for full height for RCC Bonna pipes and steel lined concrete encased ducts, selected non expansive material having permissible concentrations of sulphates and chlorides as approved by Employer shall be used for back filling and same shall be arranged by the Bidder. Excavated earth can also be used for backfilling, if the same is non-expansive and having permissible concentrations of sulphates and chlorides and approved by the Owner.

For steel pipes encased in concrete, concrete encasement to steel pipe shall be with M20 grade concrete conforming to IS:456 and shall be minimum 300 mm thick all round for pipes upto 2100 mm diameter and 500 mm all around for pipes having diameter more than 2100mm. The minimum thickness of steel pipes shall be as follows including corrosion tolerance of 2 mm:

- a) For pipes upto and including 2200 mm dia -12 mm

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b) For pipes above 2200 mm upto and including -14 mm 3200 mm dia

a) For pipes greater than 3200 -16 mm

Required number of stub connections shall be provided to fix air release valves. Flow measurement devices as required shall also be provided. As required ducts shall be tested for leak proof upto a pressure upto 1.5 times the normal operating pressure. Pressure tests shall be conducted in segments after laying.

Steel hume-pipe shall have minimum 25mm thick internal spun concrete lining of M-25 grade with 10 mm nominal size aggregates and 40 mm thick out side cement mortar (1:3) brush coating with pre-tensioned wire.

All additional measures as necessary for protection against corrosion of C.W. pipes and to take care of any adverse soil characteristics shall be provided by the Bidder.

The C.W. ducts shall be tested for leak proof by hydraulic testing. Each piece of pipe shall be hydraulically tested in shop for water tightness. Each field joint shall be tested against leakage by applying hydraulic pressure locally at the field joint or by testing the complete length of pipeline. Hydraulic pressure for all testing shall be 2 times the working pressure of C.W. pumps or 1.5 times the design pressure of C.W. pumps, whichever is higher. The testing pressure shall be held for minimum period of 30 minutes without any signs of leakage or failure of weld.

Any defect observed during testing shall be rectified and if instructed by Employer, defective pipes shall be replaced by new pipes and the system shall be retested. Necessary valve pits, thrust blocks and anchor blocks shall be provided.

For inlet/outlet structures suitable stop logs alongwith lifting bean and electrically operated hoisting arrangement shall be provided.

All mild steel parts used in the water retaining structures shall be epoxy painted.

Stop logs and Trash Racks

All stop logs and trash racks shall be of structural steel, which shall be hot double dip galvanised. The leakage, if any, through the rubber seal shall be measured and it should not be more than 5 lit./min./meter length of seal under maximum load.

The stop log units shall be operated under balanced head and they shall be designed for maximum water head to which they shall be subjected to. The stop log shall be used only for the maintenance/ inspection of pumps. These are not to be designed for lowering under flowing water. The stop log shall be operated by means of a monorail trolley with electric rope hoist and a lifting beam which shall engage and disengage

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automatically with stop log in required position. Lifting beams shall be designed and fabricated by the Bidder in coordination with the manufacturer of monorail with electric hoist. The structural design of stop log shall conform to IS:5620.

Trash racks shall be installed in inclined position. Trash racks shall be designed for a differential head of 1m of water column. Each unit of trash rack shall consist of vertical flats and horizontal flats of minimum 10 mm thickness from durability point of view. The grating shall be pressure locked. Size of the openings for the trash racks shall be 100 mm x 100 mm(clear). All trash racks should be capable of being lowered in the associated stop log grooves to enable drawal of clean water while a particular trash rack is raised for cleaning purposes. Details of block -outs to be provided in structural concrete for stop logs and trash racks shall also be shown on the drawings.

All the design computations and drawings for the structural and mechanical parts including hoist supporting structure and connections of various components for stop logs and trash racks shall be submitted by the Bidder for approval of the Employer before the manufacture is taken up. Detailed drawings of mechanical parts such as wheels, wheel parts, hoists and various component parts of the hoists shall also be supplied along with calculations.

Bidder shall prepare all necessary shop drawings for the fabrication of stop log/ trash rack and shall be responsible for the correct fitting of all parts. Any fabrication done before the shop drawings are approved will be at the Bidder's risk. The Employer shall have the right to instruct the Bidder to make any change in the Bidder's fabrication details, which may be necessary in the opinion of the Employer to make the finished construction conforming to the requirements and intent of these specifications without additional charges to the Employer. Fabrication shall conform to the requirements of the relevant Indian Standards.

Approval of the Bidder's drawings by the Employer, shall not relieve the Bidder of any part of the Bidder's responsibility to meet the requirement of these specifications, or of the responsibility for the correctness of the drawings. The Bidder shall furnish the Employer for record purposes three complete sets of the final shop drawings from which the stop logs/ trash racks etc. have actually been fabricated. Dimensions, tolerances, types and grades of materials and various component parts shall be shown in sufficient detail to enable the Employer to make a complete review and thoroughly check the drawings.

All components of stop logs and trash racks covered under this specification shall be subjected to inspection tests by Employer during manufacture at works. Shop tests shall include all tests to be carried out at Bidder's works, works of his sub-Vedner and at works where raw materials are supplied for manufacture. The tests to be carried out shall include but not be limited to the tests described herein.

Bidder shall conduct all tests according to relevant I.S. or according to relevant British/ American Code of Practice in the absence of suitable I.S. Code to ensure that

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all the components and accessories of stop logs, trash racks, bulk heads, hoists etc. to be supplied as per the contract conform to the requirements of this specification. The accessories, e.g. bearings, couplings, etc. will be subjected to tests as per Manufacturer's Standard. The applicable test reports/ certificates shall be submitted to Employer.

Tests on motors shall be conducted as per latest revision of IS: 325 and IS:4029. Tolerance in dimensions shall be within the limits as prescribed in the relevant I.S. Codes and Standards. Surface defects shall be removed as required by the relevant Standards. All local repair, grinding or machining shall be smoothly blended into the surrounding surface.

Complete stop logs, trash racks including exposed surfaces of hoists, gear housing, shafting bearing pedestals, base plates and other machinery shall be fully galvanised.

After the equipment has been installed in the field it will be operated and tested by the Employer and when so operated and tested it shall meet all the requirements of specifications and drawings. The gates shall be raised and lowered several times for their full lengths of travel. The primary requirement for acceptance shall be that each stop log operates smoothly and guarantees satisfactory water tightness. Any equipment required for inspection and testing shall be provided by the Bidder and no such equipment shall be supplied by the Employer. All defects detected during testing shall be repaired to the satisfaction of the Employer after completion of all installations, the frames and guides etc. shall be thoroughly cleaned of dirt, dust, rust and concrete spalls or other foreign materials.

The stop logs shall be thoroughly cleaned with particular attention being paid to bearing and seating surfaces. The mechanical hoist equipment shall be properly lubricated. Each set of stop logs, Bulkheads and Trash Rack shall be tested under dry conditions and under full water load conditions, by traversing the item concerned from its extreme raised position to full seating position and return at least thrice.

Upon successful completion of such tests, final acceptance shall be made by the Employer. But before a completion is issued by Employer, the Bidder shall have to remove from the area of operation, on which the work has been executed, all scaffoldings, surplus materials, rubbish and other materials. If the Bidder fails to comply with this requirement, the Engineer shall get it done by other agencies at Bidder's Cost.

The Bidder shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in the Indian Standard Safety Code for erection of structural steel work IS:7205. Local Statutory labour safety regulations are also applicable.

The Bidder shall furnish to the Employer a complete and unused set of all special tools and tackles, which are necessary, or convenient for erection, commissioning,

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maintenance and overhauling of any of the equipment provided under the specification. The tools shall be shipped or transported in separate containers clearly marked with the name of equipment for which they are intended.

Leakage tests shall be carried out with the stop logs lowered onto the sill. Before that observation for leakage, the stop logs shall be raised and lowered about one meter several times in order to dislodge any debris that might have lodged in the side and bottom seals.

Materials for the various components of Stop logs: -----
-----S.No. Component
Parts Recommended Reference materials -----

01 Stoplog/Gate Leaf, Structural Steel IS:2062 Stoplogs/Gate frames and embedded parts, Guide Shoe.

02 Wheels (the hardness Cast steel IS:1030 of wheel track surface shall be kept 50 points higher than that of wheel tread), Guide.

03 Wheel axles, wheel Corrosion IS:1570 track Resistant steel

04 Seals Rubber IS:5620 Appendix-D 05 Bearings SKF or equivalent 04 Cr 19 Ni

06 Seal seats, Stainless Steel IS:1570 Lifting pin

Materials for Trash Rack shall be of IS 2062.

SEWERAGE SYSTEM

Cement concrete pipes of class NP-3 as per IS:458 shall be used below ground level for sewage disposal in all areas other than main plant area. However, for pressure pipes and in main plant areas, spun C.I. pipes conforming to IS:1536 of required class shall be used.

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RCC manholes with CI cover shall be provided at every 30m along the length, at connection points, and at every change of alignment, gradient or diameter of a sewer pipeline. This shall be as per IS:4111.

Sewage pump house shall be provided as per IS:4111.

Sewage treatment plant is to be provided by the Bidder. Bidder shall have to provide complete arrangement for sewage disposal up to the Sewage treatment plant including pumping facilities. Extended Aeration method of sewage treatment shall be used.

SWITCHYARD CIVIL WORKS

Civil works are related to the following:

- (a) Towers, lightning masts, beams, columns, equipment supporting structure etc.,
- (b) Foundations for towers, lightning masts, buildings, transformers, shunt reactor, equipment support, etc.
- (c) Cable trench with covers, fencing with gate, fire protection walls, earthing mat, etc.,
- (d) Roads and drains in switchyard area.
- (e) Entire area of the switchyard shall be provided with 150 mm thick gravel filling which shall consist of 75 mm thick stone metal filling of 40 mm stone aggregate on the top and 75 mm thick filling of 20 mm stone aggregate below. Each layer shall be compacted by using 1/2 tonne roller with 4-5 passes and suitable water sprinkling. Before laying the gravel fill, the top layer of the soil shall be treated for anti-weed considering the types of weeds found in the vicinity. The anti-weed/soil sterilization chemical shall be procured from reputed manufacturer. The contractor shall submit necessary details pertaining to the types of weeds found in the vicinity, anti-weed/soil sterilization such as manufacturer's name, their specification, test certificate, etc., for Employer's approval. Any modification, if required in the proposed anti-weed treatment chemicals, shall have to be done by the contractor at no extra cost to the Employer. The contractor shall be required to furnish a performance guarantee of three years for the anti-weed treatment. This guarantee shall commence from the date of completion of work or date of handing over, whichever is later.
- (f) Oil soak pits, oil separation pits, oil drains to the oil separation pits.

All structural steel members including stub members, bolts, nuts, spring washers, etc., shall be hot dip galvanised after fabrication. Weight for zinc coating shall be atleast 610 g/sq.m.

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Structural arrangement, foundation system, miscellaneous requirements, finishes, etc., shall be as specified elsewhere in this specifications.

Lightning masts shall be provided with minimum two number of platforms, (with one at top level) and an internal ladder for climbing purpose upto platform at top level. Top of platform shall have grating, railing and toe guard plates.

PLANT STORM WATER DRAINAGE SYSTEM

All plant effluent drainage shall be through buried concrete pipes unless otherwise specifically required and all storm water drainage shall generally be through open drains.

Open storm water drains shall be provided on both sides of the roads and shall be designed to drain the road surface as well as all the free and covered areas, etc.,

Open RCC rectangular section shall be provided for all drains. RCC drains located within and along both sides of peripheral roads of the main plant area, shall be covered with perforated precast RCC slabs of minimum 50 mm thickness with provision of openable galvanised steel grating covers at about 4.0M intervals. Similarly

all artery drains and the drains along the periphery of building shall also have perforated precast RCC covers of minimum 50 mm thickness with provision of openable galvanised steel grating covers at about 4.0 m intervals. In areas where vehicular loads would be coming, precast RCC covers of suitable thickness without perforations and designed for the vehicular loading shall be provided. The thickness of side walls and bottom slab of RCC drains shall be minimum 200 mm or as per design considerations whichever is higher. RCC box/pre cast R.C.C pipe culverts shall be provided for road and rail crossing. All drains in the Main Plant area shall be provided with heavy duty hot-dipped galvanised steel grating.

All drains inside the building shall have minimum 40 mm galvanized thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating.

Invert of the drains shall be decided in such a way that the water can easily be discharged to the natural water bodies above the high flood level.

For pipe drains, concrete pipes of class NP3 (Minimum) shall be used. For road and rail crossings concrete pipes of class NP3 and NP4 respectively shall be used. The pipes shall be laid as per IS:783. In this case open catch water drain shall be provided on the other side of road and connected to pipe drain through RCC manholes. RCC

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manholes shall be provided at every 30m interval along the length, at connection points and at every change of alignment, gradient and diameter of pipeline.

The invert of the in-plant and plant peripheral drains shall be kept such that water can be discharged by gravity to the main/ trunk drains under all conditions.

ROADS

A detailed CBR test shall be carried out as per the procedure outlined in IS:2720 (Part 16). Shoulders with 150mm thick WBM with 75 mm-thick PCC interlocking blocks shall be provided on either side of the roads.

Unless otherwise specified, all roads including access road to buildings/facilities (other than patrol road) shall be double lane roads with 7.0 m wide black topping and 2.5 m wide shoulders on either side of the road. Patrol roads shall be single lane with 3.75 m wide black topping and 1.0 m wide shoulder on either side. The base and sub-base of the road shall be of water Bound Macadam.

All roads shall be provided with edge protection on both edges of black topping using pre-cast concrete blocks of M-25 grade.

All roads for the complete plant areas shall be provided by Bidder. Cutting/ extending/ re-routing/ remaking of existing roads including associated works to maintain continuity of road system shall also be carried out by the Bidder. In addition, access roads to all buildings and facilities (road approaches/ connections) and other equipment areas (where access is necessary from inspection, operation & maintenance point of view) shall also be provided by Bidder.

Finished top (crest) of roads shall be 250mm above the surrounding grade level.

Road construction including bitumen macadam, water bound macadam base and sub-base shall be as per IRC standards. Minimum total thickness of black topping (premix carpeting) shall be 50 mm in 2 layers of 25 mm each followed by seal coat (Type B). First layer shall be provided during construction and second layer after the commissioning of the plant. Seal coat shall be provided over the second layer. For premix carpet, recommendation of IRC-14 shall generally be followed. Spreading of black topping work shall be carried out using paver.

All culverts and RCC bridges at crossing of all roads / facilities (included in the scope of Bidder) with nallahs / channels / drains / roads / pipes / other facilities etc. RCC culvert cum road-bridge shall be provided by the Bidder.

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INDUCED DRAUGHT COOLING TOWER

Cooling Tower Basin, Sumps and Duct

The basin underneath the cooling tower for collection of cold water shall be made of RCC of grade M-25. The inside walls of cold water basin sumps, outlet channel and desludging sumps and other similar structure shall be applied with extended two component coating system or its equivalent as specified in Tables -D. The floor of the basin shall be sloped to minimum 1V:120H towards drain sumps which will be connected through CI pipe to sludge sump. For drainage arrangement of basin reference shall be made to mechanical technical specification. One outlet channel shall be constructed from the outer faces of the basin and connected to the C.W. system. The stoplogy gate shall be tested for water tightness as stated elsewhere in the specification.

Lifting arrangement for the gate/stoplog gate shall be provided with necessary civil and structural works. The outlet channel shall be covered on top with removable precast concrete slabs with G.I. handrail on both sides for access to gate lifting arrangement.

Foundation

Cooling tower including basin shall be provided with suitable foundation system at a depth minimum 1.5m or as required below finished ground level. No deviation shall be checked for uplift forces considering empty of the basin with ground water table at finished ground level. A minimum factor of safety of 1.20 against uplift shall be ensured for the following conditions:

- i) Basin walls constructed upto finished ground level and there is no water in the basin and super structure columns not constructed and ground water table at finished ground level.
- ii) No pressure relief valves shall be provided in the cold water basin. The water tightness of the basin shall be ensured to prevent mixing of ground water with sweet water of C.W. system.

Super structure

Cooling tower support structures like columns, beams and slabs etc. shall be of reinforced cement concrete of grade M-25 as per IS: 456.

The fan deck slab shall be properly sloped so that rainwater does not accumulate over the deck slab. The slope shall be 1V:120H (min). The slope may be provided with

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screed concrete (1:2:4) also. Deck slab and all other over ground platforms shall be provided with 32 mm dia G.I. hand rails (vertical post as well as horizontal pipes) and with the guard around.

Cells and distribution systems

Cooling tower cells shall consist of RCC columns and beams. Hot water distribution channel shall also be made of R.C.C. Only cell division partition walls may be of precast concrete blocks. The grade of concrete shall be M-25 for all the above structures.

Hot water channel shall be suitably covered with pre-cast/cast-in-situ concrete slab. Whenever flow control valves are located over hot water basin these shall be placed over suitably designed pre-cast concrete covers. The thickness of RCC fan stack shall be minimum 125 mm with reinforcement in both the faces of the concrete.

Two nos. stairs, one each at gable end shall be provided.

All stairs shall be RCC of grade M-25, with G.I. hand railing.

Steel structures such as stoplogs, chequered plate/grating floors, ladders, etc. shall be hot dip-galvanised as per IS:4759 with minimum value of average mass of coating 750 gm/sq.m. All inserts, embeddings, bolts nuts, etc. shall also be hot dip galvanised as per IS:4759, 4826 and 5358.

Formwork for underground work shall be of ordinary quality. For super structures plywood form work shall be provided.

Single sheet steel hinged door of 1.2 mm (18G) mild steel, heavy hot dipped galvanised shall be provided in each fan stack at fan deck level. Minimum door size shall be 2100 mm high (clear) and 1200 mm wide (clear). The galvanisation shall not be less than 750 gm/sq.m on each side as per IS:4759.

External surface of cooling tower shall be painted with three coats of water proof cement paint of approved colour applied over a coat of primer.

Stability

Computation shall be provided to verify the stability of cooling tower structures at different levels of construction to ensure that a satisfactory margin of safety always exist during construction.

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Fan Stack

The RCC fan stack shall be made of RCC M-25 grade with minimum 125 mm. thickness. Design of the fan stack shall be made on the basis of relevant stipulations.

Design Cosiderations

a) R.C.C. Structures

Design of R.C.C. structures of cooling tower which are not in contact with water/water sprary/moist air shall be carried out generally as per IS:456, Code of practice for plain and reinforced concrete for general building construction. The basis for design of all RCC structures shall be as per working stress method of design as outlined in IS:456. However, all other structures in contact with water/water spray/moist air, excluding C.W. basin shall be designed as per working stress method based on IS:456 for concrete but the stresses in reinformcement steel shall be limited to the values as given in IS:3370.

b) Pre-stressed Concrete

Design, contruction and workmanship of pre-stressed members shall be in accordance with IS:1343. Steel wires of pre-stressing shall conform to IS:1785. Particular attention shall be paid to achieve effective bonds of wires in pre-tensioned concrete units. For this purpose identical wires shall be used.

c) Fill Support structures

Fill support structures shall be of RCC M25 grade concrete. The loads of the design fill support structure shall include weight of falling water and weight of minimum 5 mm thick sludge deposit/moss.

d) Grade of Concrete

Grade of concrete to be used in all concrete elements, structures, including supporting blocks, partition walls etc. shall be design mix

Concrete (controlled concrete) of grade M-25. Grade of concrete in precast concrete members shall be M-25. Lean concrete to be placed below grade slab or below foundations shall be proportion 1:3:6 with a minimum thickness of 100mm.

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MISCELLANEOUS REQUIREMENTS

Joints in Concrete Structures

Construction Joints

Construction joints for basement type under ground structures and all liquid retaining/carrying structures shall be made watertight by chemical injection grouting or by providing PVC water stops. The PVC water stop shall meet the requirements of IS:12200 and shall have a minimum thickness and widths of 6 mm and 230 mm respectively. In either of the cases, a suitable shear key joint shall be provided. Two - Part polysulphide sealant conforming to IS:12118 or silicon sealing compound conforming to BS shall be used for sealing of joints for liquid retaining/carrying structures. Preformed bitumen impregnated fibre board conforming to IS : 1838 shall be used as joint filler. The bitumen sealing compound shall be as per IS:1834.

Expansions Joints

In case of expansion joints, preformed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler. The joints shall be sealed with bitumen sealing compound conforming to IS: 1834, however in case of liquid retaining/carrying structures, two parts polysulphide sealant conforming to IS:12118 or silicon sealing compound shall be used in case of all liquid retaining/ carrying structures.

IS:3414 shall be followed for details of joints in buildings. 3 mm thick stainless steel strip in matt or buff finish shall be provided over building expansion joints.

All steel sections and fabricated structures, which are required to be transported on sea, shall be provided with anti corrosive paint before shipment to take care of sea worthiness.

A screed or concrete layer not less than 100 mm thick and of grade not weaker than M 10 conforming to IS: 456 shall be provided below all water retaining structures. A sliding layer of bitumen paper or kraft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structure. Minimum 75mm thick lean concrete M-7.5 shall be provided below all other underground structures, foundations, trenches, etc., to provide a base for construction.

Monorails, monorail girders and fixtures shall be provided, wherever required to facilitate erection / maintenance of equipment.

a) Wherever possible all floor openings shall be provided with 100 mm thick 50 mm high RCC kerb all around.

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b) Angles 50 x 50 x 6 mm (minimum) with lugs shall be provided for edge protection all around cut outs/openings in floor slabs, edges of concrete drains supporting grating/covers, edges of RCC cable / pipe trenches supporting covers/chequered plates/ grating, edges of manholes supporting covers, supporting edges of precast RCC covers and any other place where breakage of corners of concrete is expected.

Floor of switchgear room shall be provided with embedded M.S. channel suitable for easy movement of breaker panels.

Anti termite chemical treatment shall be given to all vulnerable areas susceptible to termite including column pits, wall trenches, foundations of buildings, filling below the floors, etc., as per IS: 6313 and other relevant Indian Standards.

Trenches shall project at least 200 mm above the finished formation level so that no storm water shall enter into the trench. The bottom of the trench shall be provided with a longitudinal slope of 1:500. The downstream end of cable trenches shall be connected through pipe drains to the nearby RCC manholes (to convey water from trenches) of storm water drainage system, but avoiding back flow of storm water. The precast covers shall not be more than 300 mm in width and shall not weigh more than 65 kg. Lifting hooks shall be provided in the precast covers. The trenches shall be given a slope of 1 in 250 in the direction perpendicular to the run of the trenches. PVC water stops shall be provided at all expansion joints of all trenches.

All steel platforms above grade shall be provided with kick plates at edge of platform.

Duct banks consisting of PVC conduits conforming to IS:4998 for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.

Independent network of lines for sewerage and drainage shall be provided.

The sub-grade for the roads and embankment filling shall be compacted to minimum 95% of the Standard Proctor density at Optimum moisture content (OMC.)

Detailed scheme for dewatering shall be prepared, wherever required, before starting of deep excavation work. IS: 9758 shall be followed as general guidance for dewatering.

All buildings shall be provided with peripheral drains by the side of plinth protection for catering the storm water from roofs and adjacent area.

The under side level of base plates for structural steel columns shall be decided in such away that bolts, gussets, etc., do not project above the floor level. These shall be encased by concrete cover upto floor level.

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Non-shrink flowable grout shall be used for under-pinning work below base plate of columns. Nominal thickness of grout shall be 50 mm. Non-shrink cum plasticizer admixture shall be added in the grout. Crushing strength of the grout shall generally be one grade higher than that of the base concrete. However, for equipment foundations, high strength (minimum characteristic compressive strength of 60 N/mm² at 28 days) ready mixed non-shrink, chloride free, cement based, free flowing, non-metallic grout as recommended by equipment manufacturer shall be used.

Fencing for transformer yard area shall be of the same type as specified, elsewhere in this specification.

Plant effluent shall not be mixed with either storm water or sewage.

Concrete

General

- a) Concrete work shall be carried out as per IS:456. Mix design concrete shall be used for all areas other than lean concrete work and plain cement concrete where nominal/volume mix can be permitted. Design mix shall be carried out as per IS:10262. Specific approval of the Engineer shall be obtained regarding degree of quality control to be adopted for design mix.
- b) Grade of concrete for all foundations including piling shall be M25 unless noted otherwise. Grade of concrete for other structures/ areas (other than of machine foundations) shall be M25.
- c) The minimum Grade of concrete for foundation of gas turbine (GT) and steam turbine (TG) shall be M35.
- d) Higher grade of concrete than specified above may be used at the discretion of the Employer.
- e) Unless otherwise specified, 20mm and down aggregates shall be used for all structural concrete works.
- f) All underground concrete structures like trenches, substructures of pump houses, all water retaining/ carrying structures, etc., shall have super-plasticizer cum water proofing cement additive conforming to IS:9103. In addition, limit on permeability as given in IS:2645 shall also be met with. Special requirements for concreting of major equipment foundations shall be as given below.

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a) Coarse Aggregates

Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases, high percentage of reactive silica content, aggregate may be allowed where low alkali content cement shall be used. Lime stone aggregate shall not generally be used for foundations which are subjected to high temperature and repeated temperature cycles (like in the case of all machine foundations). However, in case other types of suitable aggregate is not available, the Employer may allow the use of lime stone aggregate provided the Bidder gets the sample tested from a reputed testing laboratory for satisfactory performance under high temperature and repeated temperature cycle. Unless otherwise specifically approved by the Employer, the tests shall be carried out for a temperature range from 10 °C to 65 °C and for 60 (sixty) temperature cycles.

b) Temperature Control of Concrete The temperature of fresh concrete shall not exceed 25 °C when placed. For maintaining the temperature of 25 °C in the top decks of machine foundations, crushed ice shall be used in mixing water.

c) Admixture Plasticizer /super plasticizer admixture shall generally be added to the concrete for promoting workability. In addition, plasticizer/super plasticizer-cum-ratarder shall be added to retard the setting time for mass concreting work as required. In case of pumping, suitable pumping additive shall also be added to avoid segregation and increase flowability. The slump shall generally be in the range given below:

Top decks of TG, -150 mm to 200 mm Block foundation -100 mm to 150 mm
Column -100 mm to 150 mm

d)Form work

Plywood with film face form work shall be used for the top decks of all machine foundations and also for columns of STG and GT foundations.

f) Placing of Concrete

Base Raft and top deck of machine foundations shall be cast in a single pour.

g) Ultrasonic Testing

Ultrasonic pulse velocity test shall be carried out for the top decks of all machine foundations and TG substructure to ascertain the homogeneity and integrity of concrete. In addition, additional cubes (at the rate of one cube per 150 cu.m. of concrete subject to a minimum of six cubes) shall be taken to carry out Ultrasonic Pulse velocity (UPV) testing on the cubes, to serve as reference UPV values. Testing

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shall be done as per IS:13311 (Part-1). In case of any defect, the Bidder shall rectify the defects suitably using cement/epoxy grout, etc.,

h) Scheme for Concreting

Weigh Batching Plants, transit mixer, concrete pump shall be mobilised. Arrangements for standby Plant and Equipment shall also be made.

Formwork

Plywood with film face formwork shall be used for all structures and concrete works.

Fencing and Gate

Fencing

The fencing, with gate (unless specified otherwise) shall comprise of PVC coated G.I. welded wire mesh fencing of minimum 4 mm diameter (including PVC coating) of mesh size 75mmX75mm of height 2.4m above the toe wall with a 600mm high galvanised concertina at the top, such that total fence height of 3.0m above the toe wall is achieved. The diameter of the steel wire for chain link fence (excluding PVC coating) shall not be less than 2.5 mm.

The PVC coated chain link will be stretched by the clips at 0.5m intervals to three strands of galvanised high tensile spring steel wire (HTSSW) of 2.5 mm diameter interwoven with chain link wire mesh and kept under tension which in turn are attached to the fence post with security nuts and bolts. On every fourth post a clamping strip will be threaded through the links of chain link and bolted to the fence post with the help of security nuts and bolts.

Above the chain link a 600mm high tensile serrated galvanised wire (HTSW) concertina made with wire diameter of 2.5mm will be stretched to 6m and attached to two strands of galvanised HTSSW of 2.5 mm diameter by means of clips at 1m intervals. These two HTSSW strands will be attached to the fence posts with 12 mm security fasteners.

All nuts, bolts, fasteners, clamping strips, clamps, clips, etc., shall be galvanised.

All fence posts shall be of 75 x 75 x 6 MS angles spaced at 2.5m c/c distance. All corner posts will have two stay posts and every tenth post will have transverse stay post. Suitable R.C.C. foundations for the post and stays shall be provided based on the prevailing soil conditions. Galvanizing (PPCL).

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Toe walls either of brick masonry with bricks of minimum 75 kg./sq.cm. crushing strength or of hollow concrete block masonry shall be provided between the fence posts all along the run of the fence with suitable foundation. Toe wall shall be minimum 200mm above the formation level with 50mm thick P.C.C. coping (1:2:4) and shall extend minimum 300mm below the formation level. Toe wall shall be plastered with cement sand mortar (1:6) on both sides and shall be painted with two coats of textured cement paint (Sandtax Matt or equivalent) of approved colour and shade. Toe wall shall be provided with weep holes at appropriate spacings.

Gate

All gates shall be of structural steel of minimum 3.75 metres clear width for single lane access road and 7.75 m clear width for double lane access roads. The height of gate shall be same as that of the fence. Each gate shall have provision for wicket gate of size 1.0 m x 2.1 m.

The gate frame and post shall be fabricated from medium class MS pipe of nominal diameter not less than 75 mm. The panel plate shall be of minimum thickness 2.5 mm conforming to IS:513.

The gate shall be complete with fabricated hinges, MS aldrops with locking arrangement, tempered steel pivot, guide track of MS tee, bronze aluminium ball bearing arrangement, castor wheel, etc.

Grating

All gratings shall be electroforged types. Thickness of the grating shall be minimum 40 mm. The opening size shall not be more than 30mmx100mm. The minimum thickness of the main bearing bar shall be 5 mm. Cutting of gratings shall not be carried at site. Any cutting of gratings required to provide passage for columns/pipes/cables/ducts, etc. shall be done by the bidder in shop and cut edges of grating shall be suitably reinforced with binding strips. All gratings shall be blast cleared to Sa 2½ finish and shall be hot dip galvanised at the rate of 610 gm/sq.m.

Minimum 1000mm high handrailing shall be provided around all openings, projections, balconies, walkways, platform, steel stairs, etc. All handrails and ladder pipes shall be 40mm nominal bore MS pipes (medium class).

Hand rails shall have top and middle rails and the vertical post spacing shall not exceed 1.5m with provision of kick plates (100 mm high and 6mm thick).

Hand rails and ladders shall be painted or galvanised as per architectural requirements. The galvanisation shall be at the rate of 610 gm/sq.m. as per IS:4736. Paints shall be as specified for structural steel work.

Fabrication

The fabrication shall be done as per fabrication drawing which would clearly indicate

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various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld.

All galvanizing of structural steel works are to be hot-dipped.

Welding

a. The works shall be done as per approved fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld.

b. Welding of structural steel shall be done by an electric arc process, submerged arc welding / MIG welding / manual metal arc welding. Welding shall conform generally to relevant acceptable standards viz. IS: 816, IS: 9595, IS: 814, IS: 1024, IS: 4354 and Indian Standard hand book for metal arc welding, and other standards, codes of practice internationally accepted. For welding of any particular type of joint, contractor shall give evidence acceptable to the owner of having satisfactorily completed appropriate tests as described in any of the Indian Standards - IS: 817, IS: 7307 and international standard as relevant.

c) process employing semi-automatic welding machine and / or MIG welding and / or fully automatic welding machine shall be used for welding longitudinal fillet welds (connecting flange with web) and butt joints for fabrication of columns, framing beams and crane girders, unless manual arc welding is specifically approved by the engineer. Necessary jigs and fixtures and rotation of structural shall be so arranged that vertically down-hand position of welding becomes possible. 'open-arc-welding' process employing coated electrodes shall be employed for fabrication of other welded connections and field welding.

d. Wherever welding is done for assembling the components of structural, the job shall be so positioned that down-hand welding is possible.

e. Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions required in such a joint.

f. The contractor shall maintain records of all the welders identification marks, the joints welded by each welder, the welding procedure adopted, welding machine employed, pre and post heating done and any non destructive test done and stress relieving / heat treatment performed on such joints. All such records for entire welding operation shall be accessible to the engineer for scrutiny.

g. In fabrication of plated columns / beams and built-up members all shop splices in each component part shall be made before such component part is welded to other parts of the member. Wherever weld reinforcement interferes with proper fitting

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between components to be assembled for welding, these welds shall be ground flush prior to assembly.

h. The members to be joined by fillet welding shall be brought and held as close

together as possible and in no event shall be separated by more than 3mm. If the separation is 1.5mm or greater, the fillet weld size shall be increased by the amount of separation.

i. The bins / silos shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular intervals. Stiffeners shall be welded on the external face.

Electrodes

a. The electrodes used for welding shall be of suitable type and size depending upon specifications of the parent material, the method of welding, the position of welding and quality of welds desired. Only low hydrogen electrodes shall be used for welding of medium / high tensile steel and for mild steel plate thickness above 20 mm.

b. All low hydrogen electrodes shall be baked and stored before use as per manufacturer's recommendation. The electrodes shall be re-baked at 250 deg.C - 300 deg.C for one hour and later on cooled in the same oven to 100 deg.C. It shall be transferred to a holding oven maintained at 60 deg.C - 70 deg.C. The electrodes shall be drawn from this oven for use.

c. Where coated electrodes are used they shall meet the requirements of IS: 814 and relevant ASME - Sec. II. Covering shall be heavy to withstand normal conditions of handling and storage.

d. Only those electrodes that give radiographic quality welds shall be used for welds, which are subjected to radiographic testing.

e. Where bare electrodes are used these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of F-60 class of AWSA-5-17-69 and IS: 3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the manufacturer's requirements as stipulated.

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f. The contractor shall take specific approval of the weld for the various electrodes proposed to be used on the works before any welding is started.

Edge Preparation for Welding

- a. Suitable edge as per weld joint detail shall be prepared either by machines or by automatic gas cutting. All edges cut by flame shall be ground before they are welded.

Pre Heating and Post Heating

a. Mild steel and medium / high tensile steel plates thicker than 20mm, will require Pre-Heating of the parent plate prior to welding as mentioned in Table - 1 for mild steel and Table - 2 for medium / high tensile steel, however, higher pre heat temperature may be required as per approved welding procedure and it shall be followed. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

b. Base metal shall be preheated, notwithstanding provisions of IS: 9595 to the temperature given in Table - 1 for mild steel and Table - 2 for medium / high tensile steel, prior to welding or tack welding. When base metal not otherwise required to be pre heated is at a temperature below 0°C it shall be pre heated to atleast 20°C., prior to tack welding or welding. Pre heating shall bring the surface of the base metal to the specified pre heat temperature and this temperature shall be maintained as minimum inter-pass temperature while welding is in progress.

TABLE - 1

MINIMUM PREHEAT AND INTERPASS

TEMPERATURE FOR WELDING MILD STEEL

----- -----	----- -----	
		Welding Using
-----	-----	----- -----
Thickness of thicker part at Point of welding	Low hydrogen electrode or submerged arc welding	Other than low hydrogen electrode
----- -----	----- -----	----- -----

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Upto and including 20mm	None	None
Over 20mm and up to and including 40mm	20°C	Not allowed
Over 40mm and up to and including 63mm	66°C	Not allowed
Over 63mm	110°C	Not allowed

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Note: Type of electrode and the preheating requirements for welding shall be as per approved welding procedure.

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TABLE - 2

MINIMUM PREHEAT AND INTERPASS TEMPERATURE

FOR WELDING MEDIUM / HIGH TENSILE STEEL

Welding Using

Thickness of thicker part at	Low hydrogen	Other
Point of welding	electrode or submerged arc welding	than low hydrogen electrode
----- -----	----- -----	----- -----
Upto and including 20mm	None	Not Allowed
Over 20mm	120oC - 140°C	Not Allowed

Note : Type of electrode and the preheating requirements for welding of medium and high tensile steel shall be as per approved welding procedure.

c. Pre heating may be applied by external flame which is non-carbonizing like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending up to a distance of four times the thickness of the plate on either side of the welded joint is obtained.

d. Thermo-chalk, thermo-couple or other approved methods shall be used for measuring the plate temperature.

e. All butt welds with plates thicker than 50mm and all site butt welds of main framing beam supporting the bunker shall require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done up to 600oC and rate of application shall be 200oC per hour.

f. The post heat temperature shall be maintained for 60 minutes per 2.5cm thickness. For maintaining slow and uniform cooling, asbestos pads shall be used for covering the heated areas.

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Welding Sequence

- a. The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion.
- b. The direction of welding should be away from the point of restraint and towards the point of maximum freedom.
- c. Each case shall be carefully studied before finally following a particular sequence of welding.
- d. Butt weld in flange plates and / or web plates shall be completed before the flanges and webs are welded together.
- e. The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges of the beam or column are assembled by automatic welding process.
- f. All welds shall be finished full and made with correct number of runs. The welds being kept free from slag and other inclusions. All adhering slag being removed from exposed faces immediately after such run.
- g. Current shall be appropriate for the type of electrode used. To ensure complete fusion, the weaving procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.
- h. Puddling shall be sufficient to enable the gases to escape from the molten metal before it solidifies.
- i. Non-uniform heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.
- j. The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of run off and run on pieces adequately secured on either side of main plates. The width of these pieces shall not be less than the thickness of the thicker part joined. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approved means and the ends and surface of the welds shall be smoothly finished. Where the abutting parts are thinner than 20mm the extension pieces may be omitted but the end of the butt welds shall then be chipped or gouged out to sound metal and side welded to fill up the ends to the required reinforcement.

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k. The fusion faces shall be carefully aligned. Presetting shall control Angle shrinkage. Correct gap and alignment shall be maintained during the welding operation.

l. All main butt welds shall have complete penetration and back surface of the weld being gouged out clean before first run of the weld is given from the back. However, partial penetration butt weld shall be permitted, when specifically shown in the fabrication drawings.

m. Intermittent welds shall be permitted only when specifically approved in the fabrication drawings.

n. The welding shrinkage shall be minimised by adopting the correct welding procedure and method. In long and slender member extra length should be provided at the time of fabrication for shrinkage.

Testing Of Welders

a. On the basis of the welding procedure, the contractor shall conduct qualification test. All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS: 817 and IS: 1181 and ASME IX / AWS D1.1.

b. All necessary arrangements required for the testing of welders are to be provided by the contractor.

Erection of Structures

All erection work shall be done with the help of cranes, use of derrick is not envisaged.

Erection Marks

a) Erection marks in accordance with fabrication drawing shall be clearly painted on the fabricated steelwork. Each piece shall be marked in at least on two places. Each piece shall also have its weight marked thereon.

b) The centre lines of all columns, elevations and girder bearings shall be marked on the sections to ensure proper alignment and assembly of the pieces at site.

Erection Scheme

a) The Erection Scheme for the erection of all major structures shall be furnished. The erectability of the structure shall be checked by the Bidder before commencement of fabrication work to avoid future modification. The erection scheme shall indicate the approximate weight of the structural members, position of lifting hook, crane boom length, crane capacity at different boom length and at different boom inclination, etc.,

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Bidder shall take up the erection work only after he has obtained the approval of the erection scheme from the Engineer.

b) The erection scheme shall also give details of the method of handling, transport, hoisting, including false work/staging, temporary, bracing, guying, temporary strengthening, etc., It will also give the complete details of the number and capacity of the various erection equipment that will be used such as cranes, winches, etc., along with disposition at the time of erection of columns, trusses, etc.

b) The erection of columns, trusses, trestles, portals, etc., shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Galleries shall generally be erected as box i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection and if required temporary strengthening during erection shall be made. The inside sheeting runners and roof sheeting purlins may be erected individually. When erection joints are provided in columns, their location shall generally be just above a floor level.

Hard surface for vehical Parking

Hard surface of concrete paving shall be provided at gate complex for vehical parking.

Gate Complex and Guard room

A decorative frame structure shall be provided at plant main entrance gate. The gate structure shall be of steel/ RCC/ stone or brick masonry matching with the plant structures and surroundings as approved by Employer.

The main entrance gate shall be fabricated out of mild steel sections completed with synthetic enamel painting. The structural steel works for gates shall include supply, fabrication, transportation, erection of structural steel gates complete with fabricated hinges, M.S. alldrops, locking arrangements, tower bolts, GI pipe stub, tempered steel template, tempered steel pivots, guide track MS tee, castor wheel with bearing arrangements and placing in position embedded parts in concrete/brick work and in road surface including cutting, grinding, drilling of holes, welding and painting etc. complete. The mild steel gate shall be electrically operated. The gate will be double leaf sliding type, which can be operated from remote push buttons from the security control room.

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A security building of single story RCC construction having minimum floor area of 32 sq.m shall be provided at gate complex.

GENERAL ARCHITECTURAL SPECIFICATIONS

General

a) Minimum 1000 mm high (from floor/ roof level) hand railing shall be provided around all floor/roof openings, projections/balconies, walkways, platforms, steel stairs, etc., All handrails and ladder pipes (except at operating floors) shall be 50 mm nominal bore MS pipes (medium class) conforming to IS:1161 and shall be galvanized as per IS : 4736 treated with etch primer and finished with suitable paint.

All rungs and ladders shall also be galvanized. Minimum weight of galvanizing shall be 610 g/sqm. For RCC stairs and around all floor openings at operating floors, 1000 mm high hand railing with 32 NB (polished) stainless steel pipe shall be provided.

b) All stairs shall have a maximum riser height of 180 mm and a minimum tread width of 275 mm. Minimum clear width of stair shall be 1200 mm unless specified otherwise.

c) All buildings having metal cladding shall be provided with a 150 mm high RCC toe kerb at the edge of the floor along the metal cladding. 900 mm high hand railing shall be provided on this RCC kerb, wherever required from the safety point of view.

d) In all buildings, structures, suitable arrangement for draining out water collected from equipment blowdowns, leakages, floor washings, fire fighting, etc., shall be provided for each floor. All the drains shall be suitably covered with grating or precast RCC panels.

e) RCC staircase shall be provided for main entrance of Turbine building; control tower area and all other RCC construction buildings.

f) Parapet, Chajjas over window and door heads, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3.

a) All fire exits shall be painted with P.O red/signal red colour shade which shall not be used anywhere except to indicate emergency or safety measure. Fire safety norms shall be followed as per National Building Codes and fire safety requirements for providing fire exits, escape stairs and fire fighting equipment. In detailing of all buildings, fire safety requirements conforming to IS: 1641 and IS:1642 shall be followed.

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Water Supply and Sanitation

Two numbers of roof water tanks (one for storing service water and another for potable water) of adequate capacities depending on the number of users and 24 hours requirement shall be provided for each building and pump house. Polyethylene water storage tanks conforming to IS:12701 shall be used. The tanks shall be complete with all fittings including lid, float valve, stop cock, vent pipe, etc.

One number underground RCC tank with two compartment for drink water storage of adequate capacity (minimum 20cum.) shall be provided along with 2 number pumps (One working + One Standby) for filling overhead potable water tanks.

Galvanised MS pipe of medium class conforming to IS: 1239 shall be used for internal piping works for service water and potable water supply. The pipes shall be concealed, and painted with anti-corrosive bituminous paint (as per IS: 158) wherever required.

Sand Cast Iron pipes with lead joints conforming to IS: 1729 shall be used for sanitary works above ground level.

Minimum one number main toilet block each (for male and female) with required facilities shall be provided on each floor of Main plant building, and Service/office building. Attached toilets shall be provided for all senior executive rooms and conference rooms. All other buildings shall have minimum one toilet block each. The facilities provided in the toilet block shall depend on the number of users.

However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.

i) Each toilet block shall have the following minimum facilities. Unless specified, all the fittings shall be of chromium plated brass (fancy type).

a) WC (Indian type, Orissa pan (580 x 440mm) as per IS : 2556 with all fittings including photo-voltaic sensor operated flushing system of appropriate capacity and type.

b) Urinal with all fittings with photovoltaic control flushing system as per IS: 2556 .

c) Wash basin (oval shape) with photo-voltaic control fittings as per IS : 2556 to be fixed on concrete platform finished and under fixed with 20mm thick polished granite stone and float glass mirror (600 x 450 x 5.5mm) with bevelled edges.

d) 25 mm dia Stainless steel towel rail (600 x 20mm).

e) Stainless steel liquid soap holder cum dispenser with all fittings.

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f) Janitor space

g) Provision for installation of water cooler with recessed floor and stainless steel grating for draining of spillage water, including provision for potable water supply connection.

h) Electric operated hand dryer with photo voltaic control.

ii) Attached toilets provided for senior executive rooms shall have one no.

European WC, wash basin (oval shape) with all fittings as per IS : 2556 to be fixed on concrete platform finished and under fixed with 20mm thick polished granite stone and float glass mirror (600 x 450 x 5.5mm) with bevelled edges, 1 towel rail, 1 liquid soap holder cum dipensor with all fittings. WC shall be of western type 390 mm high as per IS:2556 (Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type. Unless specified all other fitting and fixtures in the toilet shall have same specifications as stipulated in above clause. with photo-voltaic sensor/controls.

iii) Ladies toilet shall be provided at all level of control cum facility building. It shall consist of 1WC (European type) and one counter top washbasin, with all fittings such as Mirror, towel rail, soap container, paper holder etc. as specified above.

iv) Pantry space of adequate size shall be provided at main control room level and in service building, with stainless steel sink and pre-polished granite counter

v) In addition to the facilities stipulated elsewhere, following facilities shall also be provided in toilet at ground and operating floor of main plant:

a) Bathroom with rotating type chromium plated shower including all fitting and fixtures.

b) Toilets in control room at main plant operating floor and all toilet blocks in service building shall be provided with wall to wall mirror of entire counter length (5.5 mm thick float glass, minimum height 900 mm) in place of 600x450x5.5 mm mirror above wash basin counter.

i) Stainless steel kitchen sink of size 610x510x200 mm as per IS: 13983 shall be provided in pantry. Platform in pantry shall be finished with 20 mm thick pre-polished granite stone of approved shade and colour.

ii) Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556 (Part-5).

iii) A toilet block shall be provided adjacent to common control room for exclusive use of operation personnel.

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Flooring

The nominal total thickness of floor finish shall be 50 mm i.e. underbed and topping. The floor shall be laid on an already laid and matured concrete base. The underbed for floors and similar horizontal surfaces shall consist of cement concrete (1 part cement, 2 part sand and 4 part stone chips by volume). Stone chips shall be 12.5 mm down well graded.

Sunken RCC slab shall be provided in false flooring area and all toilet areas so as to keep the finished floor level of these areas 12 mm below as that of the surrounding area. For toilet area, sunken slabs shall be made water tight by suitable water proofing treatment.

Metallic hardener topping shall be 12 mm thick using uniformly graded iron particles, properly treated.

Polished heavy duty white cement cement concrete tiles (carborundum) of size 300 x 300 x 25 mm thick (minimum) as per IS: 1237, using colour pigments and hard chips like carborandum shall be used. Laying of tiles shall be as per IS:1443.

Dust pressed ceramic tiles (heavy duty) Group-V conforming to IS:13755 of size 300 x 300 x 7 mm thick (minimum) of reputed manufacturer and of approved finish shade and colour to be used.

Vitrified ceramic tiles of size 400mm x 400mm or 600mm x 60mm (Mat or Mirror Polished) and of specified thickness (7mm minimum) from reputed manufacturer shall be used. The finish, shade and colour shall be as approved.

For pathway, chequered and designed concrete tiles minimum 22 mm thick, 200x200 mm size conforming to IS: 13801 of approved shade and colour shall be used.

PVC flooring, wherever used, shall be minimum 2 mm thick (virgin) as per IS: 3462. The laying of flooring shall be as per IS: 5318.

Wherever required, carpet flooring shall be provided over cement concrete floor as in conference room of main control room complex. The carpet shall be of tile/roll form, machine/hand made tupled un-cut loop pile and laid with under lay of 10mm thick and shall be laid as per manufacturer's recommendations, in matching grains. It shall be treated with anti fungus and anti-termite before laying.

Kota and Granite stone slabs shall be of min 20mm thick and of approved quality, colour uniform grain and thickness. Exposed edges of granite stone slabs above counters shall be bevelled.

Skirting in general shall be 150 mm high. Dado in toilets & pantries, shall be upto 2100 mm height from finished floor level. Skirting and Dado shall match with the floor finish.

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Wherever required, removable metallic false flooring system shall be provided. Nominal height of the false flooring shall be 600 mm. The same shall comprise of special grade steel panels (of size 600x600mm). without any dimensional tolerance 1.2mm thick die cast to shape having 1mm thick top MS sheet spot welded together to form a composite steel panel, sitting on aluminum diecasted heads & mounted on steel pedestals of 25mm dia rod of adjustable height and supporting 1.2mm thick channel frame work at-top and 2mm thick 150x150mm base plate. The top finish shall be 2mm thick antistatic PVC sheet or High pressures laminate. Cavity area below the false flooring shall be made dust proof by using Polyurethane sheet.

Inter locking concrete blocks used for paving shall be of minimum M 30 grade of concrete, and of thickness 60 mm, of approved colour and pattern. It shall be laid on the sub base and bedding as per recommendation of manufacturer of inter locking concrete blocks.

Paving

- a) The RCC paving minimum 150 mm thick of M20, over an underbed as specified herein shall be provided for areas mentioned below. RCC paving shall be designed as rigid reinforced concrete pavement for the crane/ vehicular/ equipment movement loads which the paving has to bear. The underbed for paving shall consist of preparation and consolidation of subgrade to the required level, laying of stone soling of 225 mm compacted thickness with 63 mm and down aggregate with interstices filled with selected sand followed by 75 mm thick 1:4:8 PCC (1 part cement, 4 parts sand and 8 parts stone aggregate) with 40 mm nominal size aggregate. Paving areas shall be provided with the metallic hardener floor finish as specified elsewhere in the specification. However mill maintenance area and vehicular passage shall be provided with non-metallic hard granular finish in place of metallic hardener topping. Non metallic hard granules shall be spread over the green concrete paving slab at the rate of not less than 5 kg/ sq.m. Paving shall be provided for the following areas:
 - i) Entire main plant area from HRSG stack to transformer yard as enclosed within the peripheral roads (shown on General Layout Plan) of the main plant area shall be provided with paving (on stack side, paving shall be upto the edge of the storm water drain to be provided by Bidder. This paving shall be provided as one block having regular configuration.
 - ii) Ground floor of all buildings.
- b) PCC paving of nominal mix 1:2:4 (1 part cement: 2 parts sand: 4 parts aggregate), 100 mm thick laid over 75 mm thick bed of dry brick aggregate shall be provided for following areas:
 - b) 750 mm wide plinth protection around all buildings other than those covered under paved area.

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- c) 2.0 m wide pathway all along pipe/ cable corridor and all around each cooling tower. 2.0 mm wide ways inter connecting all cooling towers with each other.

Acid/ Alkali Resistant Lining

The material shall conform to the following:

- i) Bitumen primer shall conform to IS: 158.
- ii) Bitumastic compound shall conform to IS: 9510. Where the height of bitumastic layer on vertical surface is more than 2.0 m, the bitumastic layer shall be reinforced with diamond pattern expanded metal steel sheets conforming to IS: 412.
- iii) A.R. Bricks/ Tiles shall conform to class II of IS: 4860 & IS: 4457 respectively.
- iv) Mortar: Potassium silicate & resin type mortars shall conform to IS: 4832 Part-I&II respectively.

Requirements for acid/ alkali resistant flooring and lining for different areas shall be as given Table-A enclosed at the end of this specification.

Roof

Except for the roofs subjected to heavy loads, roof of all buildings having structural steel frame work shall consist of permanently colour coated (on exposed face) troughed metal sheet decking of approved profile having minimum base metal thickness of 0.8mm of galvanised (with minimum rate of galvanisation of 275 gm/sq.m.) M.S. sheet or minimum 0.8mm of high tensile steel (minimum yield strength 350 MPa) coated with zinc aluminium alloy (zincalume) (coating not less than 150 gm./sq.m). Silicon modified polyester paint having DFT of minimum 20 microns shall be used for permanent coating. The sheeting shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. RCC slab of minimum 50 mm clear thickness in excess of trough depth shall be provided over the metal decking. Water proofing cum plasticiser compound shall be added to concrete over the metal decking. Bidder shall demonstrate that the roof is leak proof by carrying out the water-retaining test by maintaining the minimum water depth of 50mm over the roof surface for a period of 48 hours. Water Proofing Treatment as given below for RCC roof slabs shall be provided to ensure that the roof is watertight.

Roof of all buildings having RCC framework shall have cast-in-situ RCC slab. Such roof shall be provided with roof water proofing treatment using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM-C-836 & 898. Thickness of the membrane shall be 1.5mm (min.). This treatment shall include application of polymerised mastic over the roof to achieve smooth surface and primer coat. Wearing course on the top of membrane shall consist of 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced

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with 0.56mm dia galvanised chicken wire mesh and sealing of joints using sealing compound/elastomeric water proofing membrane. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade conforming to IS: 13801 shall be provided for path way of 1 m. width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC / Ventilation plant, cooling towers, etc. are provided in place of PCC wearing course. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future. For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100. This gradient can be provided either in structure or subsequently by screed concrete 1:2:4 (using 12.5 mm coarse aggregate) and/ or cement mortar (1:4). However, minimum 25 mm thick cement mortar (1:4) shall be provided on top to achieve smooth surface. The roof shall be provided with RCC water gutter, wherever required. Gutter shall be made water tight using suitable watertight treatment.

For Building where metal cladding is envisaged medium class galvanised mild steel pipes conforming to IS: 1239/IS:3589 with welded joints shall be provided to drain off rain water from the roof. For rest of the buildings cast-iron pipes with lead caulked joints conforming to IS:1230 shall be used. These shall be suitably concealed with masonry work, cement concrete / or sheeting work to match with the exterior finish. The number and size of down comers shall be governed by IS:1742 and IS:2527.

Roof drain level of all RCC framed buildings having cast-in-situ RCC roof shall be provided with Rain water gutter and/or 45 x 45 cm size Khurras having minimum thickness of 30 mm with 1:2:4 concrete over PVC sheet of 1 m x 1 m x 400 micron and finished with 12 mm thick cement sand plaster 1:3. All the pipes shall be provided with suitable fittings and fixtures. Gratings shall be of stainless steel.

Roof of all buildings shall be provided with access/approach through staircase or ladder. Roof where equipment are mounted shall be provided with access through staircase.

RCC parapet wall of minimum 1000 mm height (above top of slab) for all accessible roofs and 600 mm height for all non-accessible roofs shall be provided.

Fillets at junction of roof and vertical walls shall be provided with cast-in-situ cement concrete (1:1.5:3) nominal mix followed by 12mm thick 1:4 cement sand plaster.

Pathways for handling of materials and movement of personnels shall be provided with 22mm thick chequered cement concrete tiles as per IS:13801 for a width of 1000mm.

Walls

All walls shall be non-load bearing infill panel walls.

For initial height upto 3 metres from ground floor one brick thick masonry wall shall be provided wherever metal cladding is specified

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All internal walls shall be with one brick thick in cement mortar (1:6) with coarse sand. However, internal partition walls for office area and toilets shall be with half brick masonry thick with cement mortar (1:4) with coarse sand.

For Main plant building, Control tower and other buildings, the type, thickness and initial height of external cladding facing the transformer yard shall be according to the requirements of Tariff Advisory Committee (TAC). TAC requirements shall also be complied with for all other buildings while deciding cladding type & thickness.

External face of Toilets, Air-conditioned and pressurised areas shall be provided with masonry wall as per functional / aesthetic requirements. (Inside the metal cladding wherever provided). For external face of the building, where, permanent external finish is to be provided with fire clay bricks, half brick thick fire clay brick (conforming to IS: 6) cladding in cement mortar shall be provided and shall be finished with recessed pointing.

50 mm thick DPC in Cement concrete (1:1.5:3) with water proofing compound followed by two layers of bitumen coating 85/25 grade as per IS:702 @ 1.7 kg./sq.m. shall be provided at plinth level before starting the masonry work.

Metal cladding

a) Permanent colour coated Insulated metal cladding system

i) Permanent colour coated sandwitched (insulated) M.S./High tensile steel metal cladding of approved colour combination shall be provided for main plant building, and all buildings having structural steel frame work & and any other building with metal cladding where thermal insulation is required.

ii) Permanent colour coated (non-insulated) M.S./High tensile steel metal cladding of approved colour combination shall be provided for boiler roof/canopy, and cladding over parapet walls of buildings where metal cladding is specified.

iii) Troughed galvanised M.S. sheet having 0.6 mm minimum thickness with minimum rate of galvanisation of 275 gm./sq.m. or high tensile steel sheet having minimum yield strength of 350 MPa of 0.5 mm minimum thickness and coated with zinc aluminium alloy (zincalume) at the rate of 150 gms./sq.m. shall be used on external face (outer face) of cladding system. The outer side (exposed face) of the sheet shall be permanently colour coated with silicon modified polyester coating of Dry Film Thickness (DFT) 20 microns (minimum) over primer of approved colour shade. Inner face of the sheet shall be provided with suitable pre-coating of minimum 7 microns, of off-white colour.

iii) Galvanised M.S. sheets of minimum 0.6 mm thickness with minimum rate of galvanisation of 275 gms/sq.m. or. high tensile steel, having minimum yield strength of 350 MPa of 0.5mm minimum thickness, coated with zinc aluminium alloy at the rate of 150 gm/sq.m. shall be used as inner liner (internal face) of

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cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of sheet shall be provided with suitable pre-coating of minimum 7 microns.

u) Z spacers if required shall be made out of at least 2 mm thick galvanised steel sheet of grade 275 as per IS: 277.

vi) The sheets shall be fixed by means of concealed fixing system or any other compatible method approved by the Engineer. The fasteners shall be of high quality corrosion resistant grade of self-tapping / self drilling type provided with suitable cap.

vii) The insulation shall be of Glass wool, having a density of 32 kg/cu.m. for glass wool, 48kg/cu.m. for rock wool or 40-45 kg./ cu.m

v) Permanent colour coated (non-insulated) metal cladding system:

Troughed galvanised M.S. sheets having 0.6 mm minimum thickness with minimum rate of galvanisation of 275 gms./sq.m. (or High tensile steel sheet coated with zinc aluminium alloy @ 150 gms./sq.m. of 0.5 mm minimum thickness and having minimum yield strength of 350 MPa) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with Silicon modified polyester paint of minimum DFT 20 microns over primer, of approved colour/shade and the inner side (internal face) shall be coated with same paint of minimum DFT 20 microns over primer of off-white shade. These shall be fixed with concealed fixing system or any other compatible method approved by the Engineer. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

c) Flashings, caps, trim closures etc. for jambs, lintels, softies, cornices

All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and any weather/moisture sealants with appropriate material and coating specification as mentioned above for the outer face of the sandwiched metal cladding. Overlap shall be min. 100 mm or as specified by manufacturer.

Plastering

Outer face (i.e. rough side) of all brick walls shall have 18 mm thick and inner face (i.e. smooth side) of all walls shall have 12 mm thick cement sand plaster 1:6.

Plaster of paris (Gypsum Anhydrous) conforming to IS:2547 shall be used for plaster of paris punning over cement plastered surfaces. The finish surface shall be smooth and shall be of 2 mm nominal thickness.

All R.C.C. walls shall have minimum 12mm thick cement sand plaster 1:6.

All RCC ceilings (except areas provided with false ceiling, cable vault ceiling and metal decking) shall be provided with 6mm thick cement sand plaster 1:4.

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Groove of uniform size 12 x 12 mm up to 20 x 15 mm in plastered surface as per approved pattern, shall be provided as per approved drawing.

All plastering work shall conform to IS:1661.

Painting

All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush then same shall be finished off with roller.

All paints shall be of approved make including chemical resistant paint.

Minimum two finishing coats of paint shall be applied over a coat of primer.

Exterior masonry paint (water or solvent base) shall consist of special resins & additives, mixed with fine, hard stone aggregates & finest available pigment. The paint shall be applied on a coat of primer over dried, prepared plastered surface as per manufacturer's guidelines. The final, finished coating shall be fungus resistant, UV resistant, water repellant, alkali resistant, and extremely durable with colour fastness.

Acrylic emulsion paint shall be as per IS:5411 (Part-I). Oil bound distemper shall be as per IS:428. Cement paint shall conform to IS:5410, white wash/ colour wash shall conform to IS:627.

Fire resistant transparent paint as per IS:162 shall be provided on all wood work over French polish or flat oil paint. French polish shall conform to IS:348. Flat oil paint shall conform to IS:137.

All fire exits shall be painted in post office red/signal red colour shade, which shall not be used anywhere else except to indicate emergency or safety measure.

For painting on concrete, masonry and plastered surface IS:2395 shall be followed. For painting on wood work IS:2338 shall be followed.

For painting on steel work and ferrous metals, BS: 5493 and IS:1477 shall be followed. The type of surface preparation, thickness and type of primer, intermediate and finishing paint shall be according to the painting system adopted.

Bitumen primer used in acid/alkali resistant treatment shall conform to IS:158.

All plastered areas above false ceiling shall be provided with two or more coats of white wash.

Resin bonded granular textured finish, for external applications shall consist of crushed stone / quartz chips of 2.5 mm size and of approved colour/ shade and bonded with synthetic resins, Adhesives and additives, all together in a single pack mix. It shall be applied externally, on cured and dried plastered surfaces, with a dry film

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thickness of min. 2.0 mm. The final finish shall have UV-Resistant, fungus/ bacterial resistant properties. Grooves shall be provided as per drawing and the same shall be filled with polysulphide sealant of matching colour/shade.

Doors & Windows

Doors, windows and ventilators of air-conditioned areas, entrance lobby of all buildings (where ever provided), and all windows and ventilators of main plant and facility building shall have, electro colour dyed (anodised with 15 micron coating thickness) aluminium framework with glazing. All doors of office and toilet areas shall be of aluminium. All other buildings doors windows ventilators (unless otherwise specified) shall be of steel.

Main entrance of the common control room and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing. Doors shall be of double action floor springs mounted.

For common control building, double glazed wall panels with hermetically sealed glass with aluminium frame shall be provided between air-conditioned and non air-conditioned areas and on the side of common control room and control equipment room(s) to have a clear view. One glass, on external side of control room shall be tinted one.

Single glazed panels with aluminium framework shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

a) The doors frames shall be fabricated from 1.6 mm thick MS sheets and shall meet the general requirements of IS:4351.

b) All steel doors shall consist of double plate flush door shutters. The door shutter shall be 35 mm (min.) thick with two outer sheets of 1.2 mm rigidly connected with continuous vertical 1.0 mm stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 1.2 mm. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, locks etc.

Steel windows and ventilators shall be as per IS:1361 and IS:1038.

Wherever functionally required Rolling shutter (fully closed/partly grilled) with suitable operating arrangement (manual/Electric) shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248. M.S sliding doors with suitable mechanical and electrical operations fixtures as per requirement for bigger openings shall be used.

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All windows and ventilators on ground floor of all buildings shall be provided with suitable grill.

Fire-Proof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS:3614. Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool/wood insulation.

Hollow extruded section of minimum 3 mm wall thickness as per IS:1285 shall be used for all aluminium doors, windows and ventilators.

Minimum size of door provided shall be 2.1 m high and 1.2 m wide. However for toilets minimum width shall be 0.75 m and office areas minimum width shall be 1.00m.

Electrically operated, self operable/closing, aluminium framed with tinted glass (12mm thick) sliding doors shall be provided at the entrance of all common control rooms, entrance lobby of facility building.

Glazing

All accessible ventilators and windows of all buildings shall be provided with min. 4mm thick float glass, plain or tinted for preventing solar radiations, unless otherwise specified.

All inaccessible (where regular maintenance is not feasible) ventilators and windows of all buildings shall be provided with 6mm thick Multiwall Polycarbonate plain or tinted sheet for preventing solar radiations. The Multiwall Polycarbonate sheets shall be fire and u/v resistant, and suitable for continuous use up to a temperature of 1000C.

Suitable aluminium beading shall be used. The open ends of the sheet shall be sealed as per manufacturer's recommendations.

The sky light/ north light shall have Multiwall Polycarbonate sheet fixed with anodised aluminium frame of approved colour & the same shall be made leak proof.

All windows and ventilators located in fire prone areas shall be provided with minimum 6 mm thick wired glass conforming to IS:5437.

For single glazed aluminium partitions and doors, float glass of minimum 5.5 mm thickness shall be used.

Double glazing shall consist of two 6 mm thick glass hermetically sealed and separated by 12 mm gap to provide thermal insulation. The outside of the glazing shall be of tinted glass where exposed to sunrays.

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Ground glass of minimum 4 mm thickness shall be used for all windows/ ventilators in toilets.

All glazing work shall conform to IS:1083 and IS:3548.

False ceiling

Aluminium panel lineal false ceiling system Aluminium panel (coil coated) lineal / panel ceiling system shall consist of rolled formed, coil coated aluminium precoated magnesium alloy (Al-Mg AA 5050) carrier and panels of minimum 0.9 mm and 0.5 mm thickness respectively. The ceiling system shall be of approved pattern. The system shall be complete with edge cover profile, special panels, carrier splice, etc.

The carrier shall be suspended from roof by 4 mm diameter galvanised steel wire hangers having special height adjustment clips made from spring steel at maximum spacing of 1.2 m c/c both ways.

False ceiling with Mineral Fibre Tiles False ceiling shall consist of regular or tapered edge light weight mineral fibre tiles of size of 600 x 600 or 600 x 1200 or as per architecture design with minimum tile thickness of 15 mm. Exposed surface shall be semiperforated (fine fissured) with nominal depth of perforation as 4 mm. The material shall be humid resistance upto 95% RH with fire performance of class 0/class 1 (as per BS 476) and shall not sag for 10 years under 95% RH. Metal suspension system shall conform to ASTM C-635 and shall be hot dipped M.S. galvanised (grade 180 as per IS:277). Nominal size of T-section shall be 24 x 38 mm for main runners and 24 x 30 mm or 24 x 25 mm cross runners. 24 mm wide exposed flange surface shall be permanently colour coated. Suspension system shall be as per manufacturer's specification.

Gypsum plaster board, used for false ceiling, shall be minimum 12mm thick conforming to IS:2095.

Glass wool insulation shall be laid on top of false ceiling panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc.

Suitable M.S. channel (Minimum MC75 with maximum spacing of 1.2 m C/C both ways) grid shall be provided above the false ceiling level for movement of personnel and to facilitate maintenance of lighting fixtures, AC ducts etc.

Underdeck insulation shall be provided on the ceiling (underside of roof slab) and underside of floor slab of air-conditioned area depending upon the functional requirements. This underdeck insulation shall consist of Glass insulation with 0.05 mm thick aluminium foil & 0.6 mm x 25mm mesh wire netting and shall be fixed to the ceiling with 2 mm wire ties.

Suitable cut-outs shall be provided in false ceiling to facilitate fixing of lighting fixtures, AC grills, smoke detectors, etc.

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Interior Design

A comprehensive interior design scheme shall be conceived with the intention of projecting a definite theme and aesthetic appearance to inside working environment. It shall take into account the mutlidisciplinary engineering activities involving power plant technology, and architectural & civil engineering for a smooth control hierarchy and man machine interface. All the design aspects such as flooring, false ceiling, furniture, colour scheme equipment design & layout, illumination, fire fighting, acoustics and ergonomics requirements shall be detailed out so as to present an overall unified aesthetic spatial appearance. The areas to be undertaken for this interior design process shall be control room complex including common control room, computer room, conference rooms and office areas in the main plant building and the following aspects shall be reviewed and evaluated for design. Furniture to be supplied by Bidder for the control room complex shall be as specified under C&I specification. a) Layout, keeping in view the man-machine interface and suitable ergonomic practices. b) Integration of civil engineering with architecture and interior design. c) Illumination levels, noise levels, electromagnetic interference levels, taking into account the equipment and furniture. d) Comfort and safety requirements such as air conditioning, fire fighting, fire escapes, etc. e) Microprocessors based control system to control the functional requirements. The above design philosophy put into practice shall be detailed out through presentation drawings, perspective views, scale models, detail drawings, etc.

Finishing Schedule

Interior and Exterior Finishes shall be as given in Tables-B & C respectively. attached at the end of these specification.

STACK

General

The height of the exhaust gas emission point for the stack shall be as specified elsewhere in the specifications.

The stack shall be capable of serving satisfactorily, under all the respective normal and emergency operating conditions to which they may be subjected during the life of plant. The stack and the lining materials, if any, shall therefore be selected to serve the worst operating conditions. The exit diameter of the stack/lining shall be such that the

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maximum gas velocity is limited to the values indicated elsewhere in the specification.

The stack shall be provided with access ladders with fall prevention devices using safety belts along with closely spaced circular safety hoops. At least two continuous external platforms with hand railing (one near the top and one near the mid height) shall be provided on each stack.

Thermal insulation for the stack shall conform to the requirements specified elsewhere in the specification.

The stack shall be provided with aviation obstruction lighting system as per ICAO (International Civil Aviation Organisation) regulations. Necessary power supply arrangements and wiring installations shall be provided as per relevant standards. The stack shall also be provided with the required lightning protection and earthing systems.

The other components of the stack includes, doors, hatches, drainage system, ventilation openings, gas monitoring and sampling test ports, cladding, strakes, hood cap etc.

All metal surfaces shall be painted for maintenance free life of at least 10 years. The entire external surface of the stack shall be painted using heat and acid resistant paint, in alternate bands (7 bands) of colours deep red and pure/ bright white.

MATERIALS

Cement

Fly ash based portland pozzolana cement conforming to IS:1489 (Part-1) shall be used for all areas other than for the critical structures identified below. However, Engineer may allow the use of other types of cement namely, ordinary portland cement & portland slag cement conforming to IS: 269 and IS: 455 respectively under special circumstances on specific request of the bidder and prior approval of the Engineer. Minimum grade of cement shall be Grade 33. Higher grade of portland ordinary cement namely Grade 43 and Grade 53 conforming to IS:8112 and IS:12269 respectively can also be used for specific application. However the ordinary portland cement shall necessarily be used for following structures.

- TG foundation top deck and sub-structure excluding raft.
- Spring supported decks of all machine foundations.

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c) Structures requiring grade of concrete of M25 and above. In place of fly ash based portland pozzolana cement fly ash can be added in ordinary portland cement (Grade 43). Batching plant shall be deployed for producing the concrete. Fly ash shall conform to IS:3412. Percentage of fly ash to be mixed in concrete shall be based on trial mix.

Aggregates

a) Coarse aggregate Coarse aggregate for concrete shall be crushed stones chemically inert, hard, strong, durable against weathering of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.

b) Fine aggregate Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

Reinforcement Steel

All reinforcement steel used for various structures (underground or Overground) shall be TMT HYSD Bars (Thermo_Mechanically Treated High Yield Strength Deformed Bars) of grade Fe-415 and / or Fe-500 conforming to relevant IS Codes.

Mild steel & medium tensile steel bars and hard drawn steel wire shall conform to grade-1 of IS : 432 (Part-1) or grade A of IS: 2062. Welded wire fabric shall conform to IS:1566.

Structural Steel

Structural steel (including embedded steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects.

Mild Steel (Rolled Sections and Plates) shall conform to Grade 'A' of IS:2062 for thickness upto and including 20mm and shall conform to Grade 'B' of IS:2062 for thickness beyond 20mm thickness.

Medium and High Strength steel shall conform to grade 'Fe-490B' of IS: 8500 or equivalent.

Rolled Sections and Plates up to and including 20mm thickness shall be semi-killed condition. Plates beyond 20mm thickness shall be killed condition.

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All steel upto and including 40mm thickness shall be in as Rolled condition.

Plates beyond 40mm thickness shall be Normalised and Ultrasonically tested.

Pipes shall conform to IS:1161 Hollow(square and rectangular) Steel Sections shall be Hot Formed conforming to IS:4923 and shall be of Minimum grade Yst 240. Chequered Plate shall conform to IS:3502 and shall be Minimum 6mm thick excluding projection. Steel for

chequered Plates shall conform to Grade 'A' of IS:2062.

All other Materials shall be as per applicable Standards and Codes.

Bricks

Fly ash lime bricks conforming to IS:12894 and fly ash clay bricks conforming to IS:13757 shall be used. The crushing strength of bricks shall be minimum 75 kg./sq cm. Minimum percentage of fly ash shall be 25%.

Water

Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. When water from the proposed source is used for making the concrete, the maximum permissible impurities, development of strength and initial setting time of concrete shall meet the requirements of IS:456.

All materials brought for incorporation in works shall be of best quality as per IS unless specified otherwise.

STATUTORY REQUIREMENTS

Bidder shall comply with all the applicable statutory rules pertaining to Factories Act, Fire Safety Rules at Tariff Advisory Committee. Water Act for pollution control, Explosives Act, etc.

Provisions of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkways along the crane - girder

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level on both sides of building, comfortable approach to EOT crane cabin, railing, fire escape, locker room for workmen, pantry, toilets, rest room etc.

Provisions for fire proof doors, number of staircases, fire separation wall, lath plastering/encasing the structural members (in fire prone areas), type of glazing etc. shall be made according to the recommendations of Tarrif Advisory Committee.

Statutory clearances and norms of State Pollution Control Board shall be followed.

Bidder shall obtain approval of Civil/Architectural drawings from concerned authorities before taking up the construction work.

CONSTRUCTION METHODOLOGY

Construction and erection activities shall be fully mechanised from the start of the work. All excavation and backfilling work shall be done using excavators, loaders, dumpers, dozers, poclains, excavator mounted rock breakers, rollers, sprinklers, water tankers, etc. Manual excavation can be done only on isolated places with specific approval of engineer.

For controlled rock blasting specialized agency, equipped with sensors to assess the impact of the blast on the adjoining existing structures, shall be employed.

Dewatering shall be done using the combination of electrical and standby diesel pumps.

Pile installation equipment suitable for flushing with air lift technique shall be used for construction of bored piles.

For concreting, weigh batching plants, transit mixers, concrete pumps, hoists, etc. shall be used.

All fabrication and erection activities of structural steel shall be carried out using automatic submerged arc welding machines, cutting machines, gantry cranes, crawler mounted heavy cranes and other equipment like heavy plate bending machines, shearing machines, lathe, milling machines, etc. Use of derricks shall not be permitted. Special enclosures, for blast cleaning of steel structure surface preparation, shall be used.

All handling of materials shall be with cranes. Heavy trailers shall be used for transportation.

Mechanized modular units of scaffolding and shuttering shall be used.

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Grouting shall be carried out using hydraulically controlled grouting equipment. Roadwork shall be done using pavers, rollers and premix plant. All finishing items shall be installed using appropriate modern mechanical tools. Manual punching etc. shall not be permitted.

Heavy duty hoists for lifting of construction materials shall be deployed. Compressors for cleaning of foundations and other surfaces shall be used. Field laboratory shall be provided with all modern equipment for survey, testing of soil, aggregates, concrete, welding, etc. For testing of steel works, ultrasonic testing machines, radiographic testing machines, dye penetration test equipment, destruction testing equipment, etc. shall be deployed.

All persons working at site shall be provided with necessary safety equipment and all safety aspects shall be duly considered for each construction/ erection activity. Moreover, only the persons who are trained in the respective trade shall be employed for executing that particular work.

FIRE STATION COMPLEX

Fire Station complex shall consist of the following: 1) Fire station building.

Fire station Building

Garage Bays

These shall be provided to accommodate all the specified fire tenders included in bidder's scope, one no. of fire jeep and one number fire tender being separately procured by owner, with sufficient space provision around the fire tenders and jeeps based on standard requirements. The garage bays shall be provided with opening on the front as well as on the rear side. Concrete paved open space of at least 10m width with suitable underbed should be provided connecting garage bays and the nearby service road for providing easy maneuverability of the fire tenders and jeeps.

Watch room/Control room

This room of minimum area 16sqm should be provided adjacent to the garage bays. An automatic siren/fire alarm, which can be sounded by fireman on duty, shall be provided. Watch room shall have glazed walls towards the verandah and garage bay side.

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General stores/Repair workshop

These shall be rooms of minimum 32 sq.m in area for storing fire extinguishers, spares etc. in addition, 16 sq.m for repair shop, 16 sq.m for storing fire hoses etc. shall be provided. Adequate racks shall be provided in the storeroom as well as pegs in the hose-room so that water hoses can be properly stacked.

FACILITY BUILDING

Facility building shall be provided for operation and maintenance facilities and personnel. This building shall be provided as combined building with control building or as separate building, adjacent to the control building with interconnecting corridor. This building shall have air-conditioned usable area for providing office space for the operating staff.

The total covered area for the facility building has been specified elsewhere in this specification. The building shall be with not more than 5 storied In addition to the above, building shall have specified usable covered area for maintenance facilities and personnel.

The facility building shall have an RCC staircase of clear width of minimum 1400mm.

ADMINISTRATIVE BUILDING

Administrative building shall be provided for housing the administrative staff and official of various functional departments. This building shall be located closer to plant entrance and shall be located outside main plant battery limit security zone. Administrative building shall be of RCC frame construction with brick walls with not more than three storied. The total covered floor area for the building shall not be less than 1000 sq.m. Additionally covered parking area at least for 20 cars and 40 scooters with RCC canopy shall be provided. Building shall be provided with porch at the entrance. The building shall have provision of attached toilet with the cabin of senior executives and conference rooms. The building shall have provision of separate gents toilets and ladies toilets in each floor for common use. In addition, one pantry, library and documentation rooms and one storeroom shall also be provided in the building. The internal partitions of the building shall be done using pre-laminated particle board and clear glass fixed in electro colour coated (anodized) aluminium frame work as per approved layout. False ceiling shall be provided as specified elsewhere in this specification. Inter-connecting galleries wherever provided shall be covered on top and with appropriate glazing on sides in electro colour coated aluminium framework.

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Structural arrangement, foundation, cladding, interior and exterior finishes etc. for the building shall be as specified elsewhere in this specification.

LANDSCAPING AND HORTICULTURE WORKS

After completion of construction work, the bidder shall take up final dressing and landscaping of the site. The bidder shall remove the top ash layer of minimum 500mm thick and replace the same with good earth, suitable for horticulture works, approved by the employer. Landscaping of entire Project Complex shall embrace a number of measures at different stages of site development.

- j) The design of structures, Buildings, roads, pathways, lighting system etc. so that these components are not out of scale with the surrounds.
- ii) The apt contouring of all ground affected by works, especially the excavations and embankments with a view to unify the landscape and avoid any visual jolt.

- iii) The grassing, turfing and planting of trees and shrubs, which properly integrate the environment.

- iv) Water supply network, with pipes, valves, stop cocks, complete accessories for irrigation of tree plantation and horticultural works, lawns etc. The bidder shall prepare and submit landscape drawings required to complete the work up to the satisfaction of the employer. Bidder shall furnish at least two alternative perspective drawings in colour depicting Landscaping and Horticultural Work.

The treatment to be adopted for landscaping will depend on the topography, climate, nature and type of soil, vegetation pattern and other environmental features. For best results, designing of entire complex and landscaping should be regarded as complementary and tackled as a single planning task.

The bidder should arrange services of Landscaping architects and horticulturist to integrate the related aspects.

The bidder shall prepare perspective drawing in colours and models so that landscape features can be studied in advance and further improvement made wherever possible.

The landscape plan shall consist of but not be limited to the following components:

Formal or/and informal landscaping, lawns, pathways, rockery, stonework, mounds, water bodies, fountains, cascades, water fall, decorative fencing, suiting to garden/greenery, ornamental lighting, fixtures, plantation, such as trees, shrubs, hedges, creepers, artificial plants, hanging, seasonal flowers beds, rosary, potted plant etc.



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TABLE - A

PROPOSED ACID/ ALKALI RESISTANT TREATMENT

S. NO.	AREA	PRIMER (ONE COAT)	TYPE OF LINING AND THICKNESS				EPOXY COATING (TWO COATS)
			A.R.BRICKS	A.R. TILES	EPOXY MORTAR	BITUMASTIC	
1	Neutralizing pit						
	i) Floors	Bitumen	75 mm thick			18 mm thick	
	ii) Walls	Bitumen	115 mm thick			18 mm thick	
	iii) Ceiling	Epoxy					150 micron
	iv) Pillasters		115 mm thick			18 mm thick	
2	Chemical House	Epoxy					150 micron
3	Lime, Alum Preparation and dosing tanks	Bitumen	115 mm thick			18 mm thick	
4	Acid / Alkali storage are	Bitumen	38 mm thick			12 mm thick	
5	Floor around chemical handling equipment	Bitumen	38 mm thick			12 mm thick	
6	Pedestals for supporting chemical handling equipment	Bitumen	38 mm thick			12 mm thick	
7	M.S. Grating / Chequered plate in chemical handling / storage area	Epoxy					150 micron
8	Effluent Drains	Bitumen	38 mm thick			12 mm thick	

Note : -

1. The above table is for general guidance only, however, actual areas/ facilities to be covered shall be as per Scope of work.
2. Suitable end sealing shall be provided.
3. Structures shall be tested for waterproofing before application of Acid / Alkali Resistant Treatment.
4. This treatment shall be applied on dry surface.
5. For laying of AR bricks / tiles, the bedding mortar shall be of potassium silicate 6 mm thickness and the pointing mortar shall be of Epoxy / furane 20 mm deep and 6 mm thickness.



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TABLE-B

INTERIOR FINISHING

S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS
1.	Operating/Maintenance areas of workshop, pump houses, compressor house, DG set, Air Washer building, AC Equipmt.Room, Air handling area	Cement concrete with Metallic hardener topping	Oil bound distemper over plaster of paris	Oil bound distemper
2.	General storage areas	- do -	Oil bound distemper	Oil bound distemper
3	Cable Vault/cable spreader	- do -	Oil bound distemper	Oil bound distemper
4.	Area paving		-	-
	a) Equipment / vehicle movement area	Reinforced cement concrete with metallie hardener toping		
	b) Balance area	Haeeavy duty cement concrete chequered tiles with colour pigment		
	c) Parking area	Inter locking concrete blocks		
5.	GT & STG Buildings			
	a) Ground floor i) Unloading Bay	Cement concrete with Metallic hardener topping	Oil bound distemper over plaster of paris	Oil bound distemper

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S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS
	ii) Balance area including passage	Heavy duty cement concrete tiles	-do-	-do-
b)	Mezzanine floor (excluding grating area)	-do-	-do-	-do-
c)	Deareator floor	Cement concrete with Metallic hardener topping	-do-	--
d)	Operating floor of STG Building			
i)	Operating area, laydown area, heater area	20 mm (Min.) thick polished granite slab (1st quality)	Oil bound distemper over plaster of paris	Oil bound distemper(except metal deck area)
ii)	General circulation and movement areas	7 mm thick vitrified ceramic tiles in combination of mirror polished and unpolished tiles	-do-	-do-
6.	a) MCC room	7mm thick vitrified ceramic tiles (unpolished)	Oil bound distemper over plaster of paris	Oil bound distemper
	b) Switchgear room	Cement concrete with metallic hardener topping	-do-	-do-
7.	a) Control room area including control room, Computer room, Control equipment room	7mm thick mirror polished vitrified ceramic tiles / false flooring (wherever required)	20 mm thick mirror polished marble tiles on masonry walls upto false ceiling height.	0.5 mm, thick precoated (colour)/Al.Lineal false ceiling in



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S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS
			Glazed partition with colour anodised aluminium frame.	
b)	Conference room, GM's room	Wooden panel flooring PERGO or equivalent	i) Wooden panel wall, PERGO or equivalent	AL. Lineal false ceiling
			ii) Glazed partition with colour anodized Aluminum frame work	
c)	Record room	20 mm thick polished kota stone	Oil bound distemper Over plaster of paris	Mineral fibre board with MS coated frame work
d)	Locker room	-do-	-do-	-do-
e)	Model room	20 mm thick polished granite stone	Resin bonded granular finish	AL. Lineal false ceiling
8.	Office room, Staff room	7 mm thick unpolished vitrified ceramic tiles	Acrylic emulsion paint over plaster of Paris	AL. Lineal false ceiling
9.	SWAS room	7 mm thick mirror polished vitrified ceramic tiles	Acrylic emulsion paint over plaster of Paris	AL. Lineal false ceiling
10.	Toilet area	i) 7mm thick dust pressed ceramic tiles in combination with 20 mm thick polished	Coloured 5 mm (min.) thick ceramic tiles upto ceiling / false ceiling height with border tiles	oil bound distem- per over plaster of paris / AL. Lineal false ceiling

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S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS
			granite stone.	wherever required
	(wherever required)			
		ii) 20 mm thick Polished granite in one piece for wash basin platform.		
11.	Pantry Area	i) 20 mm thick polished Kota stone	Coloured 5 mm thick ceramic tiles upto ceiling / false ceiling height with border tiles wherever required	oil bound distemper over plaster of paris / AL. Lineal false ceiling, wherever required
		ii) 20mm thick polished granite stone for platform		
12.	Laboratory area	7mm thick dust pressed ceramic tiles	Acrylic emulsion paint over plaster of paris	Oil Bound Distemper over plaster of paris / AL. Lineal false ceiling, wherever required
13.	RCC Stair case			
	i) ADM/CCR/Facility Building	20 mm thick polished granite stone for riser & tread	20 mm thick polished granite stone with nosing upto 2.1 m height & resin bonded granular finish for	Oil Bound Distemper over plaster of Paris on underside of

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S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS
	ii) Other area	20 mm thick polished kota stone for riser & tread	balance height Coloured 5 mm thick ceramic tiles upto 1.2 m height & resin bonded granular finish for balance height	staircase Oil bound distemper over plaster of Paris on underside of staircase
14.	Entrance Lobbies and Lift areas	20mm thick polished granite stone	20 mm thick polished granite stone with nosing upto 2.1m height & resin bonded granular finish for balance height	
15.	Passages and general circulation areas		20 mm thick polished granite on lift facia	
	i) ADM/CCR/Facility building	7 mm thick unpolished vitrified ceramic tiles	Acrylic emulsion paint over plaster of Paris	OBD over POP / AL. Lineal false ceiling
	ii) Other Areas	20 mm thick polished kota stone with marble stone border	OBD over Plaster of Paris.	OBD over POP / AL. Lineal false ceiling
16.	Battery Room	Acid/Alkali resistant tiles	Acid/Alkali resistant tiles	Acid/Alkali resistant paint

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S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENTPLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS
17.	Oil canal, oil room, oil purification Tank and other areas where oil spillage is likely to occur	Oil resistant paint (epoxy based amine cured) 150 micron over primer. over CC flooring	Oil resistant paint upto 2.1 m height and OBD over POP for balance height	OBD except oil canal area
18.	Chemical house, Chlorination building, CW treatment facility (Other than areas requiring acid/ alkali resistant treatment)	Cement concrete flooring with Metallic hardener topping	Oil Bound Distemper over plaster of Paris	Oil bound distemper
19.	Covered parking area/pathway	Interlocking cement concrete blocks with colour pigment	OBD	OBD
20.	Pathways including equipment installation area on top of roof	22 mm thick concrete chequered tiles	————	————
21.	Switchyard Control Roomg Control room, equipemnt room, battery room, battery charger room, conference room, office room, lobby, coridor, toilets etc.	Same as similar area	Same as similar area	Same as similar area
22.	Canteen building a) Kitchen, wash room	i) 20 mm thick polished kota stone ii) 20 mm thick polished granite for platform	Coloured 5mm thick ceramic tiles upto ceiling / false ceiling height with border tiles	OBD over POP AL. false ceiling

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S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS
	b) Dinning area	7mm thick vitrified ceramic tiles	OBD over POP	OBD over POP AL. false ceiling
	c) Toilet	Same as similar area	Same as similar area	Same as similar area
23.	Gate house	20mm thick polished kota stone	OBD over POP	OBD over POP
24.	DG control building	Cement concrete with metallic hardener topping	OBD over POP	OBD
25.	Fire station			
	a) Office room, control room, store, dinning room, pantry, toilet	Same as similar area	Same as similar area	Same as similar area
	b) garage bay	Cement concrete pavement	OBD	OBD
	c) Repair work shop	Cement concrete with metallic hardener topping	OBD	OBD
	d) Rest room, recreation room	7mm thick vitrified ceramic tiles	OBD over POP	OBD over POP
26.	Administrative building	Same as similar area	Same as similar area	Same as similar area

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S.NO.	DESCRIPTION OF AREA	FLOORING	WALL FINISH OVER CEMENT PLASTER	CEILING FINISH OVER CEMENT PLASTER/ PLASTER OF PARIS

27.	Store area	20 mm thick polished Kota stone	Oil bound distemper Over plaster of paris	oil bound distem- per over plaster of paris / AL. Lineal false ceiling, wherever required

- NOTE :**
- All wall and roof areas above false ceiling shall be plastered and white washed.
 - The colour and pattern of finish shall be as approved by Employer.
 - All material shall be of reputed and established brand approved by Employer.
 - Wherever alternative materials are specified, the final selection rests with Employer.
 - This finishing schedule shall also be applicable to similar functional areas for all other buildings and facilities.
 - All the finishing materials shall be applied/ provided as per manufacturer specification and guidelines.
 - Requirement given above are suggestive and minimum. Bidder is welcome to suggest alternative scheme conforming to design functional requirement subject to approval of the Employer.

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TABLE -C
EXTERIOR FINISH SCHEDULE

S.NO.	DESCRIPTION OF AREA	WALLS AND PROJECTIONS	SOFFIT OF PROJECTIONS
1.	Main plant building GT, STG, Control cum facility building	i) Initial height of 3 m (nominal) permanent finish using combination of a) fire clay bricks cladding in cement mortar finished with recessed pointing and b) Grit finish with marble stone chips over cement plaster ii) Approved colour/ colour combination of colour coated metal cladding for balance height.	Resin based textured paint Approved colour/colour combination of colour coated metal cladding
2.	Building with concrete frame work,	Combination of fire clay brick, resin bonded granular textured finish and resin based textured paint to match in harmony with the main plant,	Resin based textured paint
3.	Fire walls, etc.	Combination of grit finish with marble chips, Resin bonded granular textured finish in harmony with main plant	_____
4.	Steel Structures, trestles, etc.	Paint as specified for structures steel of approved specification and shade	_____
5.	Boundary wall, watch towers	Water proof cement paint of approved colour / colour combination	

NOTE:

1. The colour and pattern of finish shall be as finalised by Engineer.
2. All materials shall be of reputed and established brand approved by Engineer.
3. All the finishing work shall be carried out as per manufacturer specifications and of approved colour

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TABLE –D

TAREXTENDED TWO COMPONENT COATING SYSTEM

- a. Proving and applying tar extended two component coating system based on synthesized epoxy resin and amine adduct manufactured as per technical specifications of Central Electrochemical Research Institute, Karaikudi, (C.S.R.I. affiliate Institute), Tamil Nadu, Pin-630 006
- b. The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under prepared surface and existing residual tar/paint. The system shall also be quick curing so as to be suitable for application during shut downs.
- c. The coating system shall conform to the following:

Base	Tar extended epoxy – amine adduct quick curing two component
Colour	Black
Volume of solids	80% (minimum)
Drying time (Touch Dry)	2 hrs.
DFT in two coats	300 microns – 350 microns
Chemical resistance	Excellent against chlorides, salts, sulphates, alkalies
Salt spray test	Should pass as per ASTM-B-117 1000 hrs. minimum
Adhesion	3.8 kilonewtons min. as per ASTM-D-4541
Resistance (Impedance)	10^8
Surface preparation	As per manufacturers specification or as per relevant IS codes.
- d. Paint material and its application method can be obtained from any manufacturer who has been granted license by CERIL, Karaikudi for technical know how for “comprehensive system repair and protection of concrete /steel surface in wet and under water conditions.

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PART-III : QUALITY REQUIREMENT

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This part of the specification covers the sampling, testing and quality assurance requirement (including construction tolerances and acceptance criteria) for all works and structures covered in this specification i.e. excavation and filling, cast in situ concrete and allied works, fabrication and erection of structural steel works, masonry / sheeting and allied works, finishing items, water supply and sanitation, modular aerated concrete panel, pre-engineered building, special items of works, and piling

This part of the technical specification shall be read in conjunction with other Parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

All tests required for all materials (bought by Contractor) and workmanship shall be done / got done by the contractor at his own cost. The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part.

The Contractor shall provide the facilities whatsoever required and also bear all cost for all sampling, testing and quality assurance in the field and in the laboratory. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian standards and / or international standards and this technical specification. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All sampling shall be done in the presence of the Engineer or his authorised representative. The Contractor shall establish the Field Quality Assurance (FQA) laboratory and field tests shall be done in the presence of the Engineer and / or his authorised representative. The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute (like CSMRS, NCBM, IIT's, Shriram Test House, New Delhi / National Test House, Kolkata etc.) as agreed by the Employer, If the Employer desires to witness such tests at laboratory, Contractor shall arrange to conduct the test in his presence.

The recommendations and suitability of material for concreting and other building materials like brick, cement, aggregates etc., shall be ascertained by contractor prior to start of work. Preliminary evaluation of aggregate and its evaluation for potential alkali-aggregate reactivity as per following scope of work shall be done:-

A. Evaluation of Aggregates i) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and flakiness index, as per IS: 2386. ii) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis, soundness, deleterious material, silt content, clay content and organic impurities as per IS: 2386. iii) To prepare evaluation report based on test results of i) and ii) above and to advise regarding suitability of fine and coarse aggregates.

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B. Evaluation of Aggregates for Potential Alkali-Aggregate Reactivity: Evaluation for Potential Alkali-Aggregate reactivity as per following scope of work: i) To carry out petrographic analysis and accelerated Mortar bar Test on aggregate samples (1N NaOH at 80 deg. Centigrade for 14 days as per ASTM 1260, or the method established/ developed by CSMRS for 22days test. ii) To prepare a report based on test results of I) above and to advise regarding suitability of aggregates and further testing required if any.

C. To carry out repeated temperature cycle test on aggregates for aggregates to be used in RCC of dynamic foundations from a reputed rock mechanics laboratory like National Institute of Rock Mechanics, Kolar etc. and to advise regarding suitability of fine and coarse aggregates. Moreover Contractor prior to start of work shall ascertain the recommendations and suitability for fill material. A full-scale test shall be conducted including Grain Size Analysis, Specific Gravity, Moisture Content and Standard Proctor Density of fill material. The Contractor shall submit the test results to the Owner in triplicate, within three (03) days after completion of any test. All records shall be submitted, unless specified otherwise, as per the format developed by the Contractor and approved by the Employer. The contractor shall identify the main purchase orders & that of sub-contracts as per owner's specification and shall forward the list of manufacturers/ vendors for each bought out items envisaged in the contract. The bought out item list shall include all the materials brought out in technical specifications & finalised drawings. The BOI's shall conform to the relevant IS/technical referred specifications for the highest quality grade of material unless otherwise specified. All bought out items shall be procured from the manufacturer's approved by Employer and tested as per relevant IS Codes/ Employer Specification. To facilitate advance planning (well before the start of activity as per L-2 network) of material testing/ approval of bought out items, representative samples shall be procured by the Contractor (from approved vendors) and submitted to the Employer for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. Approval of material / sample by the Employer shall not relieve the Contractor of his responsibility, for their conformance to the specification, as well as the requisite quality and performance of material. Structural Steel and reinforcement steel shall be procured from main steel producers like SAIL, TISCO, IISCO, RINL, Jindal Steels etc.. In case the sections are to be supplied from the re-rollers of main steel producers, the name of such re-rollers will have to be cleared by the Employer for which details such as –BIS approval, Main steel producer's approval, Past experience for production of sections of specified material, details of machines plants testing facilities etc., confirmation that the process control and manufacturing of steel sections by re-rollers shall be same as that of main steel producers, that billets for re-rolling will be sourced from main steel producers only shall be furnished with regards to re-roller. Even after clearance of re-rollers, induction of billets with identified and correlated Mill test certificates (TC's) in the process of re-rolling, sampling of steel, quality checks thereof and stamping of final product for further identification and correlation with TC's prior to dispatch will be in presence of authorised representative of main Contractor. Field Quality Plans shall detail out all the equipment, the quality practices and procedures etc. to be followed by the Contractor's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.

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The contractor shall furnish complete QA & QC programme for the work envisaged which may include the following :- The organisation structure for the management and implementation of the proposed Quality Assurance Programme . Documentation Control System The procedure for procurement of materials and source inspection. System for site controls including process controls.

Control of non-conforming items and systems for corrective action Inspection and test procedures for site activities System for indication and appraisal of inspection status System for maintenance of records System for handling, storage and delivery. Quality Plan detailing out quality practices and procedures, relevant standards and acceptance levels for all types of work under the scope of this contract. The Contractor shall appoint a dedicated, experienced and competent quality management representative on site, preferably directly reporting to the Project Manager, supported as necessary by experienced personnel, to ensure the effective implementation of the Approved quality assurance programme. The onsite quality management representative shall have the organisational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints.

The QA setup of the contractor shall consist of qualified and experienced Engineers, with their supporting staff for approval of the owner. Field Quality Assurance (FQA) organisational set up in addition to requisite mechanical & electrical engineers, shall consist sufficient graduate civil engineers & supervisors to take care of quality assurance activities of both site & laboratory. Bidder shall submit QA organization chart for employer approval. The deployment of man power for FQA set up shall be scheduled on the basis of L-2 network so that necessary manpower shall be available to take care of relevant areas of works in progress during currency of works or as and when directed by the Employer to cope with the work demand. Based on the schedule of work and the approved FQP, the Contractor shall prepare a schedule of FQA tests and shall submit to the Employer and shall organise the tests as scheduled.

The contractor shall prepare and obtain the approval of the Owner of the Field Quality Plan (FQP) before the award of the work. This FQP shall cover for all the items / activities covered in the schedule of items and required for the completion of the work.

All materials components and equipment covered under this specification which shall be manufactured at shop/ factory of the vendor/subvendor shall be covered under a comprehensive quality assurance programme. The detailed quality plan for manufacturing shall be drawn up by the contractor and will be submitted for Employer for approval in the prescribed format for manufacturing quality plan. Manufacturing Quality Plan (MQP) will detail out for all the components and equipment, various test/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/Sub-Bidder's/ sub-supplier's quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing / performance testing . the quality plan shall be submitted on electronic media e.g. floppy or E-mail in addition to hard copy, for review and approval . After approval the same shall be submitted in compiled form on CD-ROM.

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The contractor shall store and handle the materials as per the requirements of the relevant standards at his own cost.

All T&P / equipment brought at site for the use shall be in a good working condition and shall preferably be not more than two years old. The contractor shall submit to the engineer the weekly status of performance of tools & plants deployed at site for mechanised working. These shall include availability of batching plant with printer for recording batch wise details, transit mixers, concrete pumps, vibrators, winches, cranes, welding machines, hoists etc. as per format enclosed at Annexure-IV. In case of outage of any T&P / equipment for more than 40% of requirement, the contractor shall ensure the deployment of additional T&P / equipment to augment the mechanised work at no extra cost to Employer. All major bought out items shall be included in the quality plan.

The Quality plan shall include following works/ Bought out items wherever relevant to the Technical specifications, BOQ & drawings:

Earthwork including selection of fill material, compaction, proctor density tests etc.

Preparation of subgrades & sub-base for paving/ road works

Bituminous paints for water proofing & Bituminous concrete

Cement, reinforcement steel & structural steel procurements

Coarse/ Fine aggregates, ash, water for concrete

Cast-in-situ concrete & allied works

Masonry & allied works

Sheeting & allied works

Water supply & sanitation

Piling works if required Structural steel works including approved welding procedures

Floor finishes, tiling etc.

Doors including fire proof doors, windows, ventilators, partitions, louvers, rolling shutters etc

Pre-fabricated buildings False ceiling & insulation systems

Roof metal decking/ Wall claddings Painting system- Procurement & application

Acid-Alkali resistant linings

Electro forged gratings

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Pressure locked gratings

Concrete Admixtures, chemical injection grouting, waterproofing chemicals etc.

Anti-termite treatments

Preparation of Concrete joints & joint fill materials

Roof water proofing Pond

Hydraulic tests of water retaining structures Drainage

Cross drainage works

Hume pipes Glazing & aluminum works as specified

CW liners

List of Annexure is as follows:

- a) Annexure I Typical Field Quality Lab Equipment
- b) Annexure II- List of Bought out Items
- c) Annexure III – Not used
- d) Annexure IV- Weekly Reporting of utilisation of equipment
- e) Annexure V-Indicative Quality Plan.

GENERAL QA REQUIREMENTS

QA REQUIREMENTS FOR PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

1. All the materials like Bricks, Stones, Concrete Blocks, Lime, Cement, Water, Aggregates, Sand Reinforcement Steel, Structural Steel shall conform to the relevant IS Codes / Employer Technical Specification requirements.

2. All materials shall be stacked and stored by the Contractor as per IS-4082 and as per the requirements specified in Employer Technical Specification.

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3. All material shall be stacked separately.
4. Lime and cement shall be stored in Weather Proof, Dry & Leak Proof Conditions stores.
5. Different consignment of different types of cement shall be stored separately with clear identification mark.
6. Cement stored for more than 60 days in contractors godown shall be retested.
7. Cement shall be consumed on first in first out basis.
8. Steel shall be stacked and stored consignment wise, size wise and grade wise with identification mark.
9. For properties, storage and handling of all materials used shall comply with the requirements of Employer Technical Specification

QA REQUIREMENTS FOR ACID/ALKALI RESISTANT LINING

1. Acid Resistant Bricks/Tiles shall be tested for Water Absorption, Compressive Strength, Resistance to Acid, Flexural Strength, Dimensions and all other tests as per IS-4860 and IS-4457.
2. Acid and Alkali Resistant Bitumastic ready mixed paint shall be tested for all tests as per IS-158.
3. Bitumastic shall be tested as per IS-9510.
4. Potassium Silicate, Resin type and Sulphur type Mortars shall be tested as per IS-4832, Part I, II and III/ Technical Specifications.
5. Surface preparation shall be checked as per IS-2395.
6. Application of Primer, laying of Acid Proof Bitumastic layer, Acid/Alkali Resistant Tiles/Bricks, Chemical Resistant Epoxy Lining and Epoxy Paint shall be as per Employer Technical Specification.
7. Thickness of Acid and Alkali Lining shall be checked.
8. Epoxy painting shall be carried for required coating thickness and dry film thickness.

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QA REQUIREMENTS FOR PRE CAST CONCRETE WORKS

1. All the materials used in Pre cast Concrete work shall be tested and conform to the requirements of IS codes and Employer Tech. Specification.
2. Concrete mix for Pre cast members shall conform to IS-456-2000.
3. All relevant QA requirements pertaining to cast insitu concrete shall be applicable.
4. Load test on Pre cast members shall be carried out for the type of members as decided by Employer as per IS-456-2000.
5. Pre Cast Concrete member shall be checked for dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances shall be as per Employer Technical Specification.

QA REQUIREMENTS FOR RCC PILES (PART I) - BORED CAST-IN-SITU PILES

1. Standard Penetration Test (SPT) as per IS-2131 and Employer Technical Specification for determines the founding level of piles.
2. Uniaxial Compressive Strength (UCS) test shall also be performed on Rock Cores. In case it is not possible to test the cores so obtained for a Uniaxial Compressive Strength, core shall be tested for point load strength Index and correlated to obtain Uniaxial Compressive Strength.
3. Founding level of the piles shall be decided based on the criteria given in Employer Technical Specification.
4. Check for control of position and alignment of piles as per IS-2911 Part I/Sec 2
5. Boring & Drilling : Drilling mud shall be tested for the following
 - Liquid limit of drilling mud (Bentonite Slurry) as per IS-2720 Part V.
 - Acceptance criteria shall be as specified in Employer Technical Specification.
 - Sand content of Bentonite powder.
 - Density of freshly prepared Bentonite suspension shall be checked in each pile bore

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before concreting.

- Marsh viscosity
- Differential free swell index
- pH value of Bentonite suspension Properties of drilling mud shall be checked prior to commencement of the piling work and thereafter, min. once per week or as found necessary by Employer engineer. One sample consisting of 3 specimens shall be tested for above.

6. Check cleaning of pile bore

7. Concreting: All the checks/tests on concrete and concrete materials shall be carried out as per FQP and IS-2911 Part I/Sec.2

a) Before starting concreting the contaminated drilled mud at the (slurry collected in sampler tube) bottom of pile bore shall be tested for density and sand content. Density should not be more than 1.25T/CuM.

b) For Working Piles: Minimum one sample consisting of 6 test cubes shall be made for first ten piles. Out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength. Minimum one sample of 6 test cubes for every 25 nos. of piles shall be tested, out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength

8. Reinforcement bars used for concreting of piles shall be of tested quality and conform to the requirements of relevant IS codes.

- a) Check distances between two adjacent main reinforcement bars and should be as specified in Employer Technical Specification.
- b) Check proper cover and central placement of reinforcement cage in the pile bore by suitable concrete spacers/rollers. Check minimum clear cover to reinforcement as specified in technical specification.

9. Check cut off level of piles as per drawing.

10. Check recording of all data during installation of piles in prescribed pile data sheet.

11. Check that vibrators are used for preparation of test cubes/ specimens.

12. Slumps of concrete shall be tested at every one-hour interval.

13. Checking position and Alignment: Each pile shall be checked for its position w.r.t. specified location. Each pile shall be checked for its alignment. Permissible limits for deviation shall be as specified elsewhere in the Employer Technical Specification.

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14. Check for Pile Bore: On completion of boring and cleaning, the bottom of each pile bore shall be checked from the samples collected from near the bottom of pile bore or any other method approved by Employer, to ensure that it is free from pile bore spoil/debris and any other loose material before concreting.

15. Low strain pile integrity test on all job piles and test piles shall be conducted as specified in the Employer Technical Specification. This test shall be used to identify the piles for routine tests.

QA REQUIREMENTS FOR RCC PILES (PART V) LOAD TEST ON PILES

1. Pile load testing shall conform to IS-2911 (Part IV) and Employer Technical Specification.
2. Check all the equipments and instruments used are properly calibrated.
3. Initial load test and routine load test shall be carried out.
4. Initial load test to assess the safe load carrying capacity of pile before start of work.
 - a) Cyclic vertical (compression) load test to assess safe vertical load capacity.
 - b) Lateral load test to assess safe horizontal load capacity.
 - c) Pull out (Tension) load test to assess safe pull out load capacity.
5. Routine Load Test on Working Piles
 - a) Direct Vertical (Compression) load test for vertical load capacity.
 - b) Lateral load test for horizontal load capacity
6. All other tests on piles shall be carried out as specified in Employer Technical Specification.
7. Pile load-testing procedure to be got approved from Employer

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QA REQUIREMENTS FOR PLASTERING & ALLIED WORKS

1. Materials like sand, lime for preparation of putty, coarse aggregate, gypsum etc. shall confirm to the relevant IS codes specified in Employer Technical Specification.
2. Check proper mixing of mortar
3. Plaster surface shall be checked for following defects and the remedial measures for the same shall be adopted as per IS-1661.
 - a) Blistering
 - b) Bond filer or loss of adhesion.
 - c) Cracking and crazing
 - d) Efflorescence
 - e) Grinning f) Irregularity of Surface Texture
 - g) Popping or blowing
 - h) Recurrent surface dampers
 - i) Softness or chalkiness
4. Trueness of Plastering System: Finished plaster surface shall not show any deviation more than 4mm when checked with straight edge of 2 M length.
5. Check thickness of plaster.

QA REQUIREMENTS FOR CONCRETING INCLUDING CONCRETING OF MAJOR EQUIPMENTS FOUNDATIONS

All records of concreting, reinforcement, testing of materials, as-built dimensions, the details of the rectification, etc, shall be maintained as given below. Four copies of such record in a bound form shall be submitted to Employer for their record and future reference. Cement consumption at batching plant shall also be obtained through computer output. Provision of an on line printer is mandatory.

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Calibration of batching plant shall be carried out at the starting and once in three months, and shall conform to IS: 4925.

a) Testing data of aggregates

b) Mix design details.

c) Testing records of admixture including dosage, workability and setting time.

d) Approved scheme for concreting.

e) Quantity of ice used for temperature control of concrete for top decks of machine foundations.

f) Hourly records of concreting including pour card.

g) Protocol indicating the dimensional tolerance and details of inserts.

h) Records giving the details of rectification giving the location of grouting, the quantity of grout used at each location, type of grout used.

i) Bar bending schedule.

j) Location and details of mechanical anchoring used for reinforcement.

k) Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings.

l) Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification.

m) Report on petrographic examination & potential reactivity of aggregate and the repeated temperature cycle tests.

n) All tests/checks shall be carried out as per FQP.

o) Check temperature control of fresh concrete temperature of fresh concrete should not exceed 25 degree C at the time of placement.

p) Plasticiser cum Retarder type mixture to be added in the concrete shall be tested as per IS-9103.

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q) REINFORCEMENT :

Check conformity of material to relevant IS codes.

Check lapping/spacing of Reinforcement staggered as under no circumstances more than 50% of bars at cross section shall be lapped.

Sample test for mechanical bars grips shall be carried out upto the yield strength of reinforcement of bars. The no. of tests to be carried out shall be 3% of the no. of bar grips used subject to a minimum of three.

r) Batching shall be calibrated regularly atleast once in a 3 months.

s) Ultrasonic Pulse Velocity Test as per IS-13311 Part I for Top Deck and column of T.G. Foundation to ascertain the homogeneity and integrity of concrete. In addition additional cubes (@ of 150/M3 of concrete subject to minimum of 6 cubes) shall be taken to carrying out UPV test on cubes. UPV test shall be carried out by a specialized agency.

t) All precautions and control as specified in Employer Technical Specification shall be taken care of during concreting. IS 456 shall be applicable for acceptance of execution of concrete works & test results.

STAGING AND FORM WORK

Automatic climbform scaffolding systems shall be used. Slipform with proven record for similar towers may be used subject to conformance to relevant IS and specific approval of the owner. The design and detailed construction of the form work and the scaffolding system shall be based on the relevant IS code. In absence of the same DIN 4420/ACT 347 shall be followed. Concrete shall have sufficient strength to with stand the anchoring loads of scaffolding system. The concrete strength shall be continuously checked and documented during the climbing process of the scaffolding.

Design and execution of the form work, staging, shuttering and scaffolding shall conform to National Safety Council and all relevant IS Code provisions, i.e. IS:2750, IS:4014, IS:4923, IS:800 etc. In case the IS Codes do not cover the specific type of shuttering system, then any international Code of Practice, as approved by the engineer, may be followed.

Deployment of vertical laser ray equipment for measuring the dimensions and controlling the shape of the tower at all elevations and plan angles shall be carried out.

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QA REQUIREMENTS FOR STRUCTURAL STEEL WORK

1. Physical and chemical properties of material as per relevant codes. Review of correlated Mill Test Certificates or check testing in absence of MTC.

2. Ultrasonic test on plates above 40mm as per ASTM A435.

3. Welding Procedure Specifications, Procedure Qualification Record & Welders Qualification Test shall be as per ASME Section IX/AWS D1.1

4. Fillet Welds :

a) Check for size and visual examination.

b) Macroetch examination on production test coupons for main fillet welds with minimum one joint per built up beams, columns and crane girder etc.

c) 25% weld length of tension member of crane girder shall be subjected to Dye Penetration Test.

d) On all other fillet welds, DPT on 5% of weld length with minimum 300mm at each location shall be carried out

5. Butt Welds:

a) 100% visual examination

b) DPT on all butt welds after back gouging

c) Mechanical testing of production test coupons with minimum one joint per built up beam, column and crane girder.

d) 100% radiography test on butt welds of tension flange (bottom flange) of crane girder. All other butt welds shall be subjected to Radiography test on 10% weld length of each welder. Wherever RT is not feasible, UT shall be carried out.

e) Full penetration welds (other than butt welds) shall be subjected to Ultrasonic Testing in following quantum :

f) 100% UT on web to flange joint of crane girder.

g) 10% UT on other full penetration joints. 6. Every 1st and further every 10th set of identical structure shall be checked for control assembly in shop before erection.

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7. All structure components/members shall be checked for dimensional tolerances during fabrication and erection as per IS-7215 and IS-12843 respectively. 8. Check for Surface Preparation and Paint thickness.

9. In case of failure of any welds in SPOT RT/UT, the %age for retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1.

10. Low hydrogen electrode (AWS E-7018) for welding of High/Medium tensile steel, for M.S (IS 2062 Gr. A/Gr. B, IS 8500) sections thickness above 20mm shall be used. Preheating and Post weld heat treatment requirements shall be complied as specified in the technical specs. /approved WPS.

11. For CW liners Inspection of welds for shop and field erection shall be as follows:-

100% DPT after back gauging /grinding of butt welds by DPT kit shall be carried out as per IS-3658 . No line / round and no crack should be observed.

100%DPT shall be carried out on fillet welds by DPT kit as per IS:3658. 10% radiography shall be carried out on shop butt welds , the acceptance criteria shall be as per ASME Sec.V and ASME Sec. VIII Div.1.

100% Radiography/Ultrasonic test on field Butt welds shall be carried out , the acceptance criteria shall be as per ASME Sec.V and ASME Sec. VIII Div.1.

Hydro testing shall be done as per the method detailed out in Technical specifications

QA REQUIREMENTS FOR SHEETING WORKS.

1. Colour coated sheet
 - a) Chemical & physical properties of raw material sheet as per relevant codes.
 - b) Base Metal Thickness
 - c) Thickness of coatings
 - d) Type of coating/paint
 - e) Hardness of painted surface (2H pencil Hardness) (ASTM-D-3363)

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f) Flexibility Test Bend test as per ASTM D-328 at 180 degree bends (twice the thickness of sheet). There should not be any crack.

g) Dimensional check after profiling of sheets

k) Weathering Resistance Test

Salt spray test as per ASTM B-117 for minimum 1000 hrs. one sample per batch at random.

2. Bonded Mineral Wool Insulation

a) Thickness

b) Density

c) Thermal Conductivity

d) All other tests as per IS-8183.

3. Sheeting Installation

a) Workmanship including alignment

b) Level, Slope c) Side and End Laps

d) Proper Installation of Flashing

e) Fixing including opening,

f) Location, Installation of Lining & Installation.

3. All bought out items shall be procured from the manufacturer's approved by Employer and tested as per relevant IS Codes/ Employer Specification.

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ARCHITECTURAL & MISC. WORKS

1. Material used for floor finishes and allied work shall conform and tested as per the requirements of relevant IS Codes specified in technical Specification.

2. Finish shall be checked for :

Level, Slope, Plumb

Pattern & Symmetry

Alignment of joints, dividing strips etc.

Colour, Texture

Surface Finish Thickness of Paint

Details of edges, junction etc.

Performance Precautions specified for durability.

3. For fabricated item like metal doors, windows, ventilators, louvers, rolling shutters and grills etc. Following checks shall be carried out:

Overall Dimensions

Mullions Transoms

Doors & Windows shall operate without jamming

Doors, windows & frames etc. shall be on a true plane, free from warp or buckle.

All welds shall be dressed flush on exposed and contact surfaces.

Correctness of locations and smoothness of operation of all shop installed hardware and fixtures.

Provision of hardware & fixtures to be installed at site.

Glazing beads shall be cut with mitred corners.

Glazing clips, fixing devices etc. shall be supplied in adequate nos.

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Shop coats shall be properly applied.
Exposed aluminium surface shall be free from scratches, stains and discoloration.

ROLLING SHUTTERS/GRILLS

After installing the shutters, the contractor shall test the performance of the shutter in the presence of the engineer. The shutter shall be smoothly operable under all ambient conditions. All controls and locking devices shall give fault free performance.

FIRE PROOF DOORS

1. Fire Proof doors shall be tested for the requirements mentioned in IS-3614 Part-II and Technical Specification. The doors shall be approved by TAC & shall have minimum 2 hours fuse rating.
2. DFT of paint of Fire Proof Doors shall be checked.

GLASS AND GLAZING

1. Materials used in glass and glazing shall conform to the requirements of Employer Technical Specification and IS Codes specified in Employer Technical Specification.
2. All installation shall be free from cracked, broken or damaged glass, edges of large panes of thicker glass and heat insulating glass be inspected carefully for chipped, cracked or underground edges.
3. Glazing shall be carefully done to avoid direct contact with metal frames.
4. All glasses shall be embedded in mastic for steel works and fixed by neoprene gasket for aluminium works to give a leak proof installation.
5. On completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the engineer.

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ROOF WATER PROOFING & ALLIED WORKS

1. Material used shall be tested and conforms to the requirements of IS Codes/International Codes specified in Technical Specification.
2. All elastomeric membrane is fully dried to perform testing with water ponds created on minimum 5% of area of nominal size 6m x 6m for height of 25mm to 30mm at critical locations for a period of 48 Hrs. No dampness shall be visible on the underneath side of roof (i.e. ceiling, parapet and well junction etc.). The above testing shall be carried out prior to application of wearing course.

PAINTING & ALLIED WORKS.

1. Various materials used shall conform and tested for the requirements of Indian/International Codes specified in the Technical Specification.
2. Surface to receive paint shall be made smooth. 3. Painting shall be checked for thickness of different coats as specified in schedule of items and Technical Specification/ Drawing.

QA REQUIREMENTS FOR ROAD WORK

Quality Assurance and testing requirements for roadwork shall be as per IRC Publication-Specification for Road & Bridges (Section 900, Quality Control for roadwork)

1. Check for control of alignment and surface regularity as per Clause 902.
2. Quality control tests during construction as per Clause 903.
 - a) Tests on earth work for embankment and subgrades construction as per Clause 903.2
 - b) Tests on sub bases and bases (excluding bitumen bound base) as per Clause 903.3 (Table 900-2)
 - c) Tests on bituminous constructions (Bituminous works) as per Clause 903.4 (Table 900-3)

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3. Road work shall be carried out as per relevant IS provisions if IS provisions are provided in the specifications

VIBRATION ISOLATION SYSTEM

1. Chemical and physical properties of raw material
2. NDT on welds
3. MQP and Review of Manufacturer Test Certificates
4. Dimensional Check
5. Spring Rate Test

CHIMNEY STEEL LINERS FOR FLUES

- a) Check for chemical and physical properties of material as per relevant codes.
- b) Welding Procedure & Welders Qualification test as per ASME IX.
- c) Dye Penetration test on welds shall be carried out as per ASTM E 165.
- d) 10% spot radiography test on all butt weld shall be carried out where radiography test is not possible, Ultrasonic test shall be carried out.

Fabric Expansion Compensator :

Each layer of fabric Compensator shall be checked for thickness, unit weight, tensile strength & elongation, composite layer of the expansion joint shall be tested for temperature withstandability test. Thermal Insulation shall be checked for thickness, density, thermal conductivity test and all other tests as per IS 8183. Tests and checks

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on all other items shall be carried out as per relevant codes and Technical Specification.

QA requirement for Chimney Elevator

All check tests for raw material shall be done as per relevant material standards. Welding Procedure and Welder qualification as per ASME Sec IX. DPT on all full penetration and other welds. DPI/MPI after machining on forged components. Load test on Buffer Springs All Electrical equipment shall be of type tested quality. Type test certificate conducted during last 5 years shall be submitted for Employer approval.

UT on Racks and forged components. After installation of complete elevator necessary trial run and test shall be carried out in presence of Employer. After installation of elevator the contractor shall demonstrate the operation of safety interlocks provided to the full satisfaction of Employer.

CHIMNEY ELECTRICAL WORKS

All the equipments, being supplied shall be of type tested quality and proven one. All the equipment and devices shall be subjected to routine tests and acceptance tests as per relevant standard. The type test report shall be submitted to Employer for review and acceptance.

CHIMNEY STRUCTURAL STEEL WORKS AND MISC. METAL ITEMS QA

Requirement for this shall be as per Technical specification pertaining for Fabrication and Erection of Structural Steel Work.

STOP LOGS AND TRASH RACKS

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Structural design shall be as per IS 5620 and IS: 4622 and as per details given in tech specifications.

Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log

The trash rack to be provided shall Type-1 trash rack (removable section rack) , conforming to IS:11388(latest) .

Center to center spacing , clear opening and center to center spacing of trash bars to be provided in the rack shall be as per technical specifications

Leakage test shall be carried out in the stop logs as per the methodology specified in the technical specifications. The leakage shall then be measured and it should not be more than 5 liters/ minute /meter of length of seal under maximum head or as specified.

All material used for trash rack and stop logs shall be of high grade and free from defects and conforming to all the relevant standards mentioned for the various component material in the technical specification. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the contractor if asked by the Employer.

The contractor shall submit a Field quality Plan in Employer format incorporating all the quality aspects mentioned in the technical specifications .

The lifting beam is to be tested for twice the weight of the heaviest component to be lifted by the beam. IS:13591/1992 shall be referred for measurement of the deflection and acceptance criteria.

Geomembrane/ Geotextile Filter

Geotextile filter shall be woven type and shall satisfy the following criteria :

Material for Geotextile filter shall be 100% polypropylene .

Equivalent opening size shall be as required

Specific gravity shall be 0.91, Weight in gms/ sqm shall be min. 200. Thickness shall be atleast 0.55 mm and width to be supplied shall not be less than 1.75 meter.

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Other physical properties like Breaking strength , percentage elongation at break, grab strength ,percentage Elongation(GrabTest), tear strength (single rip) Water permeability shall be as per the details given in technical specification and as per ASTM-D-5035 , ASTM-D-5034 , ASTM-D-2261 and IS:169 (Latest edition)

Geotextile filter shall be with U-V (Ultra – violet) treatment suitable for a temperature range from 0 0C to 50 0C so that the strength and life of the same is not affected due to exposure to ultraviolet rays . In addition to the above, geotextile filter shall have good resistance to chemicals and to biological degradation.

CONSTRUCTION TOLERANCE AND ACCEPTANCE CRITERIA

Excavation and Filling Tolerance Finished surface level shall be within 20mm of the level shown in the drawing. Acceptance Criteria

Following acceptance criteria shall be followed.

- a) When only one set of sample is tested, then all individual samples collected and tested should pass without any deviation
- b) For retest of any sample two additional samples shall be collected and tested, and both should pass without any deviation.
- c) Where a large number of samples are tested for a particular test than 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

Tolerance on finished levels for important filling areas at approved interval shall be + 20mm. However, for an unimportant area, tolerance upto +75mm shall be acceptable at the discretion of the Engineer.

However, these tolerances shall be applicable for localised areas only.

Cast-in-situ concrete and Allied works

Tolerances

a) Cast-in-situ concrete

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Unless otherwise specified, the tolerance in construction shall be as follows:

Description of Item / Structural element	Permissible Deviation in mm	

The dimensions of concrete as cast when compared with those on the drawings shall be within the tolerance given below:

▪ Faces of concrete in foundations and structural members against which backfill is placed.	+ 25	- 10
▪ Eccentricity of footing 2% of footing width in the direction of placement but limited to 50mm.		
▪ Top surfaces of slabs and of concrete to receive base plates to be grouted.	+ 5	- 5
▪ Alignment of beams, lintels, columns, walls, slabs and similar structural elements.	+ 5	- 5
▪ Cross sectional dimensions of walls, slabs and similar structural elements.	+ 5	- 5

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**Description of Item /
Structural element**

**Permissible
Deviation in mm**

▪ Deviation from specified dimensions of cross-section of columns and beams.	+ 12	- 6
▪ Alignment of holding down *bolts without sleeves	+ 1.5	- 1.5
▪ Alignment of holding down *bolts with sleeves.	+ 5	- 5
▪ Level of holding down *bolt assemblies.	+ 10	- 10
▪ Embedded Parts (in any *direction).	+ 5	- 5
▪ Level of embeddment for equipment support	+1.5	0
▪ Level of embeddment for other embedded parts	+ 5	- 5
▪ Centres of pockets or holes * with greatest lateral dimension not exceeding 150mm.	+ 10	- 10
▪ Variation in steps:		
Riser	+ 1.5	- 1.5
Tread	+ 3.0	- 3.0

(b) Reinforcement

Tolerance on placing of reinforcement and for cover shall be as per clause 12.3 of IS: 456.

Reinforcement shall be placed within the following tolerances:

a)	For effective depth 200 mm or less	10mm
b)	For effective depth more than 200 mm	15mm

Tolerance for cover

Actual concrete cover should not deviate from the required nominal cover by + 10 mm

(c) Pre cast concrete

Tolerance on dimensions of pre-cast units shall be as follows:

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1. Length: +/- 0.1 percent subject to minimum of +/- 5 mm and maximum of + 10 mm. 2. Cross-sectional dimensions: +/- 3 mm or +/- 0.1 percent whichever is greater. 3. Straightness or Bow: 1/750 of the length subject to minimum of +/- 5 mm and maximum of +/- 10 mm. 4. Squareness: When considering the squareness of the corner the length of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm. 5. Flatness: The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.			
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(d) Formwork and staging

(i) Staging shall be checked for its soundness as a whole and for adequacy of the joints and its foundations. Formwork joints shall be inspected for soundness of connections. All joints shall be either vertical or horizontal and shall be such as to avoid loss of liquid through the formwork.

(ii) Dimensional tolerance for formwork shall be as per Clause 9.6 of IS : 14687 and 11.1 of IS : 456, which is reproduced as given below:

Deviation from specified dimensions of +12mm

cross section of columns and beams - 6 mm

Deviation from dimensions of footings

1) Dimensions in plan + 5 - 12 mm

2) Eccentricity 0.02 times the width of the footing in the direction of deviation but not more than 50 mm

3) Thickness 0.05 times the specified thickness

The above tolerances apply to concrete dimensions only, and not to positioning of vertical reinforcing steel or dowels.

(iii) Checklist for formwork shall be as per Clause 9.9 of IS : 14687. Format as per Annexure-C of IS : 14687 shall necessarily be made for all important structures including all machine foundations.

Acceptance Criteria

(a) The acceptance criteria of concrete shall be in accordance with clause no.16 of IS : 456. However in exceptional circumstances, and that too in non-critical areas, the Engineer may accept concrete work which is marginally unacceptable as per the criteria laid down in IS : 456. For such accepted work, payment shall be made at a reduced rate pro rate to the concrete cube strength obtained, against that stipulated.

(b) Unacceptable concrete work shall be dismantled by the Contractor and replaced by fresh work, meeting the specification requirements. In the course of dismantling, if any damage is done to the embedded items

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or adjacent structures, the same shall be made good, by the Contractor, to the satisfaction of the Engineer, at no extra cost to the Employer.

(c) Test shall be conducted for the water tightness of the liquid retaining structures as per IS : 3370 and IS : 6494.

(e) Tolerances for Cooling Tower Construction

- (i) Shell wall center line in horizontal plane measured radially at mid point on a 3m wide chord.
- (ii) Shell wall center line in meridional plane measured over a height of 1m.
- (iii) Shell thickness
- (iv) Horizontal radius of shell at any section other than shell base
- (iv) Horizontal radius at shell base.
 +/- 15 mm
 +/- 10 mm
 + 10 mm or
 - 5 mm
 +/- 50 mm
 +/- 40 mm

Check for shell geometry shall be carried out as per the method detailed out in the technical specification.

Fabrication and Erection of Structural Steel Work Tolerances

I. Fabrication tolerances

- (a) maximum permissible gap in built up members
- (b) maximum permissible deviation in depth and/or width of girder at the joints
- (c) maximum permissible out-of-square

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d) tolerances on length of beams and girders and their components

(e) permissible deviation in column heights All tolerances for above shall be as per drg / IS : 7215 II

Erection tolerances

(a) permissible tolerances in erected steel columns

(b) permissible tolerances in erected steel trusses

(c) permissible tolerances in crane girder and rails
All tolerances for above shall be as per approved drg / IS : 12843

The tolerances for structural steel used for structural purpose shall be as referred in IS:2062, IS:1730 III.

Requirement of pre-heating

Thickness of thickest part at the area of welding / heat affected zone	Welding using other than low hydrogen welding electrodes IS : 2062	Welding using low hydrogen welding electrodes or submerged arc welding IS:2062
Upto 20 mm (including)	None	None
Over 20 mm to 40 mm (including)	66° C	20° C
Over 40 mm to 63 mm (including)	Not allowed	66° C
Over 63 mm	Not allowed	110° C

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Acceptance Criteria

- (a) The acceptance criteria of Non Destructive Testing (NDTs) on welds shall be as per AWS D1.1 (Dynamically Loaded Structures - tension welds). In case of failure of any of the tests, the Contractor at his own cost shall also carry out rectification of such defective welds. Retesting of the rectified joint, shall also be carried out by the Contractor at his own cost.
- (b) Every 1st and further every 10th set of identical structure shall be checked for control assembly in shop before erection. Embedded part Tolerances shall be as specified under concrete works.

Masonry & Allied works Tolerances

- (a) All masonry shall be built true and plumb within the tolerances prescribed as below. Care shall be taken to keep the perpend properly aligned.
Unless specified otherwise the tolerances in construction of masonry shall be as below:
- i) Deviation in verticality in total height of any wall of a building more than one storey in height shall not exceed 12.5mm.
 - ii) Deviation from vertical within a storey shall not exceed 6mm per 3m height.
 - iii) Deviation from the position shown on the plan of any brickwork more than one storey in height shall not exceed 12.5mm.
 - iv) Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment shall not exceed 6mm.
 - v) Deviation of bed joint from horizontal in any length upto 12m shall not exceed 6mm, and in any length over 12m it shall not exceed 12.5mm total.
 - vi) Deviation from the specified thickness of bed-joints, cross-joints or perpend shall not exceed 3mm.

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b) The plastered surface shall be checked for

i) Blistering, bond failure or loss of adhesion, cracking, crazing, efflorescence, grinning, irregularity of surface texture, popping or blowing, recurrent surface dampness, softness or chalkiness defects and the remedial measures for the same shall be adopted as per IS: 1661.

ii) The finished plastered surface shall not show any deviation more than 4 mm when checked with a straight edge of 2 metre length placed against the surface.

iii) The thickness of the plaster shall be measured exclusive of the thickness of key i.e., grooves or open joints in brickwork. The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness by more than 3 mm for plaster thickness above 12mm and 1 mm for ceiling plaster. Extra thickness required in dubbing behind rounding of the corners at junctions of wall or in plastering of masonry cornices etc. shall be ignored.

Acceptance Criteria

Following acceptance criteria shall be followed:

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

Tolerances are within the specified limit.

Material test certificate is in compliance with the applicable codes

Bought out material is from the approved manufacturer / vendor.

Bought out material is matching with the approved sample.

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Finishing & Allied works Tolerances

- a) The floor finish shall be checked specially for the following :
- Level, slope, plumb as the case may be
 - Pattern and symmetry
 - Alignment of joints, dividing strips etc.
 - Colour, texture
 - Surface finish
 - Thickness of joints
 - Details of edges, junction etc.
 - Performance
 - Precautions specified for durability Local depressions on account of faulty workmanship shall not be acceptable. Tiles / natural stones with cracked or broken/chipped edges shall not be acceptable.
- b) The door, window, ventilator, partition during and after fitting and fixing etc shall be checked for the following:
- Installation shall be at correct locations, elevations and in general on a true vertical plane.
 - Fixing details shall be strictly as shown on drawings.
 - Assembly of composite units shall be strictly as per drawing, with mastic caulking at transoms and mullions, gaskets, weather strips etc. complete.
 - All frames on external wall shall be mastic caulked to prevent leakage through joint between frames and masonry.
 - All openable sections shall operate smoothly without jamming. Lock, fasteners, etc, shall engage positively. Keys shall be non-interchangeable.

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vi) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint or same quality as shop paint.

vii) Aluminium doors, windows, ventilators, partitions etc., shall be free from scratches, stains or discolouration. viii) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more

A) For False ceiling system following shall be checked for

- i) As installed shall be true to shape, level.
 - ii) Correctness for the opening for the fixtures, colour and shade.
 - iii) All joints shall be in the same line and cross joints shall be securely fixed to walls.
 - iv) There shall not be any sagging and/ or unevenness in the surface
- Acceptance criteria

Ceiling panels shall be best quality material in thickness and properties called for in the schedule of items. Material Test Certificate to be submitted before bulk supply.

Finished ceiling shall be at the correct plane and prevent an aesthetically pleasing and uniform appearance, free from sags and warps. Joints and exposed grids shall be in true lines and symmetrically placed in manner as shown in drawings. Cut outs for light fixtures, diffusers and other relevant services shall be of exact dimensions and in exact locations.

B) Water proofing

Water proofing shall be tested for water tightness by creating a pond of water minimum 25 mm height on area of 6 m x 6 m, for the period of 48 hrs on fully dried elastomeric membrane surfaces. Minimum 5%

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area of the roof shall be subjected to water tightness test. Such test necessarily be conducted on vulnerable areas like drain channel/ drain head. No dampness shall be visible on the underneath side of roof (i.e. ceiling), parapet and well junctions etc. which have been subjected for testing. The above testing shall be carried out prior to application of wearing course.

Water Supply, Drainage & Sanitation Tolerances

A) All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drain laid below ground shall be watertight.

B) Obstruction / Straightness Test

The obstructions shall be checked by inserting a smooth ball, of diameter 13 mm less than the pipe bore at the drain. If absence of any obstructions, such as yarn or mortar projecting through the joints, ball shall roll down the invert of the pipe and emerge at the lower end. The straightness shall be checked by means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of the light may be observed. The mirror will also indicate obstruction in the barrel, if the pipeline is not straight.

C) Service Pipes Testing With Water

The service pipes shall be slowly and carefully charged with water, allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working condition of pressure and flow, when all draw off taps are closed. The service pipes shall be checked for satisfactorily support and protection from damage corrosion and frost.

D) Fixtures etc.

All fixtures and fittings shall be connected by watertight joints. No dripping of water shall be acceptable.

Acceptance criteria Following acceptance criteria shall be followed:

General workmanship is being good and is recommend by the manufacturer and approved by the engineer.

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Tolerances are within the specified limit.

Material test certificate is in compliance with the applicable is codes.

Bought out material is from the approved manufacturer / vendor.

Bought out material is matching with the approved sample.



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TYPICAL FIELD QUALITY LAB EQUIPMENT

ANNEXURE - I

S.No	Equipment	Nos.
1	Vicat Apparatus with deskpot	2
2	Le chatelier flask	2
3	Le chatelier Mould	2
4	Cube Moulds for cement testing	12
5	Vibration Machine	1
6	Laboratory cement autoclave	2
7	Length comparator	2
8	<i>Shrinkage Bar mould</i>	2
9	Sieve shaker	1



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10	Sieves for sand, coarse & fine aggregate	1 set for each
11	Sieves for coarse aggregate for Road	1 set
12	Proctor testing equipment	2 sets + 18 cores
13	Slump testing equipment	6 sets
14	Oven	2
15	Physical balance	1
16	Rapid moisture meter	2
17	Thermometer	4
18	Burret	2
19	Measuring cylinders	9
20	Measuring flasks	3
21	Compression testing machine	2 sets of 2000 kN capacity each
22	Cube moulds	30
23	Electronic balance	2 (12 kg capacity), 2 (200



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		mg capacity)
24	pH balance	As per requirement
25	Radiographic facilities	Party should deploy BARC approved agency for carrying out RT
26	Mechanical weighing machine	1 (100 kg capacity)
27	Ultrasonic testing machine	As per requirement
28	D.P. Test kit	10
29	Vernier 300 mm, 600 mm	2
30	Micrometer (0.25 mm) out side (25.00)	2
31	Radiography film viewer	1
32	Inside Micrometer 25-750 dia	2
33	Digital elcometer for paint thickness	2
34	Baking oven for electrode	3
35	Portable ovens	2

Note : The list of equipment shown above is indicative additional equipment if any, required for successful completion of work shall be provided /arranged by the contractor



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LIST OF BOUGHT OUT ITEMS*

ANNEXURE -II

Zinc silicate primer

Polly Amide cured painting system

High solid content liquid applied urethane based elastomeric membrane as per ASTM C836 and C898

Epoxy based coloured pigmented finish , polyamide cured paint

Epoxy adhesive and structure sealant

Electro Forged gratings of M.S. conforming to IS:2062

Glass Block for Glass block masonry work

Unitized Glazing system of approved glass and structural system

Heavy duty C.C tiles with abrasion resistant Corborundum / quartz chips

Glass Mosaic tiles

Vitrified ceramic tiles

PTFE type sliding bearings

Modular aerated concrete panels with U channels as per IS:277m galvanized steel expansion fasteners and fiberglass tape

Colour coated metal decking

Troughed permanently colour coated sheets

Pre-Engineered Buildings .

Fire Proof single leaf / double leaf metal doors with mineral wool insulation, conforming to IS:3614 with panic device and panic lock, horizontal full width lever, openable on pressing door stoppers

Automatic operation systems for doors size 2000x2100 mm with all electrical and mechanical accessories

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False Ceiling suspension System

Anchor Fasteners

Plasticizers

Aluminium composite panel cladding comprising of 4 mm thick thermoplastic core of mid low density polyethylene sandwiched between two skins of minimum 0.5 mm thickness .

Granular textured coating finish

***Note:** The above list is indicative only additional items if any ,required for successful completion of work may be added in the list



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ANNEXURE :- IV

FORMAT FOR WEEKLY REPORTING OF UTILISATION OF EQUIPMENTS

EQUIPMENT NAME AND DETAILS :		WEEK ENDING ON :	
PLANNED WEEKLY			
Quantity Of Work	Cumulative Quantity Of Work	Hours of equipment required for planned quantity of work	Cumulative Hours of equipment required
ACTUAL WEEKLY			
Quantity Of work completed by T&P	Cumulative Quantity Of work Completed by T&P	Quantity of work completed by manual means	Cumulative Quantity of work completed by manual means
1. Whether the printer of batching plant is operational and batchwise weekly yield of batching plant is enclosed - Yes / No/ Not applicable			
2. Whether the compressor / cleaning mechanism of concrete pump is operational - Yes/ No / Not Applicable			
3. Whether the electricity supply connections to all T&P's has been checked - Yes/ No / Not Applicable			
4. Description of Needle vibrators available at site :-			
	Diameter	Nos.	
5. The calibration of batching plant is valid - Yes/ No / Not Applicable			
(Signature of Quality Personnel of Contractor)			

1500 MW PRAGATI – III CCPP
DOC. NO. CW-CM-9472-C-O-M-001

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FIELD QUALITY PLAN

ANNEXURE-V

S.No	Characteristics/Item	Type of Check	Instrument	Class	Quantum/ Frequency of check	Ref. documents and acceptance standard	Format of record	Remarks
1	2	3	4	5	6	7	8	9
1	Excavation and Filling							
1.1	Nature of soil/rock	Visual	As required	B	Random	As per Contractors scheme for excavation	SR	Field Laboratory Test Equipment List is enclosed.
1.2	Initial ground level	Measurement	Digital Theodolite/ Total Station	B	100%		SR	
1.3	Dimensions of excavated pit.	Measurement	As required	B	100%		SR	
1.4	Final pit/bed level.	Measurement	As required	B	100%		SR	
1.5	Side slope during excavation	Measurement	As required	B	Random		SR	
1.6	Excavation in Hard Rock.							
	a) Receipt & Storage of Explosive	Physical	-	A	100%	Indian Explosive Act, 1940	SR	Agency employed shall be got approved from Employer Site Engr. Incharge.
	b) Blasting Operation	Physical	Compressor Drilling Machine	A	100%	IS : 4087	SR	
1.7	Excavation in Hard Rock (Blasting Prohibited)	Physical	- do -	A	100%	As per approved drawing / scheme	SR	
1.8	Fill (suitability of borrow							



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S.No	Characteristics/Item	Type of Check	Instrument	Class	Quantum/ Frequency of check	Ref. documents and acceptance standard	Format of record	Remarks
1	2	3	4	5	6	7	8	9
	material)							
1.8.1	Grain size analysis	Physical	As required	B	One in every 2000 cum for each type and source of fill materials subject to a min. of 2 samples	IS:2720 (Pt. IV)	SR	
1.8.2	Liquid & plastic limit	Physical	As required	B	One in every 2000 cum for each type and source of fill materials subject to a min. of 2 samples	IS:2720 (Pt. IV)	SR	
1.8.3	Shrinkage limit	Physical	As required	B	One in every 5000 cum for each type and source of fill materials	IS:2720 (Pt. IV)	SR	It should not be worse than existing/ virgin soil
1.8.4	Free Swell index	Physical	As required	B	One in every 5000 cum for each type and source of fill materials	IS:2720 (Pt. XI)	SR	-do-
1.8.5	Chemical Analysis				One in every 5000 cum for each type and each source of fill materials			
i	Organic matter	Physical	As required	B		IS 2720 Pt. XXII	SR	It should not be more aggressive than existing / virgin soil
ii	Calcium carbonate	Physical	As required	B		Part XXIII	SR	
iii	pH value	Physical	As required	B		Part XXVI	SR	
iv	Total soluble sulphate	Physical	As required	B		Part XXVII	SR	
1.8.6	Standard Proctor Test to determine optimum moisture content and dry	Physical	As per IS: 2720	A	One in every 2000 cum for each type and source of fill materials	IS 2720 (Pt. VII)	SR	



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S.No	Characteristics/Item	Type of Check	Instrument	Class	Quantum/ Frequency of check	Ref. documents and acceptance standard	Format of record	Remarks
1	2	3	4	5	6	7	8	9
	density of fill							
1.8.7	Moisture content of fill before compaction	Physical	As per IS: 2720	A	One in every 2000 cum for each type and source of fill materials	IS 2720 (Pt. II)	SR	
1.8.8	Degree of compaction fill							
i	Dry density by core cutter method	Physical	As per IS: 2720	A	i) For foundation back fill one for every 10 foundations for each compacted layer	IS 2720 (Pt. XXIX)	SR	Test For compacted soil
	OR							
	Dry density inplace by sand displacement method	Physical	As per IS-2720	A	ii) For area filling, one every 1000 SQM area for each compacted layer	IS 2720 (Pt. XXVIII)	SR	
ii	Relative density (Density index)	Physical	As per IS-2720	A	-do- (i) & (ii) above	IS 2720 (Pt. XIV)	SR	Test for sand .
iii	Dry Density by proctor needle penetration	Physical	As per IS-2720	B	Random checks to be carried out for each compacted layer	Standard practice	SR	
1.8.9	Sand	Physical	As per IS 383	B	Random	As stipulated in specifications / drawing	SR	
2.0	Cast-in-situ concrete							
2.01	Materials							



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S.No	Characteristics/Item	Type of Check	Instrument	Class	Quantum/ Frequency of check	Ref. documents and acceptance standard	Format of record	Remarks
1	2	3	4	5	6	7	8	9
2.01.01	Cement							
	Setting Time*	Physical	As per IS	A	One sample from each lot	As per IS 4031	SR/TR	
	Compressive Strength*	Physical	As per IS	A	One sample from each lot	As per IS 4031	SR/TR	
	Ensure that cement is stored in weather tight covered storage on raised platform	Visual		B	100% covered storage	Covered storage, weather tight on raised platform	SR /LB	Cement held more than 60 days in contractor's godown has to be tested for compressive strength and setting time.
2.01.02	Coarse Aggregate							
i	Moisture content	Physical	As per IS Code	B	Once for each stack of 100 Cu.M. Or part there of Except during monsoon when this has to be done every day before start of concreting	IS: 2386 Part-III IS:456 IS: 383	SR/LB	Accordingly water content of the concrete will be adjusted
ii	Specific gravity, density, voids, absorption.	Physical	As per IS Code	B	Once for each source and for every change of source	IS: 2386 Part-III IS:456, IS: 383	SR/LB	These tests will be carried out while establishing design mix and the results to be intimated to Employer.
iii	Sieve Analysis (particle, size & shape)	Physical	As per IS Code	B	One per 100 cum. (or) change of source which ever is earlier once per source	IS: 2386 Part-I IS: 383	SR/LB	



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FIELD QUALITY PLAN

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S.No	Characteristics/Item	Type of Check	Instrument	Class	Quantum/ Frequency of check	Ref. documents and acceptance standard	Format of record	Remarks
1	2	3	4	5	6	7	8	9
1	Excavation and Filling							
1.1	Nature of soil/rock	Visual	As required	B	Random	As per Contractors scheme for excavation	SR	Field Laboratory Test Equipment List is enclosed.
1.2	Initial ground level	Measurement	Digital Theodolite/ Total Station	B	100%		SR	
1.3	Dimensions of excavated pit.	Measurement	As required	B	100%		SR	
1.4	Final pit/bed level.	Measurement	As required	B	100%		SR	
1.5	Side slope during excavation	Measurement	As required	B	Random		SR	
1.6	Excavation in Hard Rock.							
	a) Receipt & Storage of Explosive	Physical	-	A	100%	Indian Explosive Act, 1940	SR	Agency employed shall be got approved from Employer Site Engr. Incharge.
	b) Blasting Operation	Physical	Compressor Drilling Machine	A	100%	IS : 4087	SR	
1.7	Excavation in Hard Rock (Blasting Prohibited)	Physical	- do -	A	100%	As per approved drawing / scheme	SR	
1.8	Fill (suitability of borrow							



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S.No	Characteristics/Item	Type of Check	Instrument	Class	Quantum/ Frequency of check	Ref. documents and acceptance standard	Format of record	Remarks
1	2	3	4	5	6	7	8	9
	material)							
1.8.1	Grain size analysis	Physical	As required	B	One in every 2000 cum for each type and source of fill materials subject to a min. of 2 samples	IS:2720 (Pt. IV)	SR	
1.8.2	Liquid & plastic limit	Physical	As required	B	One in every 2000 cum for each type and source of fill materials subject to a min. of 2 samples	IS:2720 (Pt. IV)	SR	
1.8.3	Shrinkage limit	Physical	As required	B	One in every 5000 cum for each type and source of fill materials	IS:2720 (Pt. IV)	SR	It should not be worse than existing/ virgin soil
1.8.4	Free Swell index	Physical	As required	B	One in every 5000 cum for each type and source of fill materials	IS:2720 (Pt. XI)	SR	-do-
1.8.5	Chemical Analysis				One in every 5000 cum for each type and each source of fill materials			
i	Organic matter	Physical	As required	B		IS 2720 Pt. XXII	SR	It should not be more aggressive than existing / virgin soil
ii	Calcium carbonate	Physical	As required	B		Part XXIII	SR	
iii	pH value	Physical	As required	B		Part XXVI	SR	
iv	Total soluble sulphate	Physical	As required	B		Part XXVII	SR	
1.8.6	Standard Proctor Test to determine optimum moisture content and dry	Physical	As per IS: 2720	A	One in every 2000 cum for each type and source of fill materials	IS 2720 (Pt. VII)	SR	



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S.No	Characteristics/Item	Type of Check	Instrument	Class	Quantum/ Frequency of check	Ref. documents and acceptance standard	Format of record	Remarks
1	2	3	4	5	6	7	8	9
	density of fill							
1.8.7	Moisture content of fill before compaction	Physical	As per IS: 2720	A	One in every 2000 cum for each type and source of fill materials	IS 2720 (Pt. II)	SR	
1.8.8	Degree of compaction fill							
i	Dry density by core cutter method	Physical	As per IS: 2720	A	i) For foundation back fill one for every 10 foundations for each compacted layer	IS 2720 (Pt. XXIX)	SR	Test For compacted soil
	OR							
	Dry density in place by sand displacement method	Physical	As per IS-2720	A	ii) For area filling, one every 1000 SQM area for each compacted layer	IS 2720 (Pt. XXVIII)	SR	
ii	Relative density (Density index)	Physical	As per IS-2720	A	-do- (i) & (ii) above	IS 2720 (Pt. XIV)	SR	Test for sand .
iii	Dry Density by proctor needle penetration	Physical	As per IS-2720	B	Random checks to be carried out for each compacted layer	Standard practice	SR	
1.8.9	Sand	Physical	As per IS 383	B	Random	As stipulated in specifications / drawing	SR	
2.0	Cast-in-situ concrete							
2.01	Materials							



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1	2	3	4	5	6	7	8	9
2.01.01	Cement							
	Setting Time*	Physical	As per IS	A	One sample from each lot	As per IS 4031	SR/TR	
	Compressive Strength*	Physical	As per IS	A	One sample from each lot	As per IS 4031	SR/TR	
	Ensure that cement is stored in weather tight covered storage on raised platform	Visual		B	100% covered storage	Covered storage, weather tight on raised platform	SR/LB	Cement held more than 60 days in contractor's godown has to be tested for compressive strength and setting time.
2.01.02	Coarse Aggregate							
i	Moisture content	Physical	AS per IS Code	B	Once for each stack of 100 Cu.M. Or part there of Except during monsoon when this has to be done every day before start of concreting	IS: 2386 Part-III IS:456 IS: 383	SR/LB	Accordingly water content of the concrete will be adjusted
ii	Specific gravity, density, voids, absorption.	Physical	As per IS Code	B	Once for each source and for every change of source	IS: 2386 Part-III IS:456, IS: 383	SR/LB	These tests will be carried out while establishing design mix and the results to be intimated to Employer.
iii	Sieve Analysis (particle, size & shape)	Physical	As per IS Code	B	One per 100 cum. (or) change of source which ever is earlier once per source	IS: 2386 Part-I IS: 383	SR/LB	



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1	2	3	4	5	6	7	8	9
iv	Deleterious materials	Physical	As per IS Code	B	Once for each source and for every change of source	IS: 2386, Part-II, IS: 383	SR/LB	Experts opinion regarding suitability of the material shall be obtained from NCBM / CSMRS
v	Soundness	Physical	As per IS Code	B	- do -	IS: 2386, Part-V IS:383	SR/LB	- do -
vi	Acid & Alkali reactivity	Physical	As per IS Code	B	- do -	IS: 2386, (Part-VII) IS:383	SR/LB	- do -
vii	Flakiness & Petrographic examination	Physical	As per IS Code	B	- do -	IS: 2386, IS: 383	SR/LB	- do -
viii	Crushing value, abrasion value	Physical	As per IS Code	B	- do -	IS: 2386 Part-IV	SR/LB	
	and impact value		IS Code			IS:383		
ix	Repeated Temp. Cycle Test of Aggregate.	Test	As per IS Code	B	Once for each source and for every change of source	No residual expansion	Test Report	Applicable for Aggregate used in TG, BFP, Fan & Mills Foundations
2.01.03	Fine Aggregate							
i	Bulkage, moisture content	Physical	As per IS Code	B	To be done every day before start of work	IS: 2386 Part-III IS: 383	SR/LB	Volume of sand and weight of water shall be adjusted as per bulkage & moisture content



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1	2	3	4	5	6	7	8	9
ii	Mortar making Properties	Physical	As per IS Code	B	- do -	IS: 2386, IS: 383	SR/LB	Acceptability criteria as per IS:383
iii	Silt , clay content and organic impurities	Physical	As per IS Code	B	Once for each source and for every change of source .	IS: 2386 Part-II IS: 383	SR/LB	
iv	all other tests similar to coarse aggregates excluding petrographic examination							
2.01.04	Water							
i	Test for neutralization of water using indicator.	Physical	Chemical Reagent	B	Once for every change of season and on every change of source	IS:3025, IS : 456	SR/LB	
ii	Tests for ascertaining limit of solids	Physical	As per IS Code	B	-do-	IS:3025, IS : 456	SR/LB	
iii	Tests for pH Value	Physical	As per IS Code	B	-do-	IS:3025, IS : 456	SR/LB	
2.02.01	Concrete							
i	Workability - slump test	Physical	As per IS Code	B	One sample every 2 hrs. from every mixing plant.	IS: 456	SR/LB	
ii	Trial mix (Cubes compressive strength) Mix Design	Physical	As required	A	Min. 4 Trial Mixes with admixtures without admixtures	IS-516& IS: 456, IS:10262	SR/LB	For trial mix min of 6 cubes for each mix. 3 specimens shall be tested at 7 days



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1	2	3	4	5	6	7	8	9
					with fly ash			remaining 3 shall be for 28 days comp. Strength
iii	Crushing strength (works Tests cubes)	Physical	As required	A	One set of 6 cubes per 100 cum or part thereof for each grade of concrete , per shift whichever is earlier	IS: 516, IS:456	SR/LB	Min. of 6 cubes for each mix. 3 specimens shall be tested at 7 days remaining 3 shall be for 28 days comp. Strength
iv	Water cement ratio	Physical	As required	B	At random at the time of batching	As per IS: 1199 and approved design mix.	SR/LB	
v	Cement content	Physical	As required	B	At random at the time of batching	IS:1199 and approved design mix.	SR/LB	
vi	Admixtures for Concrete	Testing	As per IS Code	B	100%	IS:456 and approved design mix	Test Report	Admixtures of approved brand and tested quality shall be used.
Vii	Water Tightness Test for Water Retaining Structures	Test	As per IS Code	B	100%	IS:3370	Inspection Report	
Viii	Dimensions of finished structure	Physical	- do -	B	100%	As per Tech. specification.	- do -	
2.02.02	Concrete conveying, placing & compaction							
i	Calibration of Batching Plant	Physical	As required	A	To be calibrated at the time of starting and subsequently once in	Review of Test certificate	TC	Cement consumption at batching plant shall also be obtained



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1	2	3	4	5	6	7	8	9
					three months.			through comp. output
ii	Transportation of concrete	Physical	Visual	B	100%	as per construction erection methodology	SR	
iii	Placement of concrete	Physical	Visual	B	100%	as per construction erection methodology	SR	
iv	Temperature Control of Concrete for top deck of TGs	Test	Thermometer	B	100%	temperature 25 Deg. C.	SR	
v	Check for placement	Physical	-	B	100%	As per approved drg.	SR	
vi	Compacting	Physical	As required	B	At Random	check for segregation as per IS 456	SR	
Vii	Curing	Physical	As required	B	At Random	Check for period of curing as per IS 456	SR	
Viii	Cleanliness, provision of chute and arrangement for transportation and placement of concrete	Visual	As required	C	100%		Inspection report	
2.02.03	TEST /CHECK ON RCC STRUCTURE IN HARDEDENED CONDITIONS							
i	Ultrasonic Test on top deck of TG foundation	Test	UT Machine	A	- do -	IS:13311 Part-I, and Tech. Specification.	Test Report	The grid shall be 300 mm c/c or as required by the Engineer.
ii	Core Test	Physical	As required	A	As required by Employer.	As per IS 456	SR/LB	



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1	2	3	4	5	6	7	8	9
iii	Dimensional check on finished structures & Dimensional Tolerances	Measurement	As required	B	Approved Drawing	As per IS:456/ tech. Specification.	SR/LB	
iv	Water Tightness Test of liquid retaining structure/tanks	Test	-	A	100%	IS:3370 / Tech. Specification.	SR/LB	
2.03	REINFORCEMENT STEEL							
i	Physical, chemical properties	Review of TCS		A	Each consignment	IS: 1786 , IS:432 IS: 1566	Mfr. TCS	In the absence of manufacturer's test certificate check testing shall be carried out. "consignment shall be considered as 50 MT"
ii	Tolerance	Measurement	As required	B	At Random	IS: 1852 , IS:432, IS: 1786	SR/LB	
iii	Freedom from cracks surface flaws, Lamination	Visual	As required	B	100%	IS: 1852, IS-432, IS: 1786	SR/LB	To be checked at site. Steel collected from source should be free from excessive rust. To be stored as per Technical Specs
2.03.01	Placement of Reinforcement Steel							
i	Check for bar bending schedule with necessary laps. Spacers & chairs	Visual & measurement	As required	B	100%	Approved Drawings	SR	



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ii	Check for cover, spacing of bars	Visual measurement	As required	B	100%	Approved Drawings	SR	
iii	Check for bending of bars	Visual measurement	As required	B	100%	Approved Drawings	SR	
iv	Check for spacers and chairs after the reinforcement cage put inside the formwork	Visual measurement	As required	B	100%	Approved Drawings	SR	
v	Lapping of bars	Measurement	As required	B	100%	IS: 456 & approved bar bending schedule	SR	
vi	Check all joints, Crossing		As required	B		Approved drawing/bar bending schedule	SR	
2.04	STAGING AND FORMS							
2.04.01	Materials and accessories	Visual	As required	B	Once	As per relevant IS	SR	Formwork materials shall be strictly as per specifications and approval of the Engineer. Materials for the formwork shall be warped thoroughly clean and without broken or damaged edges either due to repetitive use or otherwise. Oiling of formwork before



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i	Soundness of staging, shuttering and scaffoldings	Visual	As required	B	Once	As per manufacturer's spec.	SR	Concreting shall be resorted to.
ii	Connections between individual scaffolding units and safe slenderness ratio. Two independent safety measures against collapse	Visual	As required	B	Fortnightly	As per National Safety council & relevant IS codes i.e. IS:14687	SR	
iii	Concrete strength during climbing process.	Physical Testing	As per provision	IS B	For each lift of shuttering	As per provisions and tolerances	SR	
iv	Hoisting for personnel and materials	Visual	As required	B	Fortnightly	As per manufacturer recommendation & safety codes	SR	
v	Alignment /shape	Measurements	As required	B	For each lift of shuttering	As per approved drawings	SR/LB	
vi	Check form's seam marks and water tightness	Physical	As required	B	Random	As per approved drawings.	SR/LB	
2.05	Embedded part							
i	Position and level of embedded parts	Dimensional	As required	B	100%	As per drawing / Part C of Technical Specifications	SR	
ii	Position depth and size of bolt hole	Dimensional	As required	B	At random	As per drawing / Part C of Technical Specifications	SR	



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iii	Location vertically of pipe sleeve/ opening of bolt hole	Dimensional	As required	B	At random	As per drawing / Part C of Technical Specifications	SR	
iv	Load carrying capacity of supporting fixtures/ Expansion fasteners(for supporting false ceiling/ pipe, grid ducts, cable supports in RCC/ Brickwork etc)	Physical Test	As required	B	3 sets of each type/ lot	1.5 times the design load as per specifications & drawing	SR	
V	Welding /tying of embedment reinforcement	Dimensional to	As required	B	At random	As per drawing / Part C of Technical Specifications	SR	
2.06	Pre-cast concrete							
i	Workmanship free from visual defects	Physical	Visual	B	100%	Tech Spec	Register	The precast units shall be free from defects like honeycombing, reinforcement exposure and should have good finish All relevant tests like workability, cube test shall be carried out as per IS 456 Same as applicable to cast in situ concrete
ii	Dimension of finish structure	Measurement	As required	B	100%	As per IS:456/ Employer Tech. specification	SR	If the material already tested of the cast-in-situ concrete and part



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								of the same is used for precast concrete , further testing is not required , otherwise testing is required for every 50 Cum of concrete
iii	Load Test	Physical	As required	B	100%	IS:456/As decided by Employer.	Inspection Report	These tests shall be carried out in case of doubt regarding grade of concrete and poor quality .
3.00	Structural steel (Fabrication & Erection)							
	Material							
	Visual Examination of raw material	Visual	--	B	100%	Free from surface Defects		
3.01	FIT UP							
3.01.00	Marking and Cutting	Visual & Measurement		B	100%	Approved Drawing	Site Register	In case, the material is supplied by Contractor, correlated MTC shall be verified. In the event of non sub-mission of MTC, sample shall be collected and tested for physical and metallurgical properties.



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3.01.01	Ensure Proper fit up before welding	Measurement	Measurement tap	B	100%	Drg. & Tech. specification dimensional Checking as per Clause 2.03.07 (I&II) Part C of Technical Specs	Log book/site register	Proper Identification mark to be put. If laminations are found during cutting of the material same shall not be used.
3.01.02	Check that the gap is minimum for all fillet welds	- do -	- do -	B	100%	- do -	- do -	
3.01.03	Ensure that the butt weld joints are properly aligned and the offset does not exceed 10% of the thickness of the thinner part of the joint maximum permitted value is 3.2 mm	- do -	- do -	B	100%	- do -	- do -	
3.01.04	Ensure match markings are punched for all trial assembled components	- do -	- do -	B	100%	- do -	- do -	
3.01.05	Check Weld Fit Up.	- do -	- do -	B	100%	Approved Drg.	- do -	
3.02	Preheating							
3.02.01	Ensure pre-heating is carried out wherever applicable	Visual	Thermal Chalk	B	100%	Employer Tech spec and Cl. 2.03.07 (III) of Technical Specs	- do -	
3.02.02	Ensure that the	Measurement	- do -	B	100%	- do -	- do -	



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	preheating temperature is uniform prior to the start of welding							
3.02.03	Post Weld Heat Treatment (PWHT)	Time & Temperature	- do -	A	100%	Employer Tech. specification	- do -	
3.03	Welding							
3.03.01	Ensure that the qualified welders and qualified welding procedures are used for all welding	Testing	- do -	A	100%	Approved WPS/WPS AWS-D1.1/ ASME-IX	Test Report	In case of WPS already available similar base material and filler, records may be submitted for Employer review, review and approval .
3.03.02	Ensure that the welding consumables used are as per procedure approved by EMPLOYER.	Testing	- do -	A	100%	Approved WPS./ Employer Rationalised list of Electrodes.	SR	WPS to be submitted for Employer approval and low hydrogen electrodes to be used for welding of high/ medium tensile steel .
3.03.03	Ensure proper edge preparation wherever applicable	Visual Measurement	Bevel Protractor	C	100%	Approved Drg. & Employer Tech. Spec.	Site Register	
3.03.04	Ensure proper sequence of welding	Visual		B	100%	- do -	- do -	
3.03.05	Check that the temporary attachment welding are removed and ground	Visual	- do -	B	100%	- do -	- do -	



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3.03.06	Check & ensure that the overlap/ excess weld metal is removed by grinding and painting.	Visual		B	100%	- do -	- do -	
3.03.07	Check the measurement of parts/ structures after welding for the correctness of dimensions & matching, absence of distortion & alignment.	Measurement	Measuring tape	B	100%	- do - IS-7215/Approved. Drg.	- do -	
3.04	Non Destructive Testing							
3.04.01	Carry out RT/UT/LP/ Micro etch test	Testing	Testing equipment.	A	CI 2.03.01 to 03 of Part C	CI 2.03.01 to 03 of Part C of Employer Tech Specs	Protocol Reports	
3.04.02	Trial Assy/Control Assy of Structures.	Assy.	-	B	Employer specification	Employer Tech. Specification & approved Drg./ CI 2.03.07 (I&II) & 2.003.08 of Part C of Employer Tech specs	- do -	
3.04.03	Micro etch on production test pieces for main fillet weld of crane girders column and butt welds	Physical	Test set up	A	Test coupons for fillet welds with min. one joint per built up columns and crane girders	AWS D1.1, ASME -IX, Employer tech specifications	TR/SR	
3.04.04	Mechanical testing of butt weld on production test coupon	Tensile and bend test	-do-	A	Min. one joint per column / built up beams / girders	Technical specifications IS :1599 & IS:1608	TR / SR	No crack should be visible on weld after the bend test and the tensile strength of the weld should not be less



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								than the present metal
3.05	Cleaning and Painting							
3.05.01	Ensure that the surface are cleaned and painted as specified. Dry Film Thickness				For details please see Appendix II / Relevant painting provisions at Sl. No.5.05 and 5.06			
3.05.02	Ensure that the following markings are done	Visual / Physical		C	100%	Employer technical Specification & approved Drg.	- do -	
	a) Assembly designation							
	b) Part number							
	c) Weight							
	d) Any other important identifications							
3.06	Foundation Checks							
3.06.01	Ensure that availability of permanent Bench Mark	Visual	-	C	100%	Approved Employer specification Drg./ Tech.	Site Reg.	
3.06.02	Ensure the foundation are cast as per requirements	Measurement	Measurement Tape	B	100%	- do -	- do -	



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3.06.03	Check the orientation of the foundation	Visual	-	C	100%	- do -	- do -	
3.06.04	Check the top level of foundation pedestal with respect of the permanent bench mark.	Measurement	Total works station	B	100%	- do -	- do -	
3.06.05	Check the center to center distance of column foundation pedestals with respect to the reference axis.	- do -	Measuring Tape	B	100%	- do -	- do -	
3.06.06	Check the diagonals between columns	- do -	- do -	B	100%	- do -	- do -	
3.06.07	Check the pitch distance of foundation bolts on both axis & diagonal.	- do -	- do -	B	100%	- do -	- do -	
3.07	Column pre-Assembly Checkup							
3.07.01	Ensure cleaning of Base Plate & HSFG bolt area	Visual						
3.07.02	Check individual column places for identification No. match mark column No. length camber sweep.	Measurement	Measurement	B	100%	Approved Drg. & Employer Tech. Spec.	- do -	



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3.07.03	Ensure columns are pre-assembled as per match marks and center line already punched on the column pieces and respective splices plates, when ever applicable. 1. Interchanging of column pieces and tuning of column by 180 degree is not permitted. 2. Splice plates are to be positioned as per match mark and placing them Upside down/ turning by 180 degree Shall be totally avoided.	Visual	-	B	100%	Drg./ Employer Tech. Spec.	Site Register	
3.07.04	Check camber, sweep, match mark and total length after trial assembly of columns. Note : Thickness of packer plates shall be decided based on total length of columns and the top level of corresponding foundation.	Measurement	Measuring Tape	B	100%	Employer technical specifications Cl. No.2.03.07 of Part c , IS:7215 and IS:12843	- do -	



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3.08	Roof Truss Pre-assembly checks							
3.08.01	Ensure roof trusses are pre-assembled as per match mark C.G. line punched on top and bottom angles.	Visual	-	C	100%	- do -	- do -	
3.08.02	Check the following							
	a) Camber	Measurement	Measuring Tape	B	100%	Employer technical specification and as per IS:7215 & IS: 12843	- do -	
	b) Sweep	Physical						
	c) Alignment of C.G. line punch mark and the match mark given on the top & bottom angles (permitted deviation) in C.G. line matching is + or - 5 mm)							
	d) Total length of assembled roof truss between faces of end gusset plates at top & bottom (permitted deviation + or - 5 mm)							
	e) End Plates are aligned and in 1 on both ends							



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3.08.03	Ensuring the following during welding of roof truss							
	a) Proper fit-up	Visual Measurement	-	A	100%	Approved Drg./Approved WPS	Site Register	
	b) Qualified welder are engaged and	verification of		A	100%	ASME (Sec IX) / Approved WPS	- do -	
	qualified procedures are employed	record if already qualified by EMPLOYER						
	c) Recommended welding consumables and methods are employed.	Physical		A	100%	- do -	- do -	
3.09	Ensure foundation bolts are free from damages and found-ation bolt pocket are free from debris and foreign material	Visual	-	B	100%	- do -	- do -	
3.10	Ensure the level of bottom of Base Plate.	Visual	-	B	100%	Approved drg	- do -	
3.11	Ensure proper orientation of column	Visual	-	C	100%	- do -	- do -	
3.12	Ensure the center line of base plate coincides with foundation pedestal axis (both in X and Y axis)	Physical	-	C	100%	- do -	- do -	

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3.13	Ensure the erection of horizontal beams/ girders and vertical bracings	Measurement	-	B	100%	- do -	- do -	
3.14	Check verticality of columns	Measurement	Plumb bob/	B	100%	- do -	- do -	
3.15	Ensure proper tightening of foundation bolts with lock nuts.	Visual	Total Works Station	C	100%	- do -	- do -	
3.16	Ensure grouting of the base bottom after ensuring verticality of columns.	Visual / Measurement	-	B	100%	- do -	- do -	
3.17	Ensure erection of second pieces of all columns.	Visual	-	C	100%	- do -	- do -	
3.18	Ensure erection of interconnecting members	Visual	--	C	100%	Approved Drg	Site Reg.	
3.19	Ensure proper Butt Welding at Moment connections and erection Welding	Measurement	--	C	100%	Do	do	
3.20	Check verticality to 1st and 2 nd pieces after the erection of connection pieces	do	Plumb bob/ Total Work Station	B	100%	Approved Drg / Tech Specs	do	
3.21	Check the verticality of total erected column	do	do	B	100%	do	do	



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3.22	Check and ensure the following during Crane girder erection wherever applicable							
	a) Crane girder bracket top level on the column are aligned (tolerance 5 mm max.)	do	water level	B	100%	do	do	
	b) Top flange level of crane girders are aligned (tolerance 5 mm max)	Measurement	Water level	B	100%	do	do	
	c) Web axes of crane girders in a row are aligned (tolerance web axis shift in a row 3 mm max.)	do	do	B	100%	do	do	
	d) Center to center distance of crane girders	do	Measuring tape	B	100%	do	do	
3.23	Ensure the following during the erection of roof trusses.							
	a) Proper handling to avoid damage & distortion to assembled trusses	Visual	--	C	100%	do	do	
	b) Alignment of bolt holes between column and truss gussets	Visual	--	C	100%	do	do	



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	c) Slope of truss as per drg.	Measurement	Spirit level	B	100%	do	do	
	d) Tightness of bolts	Torque Measurement		B	100%	Approved Drg. & Site Employer Tech. Register Specification Dimensional checking	/Log book	
	e) Connection of truss connecting members including purins	Visual		C	100%	do	do	
3.24	Welding & NDE							
	a) Ensure qualified welders are engaged & record if qualified procedure are already employed	Verification of record if already qualified by Employer		A	100%	ASME Section – IX , AWS D1.1/Approved. WPS	Site Register	In case of WPS already available for similar base material and filler , records may be submitted for Employer approval and low
	b) Ensure recommended welding consumables and methods are employed	Physical		A	100%	do	do	hydrogen electrodes to be used for welding of High / Medium tensile steel .
	c) Ensure recommended NDE checks are carried out	Visual/Testing	NDE Test Equipment	A	Tech Specs	Approved Drawing Employer Tech Spec	/do	
4.00	Brick Masonry, sheeting & allied works							
4.01	Brick Masonry							
i	Test on Bricks							



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	Dimensions, soundness, colour, compressive strength, water absorption, war-page, efflorescence,	Measurement/ Physical Test	As required	A	As per relevant IS Code One sample for 30,000 Nos	IS:1077 ;IS:2212 /Relevant IS Code	Inspection Report	Efflorescence shall be done at source
ii	Test on Mortar							
	Compressive strength, consistency and water retentivity for each portion of walls, plasters and ceilings	Test	As required	B	At random	IS 2250	do	
iii	Masonry construction							
	Workmanship, Verticality and alignment	Visual/ Physical	As required	B	100%	IS 2212,IS1905 As per Part C of Technical Specifications	SR/LB	
4.02	Sheeting & Allied works							
	a) Materials like Modular aerated panel, Permanently colour coated sheets , metal decking , Pre Engineered buildings and Insulations	Visual / lab test	as per manufacturers Standards/ Tech. Specs	A	One per each batch	Employer Tech. Spec./ As per approved Manufacturing quality plan / Review of manufacturer's TC	TC/TR	1) Where fabrication is involved FQP for structural steel is appli-cable. 2) For aluminium door/windows, check for anodisation as per Tech. Spec. 3) Fire proof Door shall be procured



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								from TC Appro-ved parties as per relevant IS / Tech
								4) For aluminium cladding grade of aluminium to be checked. Testing at manufacturer's works before dispatch
	b) Storage at site	Visual	Visual	B	100%	Standard practice and recommendations	SR	
	c) Installation, lap alignment & workmanship.	Visual / Physical	/ Visual / Physical	B	100%	As per Tech Specs	Format as per site representative	No gas cutting of sheets acceptable .
	d) Thermal insulation for wall cladding Thickness, density, thermal conductivity at 50 Deg. C and all other tests as per IS:8183	Testing	As per I.S. Code	B	100%	Employer Tech. Specification. IS : 8183	Test Certificate	
4.03	Painting of concrete surfaces / Plastered Masonry							
	a) Under ground structures ,Super structure (RCC Works)	Visual		B	100%	As per Tech Spec./ Drawing/and relevant IS Code.	SR/LB	



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5.00	FINISH ITEMS							
5.01	Plastering							
i	Ensure that the plastering of brick walls shall be of min. 18 mm thick for outside & 12 mm for inside face.	Visual Measurement	/ Steel Tape	B	100%	As per IS:1661/ Technical Specifications/ approved drawings	SR/LB	
ii	Ensure that the plastering of concrete ceiling 6 mm thick (min.) mortar	- do -	Steel Tape	B	100%	- do -	- do -	
iii	Ensure that the curing of plastering surface are carried out for 7 days (Min)	Visual		B	100%	- do -	- do -	
iv	Sand (Grading of sand)	Physical		B	50 Cum	As per IS:1542	- do -	
v	Plaster Of Paris	Physical		B	50 cum	As per Is:2547, IS:2333 / Tech. Specs	- do -	
5.02	Flooring & Finishing Work					Technical Specifications/ approved		
i	Check for levels slope	Measurement	Digital / Total station	B	100%	Drawings	SR/LB	No ponding of water on finished surfaces to be ensured.
ii	Ensure that the floors are chipped prior to	Visual		C	100%	- do -	- do -	



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	commencement of actual finishing work.							
iii	Ensure that the cement concrete floors are cured minimum for 7 days	Visual		C	100%	- do -	- do -	
iv	Ensure that the tiled finished floors are polished as per the requirement.	Visual		C	100%	- do -	- do -	Surveillance by FQA
v	a) Check for material	Review of Manufacture's Test Certificate To match with approved sample	-	B	100%	Relevant IS/ Tech. Specs.	- do -	
	b) Check workmanship	Visual	-	B	100%	Relevant IS/ Tech. Specs.	SR/LB	
vi	Galvanised hexagonal wire netting for lath plastering	Review of Manufacture's TC	-	B	Each Lot	Manufacturer's TC /conforming to IS:3150/ Tech. Specs/ Drawings	- do -	
5.03	False Ceiling							
5.03.01	Materials	Physical/ Mfr TC Review	As per relevant IS/Tech. Specs./ Mfr's TC	B	Random for each lot	As per relevant IS and Tech. Specs / Manufacturer's TC	- do -	



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1	2	3	4	5	6	7	8	9
5.03.02	Fixing and erection	Visual	- do -	B	Random	- do -	- do -	All supports , hangers , accessories shall be as per Tech. Specifications/ approved manufacturer's recommendations
5.04	Water proofing Material							
5.04.01	Materials	Review of Mfr. TC	As per ASTM C836-89& Tech. Specs.	B	Random for each lot	As per ASTM C836-89& Tech. Specs.	SR/LB	
5.04.02	Fixing and Laying	Review of Mfr. TC	As per ASTM C898-89& Tech. Specs.	B	Random	As per ASTM C898-89& Tech. Specs.	SR/LB	Laying and fixing of different layers shall be executed as per Tech . Specs.
5.05	Fencing and Gates							
5.05.01	PVC coated chain link mesh	Review of Mfr. TC	As required	B	Random for each lot	As per Relevant IS and tech. Specs.	Mfr. TC	
5.05.02	Welded wire mesh	- do -	- do -	B	- do -	- do -	- do -	
5.05.03	Reinforced barbed tape	- do -	- do -	B	- do -	- do -	- do -	
5.05.04	M.S. Gates	- do -	- do -	B	- do -	- do -	- do -	
5.04.05	Fencing Fixing	Visual/ Physical	-	B	Random	- do -		
5.04.06	Gate fabrication	Visual/ Physical	As required	B	As per Str. Steel FQP	-do-	SR/LB / Mfr.TC	



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1	2	3	4	5	6	7	8	9
5.05	Painting Material							
	a) Oil Bound distemper	Review of MFr.TC	As required	B	Random for each Lot	IS:428/As per Tech Specs./ Correlated Mfr. TC	SR/LB	These shall be procured from accredited vendors acceptable to Engineer- In - Charge duly supported by batch /consignment wise correlated manufacturers test certificate. Surface preparation and application shall be as per tech. Specs.
	b) Acrylic emulsion paint	Review of MFr.TC	As required	B	Random for each Lot	IS:5411 /As per Tech Specs./ Correlated Mfr. TC	SR/LB	-do-
	c) Chemical Resistant paint (Chlorinated rubber paint)	-do-	-do-	B	-do-	As per Tech Specs./ Correlated Mfr. TC	-do-	-do-
	d) Oil Resistant paint	-do-	-do-	B	-do-	-do-	-do-	-do-
	e) Resin & Polymer bonded Granular Decorative Coating	-do-	-do-	B	-do-	-do-	-do-	-do-
	f) Chlorinated rubber paint primer	manufacturer's test certificate with correlation	-	A	Each batch	Employer Tech. Specs.	Manufacturer's test certificate	-do-



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		and sample testing					and test report.	
	g) Inorganic zinc silicate primer	-do-	-	B	-do-	-do-	-do-	-do-
	h) Epoxy based polyamide cured paint - 1st coat.	-do-	-	B	-do-	-do-	SR	-do-
	i) Epoxy based polyamide cured paint - 2nd coat.	manufacturer's test certificate with correlation and sample testing	-	B	Each batch	Employer Tech. Specs.	SR	-do-
	j) Polyurethane coating	-do-	-	B	-do-	-do-	-do-	-do-
6.00	Water supply, drainage & sanitation Check for material, fittings, Fixtures colour, dimension & workmanship	Physical	-	B	100%	As per Technical specification & relevant IS	Review of manufacture's TC	
i	Toilets and Pantry blocks	Physical	-	B	100%	As per Technical specification & relevant IS	SR/LB/ Mfr. TC	No crack and seepage after installation. Mfr. TC for all materials to be submitted
ii	GI Pipes and fittings	Review of Mfr. TC / Physical	-	B	Random for each lot	As per IS:1239 Tech. Specs	-do-	
iii	Concrete Pipe & CI pipes							
	a) Surface finish	Visual/ Review	-	B	5% of each lot	As per relevant IS Code	SR/LB	



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1	2	3	4	5	6	7	8	9
		of Mfr. TC				/ Tech. Specs.		
	b) Dimensions & Class	Visual	-	B	5% of each lot		SR/LB	
iii	Water pipes and GI pipes					IS:458, Tech. Specs.		
	a) Hydraulic Pressure Test and Flow	Physical	As required	B	100%		Inspection Report	
iv	Drain & Sewer Pipes					IS:2065,		
	a) Smoke, Water and Straightness Test	Physical	As required	B	100%	As per relevant IS Code / Tech. Specs.	Inspection Report	No dripping of water shall be accepted
	b) Check for alignment, slope and obstruction	Measurement	Digital station	Total B	100%	Drg / Tech Specs / IS 2065	SR / LB	
	c) Ensure proper jointing of each laid length and shall be watertight including service pipes	Visual	-	B	100%	- do -	SR / LB	
v	Water Storage Tanks	Review of Mfr. TC/ Visual	-	B	100%	IS:12701 / Tech. Specs	- do -	
7.00	Doors, windows, rolling shutters / grills and fire proof shutters	Visual / Physical	/ As per IS	B	100%	As per Part C of Tech Spec and relevant IS	TC/SIQ/SR	Manufacturer's TC correlated with the consignment shall be submitted as per the Technical Specifications and relevant IS provision
7.01	Glass & Glazing works for float Glass , Wired Glass , Hermetically	Visual / Physical / Review of Mfr.	/ As required	A	100%	As per IS:14900,1081,48,5437,	Review of Mfr. TC /	- do -



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1	2	3	4	5	6	7	8	9
	sealed glasses , curtain glasses and glass block masonry	TC				419 & Tech. Specs.	SR	
7.01.01	Fixing of glasses / glazing	Visual	-	B	Random	As per IS/ Tec. Specs/ approved Mfr's methodology	- do -	
8.00	SPECIAL ITEMS							
i	Vibration Isolation System Installations/erection	Visual / Physical	/	A	100%	as per manufacturers standard practice	TR/TC/SR	The installation / erection of VIS shall be carried out by manufacturer of the spring & as per Employer technical specifications
ii	Bitumastic flooring							
	a) Bitumen grade	Visual / TC	as per Tech Specs	B	100%	As per Tech Specs	TC	
iii	Earthing Mat							
	a) Weld sizes & length	Visual / Tape	Visual / Tape	B	100%	As per Tech Specs		Low hydrogen electrode as per Employer approval shall be used
	b) DP	Physical	DP kit	A	10% at random	Free from defect	TR	
	c) Earth test		Earthing test kit	A	100%	Relevant IS	SR	Earthing required as per IS



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1	2	3	4	5	6	7	8	9
iv	Composite Aluminium Panels							
	a) Materials	Review of Mfr. TC	-	A	Random for each lot	As per IS / Tech. Specs	SR/LB	
	b) Installation	Physical / Visual	/-	A	Random	-do-	-do-	To be carried out by a specialist agency with SS Screws as per Tech Specs.
9.00	Piling Works							
9.01	Pile layout	Measurement	Total station	C	100%	As per approved drawings	SR/LB	
i	Recording ground level.	Measurement	As required	B	Random	As per approved drawings	SR/LB	
ii	Cleaning /flushing of pile bore at 3 stage- after completion of bore, after lowering reinforcement cage and just before placing concrete.	Visual	As required	B	Random	As per IS:2911 (relevant part)/ Tech. Specs.	SR/LB	
iii	Size of bore and During boring of pile record commencement of SPT / core recovery to ensure socketing length equivalent in terms of the Diameter of the pile below the socketing horizon.	Measurement	As required	B	100%	As per approved drawings/ Tech. Specs.	SR/LB	



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1	2	3	4	5	6	7	8	9
iv	Pouring of sound concrete of required grade from pile termination level to project above cutoff level.	Measurement	As required	B	100%	As per approved drawings / Tech. Specs.	SR/LB	Test method with relevant IS:2911 provisions & Tech. Specs. Shall be followed
v	Pile termination level	soil data	SPT & core recovery	A	As per Employer Tech. specifications	As per Employer Tech. specifications	SR	
9.02	Testing							
9.02.01	Bentonite	Physical	As required	B	once per source	As per IS: 2720/ Tech. specs	SR/LB	
9.02.02	Density check on sample of mud collected from pile bore bottom	Physical	sample collection	A	Random	As per Tech Spec	SR/LB	Tests to be done before placing concreting. Samples to be collected from pile bore bottom.
9.02.03	Slump test of concrete	Physical	Slump test cone.	B	100%	As per Tech Spec IS:2911	SR/LB	
9.02.04	Initial pile load tests. Vertical (Compression), Lateral (horizontal) and Uplift (tension)	Testing	Calibrated dial gauges etc. as required	A	100% for 3 nos. for each type.	IS:2911 & Tech Specs	SR/LB & interpretation as per IS: 2911 (Part 4)	In case of compression test method the loading shall be cyclic.
9.02.05	Routine pile tests, compression and horizontal	Testing	Calibrated dial gauges etc. as required	A	100% for 0.5% of the total number of piles provided for each type of test	IS:2911 & Part B of Tech Specs	SR/LB & interpretation as per IS: 2911 (Part-4)	Routine Test shall be conducted by direct loading method.



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1	2	3	4	5	6	7	8	9
9.02.06	Integrity tests	Testing	NDT	A	100%	As per technical specs & suppliers manual	Interpretation of test results	
10	Grouting							
10.01	Grouting Pressure	Physical	Test set up	B	At random	Approved Drawings		
10.02	Composition of grout	Physical	-do-	B	Each Lot/Batch	As per manufacturer's specification		
10.03	Compressive strength	Measurement	-do-	A	Each lot / Batch	Employer technical specifications .		
11.00	Bought out items							
	All bought out items to be procured from the approved vendor and on approval of Employer, FQA	Verification of TC and Testing	-	B	100%	As per approved scheme	SR/LB	List of bought-out items to be enclosed .The TC submitted should bear proper identification or correlation with the batch of material supplied and same shall be brought out in the challan / consignment note .



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1.1.1 APPENDIX II

EARTH/ ASH EMBANKMENT

Sl. No.	CHARACTERISTIC/ ITEM	FREQUENCY/ QUANTUM NORMS	INSTRUMENT	TYPE OF CHECK	CLASS	FORMAT OF RECORD	REF. DOCUMENT FOR TESTING	ACCEPTANCE
1	2	3		4	5	6	4	5
1	ASH/SOIL BORROW AREA							
a	Grain size analysis	Once for every 50,000 cu.m of earth or part thereof from each borrow area	As required	Physical	B	SR/TR	IS:2720	Employer Technical Specification
b	Specific Gravity	Once for every 50,000 cu.m of earth or part thereof from each borrow area	As required	Measurement		SR /TR	IS:2720	Employer Technical Specification
c	Moisture Content	Once for every 50,000 cu.m of earth or part thereof from each borrow area	As required			SR/TR	IS:2720	Employer Technical Specification
d	Standard Proctor Density	Once for every 20,000 cu.m of earth or part thereof from each borrow area	As required		A	SR/TR	IS:2720	Employer Technical Specification
2.	ASH/EARTH WORK IN EMBANKMENT							
a	In-situ Dry Density	i) Once for every 400 cu.m for ash or part thereof	As Required	Measurement	A	SR/TR	IS:2720 Part-II, VIII and XXIX	95% of max. dry density (Standard Proctor) for homogeneous embankment and outer shells, 98% for



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		ii) Once for every 2000 cu.m for earth or part thereof separately for cut off trench, homogeneous embankment and core and outer shells of zoned embankment						cut off trench and for impervious core and 100% for filling in pipe trenches. If less, additional rolling to be done till specified density is achieved.
		iii) Once for every 200 sq.m of area on the trimmed slopes.						
		iv) Once every 250m length of dyke in each layer separately for cut off trench, embankment and core and outer shells.						
		v) Once for every 50m width or part thereof dyke in each layer separately for core/shell						



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b	Moisture Content	-do-	As required	Measurement	A	SR/TR	IS:2720	
c	Permeability	Once for every 5000 cu.m for cut off trench and core (for clayey soil as well as soil-bentonite mix.)	As required	Measurement	A	SR/TR	IS:2720	The coefficient of permeability, K shall be less than 1×10^{-6} cm/sec.
d	Measurement of slope of embankment Up stream and down stream side after trimming	Once for every 50 mtr. length of dyke	As required	Physical	B	SR		A suitable template may be used for the desired slope.
3.	FOUNDATION AFTER PREPARATION							
a	Visual inspection to see that all voids have been filled up and no cracks are exposed	Once for every 2000 sq.m of foundation area		Physical	B	SR	IS:2720	
4.	COARSE AGGREGATE FOR CONCRETE AND FILTERS							
a	Check for gradation	Once for each stack and each change of source		Physical	B	SR	IS:2386 and IS:383	As per IS:383 for concrete and as per Employer tech specn for filter
b	Specific Gravity	Once for each stack and each change of source	As Required	Measurement	B	SR/TR	IS:2386 and IS:383	Minimum 2.4 for concrete and 2.5 for filter
c	Crushing Value (for concrete only)	Once for each source	As Required	Measurement	B	SR/TR	IS:2386 and IS:1122	As per IS:383



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d	Sulphate Soundness	Once for each source	As Required	Measurement	B	SR/TR	IS:2386 Part V and IS:1126	As per IS:383 for concrete and max. 10% weight loss after five cycles for filter materials.
	a) Acid and Alkali Reactivity (for concrete only)	Once for each source	As Required	Measurement	B	SR/TR	IS:2386 Part VII and IS:383	IS:2386 Part VII
f	Flakiness & Petrographic Examination (for concrete only)	Once for each source	As Required	Measurement	A	SR/TR	IS:2386 Part VIII	Flakiness index max. 15% aggregate constituents which are known to cause deleterious chemical reactions with cement/lime or ash slurry water should be avoided
g	Impact Value	Once for each source	As Required	Measurement	A	SR/TR	IS:2386	As per specification
h	Water Absorption	Once for each source	As Required	Measurement	A	SR/TR	IS:2386	As per specification
i	Slake Durability (for filter only)	Once for each source	As Required	Measurement	A	SR/TR	IS:10050	% retained after two 10 minutes cycles shall be more than 85%
5.	FINE AGGREGATE FOR CONCRETE & SAND FOR FILTERS, BLANKET & CHIMNEY AND MORTAR							
a	Bulkage (for concrete only)	One per week	As Required	Measurement	B	SR/TR	IS:2386	As per IS:383
b	Moisture Content (for concrete and mortar only)	One per week	As Required	Measurement	B	SR/TR	IS:2386	As per IS:383



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c	Gradation	Once for every source	As Required	Measurement	B	SR/TR	IS:2386 Part I IS:9429 & IS:383	As per IS:383 for concrete and for filter criteria as per of Technical Specification
d	Specific Gravity	Once for every source	As Required	Measurement	A	SR/TR	IS:2386 Part	Minimum 2.40
e	Water absorption & Density (for concrete and mortar only)	Once for every source	As Required	Measurement	B	SR/TR	IS:2386	Maximum 2.5%
f	Soundness (for concrete only)	Once for every source	As Required	Measurement	B	SR/TR	IS:2386 Part V As per IS:383	
g	Visual Examination	100%	As Required	Measurement	B	SR/TR	IS:2386 & IS:383	
6	ROCK MATERIAL FOR RIP-RAP AND ROCK TOE							
a	a) Specific Gravity	Once for every source	As Required	Measurement	B	SR/TR	IS:1122	Minimum 2.50
b	b) Sulphate Soundness	Once for every source	As Required	Measurement	B	SR/TR	IS:1126	Maximum 10% weight loss after five cycles
c	c) Impact Value	Once for every source	As Required	Measurement	B	SR/TR	IS:2386	Maximum 30%
d	Water absorption	Once for every source	As Required	Measurement	B	SR/TR	IS:2386	Minimum 2.5%
e	Slake Durability	Once for every source	As Required	Measurement	B	SR/TR	IS:10050	Minimum 85% after 2 cycles of 10 minutes.



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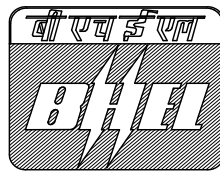
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**STANDARD TECHNICAL SPECIFICATIONS
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Bharat Heavy Electricals Limited
Project Engineering Management
PPEI BLDG
NOIDA



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**TECHNICAL SPECIFICATION FOR
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EARTHWORK IN EXCAVATION AND BACKFILLING



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**STANDARD TECHNICAL SPECIFICATION
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**

1.00.00 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

1.01.00 Work To Be Provided By The Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services including as required under statutory labour regulations, materials, scaffolding, equipments, tools and plants, transportation etc required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

1.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.00.00 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200 Method of measurement of building and civil engineering



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works, Part-I: Earthwork
IS-2720 Method of test for soils (Relevant parts)
IS-3764 Excavation work - Code of safety
IS-4081 Safety code for blasting and related drilling operations
IS-4701 Indian Standard Code of Practice for earthwork on Canals
IS:6922 Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 **Conformity with Designs**

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.02.00 **Materials**

2.02.01 **General**

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.02.02 **Material for Excavation**

For the purpose of identifying the various strata encountered during the course of excavation, the following classification are to be followed.

a) Soil

It include all type of soil including laterite and moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under clause 2.02.02 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock



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It include the rocks which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

2.02.03 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.03.00 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl.	Activity	Check



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No.		
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

3.00.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms and compaction etc within 15 days of award of the contract to the engineer for approval.

3.01.00 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.02.00 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.



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3.03.00 Excavation for Foundations and Trenches

3.03.01 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete



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blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.03.02 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.03.03 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.03.04 Blasting



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a) General

Storage, handling and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be



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erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

- * not to put their feet on the clean floor unless the magazine shoes on.
- * not to touch the magazine shoes on ground outside the clean floor.
- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have



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been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out



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it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

f) Restrictions in Blasting

- Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- Progressive blasting shall be limited to two third of the total remaining depth of excavation.



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d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.

e) The last blast shall not be more than 0.50 m in depth.

f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.03.05 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or

ii) By spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.03.06 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.03.07 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed



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during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.03.08 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.03.09 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

a) Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the



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collapse of the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

b) Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.03.10 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.04.00 Backfilling

3.04.01 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.04.02 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required



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degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.04.03 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.04.04 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.04.05 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.05.00 Approaches and Fencing



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The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.06.00 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.02.00 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the



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description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

e) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.02.00 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of



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each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

6.00.00 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.01.00 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.02.00 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.



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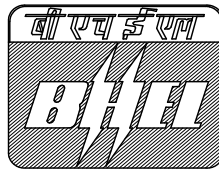
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Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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SUB-SECTION – D II

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 ACI:318 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for



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installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- g) Design and submit for approval concrete mix designs required to be adopted on the job.
- h) Furnish samples and submit for approval results of tests of various properties of the following:
 - i) The various ingredients of concrete
 - ii) Concrete
 - iii) Embedments
 - iv) Joint seals
- i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

- a) Source and arrangement of processing of aggregates proposed to be adopted.



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- b) Type of plant and equipment proposed to be used.
- c) Names of firms with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02

After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

- i) Coarse and fine aggregates.
- ii) Admixtures.
- iii) Plywood for Formwork.
- iv) Embedded and anchorage materials as may be desired by the Engineer.
- v) Joint sealing strips and other*waterproofing materials.
- vi) Joint filling compounds.
- vii) Foundation quality Rubber Pads.



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c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Bending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment
As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00

Conformity with Design

The Contractor will prepare checklists in approved Form, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour



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Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as



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Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or



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ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars above 10 mm dia. shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.



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2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture: Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.

b) Aggregate: Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.

c) Water: Impurities tests.

d) Cement: Tests to satisfy relevant IS Specifications.

e) Formwork: Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

f) Reinforcement: Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.



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- h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.
- i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.
- j) Embedded and Anchorage Items: Material, shape, location, setting.
- k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
- l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
- m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.
- n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates



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Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

- a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".
- b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.



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3.04.02

Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00

Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS: 456. All other relevant clauses of IS: 456 shall also apply.

3.06.00

Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at site. Based on various tests results and as per Engineer, the environment



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condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

- a) The requirement of strength.
- b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible



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from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.



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Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Lean concrete	- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of



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TGs, BFPs, Fans and Mills):

The temperature of fresh concrete shall not exceed 25°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 25°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 25°C.

3.09.02

Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00

Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight



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platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.



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Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid



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concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

- a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the



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middle of the span.

- c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces



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3.14.01

Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- g) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.
- k) Polymer modified patching and adhesive repair & mortar for beams & columns.

3.14.02

Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can



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be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of



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concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00

Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn



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steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed



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soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Drawings. Welding of cold twisted High yield strength deformed bar shall not be allowed.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting



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When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the



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formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or reproping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing



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of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

- For -
- a) Sectional dimension - ± 5 mm
 - b) Plumb - 1 in 1000 of height
 - c) Levels - ± 3 mm before any deflection has



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taken place

The tolerance given above are specified for local aberrations in the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.
- c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures



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The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

- a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.
- d) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All



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materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make



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and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb



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- iii) Dumb-bell or flattened ends
- iv) Ribbed and Corrugated Wings
- v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35



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Shore Hardness : 60A to SOA

Tensile Strength : 10 - 15 N/Sq.mm

Maximum Safe Continuous
Temperature : 70 Deg.C

Ultimate Elongation : Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's



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approval for important machineries.

3.25.00

Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00

Waterproofing of Concrete Structure

3.26.01

General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the



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relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02

Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the



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owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03

Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.
- b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04

Structural waterproofing



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a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1 : 4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given



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hereunder

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.
- ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,
- v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250-micron polyethylene film as second layer similar to
- vii) above.
- viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation



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The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents



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Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.



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5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.

If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

- a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall also include the cost of using curing compound, whenever used.
- b) The unit rates shall include for all working conditions including in or under water, liquid, mud, in or under foul positions, under tides, and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity tests or other relevant tests to ascertain grade and quality, etc. of the concrete, if required. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.



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- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of making additional trial mixes, using the superplasticizer and mixing in concrete etc.

6.01.02 Measurements

- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres.
- b) No deductions shall be made for the following:
 - i) Opening upto 0.1 sq.m.
 - ii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
 - iii) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.
- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 25⁰C.

6.02.00 Reinforcement

6.02.01 Rates

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.
- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the



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store, etc.

- c) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).
- d) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.
- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.
- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.
- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.
- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.



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- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- c) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
- d) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

- a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.
- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts.

6.04.02 Measurements

- a) The measurement of the embedded steel parts fabricated and installed by



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the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.
- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.
- d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

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6.06.00	Joints
6.06.01	Rates
	The unit rate shall include all the activities described in the schedule of items.
6.06.02	Measurements
	a) Bitumen Board/Expanded polystyrene.
	The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.
	b) Water Stops
	The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.
	c) Metal Cover Strips
	The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.
	d) Vibration Damping Resilient Pads
	The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.
6.07.00	Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete
6.07.01	Rates
	The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.
	In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.
	In the case of chipping work, the cutting of reinforcement shall be paid separately.



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6.07.02 Measurements

- a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be on the same basis as that employed for construction work.
- b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).
- c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.



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LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

- IS: 73 - Indian Standard Specification for Paving Bitumen
- IS: 216 - Indian Standard Specification for Coal Tar Pitch
- IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
- IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement
- IS: 455 - Indian Standard Specification for Slag Cement
- IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete
- IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
- IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete
- IS: 702 - Indian Standard specification for industrial bitumen.
- IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete



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- IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
- IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement
- IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
- IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts
- IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
- IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.
- IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
- IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks
- IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates
- IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
- IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
- IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type
- IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators
- IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables
- IS: 2571 - Code of practice for laying in-situ cement concrete floors.
- IS: 2645 - Integral cement water proofing compound
- IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)



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- IS: 2750 - Indian Standard Specification for steel scaffoldings.
- IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
- IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete
- IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
- IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.
- IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses
- IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
- IS: 3414 - Code of practice for design and installation of joints in buildings.
- IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
- IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete
- IS: 3696 - Safety Code for Scaffolding and Ladders
- IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete
- IS: 4014 - Code of practice for steel tubular scaffolding.
- IS: 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement
- IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
- IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches
- IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes



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- IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete
- IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant
- IS: 4926 - Indian Standard Specification for Ready Mixed Concrete
- IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work
- IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground
- IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
- IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.
- IS: 5256 - Code of practice for sealing joints in concrete lining on canals.
- IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials
- IS: 5513 - Indian Standard Specification for vacate Apparatus.
- IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.
- IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
- IS: 5624 - Indian Standard Specification for foundation bolts.
- IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.
- IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.
- IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.
- IS: 5892 - Indian Standard Specification for transit mixer and agitators.



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- IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use
- IS: 6909 - Indian Standard Specification for Super sulphated Cement
- IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.
- IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
- IS: 7242 - Indian Standard Specification for Concrete Spreaders.
- IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.
- IS: 7251 - Indian Standard Specification for Concrete Finishers.
- IS: 7293 - Safety code for working with construction machinery.
- IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.
- IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.
- IS: 7969 - Safety Code for Storage and Handling of Building Materials.
- IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.
- IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.
- IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.
- IS: 8989 - Safety Code for Erection of Concrete Framed Structures.
- IS: 9012 - Recommended method for shortcreting.
- IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS: 9077 - Code of Practice for Corrosion Protection of Steel



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Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.



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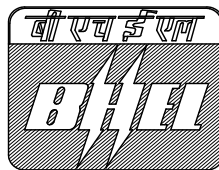
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Bharat Heavy Electricals Limited

Project Engineering Management

PPEI BLDG

NOIDA



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CARPENTRY AND JOINERY**1.00.00 SCOPE**

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION**2.00.01 Materials****a) Timber**

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848.



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The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish



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All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA**3.00.01 Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmet, Furniture, etc.**3.03.01 General**

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmet

Shall be checked for rigidity of fixing and adequate clearance of fixture.



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3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848 - Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)

IS: 1003 - Timber panelled and glazed shutters.

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

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

IS: 4021 - Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates shall include of all activities mentioned in "Schedule of Item" for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges, holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement



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Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.



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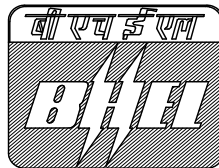
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**ROOF AND UNDERGROUND WATER PROOFING,
INSULATION AND ALLIED WORKS****1.00.00 SCOPE**

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION**2.01.00 GRADING UNDERBED**

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12 mm down stone chips and coarse sand. The aggregate



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shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expanded Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used



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for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

a) Normal Treatment - Five courses



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- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Fiber base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Fiber base self-finished felt, type 2, grade 2.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)



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7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Fiber-base self-finished felt type 2, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)
- 5) Fibre base self-finished felt type 2, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 7) Fibre base self-finished felt type 2, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 5) Hessian base self-finished felt, type 3, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 7) Hessian base self-finished felt, type 3, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.



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- 9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02

Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTM C836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70°C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.



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b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by atleast 100mm.

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03

Waterproofing By Epoxy Resin Based Application



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Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

- a) 2 layers - for depths up to 5m below ground level
- b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.



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For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

- i) Primer (For vertical faces only), as per I.S. 3384.
- ii) Hot applied blown bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base, bitumen felt type 3 grades 2
- iv) Hot applied blown bitumen @ 1.2 Kg/m²
- v) Hessian base, bitumen felt type 3 grade 2
- vi) Hot applied blown bitumen @ 1.2 Kg/m²

B) Extra Heavy treatment (Three layers of felt)

- i) Primer (for vertical faces only) as per I.S. 3384
- ii) Hot applied bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base bitumen felt type 3 grades 2
- iv) Hot applied bitumen at the rate 1.2 Kg/m²
- v) Hessian base bitumen felt type 3 grades 2
- vi) Hot applied bitumen at the rate of 1.2 Kg/m²
- vii) Hessian base bitumen felt type 3 grades 2



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viii) Hot applied bitumen at the rate of 1.2 Kg/m²

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00

ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship for 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00

I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.



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- a) IS: 73 - Paving Bitumen
- b) IS: 702 - Industrial Bitumen
- c) IS: 1203 - Methods of testing tar and bitumen
- d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.
- e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.
- f) IS: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice
- g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
- h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the “Schedule of Items”.

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.



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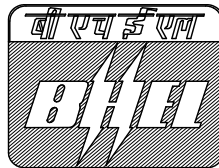
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TITLE:

**STANDARD TECHNICAL
SPECIFICATION FOR METAL DOORS,
WINDOWS, VENTILATORS, LOUVERS
ETC.**

SPECIFICATION NO. PE-TS-314-600-C001

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METAL DOORS, WINDOWS, VENTILATORS, LOUVERS ETC.**1.00.00 SCOPE**

This section covers supplying and/or erecting and installing of all metal doors, windows, ventilators, louvers, glazed partitions, etc. The scope of work shall also include the assembly and erection of all doors, windows, louvers, glazed partitions, etc. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.00.00 INSTALLATION**2.01.00 Materials**

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions etc. shall be extruded sections conforming to IS:733 or IS:1285 or as manufactured by Indian Aluminium Company Limited or approved equivalent. Aluminium door, windows and ventilator shall be fabricated as per IS:1948 and IS:1949. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified and the best quality from approved manufacturers shall only be used. The tenderer shall specifically state the particular manufacturer's materials he proposes to use. Improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility.

All hardware and fixtures shall be able to withstand repeated use. Door closures shall conform to IS: 3564 and shall be suitable for doors weighing 61-80 Kg. unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or shall be replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance Requirements and endurance test stated in IS: 3564 - Appendix-A. The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards end for incorporation in the job. The mastic for caulking shall be of best quality from a manufacturer approved by, the Engineer. In general, mastic for fixing of metals frames shall be as per IS: 1081 or as approved by the Engineer.



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2.02.00 Fabrication**2.02.01 Steel Doors, Windows, Ventilators, louvers etc.****a) Door Frames**

Frames shall be fabricated from 16 gage(G) sheets. They shall, be mortised, reinforced, drilled, and tapped for hinge lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered Corners shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be installed. Frames shall be brought to site with floor ties/weather bars installed in, place.

b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprise of the outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centres.

Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, shall have proper level on lock stiles and rails to operate without binding, and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting-stile edges bevelled or rebated. Where shown on drawing, or called for in the schedule of items, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Doors shall be mortised, reinforced, drilled, and tapped in shop for hinges, locks, and bolts. They shall also be reinforced for closers, push-plates, and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Where shown drawing, provision shall be made for fixing glazing, vision panels, louvers etc. glazing mouldings shall be of 18 G steel or extruded aluminium sections and suitable for fixing 6 mm. glass. Louvers blades shall be V or Z shaped and made out of 16 G sheets.



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c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality, 16 G mild steel sheets.

Wherever required, provisions for fixing glass panes, louvers etc. shall be made.

The manufacturing shall be done as specified in 2.02.01 (b) "Double Plate Flush Door Shutters."

d) Sliding Door

Sliding doors shall be either double plate or single plate Construction made out of 18 gauge steel sheets with adequate stiffeners. The contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where called for the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

e) Door Threshold

Door threshold shall be provided. Doors without threshold shall have bottom tie of approved type.

f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, and pivot arrangements for ventilators, etc. or as called for. All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are required the individual window units shall be joined together with requisite transoms and mullions. All windows shall be outside glazed, fixed with putty or metal glazing beads as specified. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.02.02**Aluminium Door, Windows, and Frames**



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Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 15 micron thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent Coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such method as will produce an uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.03.00**Shop Coat or Paint**

The shop Paint for steel doors, windows etc. shall be best lead or zinc chromate primer paint from, approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for, all steel doors, windows, etc. shall be hot dip galvanized to give a coating weight of 1 | - 2 oz. per sqft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame, which come in contact with masonry construction shall be (before shipment from workshop) protected with a heavy coat of alkali resistant paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.04.00**Handling & Storage of Fabricated Material**

All metal doors, windows, etc. shall be packed and crated properly before dispatch, to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are up to the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.



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All metal doors, windows etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, mortar etc.

2.05.00**Assembly & Erection at Site**

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in respective places, keening proper "Lines and levels", and in approved workmanlike manner, to give trouble free and leak-proof installations. Installation shall be done according to instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take all precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation, without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the cement in original sealed containers of manufacturer and shall apply it as per the instruction. For all frames supplied by either the owner or the Contractor, mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metres from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

2.06.0**Fire proof Door**

Fire proof doors shall be provided at all fire exit points as specified and also to restrict the spread of fire within buildings whether from internal fire or from external fire. The construction details of door shall conform to the requirements stipulated in IS:3614(Part-1). Doors shall comply with the testing requirement mentioned in IS:3614 (Part-2). The doors shall be



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approved by Tariff Advisory Committee and shall have minimum 2 hrs. fire rating.

Metal covered (on both sides) Doors having insulating core filled up with mineral wool shall be used at all fire exit points and shall open out side.

All necessary accessories and hardware shall also be supplied along with doors. Fire proof door shall be provided with zinc silicate primer (minimum DFT 75 micron) after blast cleaning the surface to near white metal surface and shall be finished painted with epoxy based painting.

3.00.00 ACCEPTANCE CRITERIA**3.01.00 For fabricated Items**

- a) Overall dimensions shall be within ± 1.5 mm of the size shown on drawings.
- b) Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ± 1.5 mm from the axis of the member.
- c) Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm for double leaf doors; the gap at the meeting stiles shall not be more than 1.5 mm.
- d) Door leaves shall be undercut where shown on drawings.
- e) Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.
- f) All welds shall be dressed flush on exposed and contact surfaces.
- g) Correctness of location and smoothness of operations of all shop installed hardware and fixtures
- h) Provision for hardware and fixtures to be installed at site.
- i) Glazing beads shall be cut with mitered corners.
- j) Glazing clips, fixing devices etc. shall be supplied in adequate numbers.
- k) Shop coats shall be properly applied.
- l) Exposed aluminum surfaces shall be free from scratches, stains, and discoloration. Anodized surfaces shall present a uniform and pleasing look.

3.02.00 For installed Items



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- a) Installations shall be at correct location, elevation and in general, on a true vertical plane.
- b) Fixing details shall be strictly as shown on drawings.
- c) Assembly of composite units shall be strictly, as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete.
- d) All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.
- e) All openable section shall operate smoothly without jamming.
- f) Locks, fasteners etc. shall be engage positively. Key shall, be non-interchangeable.
- g) Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.
- h) Aluminium doors, windows, etc. shall be free from scratches stain or discoloration.

4.00.00 INFORMATION TO BE SUBMITTED

4.01.00 With Tender

- a) Names of manufacturers for Doors, windows etc.
- b) Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.02.00 After Award

- a) Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.
- b) He shall submit a programme of work to be done for the approval of the Engineer.
- c) Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

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5.00.00	IS CODES																														
	All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. <table><tr><td>Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)</td><td>-</td><td>IS: 733</td></tr><tr><td>Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)</td><td>-</td><td>IS: 1285</td></tr><tr><td>Steel doors, windows, and ventilators</td><td>-</td><td>IS: 1038</td></tr><tr><td>Steel windows for industrial, building</td><td>-</td><td>IS: 1361</td></tr><tr><td>Aluminium doors windows, and ventilators</td><td>-</td><td>IS: 1948</td></tr><tr><td>Aluminium windows for industrial buildings</td><td>-</td><td>IS: 1949</td></tr><tr><td>Steel doorframes</td><td>-</td><td>IS: 4351</td></tr><tr><td>Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.</td><td>-</td><td>IS: 1081</td></tr><tr><td>Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type</td><td>-</td><td>IS: 3614</td></tr><tr><td>Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification</td><td>-</td><td>IS: 7452</td></tr></table>	Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733	Specification for Wrought Aluminium and Aluminium Alloy, extruded round tube, hollow section (for general engineering purpose)	-	IS: 1285	Steel doors, windows, and ventilators	-	IS: 1038	Steel windows for industrial, building	-	IS: 1361	Aluminium doors windows, and ventilators	-	IS: 1948	Aluminium windows for industrial buildings	-	IS: 1949	Steel doorframes	-	IS: 4351	Code of practice for fixing and glazing of Metal (steel and aluminium) doors, windows and Ventilators.	-	IS: 1081	Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614	Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452
Specification for Wrought Aluminium and Aluminium Alloy bars, rods and sections (for general engineering purpose)	-	IS: 733																													
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Specification for Fire-check Doors – Part 1: Plate, Metal covered and Rolling type	-	IS: 3614																													
Hot Rolled Steel Sections for Doors, Windows and Ventilators – Specification	-	IS: 7452																													
6.00.00	RATES AND MEASUREMENT																														
6.01.00	Rates																														
	Rates shall be applicable of all elevation. Rates shall include preparation of working drawings (if required), supply of material, fixtures, gaskets, erection of unit, caulking and jamming of frames, including cutting/drilling/welding, grouting, grinding, making good of the structure for installing the unit etc. complete as per “Schedule of Items”.																														



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Rates shall also include cost of surface preparation, application of primer, enamel painting or anodizing as applicable.

Rate for fire proof door is inclusive of providing insulation core, primer, shop painting (epoxy based), all hardware as specified in Schedule of items.

6.02.00 Measurement

Supply and installation of doors, windows, and ventilators shall be measured in Sqm in net outer to outer (excluding frame) area of doors, windows, and ventilators of each type used as described in "Schedule of Items". Frame for steel or aluminium shall be measured in Kgs. Wooden frames shall be measured in Cum. Measurement for aluminium partition shall be from net outer to outer area of frames i.e., frames are part of partition.

Measurement for fire proof door shall be in SqM in net area outer to outer of the door.



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ANNEXURE-A

SCHEDULE OF FIXTURES

A. TIMBER DOORS

1. For single leaf panel/flush doors

i) 100 mm brass butt hinges with screws	-	3 Nos.
ii) 150 mm brass tower bolts with screws	-	1 No.
iii) 100 mm x 225 mm clear plastic push Plate with counter sunk brass screws	-	1 No.
iv) 30 mm brass ring pull handle with Plates and screws	-	1 No.
v) 150 mm brass coat hook with screws	-	1 No.

vi) Heavy duty, cylinder locks on active leaf - for flush door. For door-closure, see "Door Schedule".

B. ALUMINIUM DOORS

1. For double leaf door

- Concealed hanging arrangement for door leaves.
- Concealed two points bolt encasing simultaneously at head and threshold on inactive leaf, operable from inside.
- Heavy duty, cylinder lock on active leaf.
- Pull handle of approved design on both leaves.
- Doors stops for both leaves.
- Overhead door closure for both leaves.



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ANNEXURE-A

C. STEEL DOORS AND WINDOWS**1. Doors****a) Double leaf doors**

- i) 100 mm butt hinges - 3 Nos. on each leaf.
- ii) 300 mm aluminum tower bolt - 2 Nos. (top and bottom)
On inside of inactive
Leaf. 1. No. (Top only)
On inside active leaf.
- iii) 200 mm anodized aluminum
pull handle - 1 No. of each leaf.
- iv) Door stop of approved design - 1 No. of each leaf.

NOTE: For locks, door closure and threshold, see "Door Schedule".

b) Single leaf doors

- i) 100 mm butt hinges - 3 Nos.
- ii) 300 mm aluminum tower bolt - 2 Nos. top & bottom of Inside
face
- iii) 200mm anodised aluminum
Pull handle - 1 No.
- iv) Door stop of approved design - 1 No.

NOTE: For locks, door closures and threshold, sec "Door Schedule".

2. Windows, Ventilators, etc.**a) Side Hung Windows**

- i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.
- ii) 12" peg stays - 1 No. per leaf

ANNEXURE-A



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iii) 2 point handles - 1 No. per leaf

b) Top Hung Ventilators (Projecting Out)

i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.

ii) Adjustable sliding fabrication
assembles - 2 Nos. per leaf.

iii) 2 point handles - 1 No. per leaf.

c) Bottom Hung Ventilators (Projecting in)

i) Hinges - As per standard Practice of the
Manufacturer, but minimum two
hinges Per leaf.

ii) Concealed side arms for
opening adjustment. - 2 Nos. per leaf.

iii) Spring Catch - 1 No. per leaf.



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ANNEXURE-A

D. ALUMINIUM WINDOW, VENTILATORS, ETC.

(As per 1.S-1948 latest editions)

a) Side Hung Windows

i) Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii) 300 mm peg stays	- 1 No per leaf
iii) 2 point handles	- 1 No per leaf

b) Top Hung Ventilators (Projecting out)

i) Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii) Adjustable sliding fabrication assemblies	- 2 Nos. per leaf
iii) 2 Point handles	- 1 No. per leaf

c) Bottom Hung Ventilation&(Projecting In)

i) Hinges	- As per standard Practice of the Manufacturer, but minimum two hinges Per leaf.
ii) Concealed side arms for opening adjustment	- 2 Nos. per leaf
iii) Spring Catch	- 1 No. per leaf



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**TECHNICAL SPECIFICATION FOR
GLASS AND GLAZING**

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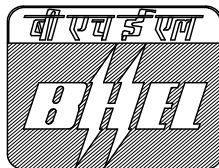
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SECTION - D

SUB-SECTION – D6

GLASS AND GLAZING

SPECIFICATION NO. PE-TS-314-600-C001



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI BLDG
NOIDA



TITLE:

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C O N T E N T

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GLASS AND GLAZING**1.00.00 SCOPE**

This section covers supplying and fixing of all glass and glazing including all clips, putty, mastic cement etc. wherever required as per specifications.

2.00.00 INSTALLATION**2.01.00 General**

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, from approved manufacturer like Hindustan Pilkinton or equivalent, having uniform refractive index and free from flaws, specks, and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

Materials

- a) Glare reducing or heat absorbing glass shall be "Calorex" of Hindustan Pilkinton or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.
- b) Clear glass shall be flat draw sheet glass and shall be at least 4 mm thick. Sheet glass for doors shall be minimum 5.5 mm thick.
- c) Wired glass shall be thick- rolled glass with centrally embedded 42g wire mesh of Georgian type. This may be of clear or coloured glass, as required.
- d) Obscure glasses shall have a cast surface in one side.
- e) Coloured and figured glass shall be as per approved sample.
- f) In general, the putty shall conform to IS: 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing.
- g) Neoprene gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.03.00 Glazing, Setting, and Finish

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.



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All glass shall be thoroughly cleaned before putting in position. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant I.S. Codes, four glazing chips shall be provided per glass pane, except for large panes where six or more clips shall be used as per engineer's instructions. All holes that may be necessary for holding the clips glazing heads and all other attachments shall be drilled by, the Contractor.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

Where owner will supply glass, the Contractor shall cut it to size and fix them in the same as specified above.

The Contractor shall supply necessary glazing clips, putty, mastic cement etc.

After completion of glazing, the Contractor shall remove all dirt stains, excess putty etc. clean glass panes and leave the work in perfectly acceptable condition. All broken cracked or damaged glass shall be replaced by new ones at the contractor's own cost.

3.00.00**ACCEPTANCE CRITERIA**

- a) All installation shall be free from cracked, broken, or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked, or underground edges.
- b) Glazing shall be carefully done to avoid direct contact with metal frames.
- c) All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.
- d) At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.00.00**I.S. CODES**

Following are some of the important I.S.Codes relevant to this Section:

IS: 3548 - Code of practice for glazing in building.

IS: 1081 - Code of practice' for fixing and glazing metal doors, windows ventilators.



TITLE:

**TECHNICAL SPECIFICATION FOR
GLASS AND GLAZING**

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5.00.00

RATES

Rates of glass and glazing are included in respective items for supply and installation of window, ventilator, and partitions. No separate payment shall be made for glazing clips, mastic cement, putty, screws; rails, etc. nor for drilling holes in frames for inserting glazing clips.



TITLE:

**STANDARD TECHNICAL
SPECIFICATION FOR ROLLING
STEEL SHUTTERS AND GRILLS**

SPECIFICATION NO. PE-TS-314-600-C001

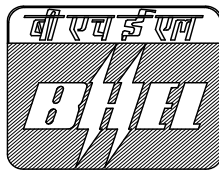
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SECTION - D

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ROLLING STEEL SHUTTERS AND GRILLS

SPECIFICATION NO. PE-TS-314-600-C001



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TITLE:

**STANDARD TECHNICAL
SPECIFICATION FOR ROLLING
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**STANDARD TECHNICAL
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ROLLING STEEL SHUTTERS AND GRILLS**1.00.00 SCOPE**

This Section covers the design and supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.00.00 INSTALLATION**2.01.00 Components**

- a) Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 1.25 mm thick for shutters having width more than 4.5 M, wide and above, machine rolled at 75 mm rolling centers, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
- b) Rolling grills shall be constructed out of 6mm rods at 35 mm on centers running horizontally flexible connected with vertical links spaced not more than 200 centers. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6mm dia rods.
- c) End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise.
- d) Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
- e) Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.m.
- f) Shafts shall be of steel pipe of sufficient size to carry the tensional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.
- g) Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.
- h) Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as prescribed by the Engineer.
- i) Power unit shall be suitable for 3 phase, 50 cycles, 400-volt A.C. power



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supply and be either floor or wall mounted unit. The motor shall be of sufficient capacity, to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated in drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

- j) Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.
- k) Reduction gears shall be high strength grey cast iron, machine moulded from machine out patterns.

2.02.00 Manually Operated Shutters/Grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for opening up to 9 Sq. metre in area. Larger shutters shall, be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Engineer.

2.03.00 Power operated Shutters/Grills

These shall be operable from a push button station conveniently located beside the door. One emergency hand chain/crank operation shall also be provided for use in case of failure of the electric system. Where called for, externally mounted shutters shall be operated by control mechanism located inside the building.

2.04.00 Shop Coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.05.00 Erection

Door shall be installed by the manufacturer or his authorized representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.



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3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE**3.01.00 Shop Inspection**

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.02.00 Field Inspection

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault free performance.

3.03.00 Guarantee

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.00.00 I.S. CODE

IS: 6248 - Metal rolling shutters and rolling grills.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates for rolling shutters and grill shall include the cost of the locks, guide channels, cost of drive as specified. In case of electrically operated rolling shutters, the rate shall also include the mounting of controls, wire and wiring from the nearest junction box, conduit and other electrical connections and cost of electric motor.

5.02.00 Measurement

Supply and installation of rolling shutter and grill shall be measured in Sqm in net outer to outer (including frame) area of each type used as described in "Schedule of Items".



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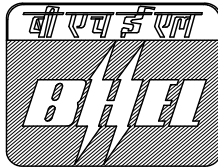
**STANDARD TECHNICAL
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SUB-SECTION – D8
MISCELLANEOUS METAL

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TITLE:

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MISCELLANEOUS METAL**1.00.00 SCOPE**

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION**2.01.00 Fabrication/casting****2.01.01 General**

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.

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2.02.00	Erection				
2.02.01	Bracing				
	The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.				
2.02.02	Temporary Bolting-Up				
	As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.				
2.02.03	Turned Bolt				
	For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.				
2.02.04	Welding				
	Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.				
2.02.05	Cutting and Fitting				
	No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.				
2.02.06	Drifting				
	Correction minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.				
	Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount of reaming and slight				



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chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1 | :3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
- The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
- The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as



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nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING**2.03.01 Chain Link Fencing**

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more then ± 0.05 mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye



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sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02**Barbed Wire Fencing**

The barbed wire shall be conform to IS:278 latest edition. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75 ± 12 mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured

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to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.					
3.00.00	ACCEPTANCE CRITERIA				
a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.					
b) For installed items, the tolerances shall be as follows					
i) Permissible deviation from, straightness – 1 in 1000.					
ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.					
c) All castings shall be free from blowholes, cracks, and other blemishes.					
d) All MS wire fencing shall be in true vertical plain, and shall not bulge.					
4.00.00	IS CODES				
IS:278 Specification for Galvanised Steel Barbed wire for fencing.					
IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.					
IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.					
IS:2721 Specification for Galvanised Steel Chain Link fence fabric.					
IS:2812 Arc welding of Aluminum and Alloy					
5.00.00	RATES AND MEASUREMENTS				
5.01.0	Rates				
Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items. Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.					
5.02.0	Measurements				



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Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.



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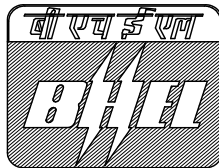
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MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor



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and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked



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separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each



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layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.



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Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.



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3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and



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filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overburnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.



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Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00

I.S. CODES

Some of the important relevant codes for this section are:

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

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.



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5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

- a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.
- b) Preparing top sand sides of existing wall for joining old with new work.
- c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

- a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.
- b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.
- c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.



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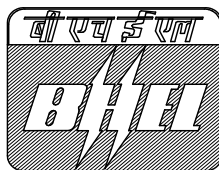
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Bharat Heavy Electricals Limited
Project Engineering Management
PPEI BLDG
NOIDA



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FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry, on a watertight platform and minimum water added to achieve



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working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.



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b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the



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g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on



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the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and



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approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates



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Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.



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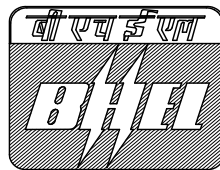
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PAINTING, WHITEWASHING, POLISHING

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TITLE:

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PAINTING, WHITE WASHING, POLISHING, ETC.**1.00.00 SCOPE**

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 Installation**2.00.01 Materials**

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.



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a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and shall conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint



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Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02**Storage**

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00**Preparation of surface**

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.



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2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.



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2.02.00 Application**2.02.01 General**

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.



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One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distemping shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint



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Shall be applied on properly primed surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flattening varnish. This shall be allowed to dry hard and be flattened down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt sienna or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with



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polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.



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Testing

- a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.
- b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.
- c) Material/workmanship unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00**I.S. CODE**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348 Specification for French polish

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

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

IS: 1477 Code of Practice for painting of ferrous metal
(I & II) in buildings.

IS: 2338 Code of Practice for finishing of wood and



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(I & II) wood based materials.

IS: 2339 Specification for Aluminium, Paints for general purposes in dual containers.

IS: 2395 Code of Practice for painting concrete, masonry, and Plaster surface.

IS: 2932 Specification for enamel, exterior type-1.

IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates shall be unit rates for complete items described in the “Schedule of Items”.

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. unless specified otherwise.



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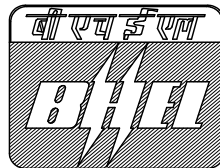
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FLOOR FINISH AND ALLIED WORKS

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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

- a) In Situ Finishes
 - i) Integral finish to concrete base
 - ii) Terrazzo finish
 - iii) Granolithic finishes
 - iv) Patent Stone
 - v) Metallic Hardener like “Ironite”/Hardonate Finish
 - vi) Mastic Asphalt finishes
 - vii) Chemical Resistant finish
- a) Tiled Finishes
 - i) Terrazzo tile
 - ii) Chequered tile
 - iii) Glazed tile
 - iv) Tesse rae (Mosaic etc.)
 - v) Chemical Resistant
 - vi) Rubber, Vinyl etc.
 - vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence



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Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be bone dry where adhesives are used for fixing the finishes.



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Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to acc ate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1 | parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips



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shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1 parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Sieve No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in an even pattern of distribution.



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d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03

Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.



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c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface ' of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all, marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

d) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing



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Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.



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2.01.05 Metallic Hardener Like 'Ironite'/ 'Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very 'green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothed with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.



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a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be leveled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07

Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get



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it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).



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The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.



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If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed

As per clause 2.02.01 (c).

d) Laying

As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness



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The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.



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- d) Laying
Same as clause 2.02.01 (d).

- e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

- a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

- b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

- c) Mix: Underbed
Same as clause 2.02.03 (c)

- d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.



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2.02.05

Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06

Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalis, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of



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manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.



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2.02.07

Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed

Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually



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exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08

Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00

ACCEPTANCE CRITERIA

The finish shall be checked specially for:

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

4.00.00

I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian



TITLE:

**STANDARD TECHNICAL
SPECIFICATION FOR FLOOR
FINISH AND ALLIED WORKS**

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Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 777	:	Glazed earthenware tiles
IS: 1196	:	Code of practice for laying bitumen mastic flooring.
IS: 1197	:	Code of practice for laying of rubber floors
IS: 1237	:	Cement concrete flooring tiles
IS: 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 2114	:	Code of practice for laying in situ terrazzo floor.
IS: 3461	:	PVC asbestos floor tiles
IS: 4860	:	Specification for acid resistant bricks
IS: 5518	:	Code of practice for laying of flexible PVC Sheet and tile flooring.
IS: 5491	:	Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.



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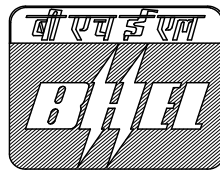
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SHEET WORK IN ROOF AND SIDING

SPECIFICATION NO. PE-TS-314-600-C001



Bharat Heavy Electricals Limited

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TITLE:

**TECHNICAL SPECIFICATION FOR
SHEET WORK IN ROOF AND
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SHEET WORK IN ROOF AND SIDING

1.00.00 SCOPE

This section covers supply, cutting & fabrication and erection of corrugated/plain asbestos, corrugated galvanized iron, aluminum, permanently colour coated troughed zinc-aluminium alloy coated M.S. sheet or other sheet for covering to roof and sides at various elevations as specified.

2.00.00 INSTALLATION

2.01.00 Storage of Materials

All materials shall be stored by the Contractor in proper way to prevent all damage.

2.02.00 Workmanship

The workmanship shall be according to best construction practice to give a watertight finish to the satisfaction of the Engineer. Fixing of gutters and down pipes shall be according to IS: 2527.

2.02.01 Asbestos Sheeting

Asbestos sheets of profiles as specified shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification. Hook bolts or J-bolts shall be 8 mm dia. at 305 mm centres. Six (6) mm dia. galvanized iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge cappings, corner pieces, ventilators, north light curves etc.

2.02.02 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used, the end laps shall be minimum 100 mm. Holes in C.G.I. sheets shall preferably be made on the ground. The sheets should be placed on purlins/trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum spacing of the bolts shall be 305 mm. The length of the hook or J-bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanized iron seam bolts and G.I. flat washers and bituminous washers.

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2.02.03	Fibre Glass Reinforced Plastic Sheeting This shall be of thickness and profile as specified. Colour and light transmittance shall be as mentioned. Where used in conjunction with C.G.I. or asbestos sheeting, the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.
2.02.04	PERMANENT COLOUR COATED SANDWICHED INSULATED METAL CLADDING SYSTEM i. Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6mm minimum thickness (or high tensile steel sheet having minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm/sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF₂) of Dry Film Thickness (DFT) 20 microns (minimum) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns. ii. Galvanised M.S. sheets of minimum 0.6mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (minimum) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanization shall not be less than 275 gm/sqm. iii. The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability. iv. Inner sheet shall be fixed directly to side runners and Z spacers made out of at least 2 mm thick galvanized steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50M centre to centre to hold the insulation and external sheeting. The fasteners shall be of high quality corrosion resistant grade of self tapping / self drilling type provided with suitable cap. v. The insulation shall be of bonded mineral wool of minimum thickness 50mm conforming to IS:8183, having a density of 32 Kg/cu.m. for glass wool & 48 Kg/cu.m. for rock wool.
2.02.05	PERMANENT COLOUR COATED (NON-INSULATED) METAL CLADDING SYSTEM i. Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S. sheets having 0.6 mm minimum thickness (or High tensile steel sheet having

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minimum yield strength of 350 Mpa of 0.5mm minimum thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF₂ paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.																	
ii. FLASHING, CAPS, TRIM CLOSURES ETC. All flashings, trim closures caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.																	
3.00.00 ACCEPTANCE CRITERIA The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked: a) Side and end laps b) Absence of cracks, holes or damages in sheet c) Spacing of bolts d) Provision of double washers (G.I. and asbestos or bituminous washers) e) Proper installation of flashing.																	
4.00.00 I.S. CODE All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. <table><tr><td>IS: 3007</td><td>:</td><td>Code of practice for laying of asbestos cement sheets.</td></tr><tr><td>IS: 2527</td><td>:</td><td>Code of practice for fixing rainwater gutters and down pipes for roof drainage.</td></tr><tr><td>IS: 1626</td><td>:</td><td>Specification for asbestos cement building pipes, gutters and fittings.</td></tr><tr><td>IS: 277</td><td>:</td><td>Specification for galvanized steel sheets (plain and</td></tr></table>						IS: 3007	:	Code of practice for laying of asbestos cement sheets.	IS: 2527	:	Code of practice for fixing rainwater gutters and down pipes for roof drainage.	IS: 1626	:	Specification for asbestos cement building pipes, gutters and fittings.	IS: 277	:	Specification for galvanized steel sheets (plain and
IS: 3007	:	Code of practice for laying of asbestos cement sheets.															
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**TECHNICAL SPECIFICATION FOR
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corrugated).

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rate for complete item described in “Schedule of Items” and shall include all wastage.

5.02.00 Measurement

Sheeting work in roof & sides shall be measured in Sq.M. for net area of the work done. Profiled sheeting shall be measured flat and not girthed. Opening less than 0.40 Sqm shall not be deducted. No extra shall be paid for extra labour in cutting and for wastage etc. No payment shall be made for laps in sheeting works.



TITLE:

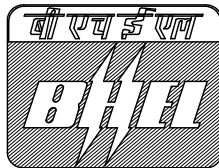
**STANDARD TECHNICAL
SPECIFICATION FOR SUSPENDED
CEILING**

SPECIFICATION NO. PE-TS-314-600-C001

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SECTION - D
SUB-SECTION – D14
SUSPENDED CEILING

SPECIFICATION NO. PE-TS-314-600-C001



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TITLE:

**STANDARD TECHNICAL
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4.00.00	SHOP DRAWINGS	4
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SUSPENDED CEILING**1.00.00 SCOPE**

This section covers supply and installation of suspended ceiling together with the suspension system as shown on drawing or specified in schedule of item with all materials, labour and equipments. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers etc. as shown on drawings or as instructed by the Engineer.

2.00.00 INSTALLATION**2.01.00 Suspension System****2.01.01 General**

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural works, slabs and beams.

All members of the suspension system shall be of sufficient strength and rigidity to carry, the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angles. Angle moulds where shown on drawings shall be securely fixed to walls. All drillings of structural concrete and installation of suitable anchoring device for installation including welding of the suspension system shall be included in the rate. All M.S. sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

2.01.02 Metal Grid Suspension System

Aluminium grid ceiling system shall be "Bead lock" as manufactured by W A Beard shell and Co. Pvt. Ltd. or Ajit India Limited or approved equal. Steel grid ceiling system shall be 'Jolly Snap Grid' as manufactured by Jolly Board Limited or approved equal.

Steel tees as intermediate members and steel channels, as end pieces will be assembled in the form of grid. Size of tees and channels shall be as required.

The cross-tees shall intersect main tee runners in pattern shown on drawing and positively locked together with intersection members. All perimeter areas shall have tee runners fixed to vertical wall surfaces and end channels shall be fixed to runners leaving return air space between vertical wall and channels, unless otherwise shown on drawings. Angle cleats or other suitable fixing



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device shall be fixed to the structural beams above for fixing of hangers. Main runners shall be hung by M.S. flats, angles, rods or 12G or heavier galvanized tie wire hangers at maximum 1.2 metre centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings. Turnbuckles shall be provided in M.S. rods for adjustment in levels.

2.02.00 Ceiling Panels**2.02.01 Material**

Ceiling panels shall be best quality material in thickness and properties called for in the "Schedule of items". The Contractor shall submit test certificates to the Engineer for approval before bulk supply. The ceiling panels may be of following type:

- Plaster of Paris board (decorative)
- Expanded polystyrene insulation board with plastic fascia.
- Fibre Insulation board.
- Bonded wooden particle board (Plain and decorative)
- Glass fibre reinforced polystyrene sheets.
- Flat asbestos sheets (with plastic fascia).

2.02.02 Installation of Ceiling Panels

Installation of Ceiling panels shall be strictly as per manufacturer's instruction.

For concealed grid system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall be in true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

2.02.03 Aluminium Lineal Ceiling System

Aluminium lineal ceiling system shall be "Luxalon 84C " or approved equal and the installation shall be strictly as per manufacturer's instruction/ specification subject to approval of the Engineer.



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Aluminium lineal ceiling shall comprise of plain panels, 84 mm wide and 12.5 mm deep with a 23.9 mm recessed flange, roll formed out of 0.5 mm thick aluminium alloy panels stove enamelled on both sides, fixed on roll-formed carriers made of enamelled 0.95 mm thick aluminium, 32 mm wide and 39 mm deep with prongs to hold panels in the module of 100mm, at maximum spacing 1.2 M centre to centre. The carriers shall be suspended from roof by 4 mm dia galvanised steel wire hangers with special height adjustment clips made out of spring steel at maximum spacing of 1.2 M c/c. Hangers shall be fixed to roof by 'J' hooks and nylon inserts. 25 mm thick resin bonded mineral wool (spintex 300 or equivalent) insulation bound in polythene shall be laid on top of panels. Lineal ceiling shall be fixed in pattern as per detailed drawings.

3.00.00 SAMPLES

Samples of Ceiling panels and metal suspension system components as noted below shall be submitted for Engineer's approval:

Panels : 3 samples approximately 300 mm square/long each

Suspension System : 3 samples of short length : each of main and secondary system

4.00.00 SHOP DRAWINGS

Shop drawings shall be submitted for approval as required and approval shall be obtained prior to delivery of suspended ceiling components. Shop drawings shall be co-coordinated with all related work and shall show the following information:

- A reflected ceiling plan of areas indicated to receive the ceiling showing electrical and mechanical features.
- Typical Intermediate framing for support where required.
- Hanger fastening details.
- Panels - unit support at ceiling penetrations.
- Details of splicing method for main and cross runners.
- A table indicating load bearing capacity of main and cross runner
- A note stating that the suspension system member furnished will not deflect more than $1/360$ of the span under the indicated loading.



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5.00.00 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from, sags, warps, disfigured, or damaged board. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

6.00.00 RATES AND MEASUREMENT**6.01.00 Rates**

Rates shall be for the complete item called for in the "Schedule of Items". No extra payment will be made for alignment and adjustment of lighting fixtures, air-conditioning diffusers, access panels etc. The rate shall include all cutting and wastage from standard size sheets, runners/carries etc.

6.02.00 Measurement

Actual area of work shall be measured in Sqm correct to second place of decimal. However, no deduction will be made for opening upto 0.25 Sqm. each in area.



TITLE:

**STANDARD TECHNICAL
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DRAINAGE AND SANITATION**

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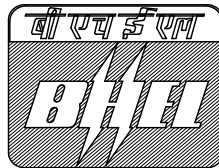
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SECTION - D

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WATER SUPPLY, DRAINAGE AND SANITATION

SPECIFICATION NO. PE-TS-314-600-C001



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TITLE:

**STANDARD TECHNICAL
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WATER SUPPLY, DRAINAGE AND SANITATION**1.00.00 SCOPE**

This section covers supply of all materials labour and incidentals required for supply, laying and installation of under/over ground pipes for water supply, drainage and sanitation with all fittings, fixtures and jointing, construction of ancillary works like manholes, drop connections, gully chambers, septic tank, soak pits, surface drain etc.

The supply and installation of water supply/sanitation fixtures and accessories like water closets, urinals, wash basins, sinks, mirrors, shelves, towel rail, soap container etc. with all fittings, fixtures, water supply/sanitation pipes and water storage tanks etc.

2.00.00 MATERIAL

All materials, fittings, fixtures, and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures, which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model, and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence orders are to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets, and similar items shall be specially protected till final installation. Brass and other expansive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

2.01.01 Pipes and Pipe Fittings

For water supply, galvanised mild steel pipe of medium grade conforming to IS: 1239 shall be used. The galvanising shall not be less than 400gm/sqm of pipe surface area. Galvanising shall be smooth and shall be subjected to testing as per IS: 2633 for uniformity of coating. The zinc coating shall be free from defects.

For Roof drainage and building sanitation works following type of pipe are coved in this Section:



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- a) Cast Iron pipe
- b) Steel pipe (lined, coated with bituminous composition, out coated with cement concrete or mortar or galvanized)
- c) Concrete pipe
- d) Asbestos cement pipe
- e) PVC pipe
- f) Stoneware pipe
- g) Vitrified pipe
- h) Lead pipe (not to be used for portable water)

2.02.01**Fixtures**

All material, fittings, fixtures, appliances, accessories shall be of approved quality and shall be procured from reputed brands like Hindustan/Pasriware/Cera or equivalent or as approved by Engineer. The bidder shall procure the fixtures from the above named reputed manufacturers and shall mention in his bid the type & make of the fixtures he intends to use.

All items brought to the site must bear the manufacturer's identification mark. Procurements shall be made well in advance and should get inspected & approved immediately by the Engineer. All fixtures shall be adequately protected, covered, and plugged till handing over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated. The chromium plating shall be of grade-2 (10micron thickness) confirming to IS: 4827. Powder coating shall be of approved colour and shall have minimum thickness (DFT) of 20micron. Stainless steel accessories shall be of grade SS-304 and from reputed manufacturer (like Salem Steel) and shall be polished bright finish.

Unless specified in the contract the fixtures shall be as specified hereinafter.

Water closet**a) European type**

It shall consist of European type glazed vitreous china basin (confirming to IS: 2556, part-II), with siphon open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium



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plated. Colour of basin, cistern, seat and cover shall be as approved by the Engineer.

b) Squatting type

It shall consist of Orissa pattern glazed vitreous china squatting pan with integral foot rests (confirming to IS:2556, part-III) and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The flushing cistern shall be painted as specified by the Engineer.

Urinals

It shall consist of wall type glazed vitreous china urinals (conforming to IS:2556), cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Frequency of automatic flushing shall be approximately once every five minutes. For every four urinals (maximum) located together may be served by one cistern of adequately capacity. All fittings shall be chromium plated.

Wash Basin

It shall be made of glazed vitreous china conforming to IS:2556, part-IV. The basin shall be flat back, wall hung by painted cast-iron brackets and complete with hot and cold CP brass faucets with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 32mm dia. Chromium plated brass waste of standard pattern, 32mm dia. CP brass trap union complete with necessary fittings.

Sink

It shall be made of glazed vitreous china conforming to IS:2556, part-V. It shall be wall hung by painted cast iron brackets and complete with one CP brass faucet with nylon washers, PVC connection pipe with CP brass nuts, CP brass chain with rubber plug, 40mm dia. chromium plated brass waste of standard pattern, 40mm dia. CP brass trap union complete with necessary fittings.

Bathroom mirror

It shall be made of the best quality 6 mm thick glass and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws, and other fittings shall be chromium plated.

Glass shelves



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Class shelves shall consist of 6 mm thick clear glass with guardrails and shall be wall mounted with brackets. All brackets, guardrails, and screws shall be chromium plated.

Towel rail

Towel rails shall be 20 mm dia chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

Soap holder

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium-plated screws.

Liquid Soap Dispenser

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screw shall be chromium plated.

Valve, cocks, Taps

All valves, stop cocks, taps etc. shall conform to relevant Indian standard specification and shall be of best quality from approved manufacturers. These shall be suitable for normal working pressures. Nominal size and material shall be as required / specified.

2.03.00 Water Storage Tank

Water storage tank shall be PVC of approved brand and make (Syntex or equivalent). Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

3.00.00 INSTALLATION**3.01.00 General**

Basic layouts may be available in the drawings provided, the details might have to be supplemented by the Contractor and get the approval of the Engineer before installation. Special attention shall be given to economise the layout. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance,



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repairs, and replacements of pipes, fittings, and fixtures must be conveniently possible. All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry, and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipelines, fittings, and fixtures shall be installed leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

3.02.00 Portable water supply Pipe Lines**3.02.01 Laying**

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level and shall run on the surface of the walls, ceiling or in chases. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. All pipes used for water supply should be thoroughly and efficiently disinfected before taken in to use.

3.02.02 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

3.02.03 Contamination

There shall be no cross connection whatsoever between a pipe/fitting for conveying or containing wholesome water and a pipe/fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any other purpose. No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

3.02.04 Underground Piping



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Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable. The size and depth of the trench shall be as approved by the Engineer. Back filling shall be done with selected fine earth, unless otherwise permitted, in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling, the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support. The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

3.02.05 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, and conduits as necessary. However, the Contractor will rectify if required the chases, openings, and conduits, supplement and make good after laying and testing of the concealed pipelines.

3.02.06 Jointing of Pipes

All G.I. pipes shall be properly thread/weld jointed and made completely water tight and durable. Burr from the joints shall be removed after screwing. Union joints shall be provided for all required location to facilitate maintenance.

3.02.07 Painting

Where required, underground G.I. pipes shall be given 2 coats of bituminous paint on the outside after laying. When painting is to be done above ground G.I. pipes shall be given one coat of red lead or zinc chromate primer and top coats shall be minimum 2 coats of best quality paint as specified.

3.03.00 RAINWATER DOWN COMERS**3.03.01 Pipes**

Rainwater down comers shall be standard Cast Iron or Asbestos Cement Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater down comers shall run along and be secured to walls, columns etc. Where desired by the Engineer these may have to be installed in chases cut in the structure. All pipes shall be well secured and supported by adequately strong brackets. The brackets may be wrought iron clevis type, split ring type,



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or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

3.03.02 Khurras

The khurras shall be constructed before the work in parapet wall is taken up and it shall be 45x45 cm in size, unless otherwise specified and shall be formed of cement concrete of M-20 grade.

3.03.03 Gutters

The gutters shall be made of G.I. or A.C and procured from reputed specialised manufacturers. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. Adequate number of string supports shall be provided so that there is no sagging even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5 cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.04.00 SOIL AND DRAINAGE PIPES**3.04.01 Gradients**

If not specified the minimum gradients of soil and drainage pipeline shall be as follows:

100 mm nominal dia	:	1 in 35
150 mm nominal dia	:	1 in 65
230 mm nominal dia	:	1 in 120



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300 mm nominal dia : 1 in 200

3.04.02 Relation with water supply pipelines

Unless specifically cleared by the Engineer, under no circumstances shall drainage and sewer pipes be allowed to come close to water supply pipelines.

3.04.03 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

3.04.04 Support and Protection of Pipelines

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the Engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

- When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.
- Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.



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c) Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

d) Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150 mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

3.04.05 Entry into structures

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipelines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

3.04.06 Ducts

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin, or backflow.

3.04.07 Traps and Ventilating Pipes

Pipes are carrying off the waste from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap. Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of C. I. unless desired otherwise by the Engineer.



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3.04.08 Manhole & Inspection Chambers

At every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The maximum distance between manholes shall be 30 meter unless specially permitted otherwise. However, for truck route (for pipes above 900 mm dia.) this distance can be increased to 45 M. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise provision of IS: 4111 (Part-1) shall be followed for construction of a manhole. Manhole shall be constructed so as to be watertight under test. The change in alignment shall be carried out in such a manner as to provide no lodgement for any splashings in case of accidental flashing of the chamber. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connecting to existing sewer lines shall be through a manhole.

Unless otherwise specified, 560 mm dia. circular cast iron manhole cover with frame, heavy-duty, conforming to IS: 1726 shall be provided. The covers shall be close fittings so as to prevent gases from coming out.

3.04.09 Cutting of Pipes

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

3.04.10 Jointing

Jointing of pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and watertight when underground. Method of jointing shall be as per instructions of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the



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socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton' Joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

b) Concrete Pipes

Jointing of concrete pipes shall be generally of rigid type. Unless otherwise stated collar type joint shall be provided. IS: 783 shall be followed for general guidance.

The two adjoining pipes shall be butted against each other and adjoined in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The angular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement : 2 sand) which shall be rammed with caulking tool. After a day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured for 7 days.

c) Glazed Stoneware Pipes

Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than 1/4 of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar 1:1 (1 cement : 1 sand). A fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. with the barrel of the pipe. The newly made joints shall be protected, until set and shall be cured by covering with damp cloth or other suitable materials.

d) Vitrified clay pipes

The vitrified clay pipe shall be made from refractory clay mixed with crushed pottery and stone and burnt at a high temperature. These shall be hard, compact, and glazed to make them acid resistant and impervious, and shall be obtained from approved manufacturer.

Special care shall be taken in handling these pipes. The pipes shall not be



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jointed until the earth has been partly refilled over the portion of the pipe between the joint holes. Before laying the second pipe, the socket of the first pipe laid shall be thinly painted all round on the inside with cement slurry (1 part of cement and 2 parts of clean, sharp sand). A ring of rope yarn (closely twisted hemp or jute) dipped in neat cement paste or tar or bitumen, shall be inserted in the socket of pipe and driven home with caulking tools. The rope shall fully encircle the spigot with a slight overlap and shall not occupy more than one-fourth of the total depth of the socket. Where the spigot end of the pipe is made for receiving the gasket, it shall be wrapped with two or three turns of tarred spun, as close to the end as possible, before inserting into the socket. The joint shall then be completely filled with cement mortar (1:1), which shall have very little water. A fillet shall be formed round the joint with trowel, forming an angle of 45 degrees with the outside pipe. Special care shall be taken so that any excess mortar etc. left inside the pipe joints is neatly cleaned off immediately after each joint is made. A semi-circular wooden scrapper or a rubber disc to which a long handle is fixed could be used for this purpose.

e) Lead Pipes

The joints in lead pipes shall be made as wiped solder joint. The minimum and the maximum length of the wiped solder joints shall be 8 cm. and 9 cm. respectively. The solders shall generally consist of two parts of lead and one part of tin.

f) Polyethylene Pipes

The joints shall be thermo welded or bolted as per manufacturer's instructions.

g) Jointing Cast Iron Pipes with Stoneware Pipes

Where any cast iron drain pipe, ventilating pipe or trap is connected with a stoneware or semi-vitrified waste pipe, the beaded spigot end of such cast iron drain pipe, waste or ventilating pipe or trap shall be inserted into a socket of such stoneware pipe and the joint made with mortar consisting of one part of cement and one part of clean sand after placing a ratted gasket or hemp yarn soaked in neat cement slurry round the joint and inserted in it by means of a caulking tool.

h) Jointing Stoneware with Cast Iron Pipes

Where any water closet pan or earthenware trap connected to such a pan is to be jointed with a cast iron soil pipe, the joint between the stoneware spigot and the cast iron socket shall always be of a flexible nature. Such joint shall be made with a mixture of bitumen and chopped asbestos fibre.



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3.04.11 Trenches and other excavations

Width of the trench at the bottom shall be such as to provide 200 mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench behind the work.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary.

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimize inconvenience of traffic where applicable.

3.04.12 Protection

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets, or spigot are not damaged and no foreign material can find its way into the pipeline. Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.05.00 WATER STORAGE TANKS



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Overhead/loft type water storage tank shall be made of PVC. These tanks shall be provided for each toilet block and placed on the roof/loft of the building. Tank shall be installed with proper supports and anchorage for applicable wind and seismic condition. Installation of tank shall be carried out according to the recommendation of IS: 12701. These tanks shall rest preferable on flat surface so as to distribute the load evenly. The tank shall be leakproof and water tight.

The outlet pipe shall be 50 mm above the bottom of the tank and provided preferably with strainers. The wash out or draining pipe shall be connected at the lowest point and flush with bottom of tank.

Tank shall be provided with all fittings for inlet, outlet, overflow pipes and ball valves.

3.06.00 SEPTIC TANK AND EFFLUENT DISPOSAL**3.06.01 Septic tank**

Septic tank shall consist of the tank itself with inlet and outlets there from complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This item shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wiremesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

3.06.02 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed SW pipes laid in a trench filled with broken bricks.

3.06.03 Soak pit

The soak pit shall be complete. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone; brick or concrete blocks set in cement mortar (1:6) and filled with brickbats. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti-mosquito measure.

3.06.04 Open jointed SW Pipe/dispersion trenches

Minimum dia of the SW pipes shall be 150 mm nominal. The trench for laying



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the pipes shall be a minimum 600 x 600 mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well-graded coarse aggregate. Ordinary soil is used for filling the top of trench.

3.06.05 Commissioning septic tank

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

3.07.00 Related Works

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply and sanitation systems shall come under scope of the Contractor unless specifically excluded. These works are not detailed out in this Section.

3.08.00 Regulation

The work which is required to be carried out under this section, shall be executed by a licensed Plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc., from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

4.00.00 TESTING AND ACCEPTANCE CRITERIA**4.01.00 Inspection Before installation**

All pipes, fittings, and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

4.02.00 Testing of Water Supply pipe line**4.02.01 Testing of Mains After Laying**

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main by providing a 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and



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then tested under pressure. The test pressure shall be 5 Kg/sq.cm or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power driven test pump, provided that the pump is not left unattached. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable less for at least five minutes. The end of the main shall be closed by fitting a watertight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

4.02.02 Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw-off taps are closed, the service pipes shall be absolutely watertight. All piping, fittings, and appliances shall be checked for satisfactory support and protection from damage, corrosion, and frost.

4.03.00 Testing of Drain and Sewerage Pipelines

All soil pipes, waste pipes, ventilating pipes and all other pipes, when above ground, shall be gas tight. All sewers and drainpipes laid below ground shall be tested water tight. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:



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a) Smoke test

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test conducted under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced by burning oily waste or tarpaper or similar material in the combustion chamber of a smoke machine. Chemical smokes shall not be used.

b) Water test

The pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system, with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the required test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may be due to one or more of the following cases:

- a) Absorption by pipes and joints
- b) Sweating of pipes or joints
- c) Leakage at joints or from defective pipes
- d) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

c) For straightness

- i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end; and
- ii) By means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.



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4.04.00 Fittings and Fixtures etc.

All fittings and fixtures shall be connected by water tight joints. No dripping of water shall be acceptable.

4.05.00 Testing Septic Tank

The septic tank shall be tested for water tightness. It shall be filled up with water and allowed to soak for 24 hours. Then, it shall be topped up and allowed to stand again for 24 hours and loss of level recorded. The fall shall not be more than 15 mm in 24 hrs.

5.00.00 I.S. CODES

Important relevant IS Codes for this specification are listed below:

Latest editions shall always be consulted.

IS: 404	:	Lead pipes.
IS: 407	:	Brass tubes for general purposes.
IS: 458	:	Concrete pipes (with or without reinforcement)
IS: 783	:	Code of Practice for laying of concrete pipes.
IS: 1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS: 1200 (Pt.XVI)	:	Laying of water and sewer lines, including appurtenant items.
IS: 1230	:	Cast iron rain water pipes and fittings.
IS: 1239 (Pt.I & III)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter).
IS: 1536	:	Specification for centrifugally cast (Spun) iron pressure pipes for water gas and sewage.
IS: 1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
IS: 1592	:	Asbestos cement pressure pipes,

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	IS: 1626 : Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types). IS: 2065 : Code of Practice for Water Supply in buildings. IS: 2501 : Copper tubes for general engineering purposes. IS: 2556 : Specification for vitreous sanitary appliances (vitreous china) Part – I - General requirement IS: 2633 : Method of testing, uniformity of coating on zinc coated articles. IS: 3076 : Low density polyethylene pipes for portable water supplies. IS: 3486 : Specification for Cast iron spigot and socket drain pipes (80 mm to 250 mm nominal diameter). IS: 3589 : Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter). IS: 4827 : Specification for electro plated coatings of nickel and chromium on copper and copper alloy. IS: 4964 : High-density polyethylene pipes for portable water supplies. IS: 12701 : Rotational moulded polyethylene water storage tanks				
6.00.00	RATE AND MEASUREMENT				
6.01.00	RATE				
6.01.01	G.I. Pipes For Water Supply				
	Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. with cutting, making chases and jointing of pipes, making good the walls.				
6.01.02	Rainwater Down-comers				
	Rate shall include providing and fixing of the pipes including all specials and fittings, such as tees, bands, elbows, clamps, drain heads, cleanouts etc. The rate also include cost of jointing and making good the opening in structure.				



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6.01.03 Sanitary Fixtures

Rate shall include providing and fixing of sanitary appliances & fixtures and at all elevation, including all accessories and fittings, connections pipes, waste trap and pipes all complete as per description of "Schedule of Items". Rate shall also include the jointing of waste & traps to drain pipes.

6.01.04 Drainage and Sewer Pipes

Rate shall be inclusive of providing, laying and jointing of pipes as specified. Rate also include cost of lead joints or other joint as specified, cost for painting and cutting and making good walls, floors etc.

6.01.05 Floor and Gully Traps

Rate of traps is inclusive of all excavation, filling, repair, making good of opening in floor and walls, grating, painting etc. complete as described in "Schedule of Items".

6.01.06 Manholes, Septic Tank, Soak Pit and Cover

Rate of manholes, septic tank, soak pit shall be paid under respective items of work executed like brick work, plastering, concrete, reinforcement steel etc. provided for completion of the structure as per drawing and specifications. Manhole cover shall be paid separately as per description of item.

6.01.07 Water Storage Tank

The rate for water storage tank is inclusive of supply and installation of tank with all fittings, inlets, outlets, valves etc. complete.

6.02.00 MEASUREMENTS**6.02.01 Pipe for Water Supply and Drainage**

For G.I.Pipe of water supply line, rainwater down comers, drainage and sewer pipe, the measurements shall be in running metres and shall be taken along centre line of pipe or specials.

The pipe shall be measured separately according to dia. and class of pipe.

Fixtures like bibcock, stopcocks, valves etc. shall be measured in numbers.

6.02.02 Sanitary Appliances & Fixtures and Allied Works



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All sanitary appliances & fixtures like sink, washbasin, WC, shall be measured in numbers for the complete work as described in schedule of items.

Floor and gully traps shall be measured in numbers unless otherwise specified.

Water storage tank shall be measured in numbers for the capacity as specified in "Schedule of Items".

The item of work executed for completion of manholes, septic tank & soak pit shall be measured in respective items of work like brick work, RCC, plastering etc. CI cover shall be measured in numbers as specified in "Schedule of Items".



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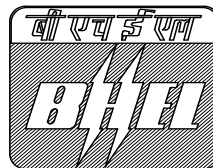
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SUB-SECTION – D16

ROAD AND DRAINAGE

SPECIFICATION NO. PE-TS-314-600-C001



Bharat Heavy Electricals Limited
Project Engineering Management
PPEI BLDG
NOIDA

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CLAUSE NO.	DESCRIPTION	SHEET NO.				
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Standard Technical Specification For Road And Drainage 1.00.00 Scope The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc. The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc. 1.01.00 Works To Be Provided By The Contractor The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following. a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work. b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval. c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc. 1.02.00 Work To Be Provided By Others No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract. 1.03.00 Conformity With Designs The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer. 1.04.00 Materials To Be Used		

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All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

- a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC
- b) IRC: 19 - Standard specification and code of practice for Water bound Macadam
- c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways
- d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.
- e) IS:2212 - Code of Practice for Brick work
- f) IS: 783 - Code of Practice for Laying of Concrete Pipes
- g) IS: 1201 - Methods of testing tar and bituminous materials to 1220
- h) IS: 73 - Specification for paving bitumen
- i) IS: 215 - Specification for Road tar
- j) IS: 216 - Coal tar pitch
- k) IS: 217 - Specification for cut-back bitumen
- l) IS: 454 - Specification for cut-back bitumen from waxy crude
- m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete
- n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre

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Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade	± 25 mm
Sub-base	± 20 mm
Base course	± 15 mm



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Wearing course ± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I**PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES**

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8

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6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6	
7.	Bituminous macadam	10	-	-	-	20***	6	
8.	Semi-dense carpet	10	-	-	-	20***	6	
9.	Asphaltic Concrete	8	-	-	-	10***	4	
Notes: 1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing. 2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table. 3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied. 3.00.00 Execution 3.01.00 Setting Out Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen. 3.02.00 Clearing and Grubbing								

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Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.



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Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skew/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

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3.03.03 Stripping and Storing top soil		
The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.		
3.03.04 Compacting Original Ground		
In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer. Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller. Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.		
3.03.05 Filling		
The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under		



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construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06

Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.

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Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as

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shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

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3.04.04	Staking the Sods	Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.			
3.04.05	Top Dressing	After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.			
3.04.06	Watering and Maintenance	The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.			
3.05.00	Shoulder Construction				
3.05.01	Description	This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.			
3.05.02	Materials	Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.			
3.05.03	Construction Operations	Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside			

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		edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer. In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted. Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water. 3.06.00 Kerb 3.06.01 Material Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level. 3.06.02 Laying The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm. The gap shall be filled with cement mortar as specified. The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer. 3.07.00 Sub-base (Granular Sub-base) 3.07.01 Description This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer. 3.07.02 Materials

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The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm	100	100	100
63 mm	90 - 100	90 - 100	90 - 100
4.75 mm	35 - 70	40 - 90	50 - 100
75 micron	0 - 20	0 - 25	0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of

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loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm. Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet. Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material. Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted. 3.08.00 Water Bound Macadam Sub-base/Base Course 3.08.01 Description Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings. 3.08.02 Materials a) Coarse Aggregates - General Requirements		

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Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	Test method	Requirements
1.	Sub-base	Los Angeles Abrasion Value * or Aggregate Impact Value	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640**	50 percent maximum 40 percent maximum
2.	Base	a) Loss Angeles Abrasion value* or Aggregate Impact Value b) Flakiness Index ***	IS : 2386 (Part IV) IS : 2386 (Part IV) or IS : 5640 ** IS : 2386 (Part I)	50 percent maximum 40 percent maximum 15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates



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The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

**Table - VI
Grading Requirements of Coarse Aggregates**

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.



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**Table - VII
Grading For Screenings**

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720, Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading



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shall be done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not



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be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled

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with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.					
3.09.00	Tack Coat				
3.09.01	Description	The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.			
3.09.02	Materials	The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.			
3.09.03	Construction Operations				
	a) Preparation of Base	The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.			
	b) Application of Binder	Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.			
3.10.00	Bituminous Macadam Binder Course				
3.10.01	Description	This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in			



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accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

**Table – VIII
Physical Requirements of Aggregates For Bituminous Macadam**

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.



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**Table-IX
Aggregates Grading For 75mm Compacted Thickness Of Bituminous
Macadam**

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

**Table-X
Aggregates Grading For 50mm Compacted Thickness Of Bituminous Macadam**

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

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The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit



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manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

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Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C. Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it. The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it. 3.11.00 Open Graded Premix Carpet 3.11.01 Description This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification. 3.11.02 Materials a) Binder The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable. b) Aggregates The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30. c) Proportioning of Materials The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet. Table - XI		

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Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet

i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
Total		0. 27 Cu.m

Binder for premixing (quantities in terms of straight run bitumen)

i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
Total		14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat



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A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be



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The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

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c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03

Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable

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design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained. 3.12.04 Opening to Traffic In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day. 3.13.00 Repair of Existing Water Bound Macadam Surfaces Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under. Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer. 3.14.00 Road Side Drains 3.14.01 Drains The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer. The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments		

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as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown on approved drawing, drains shall be of R.C.C. construction with necessary slopes. 3.15.00 Culverts Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the “Specification for Earthwork in Excavation and Backfilling”, backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable. 3.16.00 Pipe Culverts and Drainage Pipes 3.16.01 Materials The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer’s specification. The tenderer shall specifically mention the particular manufacturer’s product he proposes to use. Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383. 3.16.02 Laying of Pipes Laying of concrete pipes shall correspond to IS:783 and as per the specification given below. a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.		



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Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

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e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03

Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00

Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00

Testing And Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the “Specification for Roads and Bridge Works, 1983” published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00

MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.



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FABRICATION OF STRUCTURAL STEEL WORK



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SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

- a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.
- b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.
- c) To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings.
- d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,
- e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.
- f) Suitably mark, bundle, and pack for transport all fabricated materials.
- g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.
- h) Insure, load and transport all fabricated steelwork field connection materials to site.
- i) Maintain a fully equipped workshop at site for fabrication, modification

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and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.					
2.02.00	Work by others				
No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.					
2.03.00	Codes and standards				
All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:					
IS : 226 - Structural steel (Standard Quality)					
IS : 800 - Code of Practice for general construction in steel.					
IS : 806 - Code of practice for use of steel tubes in general building construction.					
IS : 808 - Rolled steel beams, channels, and angle sections					
IS : 813 - Scheme of symbols for welding					
IS : 814 - Covered electrodes for metal arc welding of structural steel					
IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.					
IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel					
IS : 817 - Code of practice for training and testing metal arc welders					
IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations					
IS : 822 - Code of practice for inspection of welds					
IS : 919 - Recommendations for limits and fits for Engineering					
IS : 961 - Structural Steel (High Tensile)					

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IS : 1148 - Rivet bars for structural purposes IS : 1149 - High tensile rivet bars for structural purposes IS : 1161 - Steel Tubes for structural purposes IS : 1200 - Method of measurement of steelwork and ironwork (Part 8) IS : 1239 - Mild Steel Tubes IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm) IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia, range 6 to 39 mm) IS : 1367 - Technical supply conditions for threaded fasteners IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes. IS : 1731 - Dimensions for steel flats for structural and general engineering purposes IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products IS : 1977 - Structural steel (ordinary quality) St-42-0 IS : 2062 - Steel for General Structural Purposes IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming IS : 2595 - Code of Practice for Radiographic Testing IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles IS : 3757 - High strength structural bolts IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel					

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and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00

Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00

Materials to be used

2.05.01

General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02

Steel



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All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

- a) IS : 2062 - Steel for general structural purposes
- b) IS : 961 - Structural steel High Tensile
- c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

- a) IS : 1148 - Rivet Bars for structural purpose
- b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture and shall comply with any of the following Indian Standard Specifications as may be applicable

- a) IS : 814 - Covered electrodes for metal arc welding of structural steel
- b) IS : 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel
- c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel
- d) IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels

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2.05.05

Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 $\sqrt{A}$, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06

Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS : 6649 - Hardened washers

2.05.07

Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.

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2.06.00	Coal Bin				
2.06.01	Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.				
2.06.02	For general requirements, fabrication and construction details IS: 9178 (Pt.1 & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.				
2.06.03	The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.				
2.06.04	Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.				
2.06.05	Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.				
2.07.00	New Erection Marks				
2.07.01	Additional structures involving new erection marks may be required to be added at any stage of work.				
2.07.02	All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.				
2.07.03	All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.				

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2.08.00 2.08.01 2.08.02 2.08.03 2.08.04 2.08.05 2.08.06 2.08.07 2.08.08 2.08.09 2.08.10	ELECTRO FORGED STEEL GRATINGS Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc. All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise. The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed. The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance. Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses. The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained. Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars. Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel. Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site. Grating units shall be provided with all necessary clips, bolts, nuts and lock	SHEET	10	OF	40

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material liable to rejection.					
2.09.05	There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.				
2.09.06	When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.				
2.09.07	Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.				
2.09.08	All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.				
2.09.09	If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to be redone in the similar manner as stated above at no extra cost to the Owner.				
2.10.00	STAINLESS STEEL HOPPERS				
2.10.01	Material				
	Stainless steel hopper of grade SS 4 15M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.				
	Material	%	Remarks		
	Carbon	10.03%	Max.		
	Silicon	1.60%	Max.		
	Manganese	0.80% to 1.50%			
	Phosphorous	0.03%	Max.		
	Sulphur	0.03%	Max.		
	Chromium	10.80% to 12.50%			
	Nickel	1.50%	Max.		
	Titanium	0.75%	Max.		

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Nitrogen0.03%Max. The mechanical properties shall be as follows: <table><thead><tr><th>Description</th><th>Value</th><th>Remarks</th></tr></thead><tbody><tr><td>Hardness Rock Well B Scale</td><td>90</td><td>Max.</td></tr><tr><td>Tensile Strength</td><td>450 MPa</td><td>Min.</td></tr><tr><td>Yield Strength</td><td>300 MPa</td><td>Min.</td></tr><tr><td>Elongation</td><td>25%</td><td>Min.</td></tr></tbody></table>						Description	Value	Remarks	Hardness Rock Well B Scale	90	Max.	Tensile Strength	450 MPa	Min.	Yield Strength	300 MPa	Min.	Elongation	25%	Min.
Description	Value	Remarks																		
Hardness Rock Well B Scale	90	Max.																		
Tensile Strength	450 MPa	Min.																		
Yield Strength	300 MPa	Min.																		
Elongation	25%	Min.																		
2.10.02Fabrication The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.																				
2.10.03Fabrication Drawings a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints. b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner’s store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner’s store will call for the penal recovery at three (03) times the maximum procurement rate for the weight of stainless steel pieces not returned to the store.																				

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c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.					
2.10.04 Cuffing					
Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.					
2.10.05 Jointing					
Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.					
2.10.06 Bending					
The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.					
2.10.07 Welding sequence					
The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.					
2.10.08 Acceptance Criteria of Fabricated Structures					
The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.					

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2.11.00 2.11.01	BEARINGS				
	PTFE (Poly tetra fluorethylene) slide bearing				
	a) General The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm. b) Material PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm. The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm². c) Installation The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.				

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2.12.00	Storage of material				
2.12.01	General				
	All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.				
2.12.02	Steel				
	The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.				
2.12.03	Electrodes				
	The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.				
2.12.04	Bolts, Nuts and Washers				
	Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.				
2.12.05	Paints				
	Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.				
2.13.00	Quality Control				
	The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to				



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ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

- a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
- b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.
- c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.
- d) Welders : Qualifying Tests
- e) Welding sets : Performance Tests
- f) Welds : Inspection, X-ray, Ultrasonic tests
- g) Paints : Manufacturer's certificate, physical inspection reports
- h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of



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any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00

Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

- a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.
- b) Dimensional drawings of base plates, foundation bolts location etc.
- c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.
- d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.
- e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork, including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication

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drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length. The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.					
3.00.00		WORKMANSHIP			
3.01.00		Fabrication			
3.01.01		General			
All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.					
3.01.02		Straightening Material			
Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.					
3.01.03		Cutting			
Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer. To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be					

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reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.					
3.01.04		Planning of edges			
Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.					
3.01.05		Clearances			
The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.					
3.02.00		Riveted and bolted construction			
3.02.01		Holes			
Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.					
Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.					
Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.					



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Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02

Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assembled that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with the holes. Rivets shall be heated uniformly to a temperature not exceeding 1125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

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Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer. Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.					
3.03.00		Welded Construction			
3.03.01		General			
Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.					
3.03.02		Preparation of material			
Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.					
3.03.03		Assembling			
Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°). The work shall be positioned for flat welding whenever practicable.					
3.03.04		Welding Sequence			
In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless					



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distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03.12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the

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temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.					
3.03. 13	Peening	Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.			
3.03. 14	Equipment	These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.			
3.04.00	Finish	Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butt over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.			

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shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.					
3.10.00	Chequered Plates	Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.			
3.11.00	Architectural Clearances	Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.			
3.11.00	Shop connections	a) All shop connections shall be otherwise riveted or welded as specified on the Drawings. b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection. c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.			
3.13.00	Castings	Steel castings shall be annealed.			
3.14.00	Shop erection	The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.			

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3.15.00	Shop painting				
3.15.01	General				
	Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer. After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.				
3.15.02	Inaccessible parts				
	Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.				
3.15.03	Contact surfaces				
	Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.				
3.15.04	Finished surfaces				
	Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.				
3.15.05	Surfaces adjacent to field welds				
	Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.				

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		erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.			
4.00.00	INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY				
4.01.00	Inspection				
		Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification. The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.			
4.02.00	Testing and Acceptance Criteria				
4.02.01	General				
		The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.			
4.02.02	Steel				
		All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor. All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.			
4.02.02	Welding				

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a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc. b) Non-destructive examination shall be carried out to determine soundness of weldments as follows: i) 10% at random on fillet-joints. ii) 100% on all butt-joints. c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs. d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.					
4.02.04		Rivets, bolts, nuts and washers			
All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.					
4.02.05		Shop painting			
All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.					
4.02. 12		Galvanizing			
All galvanizing shall be uniform and of standard quality when tested in					

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accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.					
4.03.00	Tolerance				
The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.					
4.04.00	Acceptance				
Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.					
When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.					
4.05.00	Delivery of materials				
4.05.01	General				
The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.					

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4.05.02

Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03

Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a)

Name and address of the consignee

b)

Name and address of the consignor

c)

Gross weight of the package in tonnes and its dimensions

d)

Identification marks and/or number of the package

e)

Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a)

Name of the Contractor

b)

Number and date of the Contract

c)

Name of the office placing the contract

d)

Nomenclature of stores

e)

A schedule of parts or pieces, giving the parts or piece number with

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reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos as applicable.

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	vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork. vii) Final date of completion of all shipments. b) Shop Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted. 5.02.00 After Award After award of the Contract the successful Tenderer is to submit the following: a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule. b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information. c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials. d) Results of any test as and when conducted and as require by the engineer. e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.				
	6.00.00 RATES AND MEASUREMENT				
	6.01.00 Rates				
	6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary operations described in the Specifications.				

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6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.					
6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.					
6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.					
6.01.05 Rates shall be inclusive of all leads and lifts/elevation.					
6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.					
6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of materials not issued by the Owner.					
6.01.08 The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the zinc silicate primer.					
6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the					

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finish paint.					
6.01.10	The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.				
6.01.11	The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.				
6.01.12	The bidder's rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.				
6.01.13	The bidder's rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.				
6.01.14	The bidder's rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unblized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.				
6.01.15	The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.				
6.01.16	The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.				

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circumscribed rectangle.					
6.02.05	For bunker wall plates the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).				
6.02.06	For all other plates, where the area of any notch/skew cut in the plate is less than 0.2 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.2 sq.m. the actual profile of the plate shall be considered for the purpose of payment.				
6.02.07	No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.2 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.2 sq.m.				
6.02.08	All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.				
6.02.09	The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.				
6.02.10	The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for welding/bolting.				
6.02.11	The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.				
6.02.12	The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.				
6.02.13	The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for				

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payment of the item of fabrication and erection of structural steel works.					
6.02.14	The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.				
6.02.15	The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.				
6.02.16	The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.				
6.02.17	The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.				
6.02.18	The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below				
6.02.19	For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.				
6.02.20	For the work of addition to, alteration in and / or modification of 'erection marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.				
6.02.21	For re-erection the weight of the modified erection mark shall only be measured.				
6.02.22	The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.				
6.02.23	The measurement for the item of PTFE bearings shall be based on the actual weight in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.				



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**SECTION - D
(PART I)**

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK



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SUB-SECTION – D XVIII

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

- a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.
- b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.
- c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.
- d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.
- e) Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.
- f) Painting of the erected steel structures.
- g) All minor modifications of the fabricated steel structures as directed by the

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Engineer including but not limited to the following: i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling. ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections. iii) Reaming of holes for use of higher size rivet or bolt if required. iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated. v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary. vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication. vii) Carry out tests in accordance with this specification.					
2.02.00	Work by Others	No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.			
2.03.00	Codes and Standards	All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent: IS: 800 - Code of practice for general construction in steel. IS: 456 - Code of practice for main or reinforced concrete.			
2.04.00	Conformity with Designs	The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.			
2.05.00	Material				

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2.07.00	Quality Control The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work : i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts. ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout. iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.				
2.08.00	Taking Delivery The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him. The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.				
3.00.00	WORKMANSHIP				
3.01.00	Erection				
3.01.01	Plant and Equipment The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.				
3.01.02	Method and sequence of erection The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and				

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sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.					
3.01.03		Temporary Bracing			
Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install, free of cost to the Owner, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations. If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner. The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer. The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.					
3.01.04		Temporary Floors for Buildings			
It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.					
3.01.05		Setting Out			
Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this. Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification. No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.					
3.01.06		Field Riveting			



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All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. "Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks



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1/2 turn

2/3 turn

Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned.
Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) (Kg.M) of IS:1367	Torque to be applied for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14.7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

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In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause. 3.01.08 Field Welding All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints. 3.01.09 Holes, Cutting and Fitting No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer. The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work. 3.02.00 Drifting Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed. Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.					



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3.03.00

Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, "ironite" or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00

Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

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All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet. Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted. The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved “Schedule of Painting”. The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932. 3.05.00 Final cleaning up Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work. 4.00.00 TESTING AND ACCEPTANCE CRITERIA 4.01.00 General Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed. The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.					



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4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.



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4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the “Strength Test” as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below:

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more

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than ±7 mm per 30m length. c) For adjacent pairs of columns across the width of the building prior to placing of truss ± 9.0 mm on true span. d) For any individual column deviation of any bearing or resting level from levels shown on drawings. ± 3.0 mm e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating 3.0 mm Trusses a) Deviation at centre of span of upper chord member from vertical plane running through least. 1/1500 of the span or greater than 10mm whichever is the centre of bottom chord. Trusses b) Lateral displacement of top chord at center of span from vertical plane running through center of supports. 1/250 of depth of truss or 20 mm which ever is the - least. Crane Cirders a) Difference in levels of crane rail measured between adjacent columns. 2.0 mm. b) Deviation to crane rail-gauge ± 3.0 mm c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding. 1.0 mm. d) Deviation of crane rail axis from centre line of web. ± 3.5 mm Setting of Expansion gaps At the time of setting of the expansion gaps, due regard shall be taken of					

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the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

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A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.					
5.02.00		After award of the Contract			
After award of the contract, the Contractor shall submit the following:					
5.02.01		Detailed Programme			
The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.					
5.02.02		Fortnightly Progress Report			
The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.					



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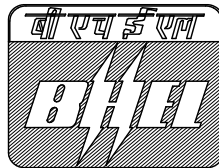
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Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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ROOF DECKING**1.00.00 Scope**

This section of the specification covers the supply, fabrication and erection of profiled light gauge Metal Decks (coated and painted) as roof decking to the main plant building and any other area as indicated in the drawings.

2.00.00 Material

2.01.01 Roof of main plant TG and Deareator bay and bunker building consists of permanently colour coated (on exposed face) galvanized MS trough metal sheet decking plate of approved colour over roof purlins for cast-in-situ roof slab as per IS: 14246 and conform to class 3. Thickness of deck plate shall be minimum 0.8mm and minimum trough depth of 44 mm and centre to centre of the valley shall be 130mm with minimum yield strength of 250 Mpa. Silicon modified polyester paint shall be used for permanent coating over galvanized surface with minimum rate of galvanization 275 gm/sqm. DFT of permanent colour coating shall be 20 microns. It shall serve as permanent shuttering for cast-in-situ roof slab. It should have adequate strength to support weight of green concrete and imposed load during construction. The thickness of the deck plate shall however be designed suitably according to the spacing of roof purlins.

3.00.00 INSTALLATION

The Contractor shall furnish all labour, equipment and materials as required for the design, fabrication, coating, erection and fixing of the decking over purlins, painting and for the complete performance of the work in accordance with the construction drawings and as described herein.

The description, which follows, gives a general indication of the nature and extent of the work but is not necessarily exhaustive and does not purport to cover all the details/operations which will be necessary in order to carry out the work.

3.01.00 Detailed Design of Roof Decking

The Contractor, in conjunction with the manufacturer, shall be responsible for the detailing of the profiled decking, fittings and fixtures and shall submit with his tender particulars of the proposed manufacturer and of the particular product proposed for use. The detailing is to be based on typical details furnished by the Engineer. The Contractor shall submit to the Engineer, two copies of the general arrangement and detailed working drawings for the proposed design, together with all calculations necessary to verify the adequacy and completeness of the design & detailing of decking sheets, fixtures, flashings



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and trims. After approval he shall supply further eight copies.

The Engineer will verify the correct interpretation of his requirements but may not necessarily check the design and details, and the Contractor shall be entirely responsible for the accuracy of the drawings and the correctness of the design and the suitability of the details. Manufacture of roof decking sheets shall not commence until the necessary approval of the Engineer has been obtained.

3.02.00 Erection & Fixing**3.02.01 Sequence of Manufacture/Erection**

Cutting Schedules, delivery to site and stacking arrangements in store shall ensure that sheets are erected in a sequence which follows that for the manufacture. The decking sheets shall be erected using an arrangement of sheets and joints to conform with the requirements of this specification. Decking erection for each elevation or feature shall commence at one end only and proceed towards the other end, in order to ensure tight fitting laps.

3.02.02 Position and Location of Laps

Side and end laps of roof decking sheets shall be located and positioned in such a manner as to provide the maximum weather protection taking into account the direction of the prevailing wind.

The lines formed by horizontal laps and fixing shall where possible, be continuous and coincide with the edges of large openings in the roof.

3.02.03 Alignment of Sheets and Fixings

All roof decking sheets shall be fixed plumb and level with all fixings evenly spaced and accurately lined. All dirt and grease shall be removed from the surfaces of the sheets as the work proceeds.

3.02.04 Site Cutting

Approval must be obtained before the roof decking sheets are cut at site. Generally cutting of sheets to length will not be permitted, only special cutting and trimming for small openings shall allowed. Where possible, site cut edges shall be concealed at laps.

3.02.05 Damaged Sheets

Distorted, blemished or water stained sheets and any other fittings shall not be used.

3.02.06 Laps



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End laps and side laps to roof decking sheets shall be sufficiently large to ensure that the decking complies with the weather tightness and other requirements of this specification. The length of each decking sheet shall be adjusted so that the end laps shall bear on the purlins. In no case end laps shall not be less than 150 mm and side laps shall not be less than 53 mm.

3.02.07 End Lap Fixings

End lap fixings shall be located at least 25 mm from the end of each sheet.

3.02.08 Side Lap Fixings

The spacing of side lap fixings shall ensure compliance with this specification regarding tightness. The spacing of these fixing screws shall not exceed 500mm. The fixing shall be located in the bottom flat of the corrugation.

3.02.09 Holes

Holes in MS decking sheets shall be punched. In case holes are drilled holes, it is to be ensured that the holes do not go oversize due to the small thickness of the sheeting. All drilling swarf shall be removed from the surfaces of decking, supporting steel work, purlins etc.

3.02.10 Location and Spacing of Fixings

Fixings shall be accurately located in position in the centre of the corrugations to ensure that the heads of bolts, nuts and washers bear squarely down on the surface of the sheeting and are not located at the edge or on the joints in supporting purlins.

3.02.11 Fixings

The tenderer shall submit with his tender details of the proposed method for securing the roofing sheets to the metal purlins. The roof decking sheets are to be fixed to the roof purlins with hex washer head white zinc plated heat treated carbon steel self drilling / self tapping screws of minimum thread diameter of 5.6mm. These self drilling screws shall be drilled through the roofing sheets and purlins supporting the roofing sheets. These purlins shall be suitably spaced as per the requirement of roofing sheets and the roofing sheets shall not sag more than span/250 for the loads likely to be imposed during concreting and in future. The self-drilling screws are to be spaced at a maximum distance of 390mm centre to centre along the length of the purlins and top chord of truss. The screws are to be located preferably in the valley only and shall be installed in accordance with the manufacturer's recommendations using tools approved by the manufacturer which do not damage the coating of the decking sheets.



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3.03.00 Protection during Construction

Precautions shall be taken during the erection of the roof decking to ensure that partially erected decking are protected during inclement weather and damage at all times.

3.04.00 Damage

Any damage to coating & primer during transportation is to redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 Acceptance Criteria

The installation shall present a neat appearance and shall be checked for water tightness. The following shall be checked :

- a) Side and end laps
- b) Absence of damage in the sheeting.
- c) Conformity of fixings with the approved design.

5.00.00 IS Codes

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- IS : 513 - Specification for cold rolled carbon steel sheets.
- IS : 3618 - Specification for phosphate treatment of iron and steel for protection against corrosion.
- IS : 4431 - Specification for carbon & carbon manganese free cutting steel.
- IS : 1573 - Electroplated Coatings of zinc on iron and steel.

6.00.0 RATES AND MEASUREMENTS**6.01.00 Rates**



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Rates shall be unit rate for complete item described in the Schedule of Items and shall include all wastage.

6.02.00

Method of Measurement

Roofing shall be measured for net area of the work done. Profiled sheeting (coated & painted) shall be measured in plan area of sheets and not girthed. No deduction shall be made for openings measuring up to 0.1 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.

No payments shall be made for laps.



TITLE:

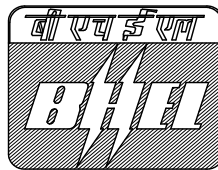
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FALSE FLOORING

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FALSE FLOORING**1.00.00 General**

This section of the specification covers the supply, fabrication and installation of false flooring system having PVC top finish particle board, GI supporting system, painting etc. as per schedule of items in the main plant building and any other area as indicated in the drawings.

The scope of contractor covers supply of all materials, fabrication & installation works required to be carried out for completion of false flooring in the area specified in the drawings.

2.00.00 MATERIAL**2.01.00 Supporting structure**

Supporting pedestals shall be made of steel and will be of height as required. Supporting pedestal shall be truly vertical and located at distances to conform with size of floor panels and shall be equipped with locking devices to prevent disturbances of finished elevation. Base of pedestal shall have integral load dispersion plate of size 100x100x8mm to transmit the load evenly to the base floor. Adjustment of pedestal shall be provided by threaded vertical rod of 25mm diameter and elevating nut. The pedestal head shall provide positive interlocking of the steel grid channels supporting system and shall prevent lateral shifting.

The grid channels shall be made of galvanised steel of 40mm x 40mm x 3.15mm thick and shall be placed at 610mm centre to centre both ways to support floor panels in uniform levelled elevations. Nominal height of the false flooring system shall be 600 mm unless otherwise indicated. Pedestal head shall be equipped with conducting grounding pad if so desired by the Engineer

2.02.00 Floor Panels

The floor panels shall be made of fire resistant particle board, phenol formaldehyde bonded. Size of each panel shall be 610mm x 610mm with all panel edges finished to a tolerance of ± 0.2 mm. Floor panel shall have 2mm thick non-static PVC on top, 2mm thick hard PVC strip lipping on four edges and 26 G aluminium sheet fixed with araldite at bottom. Minimum thickness of the panel shall be 35mm, unless otherwise noted. All panels shall be completely interchangeable and easily removable with a suction lift tool. Panels shall be square within a tolerance of ± 0.25 mm on the diagonal. The floor panels shall be cut, wherever required for providing suitable outlets for cables and edges shall be lipped with hard PVC sheets.



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2.02.01 Strength

Each 610mm x 610 mm floor panel must be capable of withstanding the designed service load. The ultimate strength shall provide a safety factor of 3. The false flooring shall be capable of carrying a axial load of 800 kg and uniform load of 2000 kg/sq.m with maximum deflection of 1/350. If required by the Engineer, the samples shall be accepted only after carrying out load tests. The Engineer may relax the test requirements with concentrated load in case cabinets are not handled with castor fitting arrangement.

One additional pedestal shall be provided under floor stringer along front panel area of each control board for taking possible additional load that may occur from time to time.

2.02.02 Surface finish

All removable panels shall have the top surface finished with 2 mm thick flexible PVC flooring conforming to IS:3462 and shall be fixed to the surface with compatible high-creep resistant adhesive. The PVC floor tile shall be in single piece for each floor panel. Under side of panels shall also be painted with suitable epoxy or oil based paint.

2.02.03 Damaged Floor Panels

Distorted, blemished or stained floor panels shall not be used.

2.03.00 Skirting

Skirting shall be 150 mm high and 2 mm thick, completely matching with false flooring surface finish materials and shall be fixed to the wall surface as per manufacturer's installation instructions.

3.00.00 INSTALLATION**3.01.00 Base**

The system shall be placed over a base of RCC floor slab and beams. Any grouting etc. that is necessary to fix the supporting structure shall be done.

The concrete sub floor shall be sealed with two coats of polyurethane paint to prevent moisture from coming in contact with cables and to minimise dust problem.

The floor panels and channels shall be completely interchangeable and remain in position without screwing or bolting under working/imposed loadings.

Any damage to the sub floor during installation of the false flooring system



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shall be made good by the contractor without any extra cost to the Owner. All steel surfaces are to be protected by two coats of polyurethane paint over a compatible primer and any damage to the paint during installation shall be made good. In case the loads exerted by the weight of machines are above the stated characteristics of floor finish material, the floor shall be protected by overlaying hard board during installation of machine or equipment.

All installation work of the false flooring system shall be supervised by the manufacturer's authorised representative.

3.03.00 Painting

After fixing the false flooring supporting system the sub floor shall be given a coat of polyurethane paint.

3.04.00 Protection during Construction

All precautions shall be taken during the erection of the false flooring to ensure that partially erected flooring are protected and shall not be damaged before handing over to owner.

3.05.00 Damage

Any damage of coating to supporting system caused during transportation is to be redone with the similar type of coating as per the manufacturer's specification at no extra cost to the Owner.

4.00.00 ACCEPTANCE CRITERIA

The false flooring system shall only be accepted after completion of following checks :

- a. Level
- b. Alignment of joints
- c. Thickness of joints
- d. Surface finish
- e. Colour and texture
- f. Details of edges, junctions etc.
- g. Performance
- h. Criteria specified for strength.



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5.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS:5318 Laying of flexible sheet and flooring.

IS:3462 Flexible PVC flooring

IS:3087 Wood particle boards (medium density) for general purposes.

6.00.0 RATES AND MEASUREMENTS**6.01.00 Rates**

Rates shall be unit rate for complete item described in the Schedule of Items and shall include, but not limited to, supply & installation of floor panels, supporting systems, paintings etc.

6.02.00 Method of Measurement

False flooring shall be measured in Sq.M for net area of the work done. No deduction shall be made for openings measuring up to 0.4 sq.m. in area. No extra shall be paid for extra labour in cutting and for wastage etc. in making opening and cutting to size.



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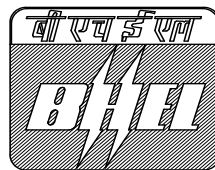
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**STANDARD TECHNICAL SPECIFICATION
FOR
SITE LEVELLING AND GRADING**

1.00 GENERAL

This specification cover the works to be carried out for **“Site Levelling and Grading Works including Slope Protection”** etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.



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d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works,
Part-1: Earthwork

IS: 2720 Method of test for soils (Relevant parts)

IS: 3764 Excavation work- Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.



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3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

- a) Materials from swamps, marshes and bogs
- b) Expansive clays
- c) Peat, logs, sod and perishable materials
- d) Materials susceptible to combustion
- e) Any material or industrial and domestic produce which will adversely affect other materials of work
- f) Materials from prohibited areas



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The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as far as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the



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soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other



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activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**

The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for



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obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the



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magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

- * not to put their feet on the clean floor unless the magazine shoes on.
- * not to touch the magazine shoes on ground outside the clean floor.
- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying



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explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or



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string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
- d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
- e) The last blast shall not be more than 0.50 m in depth.
- f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The



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useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as far as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as determined by standard Proctor's test as per IS: 2720, part-VII. Moisture content of the fill material shall be controlled near optimum moisture content during compaction

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.



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Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720, part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, cross-



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sections and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughened** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.



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b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

a) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site



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clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turving, the measurement shall be made on the finished work in square meter.



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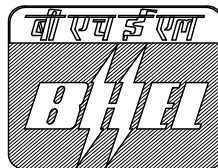
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BORED CAST-IN-SITU RCC PILES

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Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049

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**TECHNICAL SPECIFICATION FOR INSTALLATION OF BORED
CAST-IN-SITU PILES****1.00.00 SCOPE**

This specification covers the installation of bored cast-in-situ reinforced concrete vertical piles of specified load carrying capacity and diameter for various structures. This specification also covers carrying out initial and routine load tests on piles to assess their vertical, horizontal and pull out load carrying capacities.

2.00.00 GENERAL REQUIREMENT

2.01.00 This specification along with specific requirements under Annexure-A covers the technical requirements for piling work.

2.02.00 The work shall include supplying and providing necessary materials, mobilization of all necessary equipments (Annexure-B), providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carryout the complete piling work, and submission of records as per schedule.

2.03.00 The Contractor shall carryout all works as mentioned in Scope above. All works shall be executed to the satisfaction of the Engineer.

2.04.00 Pile capacities in vertical compression, horizontal, pullout loads for various pile diameters are given in Annexure-A.

2.05.00 The Contractor shall confirm and guarantee the "Safe Load" capacities by conducting both initial and working load test on piles as mentioned in the specific requirements.

2.06.00 The Contractor shall submit along with tender documents his tender design of piles based on soil data furnished by the Owner.

2.07.00 In case of initial or routine load test piles, if the Contractor fails to establish the safe load capacity as per his design, the Owner has the right to either derate the pile capacity on prorata basis or insist the Contractor to modify the pile design, to achieve the desired safe load capacity at no extra cost to the Owner.

2.08.00 Deraiting is acceptable up to 90 percent. In such case, additional piles shall be installed as per the design requirements.

2.09.00 The Owner shall decide whether to derate or modify the design based on the design considerations such as providing additional piles in the designed pile cap, provision for extending the pile cap size, etc.

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2.10.00	In case the Owner decides to modify the design instead of derating the pile, the contractor shall carry out the same and install separate test piles and test the same to guarantee the safe load at no extra cost to the Owner. However no extra shall be charged for the additional test piles as well as testing of these piles as per agreed contract conditions.				
2.11.00	In case of working piles, if the pile does not meet the guaranteed capacity or rejected due to any other reason, the Contractor shall install extra piles at no extra cost to the Owner. Further, the extra cost, due to the increase in the pile cap size if any, on account of extra piles, shall be borne by the Contractor.				
2.12.00	It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the completion of tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer. If the Engineer so desires the Contractor shall arrange for having the instruments tested at an approved laboratory at no extra cost to the Owner and the test report shall be submitted to the Engineer. If the Engineer desires to witness such tests Contractor shall arrange to conduct the test in his presence.				
2.13.00	The Contractor shall make his own arrangements for locating the coordinates and position of piles as per drawings supplied to him and for determining the Reduced Levels (R.L.) of these locations with respect to the benchmark indicated by the Engineer. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer so that the work can be carried out accurately according to specifications and drawings.				
2.14.00	The contractor shall assure the quality of piling work including cleaning of pile bore, quality of concrete, integrity of piles, etc.				
2.15.00	AVAILABLE SUB-SOIL DATA An abstract of the sub soil data is furnished in the tender document. However, the detailed soil investigation report shall be made available for reference of the bidder, if so required, at the office of the Owner. The soil data furnished is in good faith and only for the guidance of the Bidder, to arrive at design parameters and construction methods.				
3.00.00	MATERIALS				
3.01.00	General All materials viz cement, steel, aggregates, water, etc. which are to be used for pile construction shall conform to relevant IS codes for properties, storage and handling of common building materials. However, aggregates more than 20 mm size shall not be used.				



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3.02.00**CONCRETE**

Concrete shall be manufactured either by central batching plant or Ready Mix concrete. However, for initial test piles suitable method as approved by the Engineer may be used. Concrete shall conform to IS: 10262 & IS: 456.

3.02.01

Technical Specification for Cement Concrete (Plain and RCC) works alongwith IS: 2911 Part I/Sec 2 shall be followed for concrete works of piles. Use of plasticizer to control the water cement ratio shall be permitted on specific approval from the Engineer. Water cement ratio shall not be greater than 0.5.

3.02.02

Grade and minimum cement content

Minimum grade of concrete shall be as per Annexure-A conforming to IS: 456. Minimum cement content of 400 Kg/M³ of concrete shall be used for M-20 grade concrete.

3.02.03

Slump of concrete

The slump of concrete shall vary between 150 to 180 mm.

3.03.00**REINFORCEMENT****3.03.01**

Longitudinal reinforcement in pile shall be high strength deformed steel bars conforming to IS: 1786 unless specified otherwise. Lateral reinforcement in pile shall be of mild steel conforming to IS: 432 Part-1 or HYSD bars as per IS: 1786.

3.03.02

The longitudinal reinforcement shall be provided considering the combination of vertical (compression and tension) and horizontal loads. However, the minimum longitudinal reinforcement shall be 0.4 percent of the sectional area calculated on the basis of nominal pile diameter. Minimum six numbers of bars shall be provided for longitudinal reinforcement. The diameter of longitudinal reinforcement bars shall not be less than 12mm. The stipulated minimum reinforcement shall be provided for the full length of pile.

3.03.03

The longitudinal reinforcement shall project 50 times its diameter above cut off level unless otherwise indicated.

3.03.04

The minimum diameter of the links or spirals shall be 6 mm and the spacing of the links or spiral shall not be less than 150 mm and in no case more than 250 mm. The laterals shall be tied to the longitudinal reinforcement to maintain its shape and spacing.

3.03.05

Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment, these shall

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		preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.			
3.03.06		The minimum clear distance between the two adjacent main reinforcement bars shall normally be 100 mm for the full depth of cage.			
3.03.07		The laps in the reinforcement shall be such that the full strength of the bar is effective across the joint and the reinforcement cage is of sound construction.			
3.03.08		Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a 'particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).			
3.03.09		Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers, cast specifically for the purpose.			
3.03.10		Minimum clear cover to the reinforcement shall be 50 mm, unless otherwise mentioned.			
3.03.11		Bundling of bars is not permitted.			
4.00.00	PILE INSTALLATION				
		Installation of piles shall be carried out as per pile layout drawings, installation criteria, and the direction of the Engineer.			
4.01.00	Equipment and Accessories				
4.01.01		The equipment and accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub soil conditions, ground water conditions and the method of casting, etc. These shall be of standard type and shall have the approval of the Engineer.			
4.01.02		List and details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.			
4.01.03		The capacity of the rig shall be adequate so as to reach the specified founding level.			
4.01.04		Provision shall be kept for chiselling within the pilebore, as specified elsewhere in this specification. Chiselling shall be carried out only with the approval of Engineer.			
4.02.00	Installation Criteria				

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4.02.01	For determining the founding level of piles in soil as specified elsewhere, the Contractor shall have to perform Standard penetration test (SPT) as per IS: 2131 in a separate bore hole. The SPT shall be conducted at 1.0 m interval between the depths covering 5 metres each above and below the specified founding level. The bore shall be 100 mm diameter and method of boring shall conform to IS: 1892.				
4.02.02	For determining founding level of piles in rock, as specified elsewhere socketing horizon shall be established by the Contractor by collecting rock cores of Nx size in a separate borehole, and testing the same for uniaxial compressive strength (UCS). Cores shall be collected by double tube core barrel attached with diamond bit. Coring shall be done upto a depth as indicated in the "specific requirements." Coring in rock shall conform to IS: 6926.				
4.02.03	In case it is not possible to test the cores so obtained for uniaxial compressive strength, cores shall be tested for point load strength index and correlated to obtain uniaxial compressive strength.				
4.02.04	Number of boreholes for carrying out SPT in soil or uniaxial compressive strength in rock, shall vary from one in 100 to 150 piles or pile group of 150 Sqm depending on the site condition and as decided by the Engineer. However, at the location of initial load test piles, one such borehole shall be done.				
4.02.05	A protocol between contractor and BHEL site shall be maintained regarding the strata at founding level. SPT value and UCS from the nearest borehole shall be indicated therein.				
4.02.06	The founding level of the pile shall be decided based on the criteria elaborated in the specific requirements under Annexure-A. Concreting shall not be done until the above conditions for founding level are satisfied.				
4.02.07	Approval of founding level by the Engineer shall in no way absolve the Contractor of his responsibility to guarantee the Safe load capacity of the piles as indicated in this document.				
4.03.00	Control of position and alignment				
4.03.01	Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and (inclination) alignment shall conform to IS: 2911 Part I/Sec. 2, which is reproduced below for ready reference. a) The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment. b) Piles shall not deviate more than 75 mm or D/4 whichever is less (75mm or D/10 whichever is more in case of piles having diameter more then 750mm) from their designed position at the working level.)				

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4.04.00	Boring				
4.04.01	Boring operations shall be done by rotary or percussion type drilling rigs using reverse mud circulation (RMC) method. Rotary hydraulic pulley shall be preferred.				
4.04.02	The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC (Direct Method of cutting) or RMC is used Bentonite slurry shall be pumped through drill rods by means of high-pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilisation, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer at no extra cost to the Owner.				
4.04.03	Working level shall be above the cut off level. After the initial boring of about 1.0m a temporary guide casing of suitable length shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter, so as to give the necessary finished diameter of the concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.				
4.04.04	Use of drilling mud (bentonite slurry) for stabilizing the sides of the pile bore is necessary wherever subsoil is likely to collapse in the pile bore. Drilling mud to be used shall meet the requirement as given in Annexure-C.				
4.04.05	The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of the slurry, shall pass through settling tanks of adequate size to remove the sand and spoils from the slurry before the slurry is recirculated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.				
4.04.06	The bentonite slurry shall be maintained at 1.5m above the ground water level during boring operations and till the pile is concreted. When DMC or RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.				
4.04.07	The size of cutting tools shall not be less than the diameter of the pile by more than 75mm. However, the pile bore shall be of the specified size.				
4.05.00	Chiselling				
4.05.01	Chiselling may be resorted to with the permission of the Engineer below the socketing horizon. The chiselling tool or bit shall be of adequate size and weight so as to reach the desired depth.				
4.06.00	Cleaning of Pile bore				



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BORED CAST-IN-SITU PILES**

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4.06.01 After completion of the pile bore upto the required depth three stage flushing shall be ensured by Airlift technique or any other internationally accepted method duly approved by the Engineer. The bottom of the pile bore shall be thoroughly cleaned. Cleaning shall ensure that the pile bore is completely free from sludge/bored materials, debris of rock/boulder etc. Necessary checks shall be made as given in clause 5.0 to confirm the thorough cleaning of the pile bore.

4.06.02 Pile bore shall be cleaned by fresh drilling mud through tremie pipe after placing reinforcement and just before start of concreting.

4.06.03 Pile bore spoil along with used drilling mud shall be disposed off from site upto 2 Km beyond plant boundary or as directed by the Engineer.

4.06.04 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

4.07.00 Adjacent Structures

4.07.01 When working near existing structures care shall be taken to avoid any damage to such structures.

4.08.00 Concreting

4.08.01 The Contractor shall carry out concrete mix design in accordance with IS: 10262 and submit mix design calculations and get them approved from the Engineer well in advance for installation of piles. Adequate number of tests on cubes, etc. shall be carried out as mentioned in clause 5.0 to ensure concrete of the minimum specified strength in accordance with IS: 456 at requisite workability (slump).

4.08.02 Concreting shall not be done until the Engineer is satisfied that the bearing strata (soil/rock) met with at the termination level of pile, satisfies the installation criteria mentioned else where in the specification.

4.08.03 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

4.08.04 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

4.08.05 Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS: 2911 Part I/Sec.2. Drilling mud shall be maintained sufficiently above the ground water level.

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4.08.06	Concreting operations shall not proceed if the contaminated drilling mud at the bottom of the pile bore posses density more than 1.25 T/cu.m or sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in clause 9.				
4.08.07	Consistency of the drilling mud suspension shall be controlled throughout concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.				
4.08.08	It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.				
4.08.09	The temporary guide casing shall be withdrawn cautiously, after concreting is done upto the required level. While withdrawing the casing concrete shall not be disturbed.				
4.09.00	Cut off level (COL)				
4.09.01	Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer.				
4.09.02	The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.				
4.09.03	When the pile cut off level is less than 1.0 metre below the working level, concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection. In case COL of pile is more than 1.0 metre below working level then concrete shall be cast to a minimum of one metre above COL.				
4.10.00	Sequence of Piling				
4.10.01	Each pile shall be identified with a reference number.				
4.10.02	The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.				
4.11.00	Building up of Piles				
4.11.01	If any pile, already cast as per construction drawing, requires any extra casting due to any change in cut off level or the cast pile top level is less than the specified level or for any other reason, then the pile shall be built-up by using atleast the grade higher concrete than that used for concreting the same pile, ensuring proper continuity with the existing concrete and to the satisfaction of the Engineer. Necessary reinforcement as per design requirement and suitable shuttering shall				

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		be provided before casting the concrete. Surrounding soil shall also be built up to the required level by proper compaction to ensure lateral capacity of the pile.			
4.12.00	Breaking off of Piles				
4.12.01	If any pile already cast, requires breaking due to lowering in cut off level or for any other reason, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile such as loosening, cracking etc. and to the satisfaction of the Engineer.				
4.13.00	Preparation of Pile head				
4.13.01	The soil surrounding the piles shall be excavated upto the bottom of the lean concrete below the pile cap, with provision for working space sufficient enough to place shuttering, reinforcement, concreting, and any other related operations.				
4.13.02	The exposed part of concrete above the COL shall 1 be removed/chipped off and made square at COL not before seven days of casting of pile.				
4.13.03	The projected reinforcement above COL shall be properly cleaned and bent to the required shape and level to be anchored into the pile cap.				
4.13.04	The pile top shall be embedded into the pile cap by 50mm or clear cover to reinforcement, whichever is higher.				
4.13.05	All loose material on the top of pile head after chipping to the desired level shall be removed and disposed off upto a lead of 2km or as directed by the Engineer.				
4.14.00	Rejection and Replacement of Defective Piles				
4.14.01	The Engineer reserves the right to reject any pile which in his opinion is defective on account of load capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer, at no extra cost to the Owner.				
4.15.00	Recording of Piling Data				
4.15.01	The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as shown in Appendix D of IS: 2911 Part I/Sec.2. The pile data shall also include all the details as in Annexure-D. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer within two days of completion of concreting of the pile.				
5.00.00	SAMPLING, TESTING AND QUALITY ASSURANCE				



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- 5.01.00 Facilities required for sampling and testing materials, concrete, etc. in field and in laboratory should be provided by the Contractor. The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this Specification. Where no specific testing procedure is mentioned the tests shall be carried out as per the prevalent accepted engineering practice and as per the directions of the Engineer. Tests shall be done in the presence of the Engineer or his authorized representative. In case the Engineer requires additional tests, the Contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.
- 5.02.00 The Contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.
- 5.03.00 Materials found unsuitable for acceptance shall be removed and replaced by the Contractor. The work done by this unsuitable material shall be redone as per specification requirements & and to the satisfaction of the Engineer at no extra cost to the Owner.
- 5.04.00 Quality Assurance Programme**
- a) The Contractor shall submit and finalize a detailed Field Quality Assurance Programme within 30 days from the date of award of the contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated/ corrected by the qualified persons as frequently as possible to give accurate testing results.
- b) Frequency of sampling and testing, etc. and Acceptance Criteria are given in Table - 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to meet all the specified requirements before acceptance at manufacturers premises or at independent government approved laboratory. Tests indicated in the table are for cross checking at site the conformity of the materials to some of the specifications.
- 5.05.00 Testing of Concrete**
- 5.05.01 Concrete and other materials shall be tested for quality and strength and other properties. Details of testing shall be as specified under standard technical specification for concrete and allied works.

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5.05.02	One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.
5.05.03	For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter, minimum one sample consisting of three test cubes for every 25 piles shall be tested for the 28-day cube strength.
5.05.04	In preparation of test cubes/specimens vibrators shall not be used.
5.05.05	Concrete shall be tested for slump at every 1-hour interval.
5.05.06	Other properties of concrete and materials shall be tested as per Table-4 for frequency of sampling and testing pertaining to concrete and allied works.
5.05.07	The acceptance criteria shall be as mentioned in Table-1.
5.06.00	Testing for position and alignment
5.06.01	Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.
5.06.02	Permissible limits for deviation shall be as specified under clause no. 8.
5.07.00	Properties of Drilling mud
5.07.01	Properties of drilling mud shall be checked as per requirement under clause no. 8.4.4. Prior to the commencement of piling work and thereafter minimum once in a week or as found necessary by the Engineer, one sample consisting of 3 specimens shall be tested. Acceptance criteria applicable are as specified else where with 5% variation. This relaxation is not applicable for properties of drilling mud before concreting.
5.07.02	Density of the drilling mud shall be checked in each pile before concreting.
5.08.00	Check for Pile bore
5.08.01	On completion of boring and cleaning the bottom of each pilebore shall be checked from the sample collected from near the bottom of pile bore or by any other methods as approved by the Engineer, to ensure that it is free from pilebore spoil/debris and any other loose material, before concreting. Concreting shall be done only after the approval of the Engineer.
5.08.02	For sampling of drilling mud from the pilebore the following method or any other suitable method shall be adopted.



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- a) A solid cone shall be lowered by a string to the bottom of pilebore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, and then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.
- b) Use of borehole camera for checking the pile bore spoil and strata is acceptable on approval of the Engineer.

5.09.00 Pile Integrity test

5.09.01 Low strain integrity test shall be conducted on 50% of the jobs piles, on all test piles and as directed by Engineer. The system shall have the computer readout facility and report on the findings of this shall be furnished to the Owner. This test shall be used to identify the job piles for routine load test.

Piles shall be trimmed to cut off level or sound concrete level. No pile cap blindage work should be undertaken prior to this test. The cast in-situ piles should not be tested before 14 days of casting.

5.09.02 The test shall be undertaken by persons trained and experienced and capable of interpreting the result with specific regard to piling. This test is limited to testing the integrity of the shaft and is not intended to replace the use of static load testing.

5.09.03 Low Strain Integrity Test Methodology:

- a) In this test, a low stress wave is set up in the pile shaft and is also known as Sonic Integrity or Sonic Echo test.
- b) A small metal/hard rubber hammer is used to produce a light blow on top of the pile. The shock wave travelling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/ accelerometer in a computer for subsequent analysis.
- c) The primary shockwave, which travels down the length of the shaft, is reflected from the toe by the change in density between the concrete and sub strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections, which will be added to the return signal.
- d) By analysis of the captured signal and knowledge of the conditions of the ground, age of concrete, etc. a picture of the locations of pile shaft defects can be built up. The observed signals are amplified into digital display as velocity versus length records providing information on structural integrity of piles.

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	e) The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's Modulus and mass density of pile concrete. f) More than one recording of signals shall be done until repeatability of signals is achieved on the same pile. g) The tests shall be conducted at 3-6 locations to cover the entire cross section of the pile. 6.00.00 PILE TESTING Pile load test shall be carried out as per IS:2911 Part-4 (latest edition) or as directed by Engineer. 6.01.00 INITIAL LOAD TEST Initial load test shall be carried out on separately cast piles for confirmation of estimated pile capacities. At least 2 nos. of tests shall be conducted for each mode (vertical compression, pull out and lateral). Maximum test load shall be taken as 2 times the design load capacity. 6.02.00 ROUTINE LOAD TEST Routine load tests shall be carried out on job piles for 0.5% of total no. of piles (for each type). Maximum test load shall be 1.5 times the design safe load capacity. 7.00.00 CODES AND STANDARDS All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed. <table border="0"> <tr> <td>IS: 432</td><td>-</td><td>Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.</td></tr> <tr> <td>IS: 456</td><td>-</td><td>Code of practice for plain and reinforced concrete.</td></tr> <tr> <td>IS: 1200</td><td>-</td><td>Measurement of Building and Civil Engineering works</td></tr> <tr> <td>(Part 23)</td><td></td><td>Piling.</td></tr> <tr> <td>IS: 1786</td><td>-</td><td>Code of practice for twisted steel high strength deformed bars for concrete reinforcement.</td></tr> <tr> <td>IS: 1892</td><td>-</td><td>Code of practice for Subsurface Investigation for foundation.</td></tr> </table>	IS: 432	-	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.	IS: 456	-	Code of practice for plain and reinforced concrete.	IS: 1200	-	Measurement of Building and Civil Engineering works	(Part 23)		Piling.	IS: 1786	-	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.	IS: 1892	-	Code of practice for Subsurface Investigation for foundation.	
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IS: 2131 - Method of Standard Penetration Test for Soils IS: 2911 - Code of practice for design and construction of pile Part I/Sec 2 foundations - Bored cast-in-situ concrete piles. IS: 2911 - Code of practice for design and construction of pile Part IV foundation - Load test on piles. IS: 6926 - Code of practice for Diamond core Drilling for Site Investigation for River Valley Projects. IS: 10262 - Recommended guidelines for concrete mix design. 8.00.00 RATES AND MEASUREMENTS The clauses below shall apply for item rate contracts only. They shall not be applicable to turnkey/lump sum Contracts. 8.01.00 Rates 8.01.01 The items of work in the schedule of items, describe the work in brief. The various items in schedule of items shall be read in conjunction with the corresponding sections in the Technical Specifications, including amendments, and additions, if any. For each item in schedule of items, the unit rate shall include for the activities covered in the description of the item as well as for all necessary operations described in the specification and specific requirements. 8.01.02 The unit rates shall include for minor details which are obviously and fairly intended, and which may not have been included in the description in these documents, but are essential for the satisfactory completion of the work. Unit rates shall also include for all safety measures as required by codal provisions, local regulations, acts, bye-laws, etc. and for execution of work to the satisfaction of the Engineer. 8.01.03 Unit rate for each item shall be inclusive of mobilization of all plant, equipment, scaffolding, labour, materials, skilled and unskilled labour, and demobilization after completion of work, supervision, establishing the level and coordinates at each work. 8.01.04 Unit rate per metre length basis for a particular diameter and capacity of pile shall remain valid for the actual lengths provided /to be provided irrespective of the minimum length specified elsewhere in this specification. 8.01.05 The unit rate for pileboring through soil including weathered rock/laterite shall be inclusive of providing all plant equipment, labour, materials, skilled and unskilled labour, making observations, establishing the ground level and							

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	coordinates at each location of pile by carrying levels from one established bench mark and distances from one set of grid lines furnished by the owner. 8.01.06 Unit rate for pileboring through soil including weathered rock, and chiselling through rock shall be inclusive of bailing out all the pile bore spoil from the pilebore, keeping the borehole free from bored material/debris etc. and disposing the bored/chiselled material along with the drilling mud upto 2 Km. beyond plant boundary or as directed by Engineer, flushing the pile bore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results. 8.01.07 Unit rate quoted for pileboring through soil including weathered rocks and chiselling through rock shall include shifting of plant and equipment from one pile location to another providing temporary casing pipe and removal of the same after completing, concreting, supply of necessary materials, equipment and manpower, cost of boring by approved method as specified, circulation of bentonite slurry and cleaning of borehole free from sludge, as specified, etc. 8.01.08 Unit rate for pileboring through soil including weathered rock/laterite shall also include chiselling, if any, required upto the socketing horizon. 8.01.09 Unit rate for chiselling through rock in pilebore below socketing horizon upto the specified level shall be inclusive of bailing out the pilebore debris/spoils from the pilebore and disposing of the chiseled material/debris along with the sludge/mud up to 2 kms from plant boundary or as directed by Engineer, flushing the pilebore by fresh bentonite before concreting, collection of samples from bottom of pilebore, transporting to laboratory, testing and reporting of results. 8.01.10 Unit rate quoted for the pile concreting shall include concreting by termite method, length of pile above COL, withdrawal of guide casing, cost for preparation of pile head and disposal of debris etc., resulting from breaking off of pile upto COL, upto a distance of 2 Km from the plant boundary or as directed by Engineer. 8.01.11 Unit rate for reinforcement shall also include providing cleaning, straightening, cutting, bending, binding with annealed wire, welding, tackwelding, providing concrete cover blocks, spacers, placing the reinforcement cage in pile casing/bore and other cost of tools and plants, materials, labours, carting the steel from store to piling site and return of unused steel to the Owners storage point, etc. 8.01.12 Unit rate shall include for all quality assurance requirements, but not limited to providing for technical inspection, transportation of samples to laboratory, testing samples, maintaining and submitting all test records, etc. 8.01.13 The rate quoted for boring in separate borehole shall be inclusive of performing of SPT at regular intervals as specified and collecting rock cores	

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	from boreholes, upto the depth as specified shall be inclusive of transporting to laboratory, testing and reporting of the results.				
8.01.14	Unit rate for low integrity test shall be inclusive of mobilization of the entire set of equipment, computer readout, printer, and equipment which may not have been included in the description but are essential for the satisfactory completion of the work as per internationally accepted practice. The rate quoted shall be inclusive of repeatability of test, preparation of pile top surface etc.				
8.02.00	Measurement				
8.02.01	Measurement for the item of boring through soil including weathered rock shall be done by linear measurement for the length bored from working platform level through soil/weathered rock up to approved termination/founding level of the pile, in metres upto second place of decimal, separately for a pile of given diameter and capacity.				
8.02.02	Measurement for the item of chiseling through rock shall be done by linear measurement for the actual length in metres upto first place of decimal separately for each diameter of pile. However, chiseling if any required above socketing horizon shall be measured as boring through soil including weathered rock (Ref. Clause 10.3.1 above).				
8.02.03	Measurement for the item of providing and laying concrete shall be done by linear measurement from pile cut-off level to the tip of pile in meters upto second place of decimal separately for each diameter of pile. The length of pile to be cast above cut off level, as per specification, and as approved by Engineer, shall be considered for cement reconciliation only. Theoretical diameter of piles shall be considered for reconciliation of cement consumption.				
8.02.04	Plasticizer/Admixture when used as directed by the Engineer shall be measured separately as specified under concrete and allied work.				
8.02.05	Measurement for the item of providing and placing reinforcement in piles shall be done by weight in tones, up to third place of decimal in the following manner:				
	i) The weight shall be arrived at by multiplying the actual length measured alongwith standard hooks, cranks, bends, authorized laps, etc. by sectional weight. Claims for payment of this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS sectional weight. Nothing extra shall be payable to the contractor on account of difference in weight, if any, due to different methods adopted for issue and measurement.				
	ii) Standard hooks, cranks, bend, authorized laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tones.				



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iii) Dowels, neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured.

8.02.06 Breaking off of piles, due to subsequent change in design cut off level, shall be measured separately. This shall be measured in cubic metres upto second place of decimal. This will be payable only when the pile is cast and on the basis of written instruction of the Engineer for lowering of COL.

8.02.07 Measurements for the item of boring in a separate borehole shall be measured in metres from ground level upto the depth as specified, upto second place of decimal. Item of work of boring in soil and coring in rock shall be measured separately for the actual length of boring in soil and coring in rock.

8.02.08 The item for pile integrity test shall be measured in terms of no. of piles tested.



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ANNEXURE-A**Specific Requirements for Bored Cast-in-situ RCC Piles**

A1.0 Minimum cement concrete grade M-25

Minimum cement content 400 Kg/M³

A1.1 Safe load

Diameter of Pile

Diameter of Pile (mm)	Vertical/ Compression (MT)	Horizontal/ Lateral (MX)	Pull out/Tension (MT)
*	*	*	*
*	*	*	*

A2. Installation criteria

The installed pile(s) shall satisfy the following criteria.

A2.1 In Soil/weathered Rock

- a) Minimum length of the pile shall be _____* m below COL.
- b) The pile shall be terminated after penetrating through the strata having SPT penetration less than ____* cm for ____* blows, for a minimum length of _____* times the diameter of the pile.

A2.2 In Rock

- a) Piles shall be installed and socketed into the rocks for a length {socketing length) equal to _____* times the pile diameter subject to a minimum of _____* meter below the socketing horizon.
- b) Socketing horizon shall consist of rock strata having minimum uniaxial compressive strength of _____* kg/sq.cm.

A2.3 For chiseling

The following shall be satisfied for payment for chiseling

- a) Pilebore spoil shall contain a minimum of 50% of the intact rock fragments, which cannot be broken by hand pressure.
- b) Clause A2.2 shall also be satisfied/met.



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c) Depth of boning/coring in separate borehole shall be _____ * M.

A3. Average cut-off level for tender design and initial load test can be assumed as _____ * m below ground level.

A4. A protocol shall be signed between BHEL site and contractor regarding,

Strata at the founding depth

Installation criteria

Socketing depth

Density of bentonite before concreting

Slump of concrete.

Time interval between end of boring and start of concreting,

* Values shall be indicated separately for specific packages depending upon sub-soil strata of the respective sites.



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ANNEXURE-B

List of Equipments

Sl.No	Description	Capacity No.
1.	Piling Rigs	
2.	Chisel	3 T min 6 T max
3.	High pressure Mud Pumps	10 HP min 25 HP max
4.	Bentonite mixing plants	
5.	Concrete batching plant	
6.	Soil testing equipments	

Note:

1. The no. and capacity of the piling equipment varies for each work.
2. Additional equipments shall be mobilized if required as per the directions of the Engineer to match the work schedule at no extra cost to the Owner.



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ANNEXURE-C

Cl.0

Bentonite suspension used for piling work shall satisfy the following requirements

- a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part V) shall be more than 300 percent and less than 450 percent.
- b) Sand content of the bentonite powder shall not be greater than 7 percent.
- c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 g/ml depending upon the pile dimensions and type of soil in which the pile is to be installed. However, the density of bentonite suspension after mixing with deleterious materials in the pilebore may be upto 1.25 gm/ml.
- d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.
- e) The differential free swell shall be more than 540 percent.
- f) The pH value of the bentonite suspension shall be between 9 and 11.5.



TITLE:

**TECHNICAL SPECIFICATION FOR
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ANNEXURE-D
PILE DATA

1. Reference No. Location (Co-ordinates) _____ area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working level (Platform level)
5. Cut off level (COL)
6. Actual length below COL
7. Pile termination level
8. Top of finished concrete level
9. Date and time of start and completion of boring.
10. Depth of Ground water table in the vicinity.
11. Type of soil at pile tip
12. Method of boring operation
13. Details of drilling mud as used:
 - i) Freshly supplied mud
 - Liquid limit -
 - Sand content -
 - Density -
 - Marsh viscosity -
 - Swelling index -
 - pH value -
 - ii) Contaminated mud
 - Density -
 - Sand content -
14. SPT* N values in soil (from the nearest bore hole).



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+UCS** value in rock (from the nearest bore hole).

* Standard penetration Test

** Unconfined compression strength

15. Chiseling if any, from..... m to m

16. Date and time of start and completion of concreting.

17. Method of placing concrete

18. Concrete quantity

Actual

Theoretical

19. Ref. Number of test cubes

20. Grade and slump of concrete

21. Results of test cubes

22. Reinforcement details:

Main Reinforcement

No. _____

Dia. _____

Depth _____

Stirrups: Type

No. _____

Dia. _____

Spacing _____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work.



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TABLE -1
FREQUENCY OF SAMPLING AND TESTING

SI. No	Type of material work	Nature of Test/ characteristics	Method of Test & frequency	No. of test	Acceptance Criteria
1.	Pilebore size a) diameter b) length		Physical measurement	each pile	as per specification
2.	Founding level	to establish socketing horizon/ and or founding level & upto depth 5m below founding level.	in separate borehole meant for the purpose a) SPT in soils/ weathered rock b) Core & UCS value of rock	1 borehole for 100-150 piles or group of 150 Sqm	Annexure - B
3.	Bentonite (Mud) properties. a) Basic properties of bentonite before use. b) Contaminated mud from pile bore bottom before concreting	Liquid Limit Marsh viscosity Specific gravity, sand content, swelling index, pH value. Density sand content	in lab as per Cl. 5.07.00 in lab	As per C 1.9.7 Each Pile	As per Cl. 8 As per Cl. 8
4.	Position and Alignment	-	Physical or any Approved method	Each Pile	As per Cl. 8.3
5.	Cleaning of pilebore	-	As per Cl. 9.8	Each Pile	Pilebore be free from bored material cuttings debris/sludge
6.	Reinforcement (R/F) Spacing of longitudinal R/F cover laps binding of laterals		Physical inspection and measurement	each cage	As per approved design Cl. 7.0
7.	Concrete a) Workability b) Cubes		As per IS : 1199.	As per Cl. 9.8 As per Cl. 9.5	As per specification. As per IS: 456
8.	Materials like aggregate, sand etc.	Refer Table-4 of Spec STS No. NTPC/C/03			
9.	Pile head		Physical	each pile	