

SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENT &
QUANTITIES

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SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1.0 SCOPE

1.1.1 The scope of work under this specification is Civil Works for 400/220kV Switchyard at Bellary Thermal Power Station, Stage-III (1 x 700MW), being executed by BHEL on turnkey basis. The Customer is Karnataka Power Corporation Ltd. (KPCL).

1.1.2 The Civil Works shall generally include, *but not limited to*, following:

- (i) Control Room Building
- (ii) Tower & Equipment foundations.
- (iii) Transformer foundation including soak pit, rail track, etc.
- (iv) Cable trenches including precast covers & cable trench crossings.
- (v) Road, Fence, drains and drain crossings
- (vi) Antiweed treatment & Stone spreading.
- (vii) Any other civil work required for completion of the project.

1.1.3 The works to be performed in the above constructions include preparation of bar bending schedules, based on the drawings released for construction and getting the same approved by the Engineer-in-charge plus the execution of the work including providing of all labour, supervision, materials, scaffolding, power, fuel, construction equipments, tools and plants, supplies, transportation, all incidental items necessary for successful completion of the work including contractor's supervision and in strict accordance with the drawings and specifications and with inspection and testing standards. The nature of work shall generally involve excavation in all type of soil , including dewatering, shoring, strutting, backfilling with available excavated earth around completed structures and cable trenches with covers, road crossing of trenches, disposal of surplus soil, concreting including formwork, providing necessary steel embedments and other inserts, roadwork, drainage work, fencing, gravel spreading (including antiweed treatment), concreting, brickwork, flooring and finishing in buildings, dismantling of fencing etc., all complete as per detailed specification, drawings and directions of Engineer-in-charge.

1.2.0 SPECIFIC TECHNICAL REQUIREMENT

The specific technical requirements for the execution of civil works shall be as per Customer's Specifications (Volume-V) & CPWD Specifications. In case of any conflict between these, Customer's specifications shall prevail.

1.3.0 BILL OF QUANTITIES

1.3.1 The Bill of Quantity-cum-Price Schedule shall be as per page 1 to page 8

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1.3.2 The quantities indicated in the 'Bill of Quantity-cum-Price Schedule' are indicative and can vary to any extent. Contractor shall not be entitled for any claim for any such variation in the quantities.

1.3.3 The provision of Bill of Quantity-cum-Price Schedule, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, the clarification shall be obtained from the Engineer-in-charge whose decision shall be final and binding.

1.3.4 Method of measurement:

1.3.4.1 Excavation shall be measured in cubic metres. The lateral dimensions to be considered for working out excavation quantity shall be the PCC dimension below the footing as per approved drawing. The sides shall be considered vertical with the lateral dimension indicated above. Nothing extra shall be paid for slope cutting, etc irrespective of whatever is provided. Backfilling & disposal quantities shall be worked out based on the above dimensions only.

For other items, unless otherwise described the method of measurement as described in 'Method of Measurement of Building and Civil Engineering Works'-IS 1200(Part I to XXV) latest edition of BIS shall be followed.

SECTION - 2

STANDARD TECHNICAL SPECIFICATION
(N.A.)

SECTION - 3

ENCLOSURES TO THE SPECIFICATION

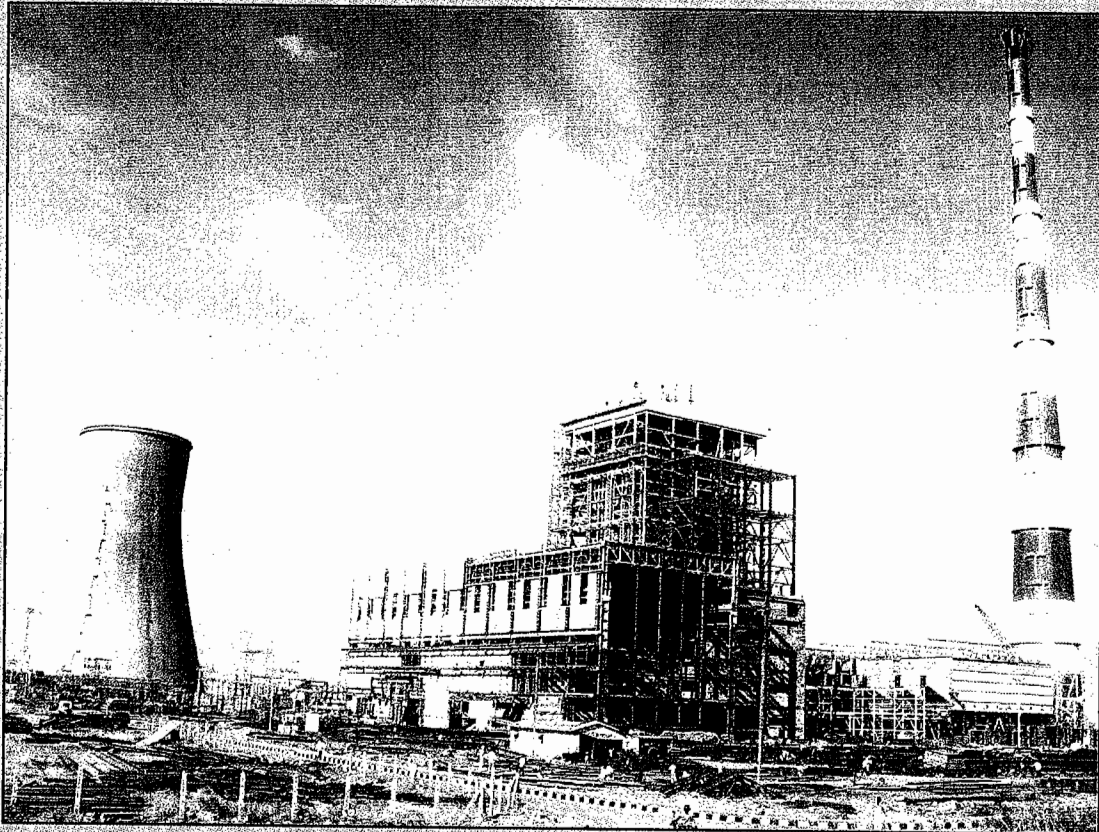
Customer's Specification (Volume-V) (Page no. 29 to 31, 42 to 99)
Drg. No. TB-1-333-607-614 (Details of Chainlink Fencing & Gates)

KARNATAKA POWER CORPORATION LIMITED



BELLARY THERMAL POWER STATION

1 X 700 MW , STAGE - III



BID SPECIFICATIONS

VOLUME - V

CIVIL WORKS

**CHIEF ENGINEER (THERMAL DESIGNS)
NO.22/23, SHEASHADRI ROAD,
2ND FLOOR, SUDARSHAN COMPLEX
BENGALURU-560 009**

MAY 2010



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DESCRIPTION OF BUILDINGS, STRUCTURES & FACILITIES

12.0 TRANSFORMER YARD

12.1 Generator transformer, station transformer, unit auxiliary transformer, service transformer etc., are located in front of the turbine building. Transformers shall be founded on RCC foundations with rails on the top and oil soak pits filled with hard stone aggregate. Burnt oil pits are provided to collect leaked oil from the soak pit through salt glazed pipes laid to slope. RCC blast wall / RCC frame with brick wall of adequate thickness and height to satisfy TAC regulations shall be provided in between transformers as Fire barrier wall.

12.2 RCC foundations shall be provided with rail to transport transformers out of transformer yard during maintenance. Entire area shall be surrounded with 3 m high chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer. Floors shall be paved with plain cement concrete and shall be sloped towards peripheral drains, which shall lead to a sump from which the drainage is led through an oil water separator. The clear water shall be led to plant drainage.

13.0 SWITCH YARD

Extent of the Switchyard will depend on the layout of the switchyard, which has been outlined in the Electrical section of this document.

13.1 Galvanised steel structure

All steel structures for the Switchyard shall be hot dip galvanised structure with welded / bolted connections at shop and bolted connection at site. All bolts and nuts shall also be galvanised. Minimum zinc consumption shall be 610 gm per square meter of exposed surface. Design criteria of Switchyard structure are furnished elsewhere in this document.

13.2 Major steel structures are towers, beams, lighting masts etc. They are all of latticed construction using angle sections. In addition, supporting structure for equipment such as, isolator, lightning arresters etc., shall also be provided. These structures may be of tubular section or latticed as the case may be. Towers, beams etc shall be trial assembled at shop, keeping in view the actual site condition, prior to dispatch to erection site, so that, they can be conveniently pre-assembled before erection or conveniently assembled during erection. Lighting masts shall be provided with cage ladder. Where platforms are provided on lighting masts for mounting of lighting fixtures, they shall have protection hand rails formed of galvanised section. Platforms shall be of galvanised gratings.

13.3 Foundations for structures and equipment

Criteria for design of foundation are given in separate section of the document. Foundations shall be of open type.

13.3.1 Trenches / Paving / Fencing

Trenches shall be of RCC construction. Trench walls shall be designed to withstand a surcharge load of 2000 kg / sq.m. Trench wall shall project 150 mm above the paved / graded level to prevent ingress of storm / rain water. All trenches shall be covered with trench cover after cable laying is completed. All



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trenches, floors shall be given a slope of minimum 1 in 750 and the slope shall lead to a sump, where pump can be installed for drainage.

13.3.2 The complete area within the fencing shall be provided with a mild slope towards peripheral RCC drains, which in turn will be connected to the plant drainage system. Entire switch yard shall be provided with 75 mm paving of 40 mm single size stone aggregate on top and 75 mm paving of 20 mm single size stone aggregate below. Before laying the paving, the ground surface shall be treated with anti weed chemicals as per manufacturer recommendations

13.3.3 Fencing around switch yard area, shall comprise of PVC coated GI chain link fencing of minimum 8G (including PVC coating) of mesh size 75 mm and of height 2400 mm above toe wall with 600 mm high galvanised anti-climbing device with barbed wire (8 rows) such that, total fence height of 3 m above toe wall is achieved.

13.4 Switchyard relay room

13.4.1 Switchyard control room will be a two storied RCC framed structure. The ground floor will accommodate cable vault, AHU rooms, Stores, Staircase, panel handling arrangements, battery rooms etc., and first floor will have relay panels / PLCC panels, etc., Floor elevation shall be decided by the CONTRACTOR to suit his requirement of operation and maintenance, package air conditioners for Relay room.

13.4.2 Cladding shall be of brick wall and the same will be supported on RCC wall beams and plinth beam such that, unsupported length is not more than about 3 m. Pleasing architecture shall be provided for the building. The external wall surfaces shall be provided with 20 mm thick plaster in two layers, with an underlayer of 14mm thick in CM 1:6 and top 6 mm thick layer in CM 1:4 with approved Waterproofing compound. Internal plastering shall be of 13 mm thick in CM 1:6. Ceiling in areas where false ceiling is not provided shall be given ceiling plaster 6 mm thick in CM 1:3. All partition walls in the ground floor shall be of single brick wall. Wall around cable vault shall extend upto the ceiling. Cable vault shall be provided with two flush type sheet steel doors. Wall around stores, air washer rooms and staircase also should extend upto ceiling. Stores and AHU room shall have flush type of sheet steel door. Door in AHU room shall be made airtight. Staircase shall have fire proof, automatically closing glazed aluminium door in the first floor. On the ground floor also similar doors shall be provided. Main entrance shall be aluminium glazed double leaf swing door of adequate size with fixed sheet glass glazing in anodized aluminium framework on either side. Separate rolling shutter entry shall be planned for panel movement with a hatch and lifting beam on the first floor. In the first floor, staircase shall be given brick enclosure. Entry to the air-conditioned area shall be through air lock lobby with aluminium glazed automatic sliding door of adequate size. At least two doors shall be given from the control room to move out during emergency. All partitions shall be of anodized aluminium framing with 6 mm sheet glass upto false ceiling. The external partition separating A/C area and non-A/C area, above the glazed partition shall be provided in brickwork. All internal partitions in the A/C area will extend upto the false ceiling. Doors in Aluminium glazed partition shall be single leaf glazed aluminium swing door. Control room proper on the switch yard side shall have continuous fixed glazing in aluminium framework above 900 mm high Brick wall. For other rooms aluminium glazed sliding windows may be provided



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with 6 mm sheet glass. False ceiling with aluminium ceiling system shall be provided in the A/C areas. Under deck insulation shall be provided above the false ceiling on the ceiling as well as for walls. Roof shall be laid to slope of 1 in 100 using screed or by sloping the top of slab. Elastomeric liquid membrane water proofing treatment shall be given to roof with HDPE pipe down comers as per IS:4985.

14.0 COAL HANDLING SYSTEM **NO APPLICABLE**


This section covers the general requirements for concept, design, construction / fabrication and erection of various structures, buildings and facilities for the Coal handling system, covering complete Civil and Structural works. Requirements shall be as specified in Volume III Mechanical works. Some of the important areas of works are described below.

14.1 Crusher house

14.1.1 Crusher house shall be of steel structure of framed / braced design. Floors and roofs shall be RCC, over structural steel framing and permanent decking sheet. Side cladding shall be of permanently colour coated non-insulated metal cladding as per clause No.3.2, part F-Finishes, above 3000 mm wall on ground floor. Roof shall be given adequate slope for drainage. Roof shall be given with Elastomeric liquid membrane water proofing treatment. Proper arrangement shall be provided to convey the rain water through gutters made out of plain sheets having same material and coating specifications as mentioned for cladding of matching colour and HDPE pipe down comers as per IS: 4985. Adequate windows shall be provided with steel glazed side hung windows using wired glass. Wherever monorails are projecting outside for lifting of equipment, steel sliding doors shall be provided. Main entrance doors shall be of rolling shutter adequately sized to carry equipment inside. Other doors shall be of flush welded steel construction. Ramps shall be provided in front of main door. Grade slab as well as intermediate floors shall be of RCC. Intermediate floor shall be supported on steel beams. Crusher shall be mounted on the floor framing using Vibration Isolation system. Handrail shall be provided around all big openings and kerb plates shall be provided around all small openings.

14.1.2 Two staircases of structural steel shall be provided, one inside and one outside. Elevator shall be provided for serving all the floors. Elevator cage wall shall be that of permanently colour-coated metal cladding system. Elevator pit shall be of RCC. Machine room floor and roof shall be of RCC. Side cladding of M/C room shall be of non-insulated metal cladding as per clause No.3.2, part F-Finishes, above 3m high brick wall. An RCC kerb wall of 300 mm shall be given around the floor over which hand railing shall be provided. M/C room shall be given adequate slope for drainage purposes. Elastomeric liquid membrane water proofing treatment shall be given to roof with HDPE pipe down comers as per IS 4985. Main door to M/C room shall be of steel of flush welded construction. Adequate ventilation shall be given using steel glazed window. Elevator pit shall be kept at least 500 mm above general grade level to prevent flooding. A sump shall be provided inside the pit to collect and pump out water. Sump shall be given an aluminium ladder for access. Toilets shall be provided in the Crusher house.

14.1.3 Foundation of the building columns shall be of RCC. Foundation design criteria are given elsewhere. All the foundations shall be connected together by tie / plinth

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	BELLARY TPS, UNIT-3 OF 700 MW	VOLUME V
	PART A - GENERAL REQUIREMENTS	SHEET 1 OF 6

1. GENERAL

- 1.1 Design and construction of buildings, structure etc., shall take into account requirement for operation and maintenance of all equipment and its users. The buildings will have good architectural features. The surrounding area shall be properly micro levelled and graded.

1.2 Architectural concepts for Buildings

The architectural design concept of buildings structure shall be evolved considering the functional, technological and other requirements to match with structures of existing Units for efficient operation, ensuring comfortable working environment for personnel, satisfying the aesthetic requirements. Special care shall be taken to provide elegance and aesthetics, with effective use of appropriate treatment, materials, fittings and finishes. To achieve the above objective CONTRACTOR shall employ a qualified architect / architectural firm to carry out all designs and hold all other architectural responsibilities for the project.

- 1.2 The CONTRACTOR shall obtain and be conversant with all laws, by-laws, regulations of local and Statutory Bodies as applicable to the project. The architectural concept evolved should also take care of these requirements. The CONTRACTOR shall provide the drawings and documents for such statutory approvals.

2. ROOF ACCESS

All roofs shall be provided with access through a staircase / cage ladder. Minimum 1000 mm wide access path shall be provided with tiles to approach equipment on roof.

3. PLATFORMS AND WALKWAYS

- 3.1 Platforms shall be provided to all major equipment, not directly accessible from the floors, for maintenance. Platforms and connecting walkways shall have a minimum width of 750 mm. However, in case of space restriction, the minimum allowable clear width shall be 600 mm with prior approval of the OWNER. Platforms in front of the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways.
- 3.2 All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off. It shall consist of 8 mm thick steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached.
- 3.3 Continuous walkway at least 500 mm wide shall be provided along the crane girder level with handrails, on both side of the building. Approach to EOT crane shall be ensured by Cage ladder or staircase.



4. STAIRS & LADDERS

4.1 Steel stairs

All steel staircases shall normally have minimum clear width (back to back of stringer) of 1000 mm and minimum inclination with horizontal of 35.75° . However, in case of space restriction, minimum clear width upto 750 mm and slope upto 45° may be provided. The vertical height between successive landings shall not exceed 5 m. Channels (min MC 200) shall be provided as stair stringers. Treads shall be minimum 250 mm wide of chequered plate/grating, with suitable nosing, and spaced equally so as to restrict the rise to maximum 180 mm (200 mm in exceptional cases).

4.2 Steel Ladders

Ladders shall be provided to platforms, walkways, instruments and equipment which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5° . Ladders shall be of minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum). Ladders shall be provided with a safety cage of minimum 750 mm diameter clear when the top of ladder is more than 4.5 m above the landing level. However, safety cages shall start at 2.5 m above the lower landing level.

4.3 RCC stairs

All stairs shall have maximum riser of 180 mm and a minimum tread of 250 mm. However, for public buildings riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of stairs shall be 1500 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminum angle nosing with minimum 50 x 25 x 3 angle shall be provided for edge protection of RCC stairs.

5. HANDRAILS

5.1 Handrails shall be provided at appropriate places to ensure safety e.g. around all floors / roof openings, projections / balconies, walkways, platforms, steel stairs etc.

5.2 All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 galvanised using 750 gm/sq. m of zinc. Handrailing shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible, but, can be proportioned to the length of the opening. In such a case, spacing shall not exceed 1850 mm center to center of posts. Handrailing shall be shop fabricated for specific locations and field welded or bolted to the erected structural steel.

5.3 For RCC stairs, handrailing with 20 mm square MS bar balustrade with suitable MS flat and Aluminum / Teakwood handrail shall be provided, unless specifically mentioned otherwise. The overall provision of this component shall be aesthetically impressive.



6. EDGE PROTECTION

Wherever possible around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected shall be provided with angles of minimum size L 50x50x6 with lugs for edge protection e.g. around the cut-outs / openings in floor slab, edges of drains supporting grating covers, edges of RCC cable / pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.

7. ANCHOR BOLTS AND INSERT PLATES

7.1 Anchor bolts shall be designed for working stress, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.

7.2 Insert plates shall be designed / checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.

8. VERTICAL HEADROOM

8.1 All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified.

Finished floors to ceiling (buildings)	3000 mm
Doors, Walkways, Platforms, Stairs etc	2100 mm
False ceiling of office areas	2400 mm
Walkway above false ceiling	1000 mm
Safety cage for ladders	2500 mm
Access for fork lift trucks	2800 mm
All roads / Railway crossings & crane access	7000 mm
Cable & Pipe rack	3000 mm except at Road / Rail crossings.

9. EXPANSION / CONSTRUCTION JOINTS

9.1 Expansion and construction joints shall be provided wherever required. All expansion and construction joints of water retaining structures in RCC shall be made water tight using PVC ribbed water stops with central bulb. However, kicker type (externally placed) PVC water stops may be used for the base slabs and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 6 mm and minimum width 225 mm. At other joints these shall be 150 mm wide.

9.2 Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound



conforming to IS: 1834 can be used. Pre-formed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler.

10. BRICK / STONE MASONRY AND PARAPET WALL

10.1 All masonry works shall be designed in accordance with IS: 1905, IS: 2212, IS: 4326 and other relevant IS codes as applicable. Structural design of load bearing and non-load bearing walls constructed with solid or perforated burnt clay bricks or concrete blocks shall be in accordance with criteria specified by Section 4 of National Building Code of India Part VI.

10.2 All walls shall be non-load bearing infilled panels walls. External walls of all buildings shall be at least one brick thick. All internal wall shall be at least one brick thick except for internal partition walls for office area, canteen, change rooms, first aid rooms and toilets which may be half brick thick. RCC bands shall be provided wherever necessary. Stone masonry / PCC wall shall be provided upto 300 mm above the finished grade level (FGL). Brick masonry shall be provided above this level.

10.3 50 mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry work.

10.4 Minimum 50 kg/ sq cm compressive strength brick shall be used for non-load bearing super structure brickwork. Cement sand mortar 1:6 for one brick thick wall and 1:4 for half brick thick wall shall be used. For half brick walls, RCC transomes and mullions shall be provided.

10.5 Type, thickness and height of external walling, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of Tariff Advisory Committee (TAC).

10.6 Even where metal cladding is specified, for initial 3 m height from the ground level, minimum one brick thick masonry wall shall be provided.

10.7 All upstands and parapet walls on roof shall be of RCC constructions, minimum height of parapet walls shall be 750 mm and thickness 125 mm with aesthetics of architectural designs as approved by the owner.

11. DRAINAGE

11.1 Floor drainage

11.1.1 For all buildings and areas, suitable arrangement for draining out water collected from equipment blowdowns, leakage, floor washing, fire fighting, etc., shall be provided on each floor. Gully traps, inspection pits, collecting pits etc., shall be located suitably and designed considering flow volume, easy access, maintenance and safety.

11.1.2 All drains inside the building shall have minimum 40 mm thick grating covers. In areas where heavy equipment loads would be coming, precast RCC covers shall be provided in place of steel grating. These drains shall lead the water to drain sump.



11.1.3 Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.

11.2 Roof drainage

11.2.1 Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rainwater down comers and fixtures. System shall be designed to handle design rain fall for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. Roof drains shall conduct water to storm drains through down comers.

11.2.2 Rainwater down comers shall be of HDPE Pipe conforming to IS: 4985.

11.3 Sumps

In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drain.

12. WATER PROOFING OF UNDERGROUND STRUCTURES

12.1 All underground structures like basements, pump houses, water retaining structures etc., shall have plasticiser cum waterproofing cement additives conforming to IS: 9103. In addition, limits on permeability as given in IS: 2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS: 9862 @ 1.7 kg/sqm (minimum) for water / damp proofing. Also provision shall be made on the inner surface of walls and base slab, so that water proofing grouting can be injected later in case of leakage.

13. ANTI TERMITE TREATMENT

Pre-construction anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations filling below the floors etc., as per IS: 6313 and other relevant Indian Standards.

14. Plinth level

14.1 Finished ground floor level (plinth level) of all buildings and pump houses shall be minimum 500 mm above the formation level / grade level.

14.2 All cable vaults shall be located above ground level i.e., vaults shall not be provided as basements in the buildings.

14.3 Finished floor levels of Boiler area / transformer area yard paving shall be kept 200 mm lower than the finished floor level of turbine building.

**15.0 Backfilling of over excavated area:**

Over excavated area / loose soil / pockets shall be backfilled filled with M10 grade of concrete

16.0 STATUTORY REQUIREMENTS

- 16.1** All the applicable statutory rules pertaining to Indian Factories act, Factory rules of State Government, Fire safety rules of Tariff Advisory committee, Water act of Pollution Control boards, Explosives act etc., and stipulations of other relevant statutory authorities shall be taken into consideration at the time of design and construction.
- 16.2** Provisions of safety, health and welfare according to Factories act shall be complied with at design stage. These shall include provision of continuous walkway (minimum 500 mm wide) along crane-girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railings, fire escape locker room for workmen, pantry, toilets, rest rooms etc.
- 16.3** Adequate no. of fire escapes shall be provided in a building. Fire proof doors, no. of staircase, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of TAC. For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to TAC requirements. All masonry firewalls shall be minimum 345 thick and RCC firewall shall be minimum 200 mm thick.



1. GENERAL

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static & dynamic) and other piping loads, wind loads, seismic loads, temperature loads, loads and forces developed due to differential settlement and any other loading conditions which can occur during the design life of the facility.

2. DEAD LOADS

2.1.1 Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature including tanks, silos, bins, partitions, roofing, piping, cable trays, bus ducts etc. The content of tanks, silo, bins and hoppers etc., shall be measured at full capacity for this purpose.

2.2 The piping loads, cable tray loads and the contents of the tank, silos, bins and hoppers shall be listed separately so that they can be excluded from dead load when dead loads are acting as stabilising load for uplift.

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

Materials	:	Unit weight
Plain cement concrete	:	2.40 t/cum
Reinforced cement concrete	:	2.50 t/cum
Structural steel	:	7.85 t/cum
Brick work	:	1.9 t/cum
Cement plaster	:	2.1 t/cum
Floor Finish	:	2.4 t/cum
Coal	:	1.20 t/cum
Fly Ash	:	1.60 t/cum
Bottom Ash	:	1.60 t/cum

3. IMPOSED LOADS

3.1 Imposed loads in different areas shall include live loads, dust loads, minor equipment loads, cable trays, small pipe racks / hanger, erection loads, operation / maintenance loads, etc. The loads considered shall not be less than that specified in IS: 875 (part II). The loads listed here under are the minimum loads for the areas involved. Special use areas shall be investigated and loads revised upward as necessary. Floors and supporting members which may be subjected to heavy equipment live loads shall be designed on the basis of the weight of equipment or specifically defined live loads, whichever is greater.



3.2 The specific minimum floor live loads are listed below:

3.2.1 Roofs:

(a)	Flat Roof	1.5 kN/sqm for roofs
		: 5.0 kN/sqm for accessible roofs with HVAC
		: Equipment etc.
(b)	Sloped Roof	: As per IS: 875
3.2.2	Turbine Building	
	(a) Ground floor	: General area 25 kN/sqm
		Heavy eqpt. Storage area 50 kN/sqm
	(b) Operating Floor	: Rotor removal Area 30 kN/sqm
		Eqpt. Laydown Area 30 kN/sqm
		Other areas (Corridors etc.) 15 kN/sqm
		Rotor removal area beams shall also be checked for $\frac{1}{2}$ the rotor load at the center of the beam.
	(c) Heater bay floor	10 kN/sqm
	(d) Deaerator floor	10 kN/sqm
	(e) Precast concrete covers	12 kN/sqm
	(f) Mezzanine floors	10 kN/sqm
	(g) Platform around deaerator	10 kN/sq,
	(h) Floor around feed water tank	20 kN/sqm

3.3	Boiler / Bunker area	
	(a) Floor at (+/-) 0.00	15 kN/sqm (under operation) or actual loads specified by Boiler manufacturer.
	(b) Feeder / Tripper floor	20 kN/sqm. Beams however shall be checked for feeder / tripper load.
3.4	Main control room/electric buildings	
	(a) Control Room Floor	10 kN/sqm



	(b)	MCC Room	15 kN/sqm
	(c)	Cable vault floor	5 kN/sqm
	(d)	Battery Rooms	20 kN/sqm
	(e)	AHU, AC & ventilation plant floors	10 kN/sqm
	(f)	Switchgear room	15 kN/sqm
	(g)	PLCC, relay room	15 kN/sqm
3.5	Pump houses		
	(a)	Operating floor slab	15 kN/sqm or as required by equipment supplier whichever higher.
3.6	Workshop		
3.7	Other Areas		
	(a)	RCC floors	5kN/sqm for offices, laboratories, conference rooms and general floors.
	(b)	Stairs and balconies	5 kN/sqm
	(c)	Chequered plate/gratings	5 kN/sqm
	(d)	Walkways	3 kN/sqm
	(e)	Toilet rooms	2 kN/sqm

3.8 Railway supporting bridges such as bridges, culverts etc., shall be designed as per Railway bridge rules.

3.9 Culverts and allied structures including RCC pipes shall be designed for Class "AA" loading and checked for Class "A" loading as per IRC standards for two-lane road and above.

3.10 Covers for trenches & channels which are not exposed to vehicular traffic shall be designed for Live load of adjoining area or 2 t/sqm whichever is higher. Where channels are likely to be exposed to vehicular traffic, the requirements of Code of practice for road bridges shall be adhered to.

3.11 Piping anchor and restraint forces of major piping shall be obtained from piping analysis results and be considered as live load in the structure design.

3.12 Ponding effects due to framing deflections for roofs, if any shall be considered.

3.13 In addition to the live loads, a minimum of 1.50 kN/sqm shall be considered as Hung loads for electrical, ventilation & air conditioning. A load of 2.5 kN/sqm shall be considered as Hung loads for piping unless otherwise mentioned.

3.14 Live loads reduction shall be in accordance with the provisions of IS: 875 & IS:1893 in case of seismic analysis.



4. EARTH PRESSURE LOADS

4.1.1 Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable). However, for design of substructure of pump house, cold water basin of cooling water and under ground liquid storage tanks earth pressure at rest shall be considered.

- a) Angle of internal friction for foundation of underground structures for calculation of earth pressure shall be from soil report or 36 degrees whichever is less.
- b) For backfilled soil, angle of internal friction shall be limited to 33 degrees.

4.2 In addition to earth pressure and ground water pressure, etc., a minimum surcharge load of 2.0 t/sqm shall also be considered for the design of all underground structures including channels, sumps, cable & pipe trenches, etc., to take into account the vehicular traffic in the vicinity of the structure.

5. WIND LOAD

5.1 Wind load on structures shall be calculated as per provisions of IS: 875 (part 3). The wind shall be assumed to blow in any direction and most unfavourable condition shall be considered for design.

5.2 In design of structures, wind force on equipment supported on frame including all fixtures, piping, staircase, ladders, etc., shall also be considered.

5.3 Wind loads generally be estimated based on 3 seconds gust wind as per IS 875 (part -3). However, wind loads for slender structure (having height to width ratio exceeding 5) shall be calculated using gust factor method also and higher of the two wind load values shall be considered for analysis.

6. SEISMIC LOADS

6.1 Seismic forces shall be as per zone III of IS:1893.

6.2 For following structures, the design methods listed below shall be used.

	Turbine Building and Bunker Buildings	Response spectrum method
	All other Buildings	Seismic Coefficient Method

6.3 The importance factor for all power plant buildings and structures shall be taken as 1.75 and for other minor structures as per IS:1893.

6.4 Ductile detailing in accordance with IS 13920 to be adopted for all concrete

6.5 structures which is mandatory for Zone - III.



7. TEMPERATURE LOAD

- 7.1 Expansion and contraction due to changes of temperatures of materials of a structure shall be considered and adequate provisions shall be made for the effects produced (as per provision in relevant IS codes). Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns. The maximum distance of the expansion joint shall be as per the provisions of IS: 800 and IS:456 for steel and concrete structures respectively.
- 7.2 Analysis shall be carried out for ambient temperature variation. The temperature variation shall be considered as 2/3 of average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the difference between the mean of the daily minimum temperature during the coldest month of the year and mean of daily maximum temperature during the hottest month of the year. The structure shall be designed to withstand thermal stresses due to 50% of the temperature variation.
- 7.3 Coefficient of thermal expansion of steel shall be taken as per IS : 800.
Coefficient for thermal expansion for concrete shall be taken as per IS: 456.

8 EQUIPMENT LOADS

- 8.1 Static and dynamic loads of major equipment such as deaerator, heaters, etc., shall be based on the manufacturer's data of the specified equipments and shall be considered in design in addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered. Eg: switchgear and control room floors are usually designed for a live load that includes the equipment weight.
- 8.2 All equipment, tanks and piping design loading shall include hydraulic testing loading. Weight of equipment, ducts, tanks, pipes, conduits, etc., supported by structure shall include maximum possible loading conditions i.e flooded conditions and associated impacts, test loading, anchorages and constraint effects.
- 8.3 Air and gas duct loads shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads applicable.

9. CRANE, MONORAIL, ELEVATOR & TRACK MOUNTED VEHICLE LOADS


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


9.2 Impact Factor

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

9.2.1 Crane loads:

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

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	<p>(b) A lateral crane surge of 10% of the weight of the trolley plus lifted load applied at the top of each rail divided in proportion to the relative lateral stiffness of the rail support system</p> <p>(c) A horizontal surge of 5% of the maximum static wheel loads of the crane applied at the top of the rail in longitudinal direction.</p> <p>9.2.2 Monorail loads</p> <p>(a) Impact factor of 10% of lifted load of hoist for monorail and support design</p> <p>(b) Impact factor of 25% of the lifted load for electrical pulley and support design</p> <p>9.2.3 Elevator</p> <p>A 100% of the lifted load including elevator live load plus the cab weight for the elevator support beams.</p> <p>9.2.4 Pedestals supporting gravity take ups for conveyors and pedestals in elevator pits shall be designed assuming 100% impact factor.</p> <p>9.3 Track mounted vehicle supporting structures shall be designed assuming 100% impact factor</p> <p>10. OTHER LOADS</p> <p>10.1 Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance loads, creep and shrinkage shall also be considered in design of all structures.</p> <p>10.2 In order to allow for unusual loading during steel member erection or during the construction period, all beams on major column lines acting as column struts or ties are designed to withstand an axial force of 45t in combination with the dead load of the beam. End connections on these beams are designed to transfer its axial load. A minimum of 12mm thick connection angles are to be provided unless thicker angles are required by design.</p> <p>10.3 Roof girders / trusses in the service / maintenance bay of Turbine building shall be designed for crane erection loads.</p> <p>10.4 Columns in turbine building near transformer yard shall also be designed to support tension due to strung conductors and shield wire if the conductors are connected to the Turbine building columns.</p> <p>11.0 BASIC LOAD CASES</p> <p>The following basic load cases shall be considered for the analysis:</p> <p>(a) Dead load : D</p> <p>(b) Self weight of permanent equipment : EL</p> <p>(c) Live load on floor / walkway : L</p>	

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partition walls in channel shall be designed considering water on one side only and the other side being empty for maintenance.

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

13.5 Effect of uplift pressure due to created water bodies like raw water pond / ash pond shall be considered.

14. SPECIAL STRUCTURES

For the following structures, additional loading criteria as mentioned below in addition to the criteria discussed above shall be considered:

14.1 Coal bunkers

14.1.1 The following densities shall be considered for design of coal bunkers :

- (a) For volume calculations : 800 kg/cum
- (b) For structural design : 1200 kg/cum

14.1.2 The coal bunker will be designed as per criteria outlined in IS:9178 (Part I&II)

14.2 Ash silos

14.2.1 The following densities shall be considered for design of coal bunkers :

- (a) For volume calculation of bottom ash silo : 650 kg/cum
- (b) For volume calculation of fly ash silo : 750 kg/cum
- (c) For load calculation of both types of silos : 1600 kg/cum

14.2.2 The steel ash silo shall be designed generally as per the criteria laid down in IS: 4995 (Part I&II). The static pressure calculated at rest shall be multiplied by an over pressure factor of 1.35 for the top 1/3 rd portion and by a factor of 1.75 for the bottom 2/3 rd portion. Special attention shall be given in assessing the effect of hot temperature of ash on the wall. Temperature of ash shall be taken as 150°C.

14.3 Switchyard structures

14.3.1 The loading for the design of switchyard structures shall be as per IS: 802 Part 1/Sec1-1995 (latest edition). Following loads shall be considered:

- (a) Dead load due to equipment and dead load due to structure
- (b) Wind load on towers, conductors, ground wires and insulator strings calculated as per clause 8 and 9 of IS: 802



- (c) Temperature effects consisting of effect of temperature variation and sag tension as per clause 10 of IS: 802
- (d) Climatic loads as per clause 11.2 of IS: 802
- (e) Anti cascading loads as per clause 11.3.1 of IS:802
- (f) Torsional and longitudinal loads caused by breakage of conductor as per clause 11.3.2 and 16 of IS:802
- (g) Construction and maintenance loads
- (h) Seismic loads as per IS: 1893
- (i) Short circuit forces including "snap effect" in the case of bundled conductors

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

14.3.3 Foundation shall be designed for a factor of safety 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire conditions. Design of foundation shall be carried out as per IS: 4091.

14.4 Coal Handling System

In addition to the loads specified in section 3 above, following additional loads shall be considered for design of various structures:

- (a) Flat roof – accessible : 0.50KN/sqm dust load
- non accessible : 1.25KN/sqm dust load
- (b) Inclined roof : 0.50KN/sqm dust load
- (c) Building floors : 5KN/sqm or equipment load
whichever is higher + 1KN/sqm Spillage load
(where equipment is located)
- (d) Load due to material on belt : 1.6 times design weight of the
Material on belt
- (e) Spillage load
- (i) Gallery walk way : 1KN/sqm
- (ii) Seal plate : 1KN/sqm
- (f) Belt tension for twin : One belt at starting conveyors condition and
one in running condition
- (g) Impact factor for drive machines : 1.50



14.5 Boiler ESP support structures


14.5.1 The supporting structure shall be designed for the following :

- (a) Live / imposed loads
- (b) Dead loads
- (c) Static and dynamic loads of piping, movable equipment and maintenance parts
- (d) Cantilever loads of not less than 2000 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the ESP, for cable trays and walkways.
- (e) Cantilever loads of not less than 500 kg/metre at a distance of 1200 mm from the external face or the columns, on both sides of the boiler, for cable trays and walkways.
- (f) Dry ash piping supported from the main columns of ESP structure
- (g) Ash water piping supported on the outermost row of boiler column
- (h) All ESP hoppers filled up with ash upto the top of the hoppers or the bottom of the electrodes (whichever is more) using a bulk density of not less than 1350 kg/cum for the ash, along with additional ash build-up from the end of the third field upto the inlet duct bottom level at a natural repose angle (not less than 30 degree to horizontal in any case)
- (i) Seismic or wind loads as specified elsewhere in the specification
- (j) Temperature variation of ± 25 deg. C for atmospheric temperature variations
- (k) Temperature variations under ESP operating conditions
- (l) **The loads listed above indicate the minimum requirements**

14.5.3 Boiler supporting structures shall be so configured that the temperature of steel does not exceed 60 deg.C unless specified otherwise. Brackets shall be provided on both sides of the outermost row of columns of both the boiler and ESP for supporting cable trays and walkways, at a height not exceeding 10.0m. The exact levels shall however, be decided during detail engineering. Each ESP hopper shall be supported at four corners by providing four columns from the ground.

14.5.4 Dry ash transportation pipes and supply air pipes shall be supported on the structural members of the ESP.

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

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14.5.6 The ESP hopper outlet flanges shall be terminated at a height of 3.5m above ground level.

14.5.7 Boiler and ESP support structures shall be checked for differential settlement of foundations which shall be restricted to 1 in 1000 of span or 8 mm whichever is less.

14.5.8 In design of boiler /ESP support structures dynamic piping loads need not be considered acting simultaneously with wind or seismic loads. Increase in permissible stresses shall be allowed in load combinations where dynamic piping loads are considered and shall be as permitted under seismic load conditions.

14.5.9 Design criteria for foundations and some other facilities / areas are covered separately in this specifications.

14.6 R.C.C chimney

Reference shall be made to IS: 4998 Part I (1992) – “criteria for design of Reinforced concrete chimneys – part I, assessment of loads” for loading details. For wind loading IS: 875 and for seismic loading IS: 1893 shall be referred to. Wind load magnification on the Chimney induced by adjacent tall structures such as Cooling towers/Boiler structures shall be included in model study conducted in wind tunnel, and necessary modification shall be made in the wind loading for design.

15.0 Specific design Requirements:

To account for revisions & additions of new loads likely to occur as the design work progress, the stress ratio / design margin for design of members shall be as follows:

(a) for foundations, the actual to allowable bearing pressure ratio shall not exceed 0.90. Further there shall be a margin of 10% on the reinforcement provided as compared to the required reinforcement.

(b) the minimum diameter of bar for foundation shall be 12 mm.

(c) for column & beams the stress ratio shall not exceed 0.90 for normal loading conditions and not to exceed 1.20 for wind/seismic loading combination.



1. GENERAL

All structures, building foundations, machines / equipments foundation, water retaining structure, trenches, pits, etc., shall be designed as per relevant IS codes in general. Construction in general shall follow provisions of IS: 456 and IS: 3370 for normal and water retaining structures respectively.

2. DESIGN METHODOLOGY

2.1 General

2.1.1 All foundations to be designed as per working stress method. All designs of RCC structures shall be carried out by limit state method as per IS: 456 unless use of working stress method is specifically mentioned. Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456:

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

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

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

2.2 Foundation and Underground structures

2.2.1 General

The depth of all the foundations from design consideration shall be reckoned from the NGL (Natural Ground Level) or FGL (Finished Grade Level): whichever is lower. The minimum depth of the foundations for structures shall be 1.5m except for minor equipment foundations.

2.2.1.1 Type of foundation system, i.e., isolated, strip or raft shall be decided based on the loading arrangement, load intensity and soil strata. Design of foundations at various levels shall be dependent upon the soil bearing capacity at that level.

2.2.1.2 Foundation system adopted shall ensure that settlement / relative settlement is as per provision of IS: 1904 and other Indian Standards. However, the settlement shall be restricted to 25 mm & 12 mm in soil & disintegrated rock respectively.

2.2.1.3 All foundation including machine / equipment foundations shall be of RCC construction. All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian standards IS: 2974 and IS: 456. Raft foundations shall be designed as per IS: 2950.



2.2.1.4 For design of underground structures, subsoil water level below the formation level shall be based on the detailed investigations carried out by the CONTRACTOR. Any variation in such assumptions during the execution shall be to the CONTRACTOR's account only. All underground pits, tunnels, basements, cable and pipe trenches, etc., shall be leak proof RCC structure where specified design depth of ground water table so warrants. Effects of uplift and reduction in bearing capacity due to underground water table shall also be considered.

2.2.2 Liquid retaining structures

2.2.2.1 RCC water retaining structure like storage tanks, reservoirs, cooling tower basin, etc., shall be leak proof and designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses in accordance with IS: 3370 (part I to IV) by working stress method.

2.2.2.2 Water channels and substructure of pump houses shall be designed as cracked section with limiting crack width of 0.1 mm and limiting steel stresses as per IS: 3370 (part I to IV) by working stress method.

2.2.2.3 All water retaining / storage structures shall be designed assuming liquid upto the height of wall irrespective of provision of any over flow arrangement. No pressure relieving devices shall be permitted in underground structures.

2.2.2.4 In all liquid retaining structures, PVC water bar shall be provided at each construction / expansion joint. The sequence of construction shall also be specified on drawings showing construction joints. Fillets of minimum size 200 x 200 shall be provided at both the horizontal & vertical joints.

2.2.2.5 Where anchors are prescribed to resist uplift, the design of the same shall be based on the recommendation of IS 10270 or the recommendations & parameters furnished below whichever is more critical.

(a) Minimum diameter of anchor rod shall be 25 mm and that of anchor hole shall be 75 mm. The diameter of anchor hole shall not be less than 2.5 times the diameter of the anchor rod.

(b) The anchor hole shall be grouted with cement, sand aggregate (of size 6 mm and down) grout 1:1:2 with non-shrink additive and shall be of strength not less than M30 or one grade higher than the grade of concrete to be used.

(c) Minimum depth of anchor in rock shall be 2.m. Anchor strength in soil layer shall not be accounted. The allowable bond stress between grout & rock shall be 0.2 N/sqmm and 0.5N/sqmm for disintegrated rock and hard rock respectively.

(d) The anchor rod shall be protected by corrosion resistant paint as per IS 10270.



(e) Adequate number of pull-out tests as per IS 11309 shall be conducted to verify the capacity of the anchors both for test and working anchor.

2.3 Machine Foundations

The design of equipment foundation shall be as per IS: 456 and IS: 2974. The provisions of DIN 4024 shall also be followed for machine foundations.

2.3.1 All machine / equipment foundations and structures subject to vibrations shall suitably proportioned so that amplitude and frequency of the foundation / structures are within permissible limits.


2.3.2 All block foundations resting on soil shall be designed using the elastic half space theory. The mass of the RCC block shall not be less than the two and a half (2.5) times mass of the machine. Dynamic analysis shall be carried out to calculate natural frequencies in all modes including coupled modes and to calculate vibration amplitudes. The Minimum reinforcement shall also be governed by IS: 2974 and IS: 456.

Frequency & amplitude criteria as laid down by relevant ISO/IS/DIN/VDI codes or machine manufacturers shall be satisfied. Unbalance loads shall be calculated as per relevant IS/VDI/ISO requirements as applicable for the relevant machines and compared with the data furnished by the manufacturers and higher of the two values shall be considered for amplitude calculation. However minimum reinforcement for raft shall be 0.12 % of the gross area in each face and in each direction. Minimum reinforcement for block foundations shall also be not less than 50 kg/cum.

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

2.3.4 Steam turbine generators, Boilers Feed Pumps, FD Fans, ID Fans, PA fans, Crushers and mills shall be supported on vibration isolation system. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC deck which support the machine. The spring units shall conform to DIN 2089 and DIN 2096. The whole system is supported on block foundation consisting of common raft and pedestals.

Dynamic analysis for frame type foundations like TG shall be carried out using special finite element soft ware packages ANSYS, NISA or

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	<p>NASTRAN. The foundation shall be modelled using solid elements with element width not exceeding 300 mm. Harmonic analysis shall be carried out to obtain responses upto +10% of the operating frequency.</p> <p>2.3.5 All such foundation shall be separated from adjoining part of building and other foundations. Joints at floor / slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitably to ensure integral action.</p> <p>2.4 Increase in Stresses</p> <p>2.4.1 Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design. However, when stresses due to wind (or seismic) loads are combined with dead load alone, no increase in allowable stresses is permitted.</p> <p>2.4.2 Bearing capacity of the soil shall be allowed to increase by 25% under seismic / wind load condition or as per applicable codal provisions whichever is lower. However, when wind (or seismic) loads are combined with dead load alone; no increase in bearing capacity is permitted.</p> <p>2.5.1 Shear enhancement as per IS 456:2000 clause shall not be considered.</p> <p>2.5.2 Walls/slabs more than 150 mm thick and footings more than 300 mm thick shall be provided with reinforcement on each face /top & bottom, even if not required from design consideration. Minimum reinforcement for slabs/footings/ shafts shall be 0.12% of the gross area in each face and in each direction.</p> <p>2.5.3 Pedestals for steel columns shall be treated as column for design and detailing purposes. Minimum reinforcement shall not be less than 0.25% of the cross sectional area.</p> <p>3 Stability of structures</p> <p>3.2 Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground tanks, pits trenches, basements, etc. Minimum factor of safety of 1.2 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken in to consideration.</p> <p>3.3 All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these</p>	



cases shall be taken as mentioned in IS: 456 and other relevant IS codes. However, following minimum factor of safety shall be followed.

- (a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum.
- (b) Factor of safety against sliding shall be 1.5 minimum.
- (c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.


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

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

4 MINIMUM THICKNESS OF STRUCTURAL ELEMENTS

The following minimum thickness shall be followed:

- | | | |
|-----|---------------------------------------------------------------------------|-------------------|
| (a) | Suspended floor / slab / walkways /
Canopy slabs, etc | 125 mm |
| (b) | Ground floor slab (non-suspended) | 150 mm |
| (c) | Water Retaining slabs / walls | 200 mm |
| (d) | Cable / pipe trenches / underground pits /
Launder walls and base slab | 125 mm |
| (e) | All footings (including raft foundations) | 300 mm |
| (f) | Parapets | 125 mm |
| (g) | Sunshades | 75 mm at
stage |
| (h) | Precast louvers / fins | 50 mm |
| (i) | Precast trench cover slabs / floor slabs / louvers | 75 mm |
| (j) | Paving | 100 mm |
| (k) | Basement walls and base slab | 200 mm |
| (l) | Silo / bin walls | 150 mm |

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(m)	Underground reservoir	
	Below ground water table	200 mm
	Above ground water table	150 mm

4.2 From fire resistance point of view minimum cover for reinforced Concrete members shall be as per fig 1 of table 16a of IS 456.

5 MINIMUM HEIGHTS FOR PEDESTALS OF STEEL COLUMNS

5.1 Pedestals to Steel Columns for building structures :
 Top or RCC foundations (pedestals) shall normally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL) unless specified otherwise. Foundation levels for some columns shall be changed suitably to accommodate underground services, pits trenches, etc.

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

5.3 Pedestals to Steel Columns for Equipment structure :

(a)	Equipment in open area	: as required (300mm min)
(b)	Equipment in covered area	: as required (150 mm min)
(c)	Structures and equipment supplied by vendor	: as per vendor's data subject to minimum as specified above

6 MINIMUM HEIGHTS FOR ENCASEMENT TO STEEL COLUMNS

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

(a)	Open area	: 300 mm above paved level
(b)	Covered area	: 150 mm above FFL

7 CONCRETE MIX

7.1 The following minimum grades of concrete as per IS: 456 shall generally be used for the type of structures noted against each grade. Ordinary Portland Cement (OPC) shall be used. Pozzalona Portland Cement (PPC) shall also be used if directed by the Owner. Grade of cement shall be 43 conforming to IS 8112. For super structure of RCC chimney, natural draft cooling towers and inertia blocks of spring supported foundation richer mix may be used as per the design requirement.

M10 : Backfilling of over excavated area.



- M15 : Foundation below brick wall, blinding layer below foundations, trenches and underground structures, minimum thickness of the layer shall be 100 mm.
- Grade M20 : Base plate encasement, paving plinth protection works, encasement of structural steel work, etc.
- Grade M25 : All RCC members except where other grades are specified e.g. Foundation and super structure, grade beams, pedestals, ground floor slabs, roof slabs, cable and pipe trenches, Water retaining structures below and above ground, Precast concrete work, etc.

7.2 Minimum cover to the reinforcement shall be as per IS:456 .

7.3 Minimum cement content shall be governed by the requirement of IS:456.

8 REINFORCEMENTS

8.1 Reinforcement bars shall be as per the following codes :

- | | | |
|-----------------------------------|---|--------------------|
| High Yield Strength Deformed bars | : | IS: 1786 |
| Mild steel bars | : | Grade I of IS: 432 |
| Welded wire fabric | : | IS: 1566 |

8.2 Intermixing of different grades of rebars or rebars of different material composition in same structure shall not be allowed.

9 GROUTING


9.1 Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. For grouting of base of machine foundation high strength flowable ready mixed non-shrink grout shall be used.

9.2 Type and grade of grouting for structural columns and equipment bases shall be indicated. Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M30.

9.3 Nominal thickness of grouting shall be atleast 50 mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25 mm thick.

10 MINIMUM COVER TO FOUNDATION BOLTS

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

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	<p>(a) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50 mm.</p> <p>(b) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.</p> <p>(c) Clear distance from the edge of sleeve or anchor plate to the outer edge of pedestal shall be 75 mm.</p> <p>11.0 MISCELLANEOUS REQUIREMENT</p> <p>11.1 Fillets at the junction of roof and vertical walls shall be provided with cast in situ cement concrete grade M 15 followed by 12 mm thick 1:4 cement mortar.</p> <p>11.2 A screed layer not less than 100 mm thick of cast in situ concrete of nominal grade M10 shall be provided below all water retaining structures. A sliding layer of craft paper or bitumen paper shall be provided over the screed layer to destroy the bond between screed and base slab.</p> <p>11.3 All under ground structures such as conveyor tunnels, wagon tippler pits, reclaim hopper pits, slurry pump house, etc, shall be designed as per IS: 456 limiting the crack width to 0.1 mm. Check for crack width shall be in accordance with BS: 8007/IS: 456. In case of leakage in the above structure injection grouting method shall be applied to repair the structure according to the requirement of IS: 6494.</p> <p>11.4 For switchyard foundations anchor bolt with mechanical anchorage shall be provided and cast along with foundation concrete. Bolts in pockets shall not be adopted. Foundation for all switchyard towers shall be designed as per IS: 4091. Contact between foundation and the soil strata shall be ensured for all conditions and combinations of loading</p> <p>11.5 Plywood formwork shall be used for all water retaining / conveying structures and for all over ground concrete works. For other areas steel / plywood formwork shall be used.</p> <p>11.6 Unless specified 20mm and down graded aggregates shall be used for all structural concrete works. However 40mm and down graded aggregates may also be used for mass / deep foundations like coal mill foundations, fan foundations etc., under specific approval from the owner.</p> <p>11.7 Tolerance for formed and concrete dimension shall be as per IS:456</p> <p>12.0 MAJOR EQUIPMENT FOUNDATIONS</p> <p>Special requirements for concreting of major equipment foundations shall be as given below:</p>	



12.1 Coarse Aggregates

Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases of high percentage of reactive silica content, aggregate may be allowed where low alkali cement shall be used. Lime stone aggregate shall not generally be used for foundations which are subjected to high temperature and repeated temperature cycles (like in the case of all machine foundations).

12.2 Temperature Control of Concrete

The temperature of fresh concrete shall not exceed 23 deg. C when placed. For maintaining the temperature of 23 deg. C in the top decks of machine foundations, crushed ice shall be used in mixing water.

12.3 Admixture

Plasticizer cum retarder type admixture shall generally be added to the concrete for promoting workability in addition to retarding the setting time for mass concreting work. The slumps shall generally be in the range given below:

TG Top deck	: 150mm to 200mm
BFP, ID/PA/FD Fan & Mill deck	: 100mm to 150mm
Block foundation	: 100mm to 150mm
Column	: 100mm to 150mm

12.4 Form work

Plywood formwork shall be used for the top decks of all machine foundations and also for columns of TG foundation


Steel trestles shall be used in staging for concreting of the TG columns / decks.

12.5 Scheme for Concreting

Weigh batching plants shall be mobilized for all machine foundations. Concrete pump shall be mobilized for TG raft, TG Top deck, BFP Deck, PA/FD/ID Fan deck, Mill Deck. Arrangements for stand-by Plant and Equipments shall also be made

12.6 Placing of Concrete

Base mat and top deck of machine Foundations shall be cast in a single pour

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12.7 Ultrasonic Testing

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

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

12.8 Quality Control

Refer Clause 3.5 of Section 4.5 of Volume-V.

**PART D : STEEL STRUCTURES****1. GENERAL**

1.1 Design of structural steel work shall include generally but not be limited to the steel constructions listed below:

- i) Steel building structure and open structures:
This shall include beams, columns, bracings, supporting structures for floors, roof slabs, cladding etc.
- ii) Crane gantry girder, monorails etc.
- iii) Coal bunkers
- iv) Coal conveyor galleries and trestles
- v) Large diameter oil tanks
- vi) Large diameter pipe line for cooling water
- vii) Galvanised latticed structures for switchyard
- viii) Pipe and cable racks
- ix) Platforms and walkways
- x) Ladders, staircases, handrails etc.

2. FRAMING


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

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

2.1.2 Simple space frame design utilises single-span beam systems, vertical diagonal bracing at main column lines and horizontal bracing at the roof and major floor levels. The most of plant steel buildings shall be designed as simple space frame structures.

2.2 The turbine building design shall be a combination of rigid frame in transverse direction and simple frame in longitudinal direction. Two plane bracing each along the flange of columns shall be adopted for columns of depth 800 mm and above.

2.3 Pipe rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, pipe rack shall be divided into sections of suitable length with an anchor bay. The main transverse frames shall be connected with longitudinal beams, which will transmit horizontal forces to braced anchor bays. The pipe and cable rack bridge structure shall be adequately rigid to carry the forces from pipelines at anchor points without undue deflection so that pipelines are really anchored at the anchor points.

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	<p>2.4 Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However, shear connectors / Lugs of minimum 65X65X6 angle at 500 c/c shall be provided. In addition, wherever large cut-outs are provided in the floor slabs, horizontal floor bracing shall be provided. Grating/chequered plate floor shall neither be considered to provide lateral support to the top flange of supporting beams nor to provide a shear diaphragm. Adequate lateral support and horizontal bracing shall be provided as required. For Axial compression, concrete floor shall not be assumed to provide restraint unless bottom flange is also restrained. Suitable stays, secondary beams with stiffener connecting the bottom flange shall be provided to have lateral restraint.</p> <p>2.5 Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimise vibration, avoid resonance and maintain alignment and level.</p> <p>2.6 Columns shall be designed to support the load combination, which produces the maximum interaction ratio. Exterior columns shall be designed to resist wind moments between braced elevation as appropriate. Columns shall also be designed to resist moments caused by discontinuous vertical bracing or non-concentric bracing work points.</p> <p>3 MATERIALS</p> <p>3.1 Structural steel shall conform to Grade A of IS: 2062 for rolled steel members or plates up to 20 mm thickness. For plates above 20 mm thickness or welded construction, steel conforming to Grade B (Killed) of IS: 2062 shall be used except for crane girders where Grade C (IS: 2062) steel shall be used.</p> <p>3.2 Chequered plates shall conform to IS: 3502. All gratings shall be pressure locked type (preferably electro-forged) manufactured in accordance with applicable Indian standard. Pipes for handrail shall be as per medium grade of IS: 1161. Crane rails shall conform to IS: 3443.</p> <p>3.3 Stainless steel used as liner in Coal bunker shall be of grade designation SS 409M. Stainless steel used in flue shall be of grade designation SS 316L.</p> <p>4. <u>CONNECTIONS</u></p> <p>4.1 Welding shall be used for shop fabrication and joints. For site connections, welding or high strength friction grip (HSFG) type bolts shall be used, except in few cases for shear connections of lighter members or removable beam connections where bolted joints may be adopted e.g. purlins, side girts etc. A minimum of two bolts per connection shall be used.</p>	



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- 4.2 IS:816 and IS:9595 shall be followed for welding of structures.
- 4.3 For high strength friction grip bolt connections IS: 4000 shall be followed. High strength friction grip bolts shall be of property class 6.6 or 8.8 and shall conform to IS: 3757 and shall not be less than 20 mm in diameter unless designated otherwise. High strength bolts shall be installed as bearing type joint except where loads are reversible.
- 4.4 All bolted connections shall have bolts of minimum 16 mm dia. The connections of stairs and handrailing shall be made with 20 mm diameter threaded fasteners conforming to IS: 1363. Erection bolts shall be black bolts of minimum 12 mm dia.
- 4.5 All bolts and nuts shall have property / class compatible to each other. For bolts carrying dynamic or fluctuating loads and those in direct tension shall be provided with an additional double coil helical spring washer conforming to IS: 6755. The threaded portion of the bolt shall project through the nut at least by one thread.
- 4.6 Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.
- 4.7 For crane girders, welding between web and flange plates shall be carried out by submerged arc welding process. Full penetration of weld between web plate and top flange shall be ensured. Intermediate stiffeners shall be connected with top flange plate by full penetration butt weld. Welding across tension flange will not be permitted. Bearing edges of crane girders shall be machined.
- 4.8 The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.
- 4.9 Horizontal bracings shall be angle / tee section located at the bottom of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at column locations.
- 4.10 For Major columns of main building, column splices shall be designed to resist the greater of the design axial tension load and moments or an axial tension load of 45 t plus 50% of the member capacity in bending in either the major or minor axis, whichever produces the greatest number of bolts.



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4.11 Minimum size of fillet weld shall be 5 mm. Main structural elements shall be welded continuously. Intermittent weld shall be used only on secondary members, which are not exposed to weather or other corrosive influence.

4.12 Efficiency of site welds to be considered shall be as follows:

a) Butt weld above 25 m from ground --- 50%

b) Others --- 80%

5. **DESIGN METHODOLOGY**

5.1 The Design of steel structures shall be done by working stress method in accordance with the provisions of IS: 800 and other relevant IS Codes as applicable to specific structures.

5.2 All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings/moment connections shall be used to assure stability of structures. Structure shall be designed such that the surfaces of all parts shall be accessible for inspection, cleaning, painting and maintenance.

5.3 Crane gantry girders shall be single web plate girder of welded construction with bearing and intermediate stiffeners. Crane girder shall be designed as simply supported and of single span length. Chequered plate shall be used for gantry girder walkway flooring. For lifting / monorails beams ISMB sections shall be preferred and the bottom flange of all beams shall be checked separately for distortion and reinforced suitably if required.

5.4 Permissible stresses for different members shall be allowed to exceed upto 33 1/3 % only when wind / seismic loads are combined with dead & live loads. No increase is permitted when wind / seismic loads are combined with dead loads alone. However members which are designed primarily to resist wind / seismic, such as bracing members, no increase in permissible stresses will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed upto 25% only under wind and seismic conditions.

5.5 For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension, etc.) the following criteria shall be used in determining minimum load: Use 85% of the column dead load, No live load is used, Uplift forces from vertical bracing are included where applicable and Wind uplift on the roof is included where applicable.

5.6 Base plates shall be placed on foundation pedestal with grouting. For large base plates necessary grout holes shall be provided. All anchor bolts for fastening steel columns on foundation shall be embedded in



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foundation during concreting itself. No anchor pockets in foundation shall be allowed. Design of base plates shall be based on design pressure on foundation which shall not exceed the following:

Pedestal in concrete grade M25	6.25 N / sq.mm
Pedestal in concrete grade M30	7.5 N / sq.mm

- 5.7 The total horizontal shear force at the base of column is transferred to the column pedestals through friction between the base plate and the grout. A coefficient of friction of 0.30 shall be used in conjunction with the minimum column load as defined above. If the horizontal shear force exceeds the frictional resistance force or if the column is subjected to a net uplift load, the total force shall then be transmitted through shear bars / shear keys welded to the base plate. Anchor bolts are not assumed to resist any horizontal shear force. Necessary recesses shall be kept in the foundation concrete for shear lugs.

- 5.8 The following criteria shall be followed for posting loads on the design drawings. For vertical beam reactions, the load shall be posted whenever the value exceeds the maximum allowable uniform distributed load. For axial loads in floor beams, the actual horizontal load which the beam end connection must resist shall be posted for each end of the beam. Note that this value may be different for opposite end of the same beam. For truss members, only one member force shall be noted for each member.

6 PERMISSIBLE DEFLECTIONS

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

6.1 Vertical Deflection

- 6.1.1
- a) For beams supporting dynamic equipment : Span / 500
 - b) For beams supporting floors / masonry : Span / 325
 - c) For beams supporting pipes (pipe racks) : Span / 400
 - d) For roofing and cladding components : Span / 250
 - e) For gratings and chequered plates : Span / 200 subject to a maximum of 6 mm
 - f) Coal conveyor gallery bridges : Span / 450
- 6.1.2 For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:
- a) For manually operated cranes & monorails : Span / 500



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b) For electric overhead cranes

i) up to 50 t capacity : Span / 750

ii) over 50 t capacity : Span / 1000

6.2 Horizontal deflections

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

- a) Single storey building (without crane load) : Height / 325
- b) Multistoried building (without crane load) : Height / 500
- c) Pipe rack columns : Height / 200
- d) Open Structures : Height / 200
- e) Crane gantry girder due to surge : Span / 2000 limited to maximum of 15 mm
- f) Building main columns at crane rail level due to action of crane surge load only : Height / 2500 limited to maximum of 10 mm
- g) Open gantry columns at crane rail level due to action of crane surge load only : Height / 4000 limited to maximum of 10 mm
- h) Coal handling trestles/ Junction Towers : Height / 1000
- i) Coal conveyor Galleries.

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

7 MINIMUM THICKNESS AND SIZES OF STEEL ELEMENTS**7.1 Minimum Thickness**

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgement in each instance.

- a) Trusses, purlins, girts and bracing : 6 mm
- b) Columns and beams : 8 mm
- c) Gussets : 8 mm
- d) Stiffeners : 8 mm



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- e) Base plates : 10 mm & above
- f) Chequered plates : 6 mm o/p & above
- g) Grating flats : 5 mm
- h) Minimum thickness of structural members other than gratings and chequered plate, directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

7.2 Minimum Sizes

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

8. SLENDERNESS AND DEPTH RATIO

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

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


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

9. FABRICATION AND ERECTION

9.1 CONTRACTOR shall prepare detailed fabrication drawings and erection scheme based on the design drawings approved by OWNER. Fabrication drawings are not to be submitted to OWNER for approval as the responsibility for correct detailing rests exclusively on the CONTRACTOR. However these drawings will be furnished to OWNER for their reference to effect payment. Detailed fabrication drawings to be furnished before commencement of work. Fabrication shall commence only on the basis of the fabrication drawings approved by the CONTRACTOR'S Consultant.

9.2 Fabrication shall in general follow the provisions of IS:800, and good engineering practice where provisions of IS:800 are not clear.

9.3 Tolerance in fabricated steel work shall be as per IS:7215.

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	<p>9.4 Erection of fabricated steel components shall be as per erection drawings prepared by CONTRACTOR and approved by his CONSULTANT.</p> <p>9.5 Tolerance for erected steel structures shall be as per IS:12843.</p> <p>10 INSPECTION OF WELDING</p> <p>The extent of quality control in respect of welds for structural elements shall be as follows.</p> <p>10.1 Visual Examination</p> <p>10.1.1 All welds shall be 100% visually inspected to check the following:</p> <ul style="list-style-type: none"> (i) Presence of undercuts (ii) Surface cracks in both welds and base metals. (iii) Unfilled craters (iv) Improper weld profile and size (v) Excessive reinforcement in weld (vi) Surface porosity <p>10.1.2 Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.</p> <p>10.2 Dye Penetration Test (DPT)</p> <p>10.2.1 This shall be carried out for all important fillet welds and groove welds to check the following:</p> <ul style="list-style-type: none"> (I) Surface cracks (II) Surface porosities <p>10.2.2 Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.</p> <p>10.3 Ultrasonic testing</p> <p>10.3.1 Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by OWNER to detect the following:</p> <ul style="list-style-type: none"> (i) Cracks (ii) Lack of fusion (iii) Slag inclusions (iv) Gas porosity 	



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10.3.2 Ultrasonic testing shall be carried out in accordance with American National Standard ANSI / AWS D1-92 Chapter 6 : Part C.

10.3.3 Before Ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

10.4 **Radiographic Testing (X – ray and Gamma – ray Examination)**

10.4.1 This test shall be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by OWNER to detect the following defects:

- i) gas porosity
- ii) slag inclusions
- iii) lack of penetration
- iv) lack of fusion
- v) cracks

10.4.2 Radiographic testing shall be conducted in accordance with American National Standard ANSI / AWS D1.1-92.

10.4.3 Any surface irregularity like undercuts, craters, pits etc shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than $0.75 \times$ focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.

10.5 CONTRACTOR shall provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the OWNER / consultant.

10.6 **Acceptable Limits of defects of weld**

10.6.1 Limits of Acceptability of welding defects shall be as follows.

i) **Visual Inspection & Dye Penetration Test**

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 8.15.1 & clauses 9.25.3 of American National Standard ANSI / AWS D1.1-92 respectively, for statically and dynamically loaded structures.



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PART D : STEEL STRUCTURESii) **Ultrasonic Testing**

The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 8.15.4 & clause 9.25.3 of American National Standard ANSI / AWS D1-92 respectively, for statically and dynamically loaded structures.

iii) **Radiographic Testing**

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clause 8.15.3 & 9.25.2 of American National Standard ANSI / AWS D1.1-92 respectively for statically and dynamically loaded structures.

10.7 Rectification of Defects in Welds

10.7.1 In case of detection of defects in welds, the rectification of the same shall be done as follows:

- (i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld
- (ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.
- (iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld and shall be re-welded. Defective weld shall be removed by chipping hammer gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

11.0 PAINTING

11.1 All steel structures shall receive two primer coats and two finish coats of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.

11.2 Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be cleaned to grade ST-2 as per SIS05-5900 or as per IS:1477 (part -I). Primer paint shall be red oxide zinc chromate conforming to IS:2074. Dry film thickness of each coat shall be 25 microns.

11.3 Finish paint shall be 2 coats synthetic enamel paint conforming to IS:2932. Dry film thickness of each coat shall be 25 microns. The undercoat and finish coat shall be of different tint to distinguish the same



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from finish paint. All paints shall be of approved brand and shade as per the OWNER's requirement.

- 11.4 Joints to be site welded shall have no paint applied within 100 mm of welding zone. Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

- 11.5 Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

12. REQUIREMENTS FOR SPECIFIC STRUCTURES

12.1 Coal handling system structures

- 12.1.1 Toe guards shall be provided on sides of conveyor gallery, toe guard shall have a minimum size of 65 x 6 mm.

- 12.1.2 In case the inclination of the conveyor is more than 10°, walkway shall be given steps.

- 12.1.3 For the design of conveyor gallery, load due to cables, light fittings and pipes as well as effect of gravity take up loads shall also be considered, in addition to dead load, wind load and imposed load.


- 12.1.4 Lattice girders supporting the conveyor shall be suitably braced at top and bottom chord levels to transmit the wind load to the end portals connected to trestles. Roof purlins and walkway runners shall also be suitably braced at both ends.

- 12.1.5 In the case of galleries, temperature expansion joint shall be introduced at intervals less than 180 m to divide the galleries into temperature block. In each block at least one number four legged rigid support guaranteeing stability of structure in the longitudinal direction shall be provided. This shall also take care of all longitudinal forces in the given block. Effect of wind load acting on 2-legged trestle shall also be considered while designing the 4-legged trestle.

- 12.1.6 Base plates for trestles shall be designed as gusseted bases with shear lugs to transfer horizontal forces. Anchor bolts shall be designed only for uplift forces.

- 12.1.7 Conveyor galleries and trestles having two conveyors belt shall be designed for both conveyors working together.

- 12.1.8 Chute loads on floors of houses shall be considered plugged with material for the entire height of the chute.

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12.1.9	In case chequered plates are used as floor covering the thickness of plate o/p shall be 8 mm. Suitable plan bracings shall be provided 75 mm from top of steel to transfer all the horizontal forces.		
12.1.10	Anchor fasteners shall not be used for supporting equipment imparting dynamic forces.		
12.1.11	Bracing patterns and locations shall be so planned such that they do not hinder movement of personnel and movement of equipment during maintenance. When floor beam form part of vertical bracing system, additional loads from the floor beams transferred to the bracing shall be taken into account.		
12.1.12	Angle section shall not be used as flexural members except for purlins, side girts and walkway runners. Minimum angle size used shall be L50x50x6.		
12.1.13	All foundation bolts shall be provided with double nuts.		
12.1.14	End connection for rolled beams and channels shall be designed for a minimum of 60% of their shear capacity and built up beams for 80% of their shear capacity in addition to axial load.		
12.1.15	Dynamic analysis shall be carried out for beams supporting screens, vibrating feeder, rotating equipments and conveyor supporting beam in conveyor gallery.		
12.1.16	To admit proper light into the conveyor gallery perspex sheet shall be provided at the rate of 0.1 square metre per metre length of gallery on the roof and 0.2 square metre per metre length of gallery per side on the sides of conveyor gallery.		
12.2	Switchyard Structures		
12.2.1	All switchyard structures comprising of towers, gantries, lightning masts, lighting towers, equipment structures etc shall be galvanised steel with bolted site connection.		
12.2.2	Three dimensional analysis shall be carried out for structures like towers and gantries whereas two dimensional approach may be followed for equipment support structures.		
12.2.3	All structural steel shall be of tested quality and shall conform to IS:2062. Steel tubes where used for equipment support structures shall conform to IS:1161.		
12.2.4	All bolts and nuts shall be galvanised. In addition to heavy washers conforming to IS:6610, spring washers conforming to IS:3063 shall be provided at all bolted connections. Bolts shall conform to IS:12427.		



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12.2.5 Fabrication and erection shall in generally be as per IS:802 and IS:800; wherever there is a contradiction between two codes the provision in IS:802 shall govern.

12.2.6 Galvanising

12.2.6.1 Galvanising of the towers shall be as per IS: 4759 and 2633 and as given in the following paras.

12.2.6.2 Before Galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the Galvanising process.

12.2.6.3 The acceptable values of the coating of zinc on the steel materials shall be in accordance with Table below:

KIND OF MATERIAL	COATING	
	Average value	Minimum value
Structural steel members except bolts, nuts and washers	Over 750 gm/sq.m	610 gm/sq.m
For bolts, nuts and washers	Over 550 gm/sq.m	500 gm/sq.m

12.2.6.4 The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.


12.2.6.5 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanised steel member shall withstand minimum four no. of one minute successive dips in copper sulphate solution as per IS:2633 unless specified otherwise.

12.2.6.6 All galvanised members shall be treated with sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.

12.2.6.7 Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted.

12.2.6.8 Wherever galvanised bolts, nuts, washers, accessories etc are specified, these shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

12.2.6.9 CONTRACTOR shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damage, CONTRACTOR shall at his

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	<p>own cost adopt scrapping and regalvanising the member to satisfy the specific requirements.</p> <p>12.3 Large diameter Oil tanks</p> <p>12.3.1 Design, fabrication and erection of the cylindrical welded oil storage tank shall follow the provisions of IS: 803. The stresses in the tank shall be computed on the assumption that tank is filled with water. Tension in each course shall be computed at 30 cm above the centre line of lower horizontal joint of the course under consideration.</p> <p>12.3.2 Wind and internal vacuum loads shall be considered together to check the stability of tank.</p> <p>12.3.3 Joint efficiency factor shall be taken as 0.85 for butt joints to determine the minimum thickness of shell plates provided all the vertical and horizontal butt welds are spot radiographed. Where welds are not inspected by radiography joint efficiency factor of 0.7 shall be used. However it is recommended that all butt welded joints shall be radiographed.</p> <p>12.3.4 Minimum thickness of shell plate shall be as given in clause 6.3.3.2 of IS:803 to which corrosion allowance shall be added. Maximum thickness of shell plate shall not exceed 40 mm. Width of shell plate shall not be less than 1500 mm.</p> <p>12.3.5 Bottom plate uniformly resting on the substructure shall have a minimum thickness of 6 mm for tanks upto 10 m in diameter and 8 mm for higher diameter. Bottom plate shall project atleast 25 mm alround beyond the outer edge of weld attaching the bottom to the shell plate.</p> <p>12.3.6 For large diameter oil tanks supported cone roof shall be provided. Arrangement of columns and rafter shall in general be as per fig 9 & 10 of IS: 803. Roof plates shall have a minimum thickness of 6 mm and shall not be attached to the supporting member. A curb angle shall be provided at the top of the shell in line with clause 6.3.6.2 of IS: 803. Roof plates shall be attached to the curb angle with a continuous fillet weld on the top side only. Minimum slope of roof shall be 1 in 16.</p> <p>12.3.7 Rafter clips for the outer row of rafters shall be welded to the shell. Columns shall not be rigidly attached to the bottom plates guide. Clips shall be welded to the tank bottom to prevent lateral movement.</p> <p>12.3.8 Roof supporting columns shall be made from structural shapes or pipe or built up section. Suitable base frames or reinforcing pads shall be provided at the column base to distribute loads coming on the tank bottom.</p> <p>12.3.9 Appurtenances and mountings covered under section 7 of IS: 803 shall be provided in addition to any other appurtenance which the</p>	



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CONTRACTOR considers essential for the safe and smooth operation of the fuel oil storage and oil handling system.

- 12.3.10 After erection and inspection of the tank, the tanks shall be tested as per clause 12 of IS: 803. Leakage if any noticed shall be repaired to the satisfaction of the OWNER and the tank retested to satisfy acceptance criteria.

12.4 **Large diameter steel pipes**


Design, installation and testing of the pipe shall in general be in accordance with the following provision

" Steel pipe – A guide for design and installation " – AWWA Manual M11 – published by American Water Works Association. Steel used shall conform to IS: 2062. Minimum earth cover over the pipe shall be 1500 mm. Internal surface of pipe shall be epoxy painted. The pipe shall be encased in RCC with a minimum thickness of 250 mm with reinforcement. Bedding shall be of sand. Thrust blocks shall be provided at all bends. Internal design pressure shall be the shut off head as furnished by the pump vendor, 1.5 times the pump working head or maximum surge pressure computed from surge analysis whichever is greater. However for surge pressure the allowable stresses can be increased by 25%. External pressure shall be due to earth pressure, surcharge pressure of 2 T/sqm and at road crossings pressure due to vehicles. In addition a vacuum pressure of 9 m water column shall be considered while checking against buckling. All site joints shall be inspected by radiography.

12.5 **Circular Coal bunkers**

Design of the bunkers shall be as per IS : 9178. Plates shall be cut to the maximum width to reduce the number of horizontal joints. Vertical joints shall be staggered. All vertical joints above bunker supporting zones and both vertical and horizontal joint below the zone shall be inspected by radiography to ensure quality. Trial assembly of the bunker including hopper shall be made at least for one bunker before commencing regular fabrication of the bunkers.


Hopper shall be of stainless steel plate of grade designation SS 409 M.


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1. **DRAINAGE AND SEWERAGE**


All drainage lines for storm water, sewage and waste drainage etc. shall preferably be laid in service aisles close to the road. Separate network shall be provided for lines of storm water, sewage, and waste drainage.


 - 1.1 **Surface Drainage**
 - 1.1.1 All the paved and unpaved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be. Unpaved open areas shall be drained through RCC drains and connected to main storm drains.
 - 1.1.2 The paved area shall be sloped towards the drains with a minimum slope of 1 in 100. The maximum drainage travel extent shall be limited to 10 metres.
 - 1.1.3 The surface drainage from uncontaminated area shall be connected to nearest open storm water drains through rectangular drains. Contaminated area surface drainage shall be collected through separate network.
 - 1.1.4 The interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.
 - 1.1.5 The rectangular drains shall be minimum 600 mm wide of RCC. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 150 mm NB. However for road crossings etc. pipe of class NP3 shall be provided. For rail crossings, pipes conforming to railway loading standards shall be provided. If sufficient clearance cannot be provided between the top of the pipe and road top, the pipes shall be encased in RCC.
 - 1.1.6 The maximum velocity for pipe drains and open drains shall be limited to 2.4m/sec and 1.8m/sec respectively. However minimum velocity for self cleansing of 0.6m/sec shall be ensured. Slope of drain shall not be milder than 1 in 1000.
 - 1.1.7 Minimum earth cover of 450 mm shall be provided over drainage pipes in paved areas.
 - 1.1.8 Garland drains minimum 300 mm wide shall be provided allround the building to lead away roof drainage to plant drainage system. Plinth protection in PCC M15 grade shall be provided between brickwall and drain with appropriate slope.
 - 1.2 **Storm Water Drainage System**
 - 1.2.1 The plant storm water drainage system shall take into account the topography of the plant area, area drainage patterns and intensity of rainfall etc. The drainage system shall be designed for precipitation


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	<p>intensity equal to hourly rainfall for a return period of 1 in 50 years. However, storm frequency of 100 years return period shall be applied for Coal Storage area.</p> <p>1.2.2 All storm water drainage shall preferably be through open storm water drains. These shall be provided on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. The drains shall be minimum 600 mm wide at the base.</p> <p>1.2.3 All open drains rectangular in cross section shall be in RCC. In the main plant block, rectangular section RCC drains in minimum M20 grade concrete shall be provided. The thickness of side and bottom shall be minimum 125 mm or as per design considerations whichever is higher.</p> <p>1.2.4 The pipes for water drainage system shall be concrete pipes of class NP2 conforming to IS:458. However, for road crossings etc. higher strength pipe of class NP3 shall be provided. Diameter of pipes used for drainage / culverts shall be between 300 mm to 600 mm. Beyond 600 mm, box drains / culverts shall be provided.</p> <p>1.2.5 Surface drains shall normally have a bed slope not milder than 1 in 1000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However, minimum velocity for self cleansing of 0.6 m/sec shall be ensured at peak flow condition (i.e. 3 times average flow) for pipes flowing at half full.</p> <p>1.2.6 Suitable manholes shall be provided to piped drainage lines at every 30 m intervals, at junctions and at change of gradient, alignment and diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be 1.0m x 1.0m or circular manhole of 1 m dia. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.</p> <p>1.2.6 The cushion over the pipes for storm water culverts shall be minimum 600 mm. Where less cushion is available, pipe shall be encased in RCC M-20. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.</p> <p>1.2.6 Invert of drainage pipe / drain shall be decided in such a way that the water can easily be discharged above the high water level in water course outside the plant boundary to which the storm water is to be led.</p> <p>1.3 Plant Effluent Drainage (Oily Waste / Process Waster Drainage)</p> <p>1.3.1 The oily / process waste shall be drained / collected through a separate sewer system consisting of underground (overground if required) concrete / cast iron pipes. Catch pits shall be provided at the source</p>	

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	<p>location and they shall be interconnected by buried pipes. No bends and branches shall be provided in the pipe line. Manholes shall be provided at all junction of pipes. Catch pits shall have a minimum internal dimension of 600 mm x 600 mm. They shall be of RCC construction and provided with CI grills.</p> <p>1.3.2 The main and branch connection pipes shall be sized for the expected maximum discharge subject to a minimum of 250 mm NB and 100 mm NB respectively. The pipes shall be adequately sloped for drainage and shall carry flow to neutralisation pit / ETP / Oil water separator as required.</p> <p>1.3.1.1 Sewage System</p> <p>1.4.1 Cement concrete pipes shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm NB. Pipes connecting various manholes shall be minimum 150 mm NB. However salt glazed stoneware pipes of diameter not exceeding 150 mm can be used in localised areas not subject to any traffic loads. For main power block below paved area, cast iron spun pipe of Class LA conforming to IS:1536 shall be used.</p> <p>1.4.2 Sewers shall have such slopes so as to have effective discharge. Sewers shall be designed for a minimum self cleansing velocity of 0.75 m/sec for peak flow condition (assumed as 3 times the average flow) and pipes flowing half full. The maximum velocity shall not exceed 2.4 m/sec.</p> <p>1.4.3 Suitable manholes shall be provided to piped sewage lines at every 30 m intervals, at junctions and at change of gradient, alignment & diameter of pipe and shall be of masonry or RCC construction. Details of manholes shall be as per IS: 4111 (Part-I). Minimum size of manholes shall be 1.0m x 1.0 m for square section or 1 m dia for circular. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.</p> <p>1.4.4 Separate septic tanks shall be provided at suitable locations for each building block. Sewage from septic tanks shall be connected to the existing common sewerage treatment plant.</p> <p>2 INTER PLANT TRENCHES</p> <p>2.1 All cable and pipe trenches shall be of RCC with minimum M20 grade. Trenches located outside buildings shall be projecting at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.</p> <p>2.2 Trenches shall be covered using precast RCC cover of minimum M20 grade, each not weighing more than 65 kg and shall be provided with lifting hooks.</p>	

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	<p>2.3 As far as possible in the open area trenches shall be provided for running cables.</p> <p>3.0 ROADS & PARKING AREA</p> <p>Roads and parking areas shall be of flexible type of construction and shall be designed in accordance with the provision of the relevant IRC Codes of Practice. Top level of parking area shall be flushed with crown of the connecting roads with a cross slope.</p> <p>3.1 Roads shall be designed for class 'E' of traffic i.e. traffic intensity of 450-1500 vehicles per day (heavy vehicles exceeding 3 tonnes laden weight) as per IRC-37:1984 "Guidelines for the design of flexible pavements". California Bearing Ratio (CBR) method shall be adopted for the design of roads.</p> <p>3.2 Sub-base shall be of granular material i.e. laterite, murrum, natural sand, gravel, crushed stone (grading-1) or combination thereof laid over well compacted subgrade. Granular base shall be of wet mix macadam course (WMM) construction. The wearing coarse shall be bituminous macadam binder course with open graded premix carpet laid over it. Shoulder provided on either sides shall be in murrum construction of 150 mm compacted thickness. Kerbs of PCC or stone shall be provided to distinguish carriage way.</p> <p>3.3 The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space for manoeuvring of vehicles. The ruling gradient for roads in longitudinal direction shall be 1 in 30. Normally the roads shall have much flatter gradient. Transverse camber of 1 in 60 shall be provided for the black topping of roads and a slope of 1 in 40 shall be provided on shoulders. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.</p> <p>3.4 Minimum radius of curvature along the inner side of the carriage way shall be generally 12m. However for minor roads this shall be reduced suitably as per layout requirements and site conditions. Road width and turning radii shall also be checked for to take largest foreseeable vehicles and equipment which can reasonably be expected.</p> <p>3.5 All service and utility lines crossing under roads shall be taken through concrete pipes / ducts and designed for imposed loadings. Number of such crossings shall however be kept to a minimum.</p> <p>4. PAVING</p> <p>4.1 R.C.C Paving</p> <p>4.1.1 R.C.C paving of grade M20, minimum 125 mm thick laid to a slope of 1 in 100 towards the nearest drain, with reinforcement placed 50 mm from the top surface, shall be provided in the following areas.</p>	

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	<p>(i) Entire backside of the main Turbine building up to the farther edge of Chimney. The paving shall extend to a minimum of 5 m on either side from the outer most face of equipment structures in the other direction.</p> <p>(ii) Ash silo area extending at least 10 m on all sides from outer periphery of the silos.</p> <p>(iii) 5 m wide corridor all along the entire width of TG and De-aerator bay at both gable ends.</p> <p>(iv) Fuel oil decantation platforms</p> <p>4.1.2 The under-bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits, followed by a layer of PCC of grade M15, 75 mm thick.</p> <p>• 4.2 P.C.C. Paving</p> <p>4.2.2 PCC paving of nominal grade M15, 100 mm, laid over 230 mm thick compacted rubble soling shall be provided in the following area.</p> <p>i) Complete Transformer Yard, covering area between A-row of the turbine building upto the fencing of the Transformer yard</p> <p>ii) Plinth protection around all building to a width of 750 mm or the distance between the brick wall to the garland drain.</p> <p>iii) Fuel oil tank farm area, DM water storage tank area and CST farm area for a width of 1 m.</p> <p>4.3 Stone Aggregate paving</p> <p>4.3.1 Entire switch yard shall be provided with 75 mm paving of 40 mm single size stone aggregate on top and 75 mm paving of 20 mm single size stone aggregate below. Before laying the paving, the ground surface shall be treated with anti weed chemicals as per manufacturer recommendations.</p> <p>4.3.2 For auxiliary transformer yard, paving of stone aggregate of 75 mm thick using 20 mm single size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.</p>	

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<p>The minimum quality of finishes to be used for various building areas are furnished in this section. However, the Bidder is at liberty to use superior finishes provided all specific requirements for the finish specified herein below are satisfied.</p> <p>1. FLOORING</p> <p>The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete M15 with stone chips, 12.5 mm down graded as coarse aggregates. The under bed shall be provided with appropriate slope towards catch pit for floor drainage.</p> <p>1.1 PVC Floor Finish</p> <p>Two mm thick PVC as per IS: 3462 laid as per IS: 5318 over concrete under bed of 48 mm.</p> <p>1.2 GRANITE FLOORING</p> <p>This shall be provided for Turbine building operating floor. The Granite slabs shall be of minimum 20mm thick with approved colour.</p> <p>1.3 Terrazo Tiles</p> <p>This shall be provided in general circulation areas such as lift entrance area, office area, laboratory etc. Tiles shall generally be of size 250 x 250 x 20 mm laid over concrete bedding to result in an overall thickness of 50 mm.</p> <p>1.4 Granolithic flooring</p> <p>1.4.1 Granolithic flooring (cement concrete flooring in M25 with non metallic floor hardener topping 12 mm thick with a total thickness of 50 mm shall be provided in maintenance and unloading area of Station building, Mill and bunker bay, Workshop floors, operating floor of pump house, permanent stores and other plant building areas where heavy duty flooring is required.</p> <p>1.5.2 Granolithic flooring without floor hardener shall be provided in all MCC and switchgear rooms, which are not air-conditioned.</p> <p>1.5.3 Granolithic flooring shall also be provided in areas, which are not provided with any special finish. Areas which are likely to be subjected to oil spillage shall be provided with two coats of oil resistant painting over Granolithic flooring.</p> <p>1.6 Heavy Duty Ceramic Tiles</p> <p>Heavy duty ceramic tiles with matt finish shall be used in toilets, pantry, dining hall of canteen, locker rooms etc. The tiles shall be 300 x 300 x 7 mm of approved shade brand and colour.</p>		

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1.7	Acid / Alkali resisting Tiles <p>Battery rooms and other areas coming into contact with acid / alkali vapours or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement slurry. Bedding shall comprise of potassium silicate mortar conforming to IS: 4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS: 4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile. The above specification do not apply to D.M. Plant.</p>	
1.8	Integral floor finish <p>For cable vaults floor finish integral to the concrete base shall be provided as per IS: 2571.</p>	
1.9	POLISHED VITRIFIED TILES <p>Polished vitrified tiles of size 600X600X10 mm of approved shade, brand and colour laid with CM 1:3 shall be provided in control rooms.</p>	
1.10	Cast-in-situ Terrazo <p>Risers and treads of staircases shall be provided with cast in situ terrazo. This shall be laid as per IS: 2114, using white cement or cement with colouring pigment. Chequered finish shall be provided for treads. Total thickness of the finish shall be 25 mm.</p>	
1.11	Acid / Alkali resistant Tiling / Brick lining in D.M Plant	
1.11.1	<p>Bitumen primer followed by 12 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 38 mm thick alkali / acid resistant bricks as per IS: 4860 shall be provided for CPU regeneration area, Chemical house floor, effluent drains, floors around equipment & chemical handling vessels, chemical storage area for the floor, kerbs and sumps, all as per the acid / alkali proofing specialist Contractor's requirement.</p>	
1.11.2	<p>For floor of neutralising pit the finish shall be as follows. Bitumen primer followed by 18 mm thick bitumastic layer, 6 mm thick potassium silicate mortar bedding and 75 mm thick acid / alkali resistant brick as per IS:4860.</p>	
1.11.3	<p>For walls of neutralising pit, the same specification as 1.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable pilasters at 2000 mm c/c.</p>	
1.11.4	<p>Special instruction to be followed for acid resistant lining in neutralising pit shall be as follows.</p> <ul style="list-style-type: none"> i) The structures shall be tested for water tightness. ii) Surface on which lining is to be applied shall be prepared as per IS:2395. 	




- iii) Joints between acid resistant bricks / tiles shall be filled with resin type mortar conforming to IS:4832 (Part II). Seal coat of ready made epoxy paint shall be provided at the joints to cover up any porosity.
- iv) Acid resistant bricks shall be laid with 6 mm wide and 20 mm deep pointing. Pointing shall be with epoxy / furane / CNSL as per the requirement of the agency guaranteeing the performance of lining.
- v) Under side of all precast slabs / steel covers over effluent drains shall be given two coats of epoxy coating, 150 microns thick.
- vi) Acid / alkali resistant treatment shall extend at least 1 metre on all sides from the outermost periphery of pedestals / saddles for indoor installations and 2 metres around for outdoor installations.


1.12 **Miscellaneous**


- 1.12.1 Aluminium angle nosing with minimum size (50 x 25 x 3) shall be provided for edge protection of R.C.C. stair treads.
- 1.12.2 Angles 50x50x6 mm (min) with lugs shall be provided for edge protection of cut-outs / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches and at any other place where breakage of edges / corners is expected.
- 1.12.3 Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.

2. **SKIRTING / DADO**

- 2.1 150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.
- 2.2 Toilets & locker rooms shall be provided with dado of 2100 mm high with glazed tiles of minimum 5 mm thickness generally as per IS:777.
- 2.3 For main Control room and control equipment room minimum 5 mm thick decorative coloured ceramic tiles shall be provided upto false ceiling level.
- 2.4 For battery room and other areas coming in contact with acid / alkali spillage / fume, dado of acid / alkali resistant tiling as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.
- 2.5 Staircase wall shall be given dado of cast in situ terrazzo to a height of 2100 mm.
- 2.6 Entrance lobby and lift area in Service building and Admin building shall be provided with granite tile dado to a height upto false ceiling level.

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3.	METAL CLADDING	
3.1	Permanent colour coated sandwiched insulated metal cladding system	
3.1.1	Troughed zinc-aluminium alloy coated (both sides) M.S. sheet having 0.6 mm minimum thickness (or high tensile steel sheet of 0.5 mm minimum thickness) shall be used on external face (outer face) of cladding system. Weight of coating shall not be less than 150 gm / sq.m. The outer side (exposed face) shall be permanently colour coated with Polyfluro Vinyl Coating (PVF2) of Dry Film Thickness (DFT) 20 microns (min) over primer. Inner side of external sheet shall be provided with suitable pre-coating of minimum 7 microns.	
3.1.2	Galvanised M.S.sheets of minimum 0.6 mm thickness shall be used as inner liner (internal face) of cladding system. The exposed face shall be permanently colour coated with silicon modified polyester paint of DFT 20 microns (min) over primer. Inner face of external sheet shall be provided with suitable pre-coating of minimum 7 microns. The rate of galvanisation shall not be less than 150 gm / sq.m.	
3.1.3	The permanent colour coated sheet shall meet the general requirements of IS:14246 and shall conform to class 3 for the durability.	
3.1.4	Inner sheet shall fixed directly to side runners and Z spacers made of atleast 2 mm thick galvanised steel sheet of grade 375 as per IS:277. Inner sheet shall be fixed at the rate not more than 1.50 m centre to centre to hold the insulation and external sheeting.	
3.1.5	The insulation shall be of bonded mineral wool of minimum thickness 50 mm conforming to IS:8183, having a density of 32 kg / cum for glass wool & 48 kg / cum for rock wool.	
3.2	Permanent colour coated (non-insulated) metal cladding system	
3.2.1	Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S.sheets having 0.6 mm minimum thickness (or High tensile steel sheet of 0.5 mm minimum thickness) shall be used for the cladding system. The outside (exposed face) shall be permanently colour coated with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 10 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.	
3.3	Flashings, caps, trim closures etc	
	All flashings, trim closures, caps etc. required for the metal cladding system shall be made out of plain sheets having same material and coating specification as mentioned above for the outer face of the sandwiched metal cladding.	

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	<p>4. PLASTERING</p> <p>4.1 Details furnished below does not include special types of plaster / plaster finishes which may be provided to enhance the architectural appeal. CONTRACTOR shall provide such superior plaster finish as indicated in his Bid.</p> <p>4.2 External face of all walls shall be provided with 20 mm thick cement mortar plastering with an under layer 14 mm thick in CM 1:6 and top 6 mm thick layer in CM 1:4 with approved water proofing compound.</p> <p>4.3 For internal walls 18 mm thick plaster in CM 1:6 shall be provided on the uneven side of the wall and 13 mm thick plaster in CM 1:6 on the even side of the wall.</p> <p>4.4 Inside surfaces of walls shall be provided with 2 mm thick plaster of paris punning over the plastered surfaces in office areas, entrance lobby, corridor, control equipment room and all other air conditioned rooms.</p> <p>4.5 Ceiling of all buildings except in cable vaults and over false ceilings shall be given 6 mm thick cement sand plaster 1:3</p> <p>4.6 All plastering work shall conform to IS:1661.</p> <p>5. PAINTING</p> <p>5.1 Details furnished here in below are the minimum acceptable standard for painting. Superior finish if any required by CONTRACTOR to enhance overall appearance will be permitted if such finish meet with the technical requirements.</p> <p>5.2 Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades, etc.</p> <p>5.3 Inside surfaces shall be provided with Acrylic emulsion paint as per IS:5411 for Control room, Control equipment rooms, all air conditioned areas and all other areas and above dado in buildings like time office, canteen, first aid centre, toilets etc.</p> <p>5.4 Inside surfaces shall be provided with oil bound distemper as per IS:428 for plant buildings like Workshop, Permanent stores, D.G. house, Compressor house, pump houses, Ash handling pump house etc.</p> <p>5.5 Walls in D.M.Plant shall be provided with chlorinated rubber based paint as per IS : 9862 over walls. Walls above Dado in battery rooms shall also be provided with similar painting.</p> <p>5.6 All plastered ceilings shall provided with water bound distemper.</p> <p>5.7 Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.</p> <p>5.8 All wood work shall be provided with fire resistant transparent paint as per IS162 over french polish as per IS:348 or flat oil paint as per IS:137.</p>	

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5.9 Painting for structural steel have been specified else where in this document..

5.10 Following general instruction for painting shall be followed.

- i) For painting on concrete, masonry and plastered surfaces IS:2395 parts I and II shall be followed.
- ii) For painting on wood work IS:2338 part I & II shall be followed.
- iii) All paints shall be of brand and make to the approval of OWNER.
- iv) A minimum of two finishing coats of paint over a coat of primer shall be provided to give a smooth uniform finish for the painted surface.
- v) All painting on masonry or concrete surfaces shall preferably be applied by rollers.
- vii) Thinner shall not be used with textured paint (sandtex matt etc) finish.
- viii) All fire exits shall be painted in Post office red colour shade which shall not be used any where except to indicate emergency or safety measure.


6. **ROOF**


6.1 All the buildings having R.C.C slabs over structural steel framing are provided with troughed metal sheet decking which acts as permanent shuttering. These sheets shall meet the general requirements of IS:14246 and shall conform to class 3 for durability. The sheeting shall be permanently colour coated galvanised M.S. troughed metal sheet decking of approved profile with minimum base metal thickness of 0.8 mm and minimum trough depth of 38mm. Silicon modified polyester painting shall be used for permanent coating over galvanised surface with minimum rate of galvanising of 180 gm of zinc per sq.m. Dry film thickness of colour coating shall be at least 20 micron.


6.2 Roof of all buildings having R.C.C. frame work shall have cast in situ R.C.C. slab with conventional shuttering.


6.3 Roof of conveyor galleries and steam generator shall be of permanently colour coated galvanised M.S. troughed metal sheet of approved profile. Minimum base metal thickness shall be 0.8 mm. The rate of zinc consumption for galvanising shall be 275 gm/sq.m. The external face shall have permanent colour coating of PVF2 paint of minimum DFT of 20 microns and inner surface shall be coated with silicon modified polyester paint with DFT of 20 microns.


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	<p>7. ROOF DRAINAGE AND WATER PROOFING</p> <p>7.1 For efficient drainage of rain water, roof concrete shall be given a gradient of a minimum of 1 in 100. The gradient shall preferably provided by sloping the structural framing system itself. Gradient may also be provided using screed concrete 1:2:4 using 12.5 mm downgraded aggregate. But the average thickness of such screed concrete may be restricted to about 50 mm. In the case of metal roofing system the roof slope shall be 1 vertical: 3 horizontal.</p> <p>7.2 All Roofs shall be provided with high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5 mm. The treatment includes application of polymerised mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40 mm screed of 1:2:4 concrete as above cast in panels of 1.2mx1.2m and reinforced with 0.56 mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provide with chequered cement tiles as above.</p> <p>7.3 Number and size of rain water down comer pipe shall be decided based on the provisions of IS:1742 and IS:2527. The pipes shall be HDPE pipe conforming to IS:4985. It is recommended that the minimum diameter of the pipe be kept as 150 mm and there shall be a minimum of two pipes provided on each gutter. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.</p> <p>8. FALSE CEILING AND UNDER DECK INSULATION</p> <p>8.1 All air conditioned areas, entrance lobbies and corridors in Service building as well as Administrative building shall be provided with the suspended false ceiling system. Under deck insulation system shall be provided on the under side of the roof / floor slab of the air conditioned areas based on the functional requirement. Ceiling of air washer room also shall be provided with under deck insulation.</p> <p>8.2 Aluminium false ceiling system shall comprise of 84 mm wide 12.5 mm deep closed type plain panels of approved colour, roll formed out of 0.5 mm thick corrosion resistant aluminium alloy AA 5050 fixed on roll formed carriers. Additional hangers and height adjustment clips shall be provided for return air grills, supply air diffusers, light fixtures, AC ducts etc.</p> <p>8.3 Gyp board false ceiling system shall consist of 600x600x12.5 mm gyp board with one coat of primer and two or more coats of acrylic emulsion paint. The suspension system shall consist of 6 mm dia galvanised steel rods suspended from ceiling supporting aluminium grid of 38x25x1.5 mm and cross tie of 25x25x1.5 mm and aluminium angle of 25x25x1.5 mm.</p>	

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8.4	Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.	
8.5	CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.	
8.6	Under deck insulation shall comprise of 50 thick resin bonded mineral wool insulation mat conforming to IS:8183. This mat shall be backed with 0.05 mm thick aluminium foil and 24 Gx25 mm wire mesh netting. They shall be fixed to ceiling or wall as the case may be with 100x50x6 slotted mild steel plate welded to M.S. plate inserts embedded at the soffit of the slab at 600 mm c/c and 14 G steel wire drawn through slots and fixed to wire netting.	
9.	DOORS & WINDOWS	
9.1	Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, electro colour coated (anodised) aluminium framework with glazing. All doors of office areas shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.	
9.2	Main entrance of the control room and control equipment room shall be provided with air-locked lobby with provision of double doors of aluminium frame work with glazing. Doors shall be of double swing type or sliding type.	
9.3	For common control building, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned areas and on the side of control room and control equipment room(s) facing the operating floor to have a clear view.	
9.4	Single glazed panels with aluminium frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.	
9.5	Coal conveyor galleries shall have steel windows/ventilators.	
9.6	All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc.	

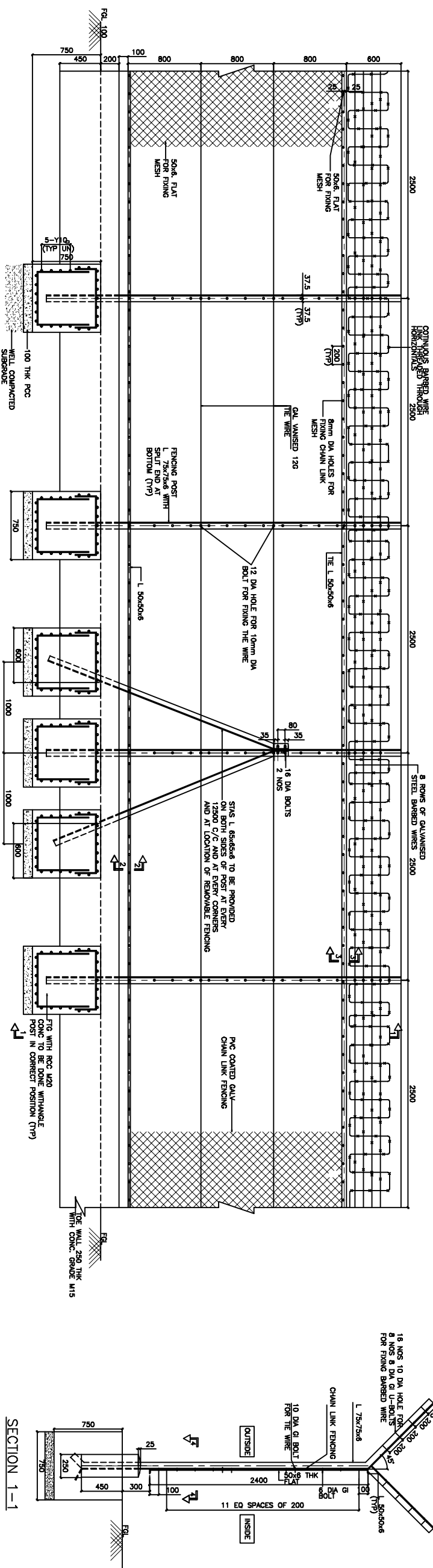
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	<p>9.7 Steel windows and ventilators for coal conveyor gallery shall be as per IS:1361 and for all other areas as per IS:1038. Windows of coal galleries shall be provided with wire mesh.</p> <p>9.8 Wherever functionally required rolling shutters with suitable operating arrangement Manual / Electric shall be provided to facilitate smooth operations. Rolling shutters shall conform to IS:6248.</p> <p>9.9 All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodised aluminium grill.</p> <p>9.10 Fire proof doors with panic devices shall be provided at all fire exit points as per the recommendations of Tariff Advisory Committee (TAC). These doors shall generally be as per IS:3614 (Part I and Part II). Fire rating of the doors shall be as per TAC requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.</p> <p>9.11 Hollow extruded section of minimum 3 mm wall thickness as manufactured by INDAL or equivalent shall be used for all aluminium doors, windows and ventilators.</p> <p>10. GLAZING</p> <p>10.1 All ventilators and windows on external face of turbine building, conveyor gallery, pump house, compressor house, DG set building, transfer points, workshop building, fire escape staircase and those buildings located in fire prone areas shall be provided with wired glass of minimum 6 mm thickness conforming IS:5437.</p> <p>10.2 Where specified, double glazing shall consist of two 6 mm thick clear toughened safety glass conforming to IS:2553, hermetically sealed and separated by 12 mm thick gap for thermal insulation.</p> <p>10.3 For single glazed aluminium partitions and doors, Float glass or flat transparent sheet glass of minimum 5.5 mm thickness shall be used.</p> <p>10.4 Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.</p> <p>10.5 Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.</p> <p>10.6 Float glass or flat transparent sheet glass shall conform to IS:2835.</p> <p>10.7 All glazing work shall conform to IS:1083 and IS:3548.</p> <p>11. WATER SUPPLY AND SANITATION</p> <p>11.1 Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. Polyethylene water storage tank conforming to IS:12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.</p>	

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	<p>11.2 Galvanised M.S. pipe of medium class conforming to IS:1239 shall be used for internal piping works for potable water supply.</p> <p>11.3 Sand C.I.pipes with lead joints conforming to IS:1729 shall be used for sanitary works above ground level.</p> <p>11.4 Minimum one toilet block with all the facilities shall be provided on each floor of main plant building and service building. Separate toilets for ladies shall be provided wherever required. Attached toilets shall be provided for all senior executive rooms and conference rooms. One toilet shall be provided in the boiler area. All other buildings where toilet is specified shall have one toilet block each. The facilities provided in the toilet block shall depend on the number of users. However, minimum facilities to be provided shall be as stipulated below. IS:1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS:2064 and IS:2065 shall also be followed.</p> <p>11.5 Each toilet block shall have the following minimum facilities. Unless specified all the fittings shall be of chromium plated brass (fancy type).</p> <ul style="list-style-type: none"> i) WC (Indian type) Orissa pattern (580x440mm) as per IS:2556 (Part-3) with all fittings including flushing arrangement of appropriate capacity and type-1 no. ii) WC western type 390 mm high as per IS:2556 (part 2) with toilet paper roll holder and all fittings including flushing system of appropriate capacity and type – 1 no. iii) Urinal with all fittings with photo voltaic control flushing system as per IS:2556 (Part-6, Sec.1) – 2 nos. iv) Wash basin (oval shape) with all fittings as per IS:2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone – 2 nos. v) Wall to wall Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings. vi) Stainless steel towel rail (600 x 20mm) - 2 nos. vii) Stainless steel liquid soap holder cum dispenser – 2 nos. viii) Janitor room. ix) Provision for installation of water cooler. x) Provision of ventilation shaft. <p>11.6 Attached toilets provided for senior executive rooms and conference rooms shall have 1 WC, 1 urinal, 1 washbasin, 1 mirror, 1 no. towel rail, 1 liquid soap holder cum dispenser. WC shall be of western type 390 mm high as per IS:2556(Part-2) with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and type.</p> <p>11.7 Boiler area toilet shall have minimum 2 no. WC (Indian type), 4 no.urinals, 4 no.wash basins, 4 no. mirrors, 4 no.towel rails, 4 no. soap holder cum dispenser, 2 no.Showers, janitor room and a provision for installation of water cooler.</p>	

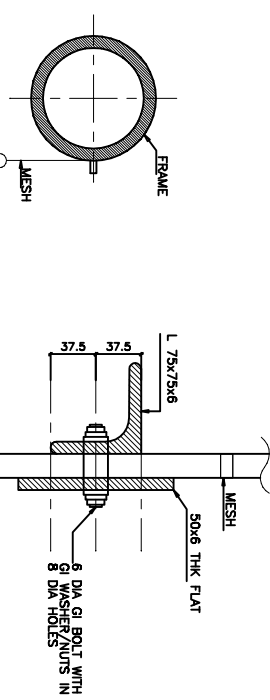
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11.8	An eye & face fountain (combined unit with receptacle) conforming to IS:10592 shall be provided in battery room, D.M plant and Chlorination plant.		
11.9	Unless specified all fittings and fixtures in the toilets shall have same specifications as stipulated in Cl.No.11.5		
11.10	Stainless steel kitchen sink (750 mm size) for pantry shall be provided. Platform in pantry shall be finished with 12 mm thick polished granite stone.		
11.11	Laboratory sink shall be of white vitreous china of size 600x400x200 mm conforming to IS:2556(Part-5) in laboratories and in Battery room.		
11.12	In Main Turbine building, Service building and Administrative building at least one toilet block shall be provided for ladies.		
12.	MISCELLANEOUS REQUIREMENTS		
12.1	Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening. Projection of sunshade from the wall shall be minimum 600 mm over window openings, 750 mm over door openings and 1200 mm over rolling shutters.		
12.2	Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.		
12.3	No cable trenches shall be provided in TG hall, Boiler/ESP area, fuel oil pump house, Ash pump houses etc.		
12.4	Duct banks consisting of MS/PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.		
12.5	All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.		
12.6	All openings in external walls provided for pipes, cables, ducts etc. shall be effectively sealed to prevent water seepage, after the routing of the services are completed.		
12.7	Natural lighting & Ventilation		
12.7.1	The area of windows shall be a minimum 15 % of the floor area to ensure adequate natural lighting.		
12.7.2	Fans shall be provided in general office area as per standard norms.		
12.8	Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.		

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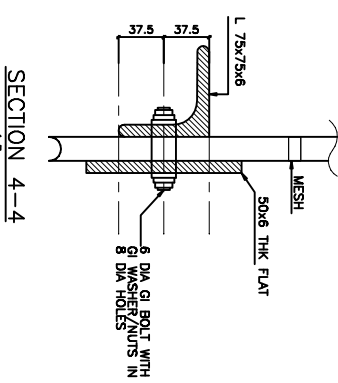
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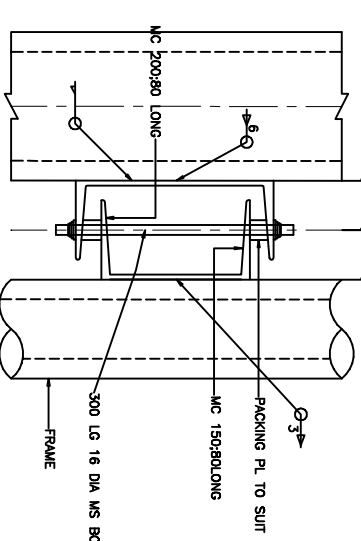
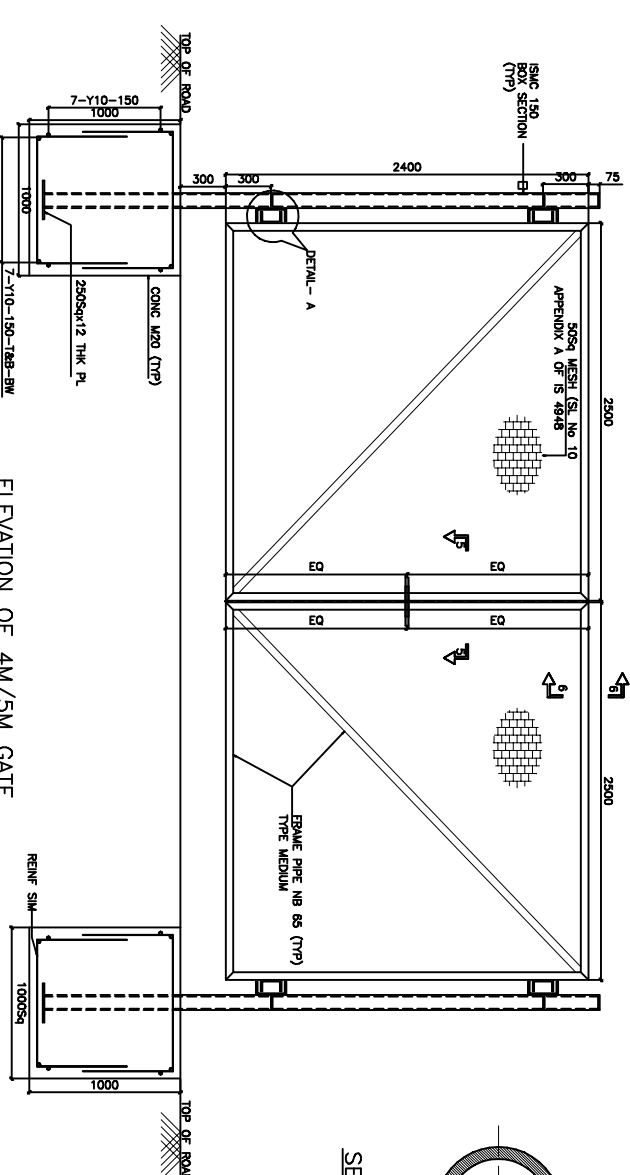
SECTION 1-1



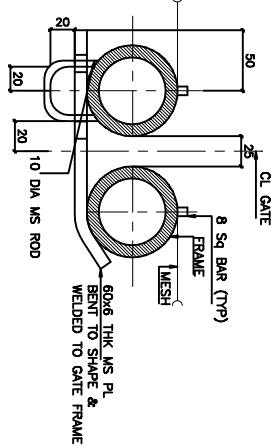
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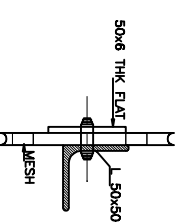
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DETAIL--A

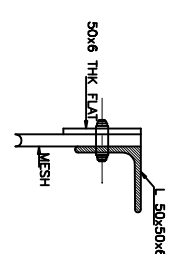
ELEVATION OF 4M/5M GATE



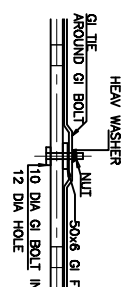
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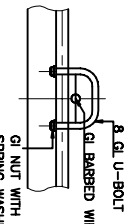
SECTION 2-



SECTION 3-3



FIXING OF THE WIRE



FIXING DET OF BARBED WIRE

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