

ENGINEERING DESIGN BASIS

DESIGN PHILOSOPHY 6.5 GENERAL CIVIL

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1.0 REFERENCE PUBLICATIONS

1. OISD Standard 118 - layout for Oil and Gas Installation
2. Petroleum Rules
3. Director General of Civil Aviation Rules.
4. IS-456-2000 code of Practice for Plain & Reinforced Concrete
5. IS codes for various civil works (latest edition) as on NIT of tender
6. IRC codes for roads.

2.0 DESIGN PHILOSOPHY / CRITERIA - GENERAL

2.1 SITE GRADING

2.1.1 All the tree roots and vegetation shall be grubbed up and removed from site.

2.1.2 The grading of the area shall be done by cutting and filling with the following:

- a. Cutting area : Thoroughly rolled and compacted.
- b. Filling area : As per Geotechnical Specifications

2.1.3 Site grading philosophy shall be based on following:

- Present Grading Level : Varies from 4.0 to 4.9 m above I.M.S.L.
- Plant FGL : 4.21 m above I.M.S.L. 
- Unit HPP : 4.51 m above I.M.S.L. 

2.1.4 Slope in Graded Areas:

- i General Site Grading 1:500 to 1:1000
- ii Micro grading 1:200

2.2 ROADS

2.2.1 Road Width

<u>Location</u>	<u>Road way</u>	<u>Carriage way</u>
i. Road around CPP	12.0 m	7.0m 
ii. Approach Roads	7.5 m	3.60 m 

2.2.2	Camber	1:50	
2.2.3	Side slope.	1V:2H	
2.2.4	Radius of curve	- 12M for 12M wide road, 10M for 7.5M wide road & 7.5M for 3.6M wide road	
2.2.5	CBR to be used for design	As per Geotech/soil Specifications	
2.2.6	Design standard	IRC 37-2001 (using 2msa & design CBR)	
2.2.7	Road finish	Bituminous carpet with seal coat	

The crust thickness of road shall be designed as per load intensity on road in terms of MSA and Soil data.

2.2.8 Finished road top level above FGL:

When pipe way bridges for pipe ways are provided	-	Road Top level shall be fixed based on max. dia. of the Process pipe crossing the road
Other areas	-	0.40 m to 0.60 m

2.3 CONCRETE PAVEMENTS

RCC pavement shall be provided in entire CPP area.

2.3.1	Pavement slope	1 in 100
2.3.2	Type	
a.	Vehicular movement area	- Type-I (200 mm, thick) RCC M30
b.	Non vehicular movement areas	- Type-II (150 mm thick) RCC M25

NOTE:

- Refer standard drawing No. 7-65-040, RCC pavement details.
- Sub-Grade below RCC pavement shall be compacted to 95% of Laboratory Dry Density as per IS:2720 Part-VIII and the slope of sub-grade shall be same as top of the pavement slope.
- In case of poor soil/ black cotton soil, treatment below base shall be carried out as per soil report/ recommendation.
- Provide minimum number of expansion joints per standard.
- For all RCC works ready mix concrete shall be used to the extent possible.

For Crane movement area pavement shall be designed as per loading and soil data.

2.4 SITE FINISH

AREA	CONCRETE	ASPHALT	WBM	OTHER COMPACTED EARTH SURFACE
- CPP Area	√ (RCC)			
- Road		√		
- Approaches		√		
- Between CPP & Roads (Except Approach Road to Units & Approaches to Fire Hydrant)				√
- Pipe Ways	√ (PCC)			

2.5 STORM WATER DRAINAGE SYSTEM

2.5.1 Run off co-efficient

- | | | | | | |
|----|---|--------------|---|------------|---|
| a. | Paved area | - Concrete | - | 1.0 | |
| | | - Bituminous | - | 0.9 | |
| b. | Compacted area such as offsite areas/expansion area | | - | 0.7 |  |
| c. | Unusable open area/ Green Belt area | | - | 0.4 to 0.6 | |

2.5.2 Ditches

- a. Type Rectangular type in and around units. Other areas, ditches shall be rectangular and/ or trapezoidal type.

b. Construction

- | | |
|-----------------------|--|
| - Rectangular Ditches | Brick work with cement plaster in off-sites (in good quality bricks
RCC in units and other RCC paved areas. |
| -Trapezoidal Ditches | PCC (M20) lining for both horizontal and sloped portion. Suitable lining/pitching upto 1.0m from edge of Trapezoidal Ditch shall be done to avoid soil erosion due to water run-off. |

2.5.3 Culverts and Road Crossings

- Pipe Culverts - Under Roads : RCC pipes (Class NP-3 as per IS:458)
- Storm Water Box culverts : RCC Pre-cast/ Cast-in-situ Construction

- Cast-in-Situ Boxes for cable crossing - RCC construction
- Electric Road Cable crossings - PVC pipe Class-1 (IS: 4985) embedded in PCC block

2.6 WATER SYSTEM

2.6.1 Drinking Water System

- Rate of water supply - 30 gals/head/day (135 lpcd).
- The drinking water shall be tapped from the header available outside the scope limit
- Underground ring main with G.I. pipes and fittings for dia 6" and below. All U/G GI pipes shall be coated with anticorrosive black paint.
- HDPE tank on roof top of every building shall be provided.

2.6.2 Cooling Water System

- Cooling water
Cooling water Return and Supply header shall be available at Power Plant Battery Limit by Client.

2.6.3 Underground Piping

All underground C.S./ M.S. pipes shall be provided with corrosion resistance protection.

2.7 SAFETY SHOWER & EYE WASH

Combined safety shower and eyewash units at various places as required where acidic/ caustic or other chemicals are handled or toxic chemicals may be present. Water shall be fed from drinking water line. Safety Shower & Eye wash units shall meet the requirements of IS: 10592

2.8 SEWERS

2.8.1 General

- Storm water drains shall not be combined with Oily waste sewer (OWS)/ Contaminated Rain Water Sewer (CRWS)/ Sanitary Waste Sewer (SWS)/ combined sewer system.
- OWS within CPP from the equipments and area around equipment pumps shall be collected through a system of U/G piping and manholes and disposed to Manhole at Power Plant Battery Limit.
Contaminated rainwater from the CPP areas (where rain water is likely to get contaminated) shall be collected through a system of catch basins & U/G Piping and disposed to CRWS manhole outside Power plant battery limit. Catch basin

shall cater to approximately 150sqm. After 30 minutes, it shall be routed to storm water open drain by two-way valve system.

RCC drain with HDG(Hot Dipped Galvanized) grating shall be provided all around the unit pavement to collect non-contaminated water. This drain shall be connected to main plant drain at CPP battery limit through double valve pit arrangement. In case of accidental contamination, the flow shall be diverted to CRWS via double valve pit.

- All underground C.S. pipes shall be provided with corrosion resistance protection for service temperature up to 60°C as per SMMS specifications for the project.
- Corrosion resistant protection given to underground CS pipe shall extend up to min. 500 mm. above/ beyond grade on both sides.
- Transformer oil (for oil filled transformer of 2000 litre) shall be drained to a RCC pit. The oil shall be pumped out of RCC pit time to time using portable pump.

2.8.2 Types of Sewers and Disposal Method

- Oily sewer - Upto CPP Battery limit
- CRWS - Upto CPP Battery limit
- Sanitary Sewer - Upto CPP Battery limit

2.8.3 Design of Contaminated Rain Water Sewer (CRWS)/ Process waste sewer (OWS- Oily waste Sewers)

- Design of contaminated rain water Sewer (Independent system)

The contaminated rainwater sewer shall be designed for the following combinations:

- Contaminated rain water **or** Fire water whichever is more.
The quantities of contaminated rainwater shall be worked out based on the contaminated area in the CPP.
- Sewer shall be sized flowing full with peak flows taking future requirements or 2/3 full without future requirements.
- Design of process water sewer /OWS (Independent system)
- The sewer shall be designed based on the quantities of process waste specified by process department/ Licensor.

2.8.4 Design of Sanitary Sewer

- The sanitary sewer shall be designed for 3 times the average flow flowing half full in case of lateral sewer and flowing 2/3 full in case of Main Sewers.
- Cover for Sewer Line
- Minimum cover over sewer line shall be 600 mm.
- Under road, sewer shall be protected by concrete encasement and minimum cushion shall be 1200 mm.

2.8.5 Material of Construction for Manholes

- Oily water sewer & contaminated rain water sewer
 - a. In units areas - RCC (M30) Manhole.
 - b. In Offsite areas - RCC (M30) Manholes
- Sanitary Sewer - RCC (M30) Manholes.

2.8.6 Manhole Seal

For trapping of gas or prevention of spread of fire through CRWS/ oily sewer from one area to another, a liquid seal of minimum 150 mm shall be provided in manhole along with suitable vents. Location of sealed manholes shall be decided accordingly. All vent pipes of sealed manholes shall be provided with flame arrestor.

2.8.7 Material of Construction for Sewers

- Oily Sewer
 - a. Within CPP areas - CS pipe As per Piping Material specs.
 - b. Offsite gravity sewer - RCC pipes class PI (as per IS : 458)
Socket and spigot, rubbering joints (Suitable concrete supports at all socket/ spigot joints of underground piping shall be provided.)
- Acidic and Alkali sewer - HDPE (as per IS:4984)
- Sanitary Sewer
 - a. Toilet block up to inspection chamber - CI pipes (as per IS: 3486/1729)
 - b. Gravity main & lateral - RCC class PI (as per IS:458) as per IS : 458) Socket and spigot, rubbering joints (Suitable concrete supports at all socket/ spigot joints of underground piping shall be provided.)
- Manhole for acid/ alkali sewer shall be provided with Acid/ Alkali proof lining.

JOB SPECIFICATIONS & DATA SHEETS (STRUCTURAL & ARCHITECTURAL)

PART: A (STRUCTURAL)

CPP

PROJECT : CPP- PARADIP REFINERY PROJECT

OWNER : INDIAN OIL CORPORATION LIMITED

PMC : ENGINEERS INDIA LTD.

JOB NO. : A011

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1.0 GENERAL

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

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

- 1.2 The Contractor shall do the structural designing of all structures and prepare complete set of civil and structural drawings needed for correct and accurate construction. The design shall be strictly in accordance with 'Design Criteria' given herein.
- 1.3 Detailed list of drawings/documents [including design calculations, design drawings, bar bending schedules (for RCC works) and fabrication drawings (for structural steel works)] and structure-wise quantity statements (showing anticipated, released and balance quantities of concrete, structural steel and piles) shall be prepared by the Contractor and submitted monthly for review by Owner/Owner's representative. This list shall also indicate the document/drawing category (approval, review or information as applicable) together with the scheduled and actual dates of submission of the documents.
- 1.4 Before proceeding with design and drawing preparation the Contractor shall submit detailed general philosophy of design of various parts of (all) the structures and equipment foundations along with explanatory sketches for review by Owner/Owner's representative. Only after the review and incorporation of comments on the general philosophy, as offered during the review, the Contractor shall submit any design document and/or drawing for review or information or issue the same for construction. Design and detailing of the

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.0 DESIGN CRITERIA - GENERAL

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

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

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

2.1 FOUNDATIONS

- 2.1.1 NGL (Natural ground level) and FGL (Finished ground level) shall be marked on all drawings showing foundation/sub-structure details and related design documents.
- 2.1.2 Machine/static equipment foundations shall be separated from adjoining parts of buildings, other foundations and floor/pavement slabs. Joints at floor/pavement slabs shall be suitably sealed.
- 2.1.3 Foundations and structures for machines subject to vibrations shall be so proportioned that the amplitude and frequency of the foundation/structure are within the permissible limits as per relevant BIS codes (or as required by the machine vendor).
- 2.1.4 Structures supported on RCC strip footings shall be provided with suitable tie beams connecting all footings at foundation level. Minimum width of footing shall be 1000 mm.
- 2.1.5 Raft foundations shall be designed as per IS: 2950.
- 2.1.6 Masonry walls shall be supported on continuous plain cement concrete mats/plinth beams. Top of plinth beams shall be located minimum 300mm below the finished grade level. Fouling of plinth beams with cable trenches, drains, pipe ducts, service lines etc. shall not be acceptable.

¹ Uncladded-open type structure housing process equipments.

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

3.0 DESIGN REQUIREMENT FOR SPECIFIC APPLICATIONS

3.1 PIPE RACK LOADING

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

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

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

3.1.1 Piping Loads

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

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

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

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

Density of insulation shall be taken as 260 kg/m^3 .

- 3.1.1.4 If cooling water headers above 30" size are to be placed on pipe rack due to Client's requirement, additional point loads shall be considered for such pipes besides UDL. Piping shall indicate such requirement in the beginning of the project.
- 3.1.1.5 Cooling water headers and other large diameter pipes shall be placed near to the rack columns (i.e. away from the centre of span).
- 3.1.1.6 The above U.D.L. does not include transfer line loads, which shall be separately considered as furnished below. Wind / seismic loads shall also be considered on these lines. For calculating the weight of all such pipes, the size, schedule and insulation thickness shall be given by Piping in the beginning of the project. In all the bays supporting transfer line, suitable plan bracing shall be provided to transfer the lateral load to the framework. At least one of the bays carrying transfer line shall have vertical bracing.

A) Transfer line with rigid support

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

B) Transfer line with spring hangers

Top level

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

Bottom level :

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

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

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

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

3.1.1.9 Loading on Intermediate Transverse Beams

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

3.1.1.9.2 Intermediate beams shall support the following :

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

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

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

3.1.1.10 Loading on Longitudinal Beams

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

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

3.1.2 Thermal Loads

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

3.1.2.2 Sliding Friction Force

3.1.2.2.1 Horizontal force shall be taken as 10% of vertical load at each tier on every portal both in longitudinal and transverse directions acting simultaneously to cater for the sliding friction and the guide forces due to the bends / tappings.

3.1.2.2.2 Horizontal force on longitudinal beams of unit pipe rack shall be taken as 10% of the vertical load on these beams and this shall be considered in transverse direction only. However, this friction force shall not be considered for the design

of portals. (While considering this load effective length of the compression flange shall be taken with lateral restraint at load points).

- 3.1.2.2.3 Sliding friction force on intermediate transverse beams shall be taken as 10% of the vertical load on these beams and this shall be considered in longitudinal direction only.

3.1.2.3 Anchor / Cross Guide / Guide Restraint Forces

- 3.1.2.3.1 Anchors, cross guides and guides for various pipes shall be staggered by Piping on different portals and also at various tiers, so as to avoid concentration of these forces. Since pipes generally have straight run on pipe rack, staggering of above restraints shall enable balancing of thermal forces largely. However, some residual unbalanced forces may still be present due to different lengths of pipes and branching off of various pipes and hence following percentages of vertical load shall be considered as Anchor / Cross Guide / Guide Restraint forces in addition to the sliding friction forces :

- 2.5% of vertical load on each tier in transverse and longitudinal direction simultaneously. This unbalanced force due to above restraints shall be applied on all portals except for the last two portals at each battery limit end.
- 15% of the vertical load in the longitudinal direction and 5% of the vertical load in the transverse direction on last two portals at the battery limit ends. At these two portals a higher thermal load is considered as large number of pipes are likely to be restrained or anchored on these portals.

3.1.3 Electrical Cable Loads

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

3.1.4 Instrumentation Cable Loads

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

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

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

3.1.5 Live Loads

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

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

3.1.6 Wind Force

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

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

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

= 0.8 x Diameter of Largest pipe (Including insulation)(m) + width of rack(m) x tan 10 deg

However , the value of H shall not exceed the distance between two consecutive tiers.

Diameter of largest pipe shall be taken as 30". In case the same is more than 30", it shall be given by Piping.

3.1.6.2 Wind load on extended framework above top tier to support flare/ vapour/ transfer lines shall be as per IS:875. (Refer Clause 4.1e of Doc. No. A011-00-16-48-DB01)

3.1.7 Seismic Force

Seismic forces shall be as per site specific seismic spectra (Refer Doc. No. A011-00-16-54-DB-01)

3.1.8 Equipment Loads

- 3.1.8.1 Equipment loads of surge drums, deaerators, silencers, etc. when supported on pipe rack shall be considered on actual load basis derived from the data sheets for the design of foundation and super structure.
- 3.1.8.2 Following loading may be considered for the design of foundations of pipe rack in case the data sheets for Air fin coolers are not available.

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

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

3.1.9 Maintenance Loads

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

Note:

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

3.2 RCC AND STEEL CHIMNEYS

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

3.3 MACHINE FOUNDATIONS

Machine foundations shall satisfy the following requirements:

- The minimum grade of concrete to be used shall be as per clause 8.3 of Doc. No. A011-00-16-48-DB-01.
- Minimum reinforcement as per requirements of IS:2974 shall be provided unless required otherwise by design.
- All units of the foundation system, except foundation raft shall be provided with symmetric reinforcement on opposite faces, even if not required by design considerations.

- d) The soil stress below foundations under dead loads shall not exceed 80% of the allowable soil bearing capacity, or safe load on pile, for static loading.
- e) The combined center of gravity of the machine and foundation system shall, as far as possible, pass through the center of area of the foundation raft or centroid of the pile group. Where unavoidable, eccentricity shall be less than 5% for block foundations and 3% for frame foundations.
- f) Foundations shall be so designed that natural frequency of the foundation system shall not resonate with the following:
 - i) Operating speed of the motor.
 - ii) Operating speed of the machine.
 - iii) 2 x Operating speed of the machine.
 - iv) Critical speed of the machine (for centrifugal machines).

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

- g) Amplitudes of vibration shall be less than values specified by the machine manufacturer. If not specified, provision of IS:2974 shall be followed.
- h) The foundation and its superstructure shall be separated from adjacent foundations and platforms. Clear air gaps shall be provided in the superstructure to avoid transmission of vibration to adjacent structures. Special note shall be given on the drawing in this respect, and suitable details shown as required.
- i) Foundations resting partly on rock and partly on soil shall preferably be avoided. However, if unavoidable, the soil area shall be replaced by lean concrete (1:4:8). However, Owner/owner's representative concurrence shall be obtained for such cases.
- j) Foundations shall not rest on previously backfilled or sensitive soils.
- k) For frame foundations, base raft shall be cast in a single concreting operation. A properly designed construction joint shall be provided between the base slab and columns. The entire superstructure of columns and upper deck shall be cast in a continuous concreting operation.
- l) If height of the frame columns above raft level exceeds 8.0m, an additional construction joint at the junction of columns/top-deck may be provided.
- m) Block foundations shall be cast in a single concreting operation.

3.4 BLAST RESISTANT CONTROL ROOMS

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

3.5 TANK FOUNDATIONS

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

3.6 SUPPORTING ARRANGEMENTS FOR TRANSFER LINE

Structures supporting transfer lines and other two phase flow lines:

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

3.6.1 Design loads

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

3.6.2 Piping supported on Pipe racks

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

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

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

3.6.3 Isolated trestles

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

3.6.4 Supports from technological structures

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

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

3.6.5 Permissible stresses

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

3.6.6 Permissible deflections

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

3.7 COMPRESSOR HOUSE, PUMP HOUSE AND OTHER SHED TYPE STRUCTURES

Roofs of all shed type structures shall have 1:3 slope. MS wind ties (40mm x 6mm) painted as per painting specifications shall be provided over roof sheeting on the last purlin towards eaves and the first purlin at ridge, on each slope of the roof. Cladding shall be provided on all sides starting at 3 metre height from FFL/HPP and continuing up to roof level. Provision for equipment entry and drop out area shall also be made as per approved equipment layout.

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

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

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

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

- a) above defined requirements.
- b) the unfused joints are not in excess of 5% of the total joints. If unfused joints found are in excess of 5%, the prototype shall stand rejected and a fresh prototype shall be prepared with revised welding parameters clearing the requirement of unfused joints limited to 5% of the total joints.
- c) the projection of secondary member above the main member is not more than 1.5mm.
- d) the unfused 5% joints of b) above are welded by SMAW/GMAW process.

- e) the joints are able to sustain a minimum pull out load of 1.2 times the allowable shear capacity of the secondary member.
- f) gratings shall be subjected to a third party inspection as per Owner/owner's representative approval.

4.0 MATERIAL REQUIREMENTS

4.1 GENERAL

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

4.2 WATER

- 4.2.1 Water used in construction for all civil & structural works shall be clean and free from injurious amounts of oil, acids, alkalies, organic matters or other harmful substances which may be deleterious to concrete, masonry or steel. The pH value of water sample shall be not less than 6. Potable water will be considered satisfactory. All requirements of IS:456, have to be met.
- 4.2.2 Tests on water samples shall be carried out in accordance with IS:3025 and these shall fulfill all the guidelines and requirements given in IS:456.
- 4.2.3 Water for curing shall be of the same quality as used for concreting and masonry works.

4.3 AGGREGATE (FOR CONCRETE)

4.3.1 General

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

4.3.2 Coarse Aggregates

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

4.3.3 Fine Aggregates

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

4.3.4 Sampling and Testing

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

4.3.5 Storage of Aggregates

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

4.4 SAND (FOR MASONRY & FILLING)

4.4.1 Sand for Masonry Mortars

- The sand shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified in IS:2116
- The sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shells in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar.
- The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand, when tested in accordance with IS:2386, shall not be more than 5% by mass in natural sand, or crushed gravel sand or crushed

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

4.4.2 Grading of Sand

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

Grading Of Sand For Use In Masonry Mortars

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

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

4.4.3 Sampling and Testing

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

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

4.4.4 Sand for Filling

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

4.5 CEMENT

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

43 grade ordinary Portland cement	IS:8112
Portland Pozzolana cement (fly ash based)	IS:1489 (Part-1)

4.6 STEEL

4.6.1 General

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

4.6.2 Reinforcement Bars

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

4.6.3 Structural Steel

Structural steel sections shall conform to following BIS codes:

Steel tubes for structural purposes	IS:1161
Mild Steel Tubes, tubular and other wrought steel fittings	IS:1239
Steel for general structural purposes (Grade A).	IS:2062
Hollow steel sections for structural use.	IS:4923

²

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

4.6.4 Miscellaneous Steel Materials

Miscellaneous steel materials shall conform to the following BIS codes:

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

4.6.5 Anchor Bolts

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

4.7 BRICK

4.7.1 General

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

Bricks shall be hand-moulded or machine-moulded and shall be made from suitable soils. The bricks shall have smooth rectangular faces with sharp corners and shall be well burnt, sound, hard, tough and uniform in colour. These shall be free from cracks, chips, flaws, stone or humps of any kind.

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

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

4.8 STONE

4.8.1 General

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

Method of identification of natural building stones IS:1123

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

Recommendations for dressing of natural building stones IS:1129

4.8.2 Quality of Stones

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

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

4.9 ADMIXTURES

4.9.1 General Requirements for Admixtures

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

Specification for integral cement water proofing compounds. IS:2645

Specification for other admixtures for concrete. IS:9103

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

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

4.9.2 Water Proofing Compounds

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

4.9.3 Bipolar Concrete Penetrating Corrosion Inhibiting Admixture

Refer Doc. No. A011-00-16-48-4201

4.10 WATER BARS (WATER STOPS)

- 4.10.1 PVC water bars shall be used in reinforced concrete construction of liquid retaining structures or any other structure to safeguard them from hydrostatic pressure and water leakage and any relative movement between two parts of the structure due to thermal loading shrinkage or differential movement of foundations. These shall be preformed and shall provide a permanent water tight seal along the entire joint in the poured concrete structures. These shall also be flexible enough to withstand deflection/ displacements at joints arising due to variation of temperatures or settlement of foundations.
- 4.10.2 Performance requirements of PVC water bars shall meet the requirements of IS:12200. These shall be of an approved make and of ribbed/serrated/plane type with a bulb at the centre. The thickness and width of water bars shall in no case

be less than 5mm and 150mm respectively. However, for concrete sections greater than 300mm thick, the width of water bars shall not be less than 230mm.

4.11 BITUMEN/BITUMINOUS MATERIALS

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

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

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

4.12 PVC PIPES

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

4.13 WOOD/TIMBER

- 4.13.1 Wood recommended for platforms of cold vessels or below cold vessels/ exchangers shall be hard and shall be of group A, grade I, and shall have safe permissible stress of 7N/mm^2 in compression, perpendicular to grains on outside location as per IS:883. General characteristics like durability, treatability etc. shall conform to IS:883 and IS:3629.
- 4.13.2 Timber required to be used for form work shall be fairly dry before use. It should maintain its shape during the use and even when it comes into contact with moisture from the concrete. Storage of Wood/Timber shall be as per the requirements of IS:4082.

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

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

4.14 ANTI-TERMITE COMPOUNDS

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

4.15 POLYSULPHIDE SEALANTS

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

5.0 CONSTRUCTION REQUIREMENTS

5.1 CONSTRUCTION

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

For Plain and Reinforced Cement Concrete Structures:

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

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

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

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

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

For Steel Structures:

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

(b) Trusses

- Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord.

$\pm 1/250$ of height of truss in mm at center of span or ± 15 mm whichever is less

- Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss

$\pm 1/1500$ of span of truss in mm or ± 10 mm whichever is less

- Lateral shift in location of truss from its true position. ± 10 mm

- Lateral shift in location of purlin from true position. ± 5 mm

- Deviation in difference of bearing levels of truss from the true level

$\pm 1/1200$ of span of truss in mm or 20mm whichever is less.

(c) Gantry girders and Rails

- Shift in the centre line of crane rail with respect to centre line of web of gantry girder

$\pm \left[\frac{\text{web thickness of girder (mm)} + 2\text{mm}}{2} \right]$

- Shift of alignment of crane rail (in plan) with respect to true axis of crane rail at any point ± 5 mm

- Deviation in crane track gauge with respect to true gauge.

- i) For track gauge upto and including 15 m ± 5 mm

- ii) For track gauge more than 15m $\pm [5 + 0.25(S - 15)]$ subject to maximum ± 10 mm, where S in metres is true gauge.

- Deviation in the crane rail level at any point from true level ± 10 mm

- Difference in level between crane track rails (across the bay) at

- i) Supports of gantry girders 15 mm

- ii) Mid span of gantry girders 20 mm

-
- Relative shift of crane rail surfaces 2 mm
(at a joining) in plan and elevation
- 5.1.11 Construction of all other items of works shall conform to relevant Indian Standards and sound engineering practices.
- 5.1.12 The Contractor shall be responsible for the complete safety pertaining to all construction works.
- 5.1.13 Before starting the piping work over the pipe rack, the contractor shall provide a hanging scaffolding, about one meter below the entire pipe rack first tier elevation, to provide an elevated working platform leaving the ground free, to provide protection from the falling material and to act as a safe working platform for the mechanical work at the first tier

6.0 SPECIFIC REQUIREMENTS

6.1 GENERAL

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

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

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

- 6.2.1 Complete structural design and AFC drawings for the structures mentioned in section A-5.2.6 shall be got reviewed by owner/owner's representative in detail before taking up any construction activity at the work site:

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

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

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

6.3 HANGER SCAFFOLDING

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

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

The design load under the working condition shall be 120kg per sqm and that for the limit state of collapse shall be twice the same. However individual panel shall be designed for the concentrated loads of 120kg at spacing of 1m and double that load for the limit state of collapse. Deflection of individual planks shall be maximum span/100. For the beam, the deflection shall be controlled as per

IS: 800-2007. The design shall be supported by the properly testing of the checking for the specified loads.

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

JOB SPECIFICATIONS (STRUCTURAL & ARCHITECTURAL)

PART-B (ARCHITECTURAL)

CPP

PROJECT : CPP-PARADIP REFINERY PROJECT

OWNER : INDIAN OIL CORPORATION LIMITED

PMC : ENGINEERS INDIA LIMITD

JOB NO. : A011

0	24.07.09	ISSUED FOR BIDS	RG	JKB	VK
Rev. No	Date	Purpose	Prepared by	Checked by	Approved by

1.0 BUILDING REQUIREMENT

The Buildings shall be designed on the basis of basic requirements furnished in this document (including attached drawings in the bid) and Design Basis/ Philosophy elaborated elsewhere in the bid package.

In case of conflict or contradictions between building requirement & design basis, provisions of the former shall override. The Buildings shall be sized in accordance with the Owner/ PMC approved GA drawings prepared on the basis of functional, maintenance, safety & statutory requirements as given in the drawings attached with bid.

1.1 Architectural Finishes:

For architectural finishes of buildings/shed, Refer Clause no. 3.0 of Document no A011-00-16-48-DB-01 REV.0

2.0 SPECIFICATION OF ARCHITECTURAL FINISHES

Note:

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

2.1 GENERAL

- (a) For any aspect of item not covered in the document, the contractor shall follow instructions of the engineer-in-charge and execute the work as per relevant IS codes/ recommendations of approved manufacturer/ good engineering practice without any cost or time implication to Owner/PMC. Contractor shall refer only to the relevant part of the specifications given below as per the Building Finishes described before.
- (b) All materials shall be of first quality conforming to the specifications & IS or equivalent with IS marks and shall be obtained from the approved Manufacturer. The Contractor shall get the materials approved by the Engineer - In - Charge before ordering & procurement. The Contractor shall furnish necessary certificates etc. as asked by the Engineer - In - Charge. Further to that he shall get the materials tested from approved test house if asked by the Engineers - In - Charge & submit the test certificate at his own cost for which no extra payment shall be made to him. The Engineer - In - Charge shall have the right to reject all or any of the materials intended to be used and such materials shall be immediately removed from the site by the Contractor at his own cost without any claim for compensation etc. due to such rejection.
- (c) Workmanship shall be to the satisfaction of the Engineer- In- Charge. The contractor shall follow the specifications, relevant Codes & Manufacturer's guidelines for achieving desired level of workmanship as per specification & good engineering practice. Any executed work not conforming to the specification or not to the satisfaction of the Engineer -In-Charge shall be rectified by the Contractor as directed by the Engineer - In-Charge. No extra payment shall be made to the Contractor for such rectification. The contractor shall use only first quality approved material for all items.

- (d) All specifications of various finishing items include construction supervision; supply of all materials, labours, tools tackles, scaffoldings etc. and are applicable for all heights, locations etc.
- (e) For specifications of construction water, sand, cement, bricks/ stone, aggregates etc. reference shall be made to the Civil/ Structural specifications attached in the bid document.
- (f) All specialised items of work (e.g. Composite Aluminium panel, Structural/ Curtain Glazing, Aluminium Doors and Windows, Waterproofing, Insulation, Pre-coated roof sheeting/ cladding, False ceiling, False Flooring, Partitioning and Panelling, Expansion joint sealing etc.) shall be got executed by the Contractor only through authorised applicators/ sub contractors of approved manufacturer/ vendor. The contractor shall submit list of such authorised applicators/ sub contractors for approval before execution of such items.

2.2 FLOOR FINISHING

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

IS: 4971	Recommendations for selection of Industrial floor finishes.
IS: 1237	Specification for Cement concrete flooring tiles.
IS: 777	Specification for glazed earthenware wall tiles.
IS: 2571	Code of practice for laying in situ cement concrete flooring.
IS: 4631	Code of practice for laying of epoxy resin floor toppings.
IS: 5491	Code of practice for laying in situ granolithic concrete floor topping.
IS: 4441	Code of practice for use of silicate type Chemical resistant mortars.
IS: 4443	Code of practice for use of resin type chemical resistant mortar.

2.2.1 Cement Concrete Flooring

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

- (a) 25 mm thick base course of M-20 grade cement concrete (with 6mm and down size stone aggregate) laid on the sub-base in panels (each panel not exceeding 1 Sq. Mtr. in area) in desired shape and pattern. The panels shall be bound by 3x20mm PVC strips panel dividers; fixed in position with their top at proper level maintaining the required levels, slopes, linearity etc. as required. Base course shall be laid in alternate panels. Before laying the base course, neat cement slurry @ 2.75Kg. of cement per Sq. Mtr. of area shall be applied (brushed) over the prepared sub base surface. Cement concrete shall be placed in position and beaten with trowel, including tamping and finishing smooth. Finishing of the surface shall follow immediately after completion of laying of base. The bed for flooring shall be prepared either level or sloped as per drawings and as instructed by Engineer-in-charge.
- (b) Neat cement @ 2.75Kg. per Sq. Mtr. mixed with water to form a thick slurry applied over the base course (when the concrete is green), spread over the surface, pressed twice by means of iron floats; once when the slurry is applied and second time when the cement starts setting. The junction of floor with wall plaster, cladding, skirting shall be rounded off uniformly upto a radius of 25mm unless otherwise mentioned.

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

2.2.2 Cement Concrete Granolithic Flooring

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

- (a) 25mm base Course (Under layer) of M-20 grade Concrete (shall generally conform to Civil structural specifications) laid over sub base in panels (each panel not exceeding 1 Sq. Mtr. in area) in desired shape and pattern. The panels shall be bound by 3x30 PVC strips panel dividers; fixed in position with their top at proper level maintaining the required levels, slopes, linearity etc. as required. Base course shall be laid in alternate panels. Before laying the base course, neat cement slurry @ 2.75Kg. of cement per Sq. Mtr. of area shall be applied (brushed) over the prepared sub base surface. The borders of the panels shall have mitred joints at the corners of the room and intermediate joints shall be in straight line with panel joints. Cement concrete shall be placed in position and beaten with trowel and finished smooth. Beating shall cease as soon as surface is found covered with cream of mortar. Necessary slope shall be provided.
- (b) 15mm thick Wearing top layer of cement mortar 1:3 (1 cement: 3 coarse sand by volume) which shall be laid within 15 minutes of laying the first layer. The cement and aggregates for the top layer shall be mixed dry. After mixing, sufficient quantity of washed sand and water shall be added to make the mix plastic but not flowing. The top and bottom layer shall firmly grip together. The base course shall be free of excessive moisture before starting the floor finishing. Use of dry cement, cement sand mixture sprinkled on the surface to stiffen the concrete or absorb excessive moisture shall not be permitted.
- (c) While the concrete is still green, cement @ 2.75 kg per Sq.M of floor area shall be mixed with water to form a thick slurry and spread over the surface. It shall be pressed twice by means of iron floats, once when the slurry is applied and second time when the cement starts setting. The junction of floor with wall plaster, cladding, skirting shall be rounded off uniformly upto a radius of 25mm unless otherwise mentioned.

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

2.2.3 Heavy Duty Cement Concrete Flooring

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

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

with trowel and finished smooth. Beating shall cease as soon as surface is found covered with cream of mortar. Necessary slope shall be provided.

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

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

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

2.2.4 Cement Plaster Skirting

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

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

2.2.5 Tile Work (Glazed/ Ceramic/Vitrified Porcelain)

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

2.2.6 Kota Stone Flooring/ skirting/ dado

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

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

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

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

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

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

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

2.2.7 Marble Stone Flooring & cladding

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

700mm to 2500mm in length and 300mm to 1000mm in width. Skirting shall normally be 125mm high unless specified otherwise. Pigments, wherever required, to be admixed with mortar or position and tapped with wooden mallets till it is properly bedded in level. The joints shall be as fine as possible. Surplus white cement on the surface of the slab shall be removed for grouting the joints shall conform to Table -1 of IS: 2114.

The slab shall be washed clean before laying. Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of veins/ streaks or as directed by the Engineer-In-Charge.

Laying in floor :

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

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

Laying in skirting/ dado/ risers :

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

Polishing and Finishing :

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

The day after the tiles are laid all joints shall be cleaned with a wire brush to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shade of the stones.

Grinding shall be commenced after a minimum period of 7 days when the stones and the joints are properly set. Grinding shall be done by machines. First grinding shall be done with carborundum stones of 60 grade grit fitted in the machine. Water shall be profusely during grinding. When the chips show up and the floor has been uniformly rubbed, it shall be cleaned with water baring all pin holes. The second grinding shall be done with carborundum stone of 120 grit. Final grinding shall done the day after the second grinding with carborundum stone of 320 grit using water in abundance. The surface shall be washed clean with water, oxalic acid powder shall then be dusted at 33 gms/sq. m. on the surface rubbed with machine fitted hessian bobs or rubbed hard with woollen rags. The surface shall then be washed clean and dried with a soft cloth or linen. If any stone is disturbed or damaged, it shall be refitted or replaced and properly jointed and polished.

2.2.8 Italian Marble slab Flooring and cladding

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

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

2.2.9 Granite Stone Flooring and cladding

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

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

2.2.10 Epoxy Coating:

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

Screed:

The screed shall be provided in flooring and shall consist of a solvent free combination of epoxy resin, modified amine hardeners filled with specially graded and selected chemically inert aggregates of high strength. The system shall include an epoxy resin primer and screed which are both supplied in pre-weighed units ready for on-site mixing and application. The thickness of screed shall be minimum 3mm thick. The primer shall be applied by brush and shall be allowed to become tacky. The screed shall be prepared as per manufacturers specification and laid evenly over the base floor by trowel. In case of flooring, the finished, cured screed shall have a slightly granular texture.

Finishing Coat:

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

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

2.2.11 Acid Resistant Tiles Flooring

The tiles shall be vitrified ceramic tiles of approved size as per approved manufacturer's specification and shall be homogeneous having following properties :-

S.No.	Property	Values	Norms
1	Water Absorptions	±0.5%	ASTM C 373
2	Scratch Resistance	≥ 6	ASTM C 373
3	Chemical Resistance	Unaffected	ASTM C 650
4	Abrasion Resistance	≥ 100	ASTM C 501
5	Breaking strength	1400 kg/sq.cm	ASTM C 648
6	Density	≥ 2.0 Gm/CC	

The base course for flooring shall be Cement Concrete flooring/ Cement Concrete granolithic flooring and for skirting/ dado it shall be Cement plaster and background surface shall be prepared as per clause no. 5.2 and IS:4443.

Tiles shall be fixed on the prepared surface over a bitumen priming layer, bitumen mastic layer and resin type chemical resistant mortar. The bitumen shall conform to IS:702 and laying of bitumen mastic shall conform to IS:1196.

Joints shall be allowed to set for 24 hours. The floor shall then be washed as per manufacturer's specifications to totally remove all marks from tile surface.

2.3 DOORS AND WINDOWS

2.3.1 Aluminium Glazed Doors, Windows And Ventilators

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

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

a. Doors

1. For fixed frames

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

2. For shutter frame : 1.202 Kg/RM

3. Glazing clips (beading) : 0.182 Kg/RM

a. Window/Ventilator

- | | | |
|------------------------------|---|-------------|
| 1. For fixed frames | : | 0.639 Kg/RM |
| 2. For shutter frame | : | 0.636 Kg/RM |
| 3. Glazing clips (beading) | : | 0.165 Kg/RM |
| 4. Coupling bars | : | 0.933 Kg/RM |

b. Member for fixing the frame : 0.463 Kg/RM

The frames shall be fixed to masonry by means of Aluminium lugs fixed to the frame by counter sunk brass machine screws and grouted with M-20 grade concrete in minimum 150 x 150 x 50 mm sized hole in the masonry. In case of RCC, the frames shall be fixed with 12mm dia dash fasteners in case of concrete. Any steel item coming in contact with Aluminium shall be galvanised.

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

Following hardware shall be provided for the doors.

1. Heavy duty & hydraulically operated double or single action adjustable door closer conforming to IS : 6315
2. 250mm and 150mm long, 10mm dia Aluminium tower bolts as per IS: 204 one each for each shutter.
3. Brass body 6 lever mortise lock as per IS : 2209
4. Aluminium door handle for each shutter for each side.

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

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

2.3.2 Steel Doors

Steel doors shall consist of :

(a) Pressed steel door frame of overall 125x 65mm size conforming to IS : 4351 and made of 16 SWG pressed steel sheet bent to required shape using bending machine to form solid/ true mitred edges/ corners, stiffened with 50 x 5mm thick MS flat spacers welded to the frame facing the wall/ column @ 600mm c/c maximum vertical spacing. The frame shall be fixed to the masonry by means of 300 x 25 x 6 mm thick MS hold fast welded to the spacer and grouted with M-20 concrete in minimum 350 x 100 x 100 mm sized hole in the masonry. In case of concrete, the frames shall be fixed by 96mm long, 12 mm dia metallic counter sunk type dash fasteners through the frame & spacers. Provision for hinges, locking arrangement and other hardware shall be provided in the frame by machine cutting of required size cutouts in the frame and welding/ screwing to 3 mm thick MS pad plates

already welded over the cutout from behind. The frame shall be thoroughly cleaned of rust, mill scale, dirt, oil etc. and then finished with 2 or more coats of approved quality synthetic enamel paint of approved shade over a priming coat of approved red oxide zinc chromate primer. The hollow frame shall be packed with PCC to fill the cavity without gap.

(b) Pressed steel door shutter shall be made with 18 gauge steel sheets formed by machine bending in the form of hollow box (overall 40mm thick) welded at meeting of the sheets with pad plate of 3mm thick MS flat all along the perimeter. The shutter shall be braced with channel shaped 35mm wide horizontal stiffeners by folding 16 gauge MS sheets @ 500mm c/c fixed by flush riveting. 3mm thick MS pad plates shall be welded inside at required locations for fixing of hardware. The cavity inside shall be packed with rigid PU foam/ phenolic foam or glass wool insulation to fill into the box cavity without gap.

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

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

Each door shutter shall have following accessories.

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

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

2.3.3 Wooden Flush Doors

Flush doors shall consist of:-

Frame :

Pressed steel door frame of overall 125x 65mm size conforming to IS : 435 and made of 16 SWG pressed steel sheet bent to required shape using bending machine to form solid/ true mitred edges/ corners, stiffened with 50 x 5mm thick MS flat spacers welded to the frame facing the wall/column @ 600mm c/c maximum vertical spacing. The frame shall be fixed to the masonry by means of 300 x 25 x 6 mm thick MS hold fast welded to the spacer and grouted with M-20 concrete in minimum 350 x 100 x 100 mm sized hole in the masonry. In case of concrete, the frames shall be fixed by 96mm long, 12 mm dia metallic counter sunk type dash fasteners through the frame & spacers. Provision for hinges, locking arrangement and other hardware shall be provided in the frame by machine cutting of required size cut outs in the frame and welding/ screwing to 3 mm thick MS pad plates already welded over the cut out from behind. The frame shall be thoroughly cleaned of rust, mill scale, dirt, oil etc. and then finished with 2 or more coats of approved quality synthetic enamel paint of approved shade over a priming coat of approved red oxide zinc chromate primer). The hollow frame shall be packed with PCC to fill the cavity without gap.

Shutter:

Flush door shutters shall be factory made and overall 35mm thick consisting of solid core block board bonded with phenol formaldehyde synthetic resin conforming to IS : 848. The shutters shall be faced on both sides with 3 mm thick Teakwood veneering conforming to IS: 303, BS: 476 part-7/ 1 mm thick approved quality melamine faced lamination shall be provided on both sides in case of toilet doors. 35 x 20mm second class Teakwood lipping shall be provided all around the shutter by means of approved quality neoprene based adhesive and nailing @ 300mm (maximum). Teakwood veneering along with lipping shall be french polished (lacquer finish) as per specifications. The shutters shall be fixed to the frame by means of 125mm long MS butt hinges conforming to IS: 1341 @ 600mm c/c maximum.

Teakwood used for lipping, beading etc. shall be second class Indian teakwood (conforming to IS : 4021) of good quality, well seasoned and free from defects such as cracks, dead knots, sapwood etc. and shall be with no individual hard & sound knots more than 15 Sq.CM in area and the aggregate area of such knots not exceeding 2% of area of the piece. The wood shall be fairly closed grains having not less than 2 growth rings per Cm. Width in cross section.

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

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

2.3.4 Steel Rolling Shutter

MS rolling shutters shall conform to IS: 6248 and shall be constructed with interlocking lath sections formed out of cold rolled 0.9mm thick, 80mm wide steel strips for shutter width upto 3.5 M, or 1.25mm thick, 80mm wide steel strips for shutter width beyond 3.5 M, jointless MS channel section of 3.15mm thickness for guide, MS girders & bottom rail, shutter suspension stud with pulley & cage, top rolling springs, locking arrangement etc. all complete as per manufacturers approved drawings. The entire shutter including all accessories shall be painted with 2 or more coats of approved quality & shade synthetic enamel paint over a coat of approved quality red oxide zinc chromate primer. All the damaged surfaces of wall, columns, plastering etc. shall be made good.

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

Wherever specified the Rolling shutters shall be electrically operated; complete with all accessories, electrical motor, cabling etc. as per approved manufacturers design and drawings

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

2.3.5 FIRE & SMOKE CHECK DOORS

a. General

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

b. Fire rating

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

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

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

c. Fire Check Doors & Windows

i. Composition of the Doors

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

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

Each vision panel shall carry a stamp of the manufacturer.

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

1. Fire Check Wooden Door
2. Fire Check Steel Door
3. Fire Check Glazed Door

4. Fire check glazed window

ii. Fire check wooden door

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

Frame :

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

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

Shutter :

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

Calcium silicate board shall have following properties:

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

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

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

Alkalinity (approx.): pH 9

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

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

Water absorption capacity (average): 0.49 g/cm³

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

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

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

Finishing :

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

iii. Fire check steel door

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

Frame :

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

Shutter :

Shutter shall comprise of single / double pressed steel shutter (The shutter width may vary as per manufacturer's approved design) with two outer skin panels of 1.25 mm thick galvanized sheet with infill of either 9mm calcium silicate board on either side with 30mm thick 96 kg/m³ ceramic fibre insulation or mineral wool or ceramic fibre or any other fire rated proprietary insulation filler with lock seam joinery and internal reinforcement for high strength and fire resistant acrylic sealant (overall shutter thickness shall not be less than 43 mm) for maintaining overall fire integrity.

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

Finishing :

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

iv. Fire check glazed door

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

Frame :

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

Shutter :

Shutter shall comprise of single / double pressed steel shutter (The shutter width may vary as per manufacturer's approved design) with two outer skin panels of 1.2 mm thick galvanized sheet with infill of fire rated proprietary insulation filler on both faces with lock seam joinery at stile edges and internal reinforcement for high strength at top, bottom and

stile edges for required fire rating. The door shutter shall consist of a top rail and side rail of nominal size 100mm x 48mm and a bottom rail of 200mm x 48mm and finished with etch primer for scratch resistance.

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

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

Finishing :

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

v. Hardware & vision panel for FCD

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

Hardware :

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

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

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

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

Vision Panel :

Vision panel shall be of 120 minutes fire rated (conforming to BS 476 part 22), UL listed or FM approved, 6mm thick Borosilicate or other special substrate clear, Non Wired, toughened float glass. The Glass shall be compliant to Class A Category of Impact Resistance to BS 6206:1981 Safety Glazing Material. Glass shall be fixed with necessary beading so as to maintain the integrity of the shutter with respect to fire rating.

vi. Fire check window

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

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

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

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

vii. Installation

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

viii. Testing

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

ix. Deliverables by the Contractor

Following documentation/ drawings shall be furnished along with the Doors

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

x. Guarantee

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

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

2.3.6 Steel Windows and ventilators

Steel windows, ventilators shall in general conform to IS:1038 and IS:7452. Rolled steel sections for the fabrication of steel windows, ventilators shall conform to IS:7452. Glass panels for glazing purpose shall be 4mm thick (wt. 7.2 kg/ Sq.M)

The profile and type of windows, ventilators (glazed, partly glazed/ 1ouvred, side hung/ top hung/ fixed shutter, composite) shall be as per approved drawings.

The frames shall be constructed of sections cut to size and mitred. Corners shall be welded to form a fused welded joint. Process of welding shall be flash butt welding. The welded joints shall be grinded to square and flat edges.

Where larger units are to be formed by coupling individual units, the mullions, transoms shall be bedded in mastic to ensure weather tightness. Mastic shall be applied liberally to the channels of the outside frame sections before assembly, and the two units being coupled shall be drawn together tight with clamps, the mastic being squeezed out and cut off neatly when the units shall be screwed together tight.

Where fixed glazing units are placed over openable units a push fit weather bar shall be provided.

Before glazing, all opening parts shall be checked for their operational smoothness. The frame shall be completely cleaned and bedding putty shall be placed in the rebate before glazing. Glass then shall be cushioned into the bedding and shall be fronted with front putty in a manner so as to enable the painting to be done upto the sight line. The back putty oozing out over the glazing rebate shall be cut off square and smoothed down.

For panels exceeding 600 x 300 mm in size, glass shall be secured by special glazing clips inserted in holes already provided in the steel sections, before applying the front putty.

For glazing of very large areas, rust proof steel beading with mitred corners shall be provided with screws @ 10 cm. from each corner and @ 20 cm. apart from each other. Putty shall be provided to the face of the bead in contact with glass, in addition to back putty.

Side hung shutters shall be connected to the frame by means of friction hinges. The handle for side hung shutters shall be of pressed brass mounted on a steel handle plate welded to the opening shutter frame and shall not be removable easily after glazing. The handle shall have a two point nose, which shall engage with a brass striking plate on the fixed frame in a slightly open as well as in a fixed position.

In case of fixing with masonry, holes for fixing the lugs/hold fasts shall be cut at required locations. In case of concrete or stone, the frames shall be fixed by means of dash fasteners. In case of masonry, the lugs shall be grouted in the holes with cement concrete, M-15 Grade when fixing to steel work, mastic shall be applied to the sill of the opening and the unit shall be placed on it with the jambs and head buttered with mastic and the unit shall be fixed with special fixing dips or with nuts and bolts.

All the steel surfaces shall be thoroughly cleaned free of rust, mill scale, dirt, oil etc. by sand and shot blasting and then painted with 2 or more coats of approved quality & shade synthetic enamel paint over a coat of approved quality red oxide zinc chromate primer.

12mm M.S. square safety bars (welded to fixed frame horizontally @ 100mm c/c) shall be provided wherever specified.

2.4 PLASTERING & WALL CLADDING

2.4.1 Plain Cement Plaster

Plain Cement plaster shall be provided in following thickness:

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

2.4.2 Sand face plaster

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

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

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

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

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

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

2.5 ROOF TREATMENT/ WATERPROOF COATING

2.5.1 POLYURETHANE (PU) WATERPROOF COATING (SINGLE COMPONENT)

Material

The material shall consist of a single component, high solid content minimum 80%, highly viscous liquid containing urethane polymers conforming to ASTM C 836. This single component coating shall cure by reaction with atmospheric moisture to give a continuous film in Aluminium/ silver colour which is rubbery and elastic. The cured coating shall have physical features like high resistance to impact, abrasion and cracking, superior tensile strength minimum 8Kg / Sq. Centimeter after 4 weeks of drying and high resistance to ultra violet rays.

The pack shall not be older than 9 months after the date of manufacture and packing. The liquid shall not be diluted with water or any other solvent.

Workmanship

Preparation of surface

The roof surface shall be thoroughly cleaned with a wire brush and all foreign matter etc. shall be removed. Well defined cracks on the surface shall be cut to a 'V' section, cleaned and filled up flush with a paste of polyurethane filling compound and cement in the ratio of 1:2. The finished surface shall be perfectly dry and any dampness should be allowed to evaporate. Potholes/depressions shall be filled up after removing weak cement concrete/ cement plaster etc. with PCC(1 cement :1.2 coarse sand :3.5 stone aggregate of 6mm & down size by volume,) laid over a coat of neat cement slurry @2.75 Kg of cement per Sq.M of area, wherever required thus preparing smooth and properly sloped surface. Slope and levelling of the existing surface shall be checked and if necessary, adequate slope shall be provided by laying PCC laid over neat cement slurry as above for effective roof drainage.

Leak-prone areas shall also be identified and rectified by raking out existing water proofing and filling up with PCC as directed by Engineer-In-Charge. The surface thus shall be prepared smooth for receiving the waterproof treatment over it.

Primer coat

Urethane primer shall be applied on the perfectly dry prepared bed with a brush in a single coat at a coverage of 6-8 SqM per litre.

The primer shall be allowed to dry for a minimum of 2 hours before applying the successive finishing coats. If the drying time exceeds 48 hours, repriming shall be done.

Finishing coats

The first finishing coat of single component urethane shall be applied over the primer with brush to a smooth and even finish. The overall dry film thickness shall be 0.5mm or minimum coverage shall be 0.5 kg per Sq.M per coat.

The second and third coats shall be applied within 24 hours of application of the previous coat when the previous coat is tacky at a coverage of 0.5 Kg per SqM to give a total dry film thickness of 1.5 mm $\pm$ 0.1 mm as per ASTM 898.

Care shall be taken for quick application and the pack shall be consumed within the stipulated period as per manufacturer's specification. Any skin formed on top of the opened pack shall be removed before using the contents.

The water proof coating shall be continued up the parapet/walls for a minimum of 150mm over the finished roof surface. It shall be continued into rain water pipes by at least 100mm.

The final coat of urethane when still tacky shall be sprinkled with 300 micron layer of clean sand. Plain cement concrete (1 cement: 2 Coarse Sand : 4 Stone aggregates, 6mm down size.) of 25mm minimum thickness with 24 SWG chicken wire mesh (20mm x 20mm) as per IS 1556 shall be laid to slope in panels not exceeding 1.2 Metre x 1.2 Metre Size over this. The joints between panels shall be raked out neatly (after stipulated curing period) to a min. 6mm x 6mm V-groove and filled up with an approved quality elastomeric compound sealant. Drain outlet shall be provided for all spouts/ rain water pipes by suitable rounding, filling and sloping of PCC as per drawing. At the junction of the roof and parapet or any other vertical surface, a fillet of 75mm radius shall be formed in cement concrete (1 cement: 2 Coarse Sand : 4 Stone aggregates, 6mm down size.)

2.6 WHITE/ COLOUR WASHING, PAINTING, POLISHING ETC.

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

IS : 6278	:	Code of practice for white washing and colour washing.
IS : 2395	:	Code of practice for painting concrete, masonry and plaster surfaces.
IS : 712	:	Specification for building limes.
IS : 55	:	Specification for Ultramarine blue for paints.
IS : 63	:	Specification for whitening for paint and putty.
IS : 5411	:	Specification for plastic Emulsion paint for interior use.
IS : 2338	:	Code of practice for finishing of wood, and wood based materials.
IS : 5410	:	Cement paint, colour as required.

IS 384	:	Brushes, paints and varnishes, flat.
IS 486	:	Brushes, sash, tool, for paints and varnishes.
IS 110	:	Ready mixed paint, brushing, grey filler enamels for use over primers.
IS 426	:	Paste filler for colour coats.
IS 345	:	Wood filler, transparent liquid.
IS 3585	:	Ready mixed paint, alum. brushing priming water resistant for woodwork.
IS 426	:	Paste filler for colour coats.
IS 106	:	Ready mixed paint, brushing, priming for enamels, for use on metals.

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

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

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

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

2.6.1 White/ Colour Washing

White washing in general shall conform to IS:6278. Scaffolding shall be erected for white washing in such a way that no part of the scaffolding shall rest against the surface to be white/ colour washed. The surface shall be thoroughly cleaned of all dirt, dust, mortar dropping and other foreign matter before white wash is to be applied. Surfaces already white/colour washed shall be broomed down to remove all dust, dirt, loose scales of lime wash or other foreign matters.

All damaged portions of the surface plaster shall be removed to full depth of plaster in rectangular patches and plastered again after raking the joints in masonry properly. Such portions shall be wetted and allowed to dry before any operation. All holes, cracks, patches etc. not exceeding 0.1 sq. m. in area shall be made good with material similar to that of the surface. Surfaces affected by efflorescence, moss, fungi, algae, lichen etc. shall be treated in accordance with IS: 2395.

The fat lime conforming to IS: 712 shall be slaked at site and shall be mixed and stirred with about 5 litres of water for 1 kg. of unslaked lime to make thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 4 kg of gum dissolved in hot water shall be added to each cubic metre of lime cream. Approved quality ultramarine blue (for white wash) conforming to IS: 55 @ 3 gram per kg. of lime shall be added to the solution. The whole solution shall be stirred thoroughly before use.

For colour washing sufficient quantity of colour wash enough for the complete job shall be prepared in one operation to avoid any difference in colour. Mineral colours of approved shade and quality not affected by lime shall be added to the white wash solution in

proportions as directed by Engineer-in-charge. Solid lumps etc. in the colour powder shall be ground to fine powder, sieved and mixed evenly and thoroughly to the white wash solution.

White/ colour wash shall be applied with "MOONJ" brush to the in minimum 3 number of coats. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied. The white washing on ceiling should be done prior to that on walls.

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

2.6.2 Oil Bound Distempering

The oil bound distempering work shall consist of:-

Preparation of surface :

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

The primer coat :

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

Base preparation

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

Application of Distemper

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

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

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

2.6.3 Plastic Emulsion Paint

The Plastic Emulsion paint work shall consist of

Preparation of surface :

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

The primer coat :

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

Base preparation :

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

Application of Plastic Emulsion Paint :

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

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

2.6.4 Plaster Of Paris Punning

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

2.6.5 Painting Of Wood Surfaces (Synthetic Enamel Paint)

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

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

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

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

Priming :

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

Stopping and Filling :

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

Application of Undercoat :

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

Finishing :

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

2.6.6 Painting of Steel and Other Metal Surface

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

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

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

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

2.6.7 Waterproof Cement Paint

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

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

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

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

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

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

2.6.8 Acrylic Copolymer Aggregate Finish

Material :

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

Preparation of Surface :

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

Application :

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

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

2.6.9 Acrylic based Exterior Emulsion Paint

Exterior wall / surfaces shall be thoroughly cleaned of dust loose paint and fungus with the help of wire brush, water and sandpaper. Special attention shall be paid to the top of parapets, eills and other horizontal surfaces where fungus is most likely to grow. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395. All cracks shall be filled up with white cement or cement and sand mixture. Scaffolding, preparation of surface shall be same as for water proof cement paint. The first primer coat shall be applied on the prepared surface. Two subsequent coats shall be applied over the primer coat. Each coat shall be applied after the previous coat has dried completely. The coverage of paint and application shall be strictly as per manufacturer's specifications.

2.7 ROOFING

2.7.1 Precoated Zinc Aluminium Steel Sheet Roofing/ Cladding

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

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

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

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

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

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

2.7.2 C.I. Rain Water Pipes

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

2.8 SANITARY FITTINGS AND FIXTURES

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

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

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

2.8.1 Indian Type Water Closet

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

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

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

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

2.8.2 Wash Down (European) Type Water Closet

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

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

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

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

2.8.3 Urinals

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

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

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

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

2.8.4 Wash Basins

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

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

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

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

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

2.8.5 Stainless Steel Sink

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

2.8.6 Glazed China ware Sink

This shall be white glazed vitreous china Lab sink/kitchen sink of 610mm x 450mm x 250mm size conforming to IS : 2556, Part-V. It shall be fixed with approved quality M.S./C.I.

brackets conforming to IS : 775. One 15mm dia CP brass bib-cock, 15mm dia PVC connection, C.P. brass chain with 40mm dia GI pipe connected to floor trap with unions shall be provided. All exposed metallic surfaces shall be painted with 2 coats of approved shade and quality synthetic enamel paint (ICI or approved equivalent) over a priming coat of approved quality red oxide zinc chromate. All necessary cutting of floor, walls, counter etc. shall be made and then finished etc. all complete

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

2.9.1 Aluminium Planks/ Tiles False Ceiling

This false ceiling system shall consist of:-

(a) Panel carriers:-

These shall be rows of 0.5mm thick galvanised steel clip in profiles of size 40mm x 20mm. These shall be suspended from roof structure by means of G.I. suspension angles, ceiling brackets and hold on clamps @ maximum 1200mm c/c all complete as per approved manufacturer's specifications.

(b) Aluminium Tiles:-

Aluminium Ceiling Tiles shall be 600mm x 600mm manufactured out of 0.7mm thick aluminium alloy AA3105, chromatised and stove enamelled (coil coated) with square edges produced on advanced equipments. Exposed side of the tile shall have 20 micron (minimum) coil coated polyester finish and 5 micron back coat of Alkyd primer. The short sides of each plank shall be raised and pipped and stopped to ensure positive engagement into the spring clip- in profiles, and shall allow for demounting of individual planks.

2.9.2 Gypsum Board False Ceiling

Gypsum Board false ceiling work shall consist of:-

(1) GI Grid System made of:

i) GI intermediate channels (main runners) shall be 0.9 mm thick, of size 45 mm and with two flanges of 15 mm each. The intermediate channels shall be suspended from the ceiling @ 1200 mm with 25 mm x 0.5 mm GI hanger bolted to the channel and fixed to the ceiling (by means of bolting to GI cleat fixed to the ceiling with dash fasteners).

ii) GI channel shaped ceiling sections (cross runners) shall be 0.5 mm thick having a knurled Web of 51.1 mm and two flanges of 26 mm each with lips of 10.5 mm. The ceiling sections shall be fixed to the intermediate channels in perpendicular direction at 450 mm C/C with the help of connecting clips

iii) Wall channels shall be made of 0.5 mm thick GI of size 27 mm, one flange 20mm and the other 30 mm. Wall channels shall be fixed to peripheral walls by rawl plugs/ dash fasteners @ 450 mm c/c.

GI grid system for supporting gypsum board false ceiling tiles shall be perfectly leveled, aligned at desired height in accordance with false ceiling pattern.

(2) Gypsum board Tiles :-

Gypsum board tiles shall be 12mm thick. The gypsum board used for tiles shall conform to IS: 2095 and shall have following properties:-

- i) Thermal Conductivity : 0.16 W/mk
- i) Thermal Resistance : 0.08 Sq.M K/W
- iii) Fire Propagation
 - a) Index of performance : Not exceeding 12 and a sub index not exceeding 6 (when each side is tested separately to BS 476, Part -6)
 - b) Surface spread of flame : Class 1 (both sides) as per test to BS 476 (Part -7).

The Gypsum board shall be screw fixed to the under side of false ceiling grid system with 12.5mm dia dry wall screw @ 230 mm C/C by drilling machine. Joints in the board shall be finished flush with fillers, finisher and primer as per manufacturer's recommendation to give a seamless finish and shall be finished with two or more coats of plastic emulsion paint of approved make and shade

2.9.3 False Flooring

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

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

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

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

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

Stringer channels then shall be fitted onto the top heads in position to form the supporting grid work for the floor panels checking the level once again by adjusting the nut position if

necessary. Now the check nut shall be finally tightened to secure the final level. Floor panels as specified shall be placed over the stringer channels.

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

Each individual panel shall be removable maintenance purpose.

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

Necessary ramps, slopes, steps etc. shall be also provided for as per drawing. Around a control panel/ rack, the residual space left out shall be filled up with cut panels of uniform size as required to fully close the gap between the adjacent full panel and the control panel base channel. In this case the part floor panel shall extend upto the full width of the base channel and the cut size shall be determined accordingly. An additional row of jack pedestals shall be provided along the cut out on which the edge of the floor panel shall rest and over which the base channel of control panel shall be placed. It shall not directly rest on the jack head pedestal or grid channels.

All accessories like screws, bolts, adhesive etc. shall be provided as per manufacturer's specifications. Necessary adjustment shall be made in grid dimensions and stringer lengths at ends or centre (to cater to specific room sizes) or at panels locations

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

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

2.9.4 Partitions

Partitioning work shall consist of:-

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

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

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

Partitions shall be double skin type with boards fixed on both sides of the framework. Frame work along the edges shall be concealed with panel boards. Necessary cutouts for electrical, AC, return air etc. and other fixtures shall be provided as required in the framework as well as boards. For glazed portions within the partitions, M.S. Frame

spacings shall be adjusted for exact location of the glazing with additional Teakwood frame to be provided. Glass shall be 5.5mm thick toughened glass and shall be fixed with putty and wooden beadings.

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

2.9.5 Polyisocyanurate Foam Underdeck Insulation

Polyisocyanurate foam (PIR) shall be rigid slabs of size 1000 x 1500mm and thickness of 30mm conforming to IS:12436 having density not less than 32kg/Cu.M, thermal conductivity(K-value) not more than 0.023 w/mk measured at 10 deg.C. The slabs shall be covered on one side with glass fibre tissue/Aluminium foil having 50mm overlap. The insulation shall be classified as Non-Combustible as per BS 476, part 5 and Class 1 for surface spread of flame as per BS 476, part 7.

First, holes in RCC slab/beam shall be drilled and nylon rawl plugs of size 8 x 25mm shall be inserted(5nos. for each slab-One each at 4 corners and one at centre. Entire RCC surface shall be thoroughly cleaned of all dust, dirt and loose particles by wire brushing. Then a coat of bituminous primer @ 0.5 Litres/Sq. M shall be applied to bare RCC surface and allowed it to dry. After the primer has dried, hot blow grade bitumen of 85/25 grade or cold adhesive CPRX shall be applied on RCC surface and to the two surface of each PIR panel and shall be pressed in position while the bitumen is still tacky. The PIR panels shall be secured in position with the help of GI screws(no. 8 x 75mm long) fixed into rawl plugs and GI washers 25mm dia. Facing side of the panels shall be the one covered with fibre tissue/ Aluminium foil. The overlaps shall be covered with appd. Quality sealing compound(MAS-94 or equivalent). Chicken wire mesh 24G X 19mm shall then be fixed to GI screws & tightened with lacing wire.

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

2.10 MISCELLANEOUS ITEMS

2.10.1 M.S. Pipe Handrail

The M.S. Pipe handrail shall consist of 25mm M.S. square balusters (one on each step; similar spacing for horizontal portions) with 40mm x 40mm x 6mm M.S flat shoe welded at bottom of baluster; embedded into floor/ steps and grouted with M-15 grade concrete in a cut out of 100mm x 100mm x 150mm size block. 32mm dia N.B. (Medium) M.S. pipe handrail shall be welded to balusters at top. The entire railing and balusters shall be painted with two or more coats of synthetic enamel paint over a coat of approved quality red oxide zinc chromate primer. All embedded metallic portions shall be provided with primer.

2.10.2 Transformer Gates/ Fencing

Transformer gates/ fencing shall be made of 50mm x 50mm x 6mm M.S. Angle frame, 50mm x 50mm x 6mm M.S. Tee stiffeners, 50mm x 50mm x 8mm welded mesh fixed to the frame by 20mm x 3mm M.S. flat beading. The gate/ fencing shall be fixed to the masonry/ R.C.C. by M.S. hinge arrangement (consisting of 65mm x 65mm x 6mm M.S. angle, bolt, washers etc.) with M.S. holdfast grouted with M-20 concrete block. The gate shall have M.S. pivot arrangement (ensuring smooth operation of the gate), one heavy duty 450mm long M.S. aldrop, heavy duty M.S. tower bolts etc. complete. The entire gate/ fencing with

fittings/ fixtures/ accessories shall be finished with two or more coats of synthetic enamel paint of approved make and shade over a coat of approved red oxide zinc chromate primer. All embedded metallic parts shall be provided with primer.

2.10.3 Plinth Protection

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

2.10.4 Cinder Filling

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

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

2.10.5 Sealing of Expansion Joints

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

- (a) The surfaces over which it is to be applied shall be totally dried and cleaned of all dirt, oils, mortar droppings, all loose material etc. by vigorous wire brushing and wherever necessary by grinding and blast cleaning (sand or water).
- (b) A backup material or joint filler tapes (as per approved manufacturers specifications) shall be fixed in the expansion joint.
- (c) A coat of primer as per approved manufacturers specifications (specially developed for use with Silicon sealant material) shall then be applied over the surface.
- (d) Silicon sealant shall be applied by means of cartridge- type caul gun, either hand or air pressure activated. The sealant shall be applied in a continuous operation, horizontally in one direction and vertically from bottom to top of joint opening. The sealant shall be applied in excess so that a positive pressure adequate to properly fill and seal the joint is created. The sealant shall be struck with light pressure to spread the material against the back up material and the joint surfaces properly. The sealant shall be tooled to slightly conclave surface. As the work progresses, the excessive sealant shall be removed. The masking tape shall be removed immediately after tooling. The sealant shall be cured as per approved manufacturers recommendations.

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

2.10.6 Anti Termite Coating

All woodwork (frames, panels etc. including hidden/ embedded portions of wooden members shall be provided with anti- termite coatings of approved quality aldrine-

chlorinated phenol compound conforming to IS: 401. Three or more coats as required @ 3 Sq. Mtr. per coat per Kg. covering capacity shall be applied before applying the finishing (painting, polishing, lamination etc. as specified) coats.

2.10.7 G.I. Spout

50mm dia GI pipe spouts shall be fixed to slope for drainage of canopy, sunshade etc., including puncturing the masonry/ RCC and grouting with M-15 grade concrete, finishing etc. all complete.

JOB SPECIFICATION

FOR

**BIPOLAR CONCRETE PENETRATING
CORROSION INHIBITING ADMIXTURE**

TO

**PROTECT EMBEDDED STEEL
REINFORCEMENT IN CONCRETE**

PROJECT : CPP- PARADIP REFINERY PROJECT

OWNER : INDIAN OIL CORPORATION LIMITED

PMC : ENGINEERS INDIA LTD.

JOB NO. : A011

0	22-07-09	ISSUED AS JOB SPECIFICATION	PM	AS	SC
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1.0 SCOPE

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

2.0 TERMINOLOGY

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

3.0 SAMPLING

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

Scale of Sampling for CPCIA

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

4.0 PROPERTIES

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

5.0 REQUIREMENTS

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

TABLE –I

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

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

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

TABLE –II

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

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

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

Note

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

6.0 SAFETY TO CONSTRUCTION MATERIAL

CPCIA should not degrade, or damage the construction materials.

- i) Concrete
- ii) Aggregates
- iii) Steel reinforcement
- iv) Form work/Shuttering

7.0 SAFETY FOR FABRICATION

The CPCIA should not cause harm to personnel by mean of inhalation or skin contact. All precautionary measures shall be intimated by the manufacturers clearly in writing along with instructions of usages. However final decision about adoption of such measurers shall lie with the EIL or client and shall depend upon the conditions prevailing at the site.

8.0 WASTE WATER DISCHARGE

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

9.0 PACKING

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

10.0 MARKING

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

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

11.0 INSPECTION

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

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

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