

TENDER SPECIFICATION

BHEL PSSR SCT 1270

**CONSTRUCTION OF FOUNDATIONS FOR BOILER, ESP,
MILL, MILL BAY, TG Etc.**

FOR

1 X 500 MW TPS

FOR

KPCL

BELLARY, KARNATAKA

**VOLUME – II
BOOK 1**

**TECHNICAL SPECIFICATION
BOOK NO**



**BHARAT HEAVY ELECTRICALS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
POWER SECTOR – SOUTHERN REGION
690,ANNA SALAI, NANDANAM, CHENNAI – 600 035**

**CONSTRUCTION OF FOUNDATIONS FOR BOILER, ESP,
MILL, MILL BAY, TG Etc.**

FOR

1X500 MW BELLARY TPS – UNIT 2

VOLUME: II

CUSTOMER SPECIFICATION

**Vol V- CIVIL WORKS
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1. This contract is to cover design, preparation of general arrangement, construction as well as Fabrication drawings, supply of all labour as well as materials and construction of all civil, structural as well as architectural work on Supply contract basis for the 1 x 500 MW Stage - 2, Bellary Thermal Power Project being set up at Kudatini village, Bellary District, promoted by M/s Karnataka Power Corporation Limited (KPCL) in the state of Karnataka.
2. Description of various items of work under this contract and nature of work in detail are given hereinafter. The complete work under this scope is referred to as CIVIL WORKS. List of various civil works covered under the scope is given in Section D4.2.
3. The work to be performed under this contract consists of design, engineering as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications and including revisions and amendments thereto as may be required during the execution of the work.
4. All materials including cement, reinforcement steel, structural steel etc. shall be arranged by the CONTRACTOR.
5. The scope shall also include setting up by the CONTRACTOR a complete testing laboratory in the field to carry out all relevant tests as per BIS or other international standards required for the civil works for the project.
6. The work shall be carried out according to the design/drawings to be developed by the CONTRACTOR and approved by the OWNER. For all building and structures, foundations, etc., necessary layout and details are to be developed by the CONTRACTOR keeping in view the statutory & functional requirements of the plant & facilities and providing enough space & access for operation, use & maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the CONTRACTOR's offer shall cover the complete requirements as per the best prevailing practice and to the complete satisfaction of the OWNER.



7. Wherever excavation is to be carried out in the vicinity of existing structures care shall be taken for the safety of the structures by resorting to controlled blasting.
- 8 CONTRACTOR shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials, water etc., and their rates, local working conditions, weather, flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of a bid by the CONTRACTOR will be construed as evidence that, such an examination was made and any later claims / disputes in this regard to rates / lumpsum amount quoted shall not be entertained or considered by the OWNER.

9.0 GEO-TECHNICAL INVESTIGATION

- 9.1 A detailed Geo-technical Investigation has been carried out at the site by the OWNER and the report is being made available to the CONTRACTOR. However, this along with the recommendation given in para 8.2 here below shall be considered by the CONTRACTOR

The detailed soil investigation carried out by the contractor for Unit -1 duly approved by the owner shall be generally considered for the design. However, for any variation in the soil parameters, foundation parameters between the detailed geo-technical investigation carried out by the owner for Unit- 2 and that carried out by the contractor for Unit-1, the stringent values of the two shall be considered for design. The CONTRACTOR is not eligible to increase his cost or demand any extension of time on this account or variance with the actual site conditions during execution of works.

Boreholes have been sunk to a maximum depth of 15 m in Main plant area. It is observed from these bore logs / soil investigation report that subsoil strata in this generally comprise of top layer of gravely sandy silt with depths varying from 1.0 to 2.0 m below ground level. A layer of gravel, depth varying from 0.5 to 1.0 m is also encountered below the top layer/ ground level. Very poor rock has been observed from depths varying from 2.0 to 2.5 m below ground level. No ground water table is observed when the work was carried out during January / February 2006. Ascertaining the depth of rock will be the sole responsibility of the CONTRACTOR.



For all major structures like Station Building, TG foundation, Boiler Foundations, Chimney, etc., and all other heavily loaded structures foundations may be isolated or combined footings or raft foundations depending upon the type and requirement of the structure as well as loads, spacing and configuration of columns. Foundation depth can be generally about 2.0 to 3.0m below existing ground level. Net Safe Bearing Capacity for shallow foundations can be taken as 25 t/m² at 2.0 m depth and 40 t/m² at 3.0 m depth. However, any variation in any of the soil parameters or foundation parameters shall be taken care of by the CONTRACTOR while finalising the designs, without any extra cost. For load bearing walls or filler walls spread foundation can be adopted.

10.0 SURVEY DATA

The OWNER has carried out a detailed survey of the plant area and drawings indicating the survey detail along with contour were furnished to the contractor during the execution of Unit - 1. The same shall be treated as for reference only. It is the responsibility of the CONTRACTOR, to verify the various features on his own. The OWNER does not take any responsibility for correctness of various features / contour shown on the drawing. The CONTRACTOR is not eligible for any extra cost or any extension of time, if the results from his detailed survey and actual conditions at site are at variance to any extent from the ground levels derived from the drawing furnished by the owner.

11.0 The grade levels for different areas shall be as followed for Unit -1 viz.

(a)	Main Plant	RL 476.00
(b)	CHP	RL 475.50
(c)	Cooling tower area	RL 473.00

12.0 STATUTORY REQUIREMENT

CONTRACTOR shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Tariff Advisory Committee, Water act for Pollution control Board, Explosives act etc. Provisions of Safety, health and welfare according to Factories act shall also be complied with. Statutory clearances and norms of State Pollution Control Board shall be followed. CONTRACTOR shall obtain approval of Civil / Architectural drawings from concerned authorities before taking up the construction work.

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TITLE

GENERAL

SECTION: D4.1

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- 13.0 In case the contractor fails to achieve the targeted progress as stipulated due to non-procurement / arrangement of materials like Steel (Reinforcement / Structural), Aggregates, Cement, Centering & shuttering , Machinery , Labour(Skilled / Unskilled) etc., KPCL reserves the right to arrange for the above at the risk and cost of the contractor.

<p>TDBT2 EPC / S</p> 	<p>KARNATAKA POWER CORPORATION LTD</p>	<p>VOLUME C 1 - V</p> <p>SECTION: D4.2</p> <p>SHEET 1 OF 3</p>
<p>TITLE</p> <p>SCOPE OF WORK</p>		
<p>1.0</p> <p>1.1</p> <p>1.2</p> <p>1.3</p> <p>1.4</p>	<p>The work covered in this section consists of collection of all site related data, design, preparation of all construction drawings, supply of all materials, construction, fabrication, erection and testing wherever necessary, of all structures required for housing all equipment and civil works for all services required for Power Plant defined in the bid document. The Civil works shall include those required for Installation, Commissioning, testing, operation and maintenance of the Power Plant. The Scope will cover but not limited to the following buildings / structure / systems / facilities etc.,</p> <p>Site development works wherever required:</p> <p>Site clearance including diversion of existing services: Any modification or diversion of existing nallas is in the scope of the CONTRACTOR, as per the requirement of their layout, with the approval of the owner. The nalla shall be protected in such a way that HFL shall not flood the plant area. The requirement of clause 2.6 shall also be adhered to. The natural course of the nalla shall be maintained to the extent possible and as approved by the OWNER.</p> <p>Site grading: The graded level in Unit 2 main Plant area is about 476.50 m. Further grading required will be done by the Contractor. For other areas such as Switchyard, Coal stock Pile, Chimney, Cooling tower and other facilities & buildings grading shall be carried out to the levels as done for Unit 1.</p> <p>Engineering & overall layout of all Roads, drains and cross drainage works in the unit 2 area will be carried out by the CONTRACTOR . The roads in this area shall be constructed by KPCL. However, CONTRACTOR shall provide roads and drains with cross drainage works including finishing etc., complete in coal handling plant area as done for Unit 1. Temporary roads required for construction purpose and its routine maintenance shall be done by the CONTRACTOR.</p> <p>Construction enabling works</p> <p>Steam Turbine Generator building</p>	
<p>BTPS Unit 2 071206</p>		



- 1.5 Control room / Electrical bay structures
- 1.6 Steam generator / ESP / Duct supporting structures
- 1.7 Mill and Bunker building including bunkers
- 1.8 Steam Generator elevator supporting structure
- 1.9 ESP Control / Switch gear rooms
- 1.10 RCC Chimney
- 1.11 Steam generator area paving
- 1.12 Transformer yard structures
- 1.13 Switch yard
- 1.14 Coal handling system
- 1.15 Ash handling system
- 1.16 Mill reject handling system
- 1.17 D. M. Plant
- 1.18 Condenser cooling water system
- 1.19 Cooling tower
- 1.20 Miscellaneous plant buildings
Air Washer Building.
Diesel generator house with provision for one additional D.G.set-
AC plant
- 1.21 **Service water overhead tank** & potable water overhead tank
- 1.22 Effluent treatment plant structures
- 1.23 Pipe and cable racks
- 1.24 Railway tracks inside maintenance building (from inlet to maintenance building) and transformer tracks in transformer yard and ODY.
- 2.0 It is not the intent to specify herein all the works in the scope of this contract. The scope also includes all other buildings, structures and works necessary which are not specifically mentioned here but required for construction, operation and maintenance of the power plant are deemed to be included in the scope of the CONTRACTOR. All works shall conform to the specification. The works shall conform to high standards of design, engineering and



workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detail specification.

NOTE: Wherever any component is not included in the list of scope of civil works and / or exclusions and also wherever the details are not furnished in their offer, the CONTRACTOR shall carry out the works as per stipulations.



TITLE

**DOCUMENTS TO BE SUBMITTED AFTER THE
AWARD OF WORK**

The following documents are to be submitted for the approval of the OWNER, prior to commencement of fabrication & erection / construction. All drawings shall be of standard sizes (Metric system) and shall be made on AUTOCAD Version 2000 and its latest version in executable format.

1. General plant layout drawing with Co-ordinates of roads, boundary wall, watch tower buildings and facilities, piping / cable corridors, pipe and cable trestles, provision of landscaping and green belt development, diversion roads and drains, equipment lay down areas etc.
2. Drawing showing underground facilities with coordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps pits, culverts, foundations etc.,
3. Site grading and storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc for storm water drainage system.
4. Study note on disposal of sewage and other effluent from the plant to satisfy the statutory requirement.
5. Separate design memorandum reports shall be submitted for (1) Civil and structural works for main & aux plant (2) NDCT (3) chimney (4) Coal handling Plant shall be submitted. Designs shall commence only after approval of memorandum.
6. Architectural floor plans, elevations, cross sections and perspective view in colour of all buildings shall match with Unit 1
7. Design calculations and drawings for foundations / substructure and superstructure of all buildings including pump houses and other structures.
8. Design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads like foundations for TG, BFP, Mill, Fans (PA, FD, ID) etc., Design and drawing of vibration isolation system shall also be furnished.
9. Design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road/rail crossings, drainage pump house (if required), drains, sewers, sewage pump house, sewage treatment plant, water supply, water tank, sumps, tunnels, trenches, ducts etc.,




TITLE **DOCUMENTS TO BE SUBMITTED AFTER THE
AWARD OF WORK**

10. Drawings of all architectural works including finishing schedule, colour schemes (both internal and external), doors & windows, flooring and false ceiling etc.,
11. Design calculations and drawings for plumbing and building drainage.
12. Design calculations and drawings for switchyard structures, transformer yard, etc.
13. Design calculations and drawings for structures pertaining to Cooling Water System.
14. Design calculations and drawings for civil structures/works associated with fuel oil handling system, ash handling system, coal handling system etc.
15. All other designs, details/drawings or any other submissions as indicated else wherein this specification and as required by the OWNER.
16. Details of corrosion protection measures for all structures.
17. Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) shall be indicated in all construction drawings.
18. All design and drawings for the Cooling tower basin supports etc.
19. All design and drawings for RCC chimney.
20. All design calculations and drawings for Boiler and ESP structures.
21. Designs for structural steel connections and detailed fabrication drawings to be furnished before commencement of work.
22. Construction and erection procedure for all major structure with specific reference to main plant building, bunker structures, transfer towers, conveyor galleries, TG foundation and other machine foundations.
23. Write-up on various statutory requirements and their compliance for various buildings and facilities.

**TITLE DOCUMENTS TO BE SUBMITTED AFTER THE
AWARD OF WORK**

24. Quality assurance and Quality Control procedures.
- 25 Soft copy (executable files) of all STAAD-PRO (or other software) packages and excel files used for analysis & design shall be submitted. Also typical hand calculations to validate the computer generated calculations shall be furnished.

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DESCRIPTION OF BUILDING, STRUCTURES AND FACILITIES

Following structures / buildings / areas / facilities are to be included in the contract. The description against each building / system is indicative only and not exhaustive. Although almost all the systems are covered here, but any other system (Civil, Structural and Architectural) required for successful completion of the project shall form a part of this contract and shall deemed to be included in the scope of works.

1.0 SITE RELATED INVESTIGATION


1.1 Topographical surveying


1.1.1 Precision Surveying shall be carried out under the direction and control of a Licensed Land Surveyor. Precision theodolites shall be of one second accuracy. Self-aligning levels shall be used for precision level survey. All Bench Mark (BM) levels of the survey shall be established with reference to the nearest GTS bench mark available. Precision levelling shall be carried out for establishing the BM at site by carrying levels from GTS BM adopting double circuit levelling.


1.1.2 All boundary lines shall be located with their distances, included angle and bearings and boundary pillars constructed. Number of pillars shall be adequate to mark the boundary limits without any dispute. A closed traverse survey shall be carried out with theodolite to form the framework for the detailed survey work.


1.1.3 Two reference line, North-South line and East-West line at right angles to each other shall be established with grid pillars constructed at 200 metres c/c in both directions in such a way that these pillars will not be disturbed during construction. Coordinates shall be painted on these grid pillars. Pillars shall also be painted using synthetic enamel paint for easy identification. Bench mark pillars shall be provided atleast at 6 locations. These pillars shall be properly protected to prevent their disturbance during construction activities. BM shall be distinguished from grid pillars with different type of painting.


1.1.4 Spot levels shall be taken in a grid of 5 metres and contours shall be established at an interval of 500 mm depending on the terrain. All Contour levels shall be with respect to MSL.


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<p>2.0 SITE DEVELOPMENT WORK</p> <p>2.1 Site clearance</p> <p>2.1.1 The plant and building areas in the site shall be cleared of all trees, shrubs or other vegetation, rubbish, slush etc and other objectionable matters. If any roots or stumps of trees are met during excavation, they shall also be removed. Where earth fill is intended, the area shall be stripped of all loose / soft patches or top soil containing objectionable matter before filling commences. Any structure or services existing at the site shall be removed / re-routed with the permission of the OWNER. Existing wells, pits, marshy areas etc., shall be filled up with earth of approved quality.</p> <p>2.1.2 The CONTRACTOR shall be deemed to have visited and carefully examined the site and surroundings and to have satisfied himself about the nature of the existing structures, underground services, general site conditions, the site for disposal of surplus materials, debris etc.(The useful and un-useful surplus materials out of site grading / excavation shall be dumped in their respective specified dump areas) and all other items affecting the work. Claims due to ignorance of site conditions will not be considered after submission of the Bid.</p> <p>2.1.3 The unusable materials obtained from the excavation of all components of unit 2 and dumped materials, if any, in the proposed Unit 2 area (during execution of Unit 1), shall be disposed off to the dump area to be identified outside the BTPS Complex and possession of the same shall be taken by the contractor or disposed off in the borrow area of Ash pond / Raw water pond, which is about 5 Km from the plant.</p> <p>2.2 Site grading</p> <p>The grade levels for all the areas shall generally be as that of Unit -1, ie., 476.00, 475.50 & 473.00 for Main plant/ switchyard, coal handling area & cooling tower area respectively.</p> <p>BTPS Unit 2 071206</p>		


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<p>2.3 Storm water drainage:</p> <p>2.3.1 The drainage system shall be designed for a maximum hourly rainfall of 70 mm. Run off coefficient for paved and unpaved areas shall be taken as 0.9 and 0.6 respectively.</p> <p>2.3.2 Storm water drainage system for non-plant area shall be designed in two parts.</p> <p>(i) Main drains</p> <p>(ii) Auxiliary drains</p> <p>Main drains shall be designed as a network covering total plant area and shall ultimately be led to nearest natural Nala. Auxiliary / branch drains shall cover individual graded terraces to collect discharge from plant buildings and shall connect to main drain at suitable locations.</p> <p>2.3.3 Drainage for plant effluent and storm water shall be carried by gravity. The drains shall generally be open type and constructed of RCC or brick. RCC pipe culverts / box culverts shall carry drainage under roads.</p> <p>2.3.4 At places where covered drainage system is required, channels with removable cover shall be preferred to piping system, as piped system tend to get blocked. Underground storm water piping shall be restricted strictly to areas where surface drains are not desirable or practicable from functional point of view.</p> <p>2.3.5 Drainage shall be provided where necessary to prevent ponding and ground erosion and to carry surface water away from building, structures and other works including roads, building or equipment foundations.</p> <p>2.3.6 The storm water drainage for the contaminated area such as coal stack pile etc., shall be designed separately and the discharge shall be led separately for treatment and disposal.</p> <p>2.4 Sewage / Waste water drainage</p> <p>2.4.1 For plant area sanitary sewage disposal, separate septic tanks shall be provided at suitable locations for each building block..</p> <p>BTPS Unit 2 071206</p>		

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<p>Effluent / Sewage from septic tanks shall be connected to the combined sewage treatment plant of Unit 1 where adequate capacity is taken care of for unit 2 effluent / sewage also. The treated effluent shall conform to the requirements of Pollution Control Board.</p> <p>2.4.2 Waste water generated from the plant and Canteen waste water shall be treated in sewage treatment system. The treated effluent shall be used for watering the trees and maintenance of green belt area. Provision shall also be made for collection and disposal of solid waste. Generally, salt glazed stone ware pipes shall be used to carry sewage / waste water where pipes are laid in original ground. Where pipes are to be laid on filled up soil or below roads / paved areas Cast iron pipes shall be used. They shall be encased in concrete at road crossings. Manholes shall be provided at junctions and at points of change of direction. In straight stretches manhole shall be provided at a maximum spacing of 30metres.</p> <p>2.5 Existing Nallahs</p> <p>Existing Nallahs within the plant area shall be retained in their original course to the extent possible with required modifications including trimming, lining, etc by the Contractor. This para shall be read in conjunction with clause 1.2 of section D 4.2.</p> <p>3.0 CONSTRUCTION ENABLING WORKS</p> <p>3.1 Construction water:</p> <p>The Construction water will be arranged by the owner free of cost at ground level reservoir of 500 cum capacity within the plant area. Arrangements for drawing the water from ground level reservoir and distribution of pipe line network for various locations as required shall be arranged by the Contractor at his own cost. In case of shortage of water, the Contractor has to make alternative arrangements at his own cost.</p> <p>3.2 Temporary site building</p> <p>The CONTRACTOR shall provide for, at his cost, the following building facilities for proper execution and quality control of the job, while meeting the provisions stipulated by Factory Rules regarding staff welfare facilities. All these building shall have brick cladding,</p>		
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<p>AC sheet roofing over steel roof truss with cement concrete flooring and false ceiling with A/C as required. The facilities indicated are only for CONTRACTOR's use.</p> <p>3.2.1 Stores</p> <p>A covered store shall be provided with brick cladding and A.C/G.I/colour coated sheeting to store at least one-month requirement of cement by the CONTRACTOR. Cement in bags shall be stored on a raised floor well away from outer walls and insulated from the floor to avoid moisture. Not more than 15 bags shall be stacked in any tier. Each consignment of cement shall be stored separately and consumed in its order of receipt.</p> <p>3.2.2 Covered storage area may also be provided to store other construction material, which will be affected on exposure to wind, sun and rain.</p> <p>3.2.3 Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.</p> <p>3.2.4 Storage yard paved or unpaved shall be provided within the stores complex for storage of other material.</p> <p>3.2.5 Proper fencing and security arrangement shall be provided for the stores complex.</p> <p>3.3 Temporary Workshop and Garage</p> <p>The CONTRACTOR shall provide for a temporary workshop and garage to attend to routine maintenance and repair of the construction equipment as well as his fleet of vehicles used for construction activities.</p> <p>3.4 Fabrication yard</p> <p>Depending on the extent of fabrication envisaged at site, the CONTRACTOR shall establish a full fledged structural fabrication yard with adequate handling facility during and after the fabrication. A fully equipped testing laboratory providing radiography, ultrasonic, dye penetration, magnetic particle test facilities shall be ensured adjacent to the fabrication yard to enforce strict quality control. Portion of the yard shall have covered shed with H.O.T /</p> <p>BTPS Unit 2 071206</p>		

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<p>E.O.T cranes, so that, fabrication work can proceed even during inclement weather.</p> <p>3.5 Quality control laboratory</p> <p>A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes etc. This laboratory shall be housed in a covered building with A/C facility as required by the testing facility. All testing equipment shall be periodically calibrated to the satisfaction of the OWNER. All the sampling and testing shall be done in the presence of OWNER's representative and the contractors shall abide by the observations of owners representative and rectification as suggested shall be effected. The owner shall have the right to carryout such tests independently, as and when so desired by the owner.</p> <p>3.6 Fuel storage area</p> <p>CONTRACTOR shall obtain necessary permission from competent authorities and establish and operate a POL outlet with proper storage, dispensing and adequate fire fighting facility.</p> <p>3.7 Staff Welfare facility</p> <p>3.7.1 CONTRACTOR shall provide adequate facility for his staff inside the plant boundary, such as, Toilets for both gents and ladies, Canteens, drinking water facility, rest places, creches etc.</p> <p>3.7.2 Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the CONTRACTOR's responsibility. He shall also provide for proper disposal of sewage and other wastewater to meet with the requirement of Pollution Control Board.</p> <p>3.8 CONTRACTOR shall identify sufficient area outside the plant boundary to locate his staff and labour colony. Construction and maintenance including insurance of the staff and labour colony to satisfy all statutory requirement is the sole responsibility of the CONTRACTOR.</p> <p>BTPS Unit 2 071206</p>		


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<p>4.0 STEAM TURBINE GENERATOR BUILDING</p> <p>4.1 Turbine building (TG Bay and Heater Bay) framing shall be of structural steel with moment connected framing in the transverse direction and bracing in the longitudinal direction.</p> <p>4.2 Service and maintenance bays shall not have any intermediate floors, however a 1500 mm wide observation gallery with hand rails shall be given along the wall at the operating floor level to observe the TG erection operation. Intermediate floors shall preferably be provided at 8.50 m and operating floor at 17.0 m. Floor at 8.50 m and operating level shall be RCC floors over steel framing, where as the floor at any other level, as required, may have chequered plate / gratings supported on structural steel frame work.</p> <p>4.3 Crane capacity and crane rail level shall be fixed based on the equipment to be lifted and the method of lifting generator stator. At crane girder top flange level a crane walkway shall be provided in line with Factory rules. Access shall be provided to crane walkway through staircase from operating floor in addition to cage ladder at two ends. Bottom level of roof framing shall be decided by the crane clearance required, duly taking into account clearance required for mounting light fixtures. Roofing shall consist of in-situ RCC slab of minimum 50 mm thickness laid to a slope of 1 in 100, constructed over permanently colour coated galvanised M.S troughed metal sheet of approved profile supported on steel purlins and trusses. Roof of Heater bay shall be of RCC slab over the steel roof beams. Over the TG Bay roof, monitor shall be provided with Exhaust system mounted on the side wall of the monitor. Sidewall at location of exhaust fan shall be of brickwork supported on the steel beam. Roof of the monitor shall be of RCC over steel beams. Side cladding and end cladding of monitor shall be of translucent sheets except in areas where fans are mounted.</p> <p>4.4 Cladding shall be of brickwall / concrete block supported on concrete encased steel wall beams, upto a height of 3000 mm above operating floor level on the transformer side as well as on gable ends. Walls in front of transformers shall be of adequate thickness to satisfy "fire rating" as per TAC regulations. On the Heater bay side the brickwall shall be provided upto 1 m above de-aerator floor level. Cladding beyond the above level shall be that of permanent colour coated sandwiched insulated metal cladding system.</p> <p>BTPS Unit 2 071206</p>		


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	<p>4.5 Windows shall be side-hung, steel glazed using 6 mm thick wired glass generally. However, in areas where cladding is of sheeting, fixed glazing in anodized aluminium frame work and in accessible areas sliding windows in anodized aluminium frame work using 6 mm thick wired glass shall be provided. All the doors on external walls shall be of double plate flush steel doors. For equipment entry into the service bay specially designed steel sliding cum folding / rolling shutters shall be provided with appropriate operating mechanism. Rolling shutter shall also be provided in front of condenser to facilitate tube removal.</p> <p>4.6 Staircases protected on all sides with fire proof enclosure shall be provided to satisfy Tarriff Advisory Committee regulations. All the doors leading to the inside of the power house from staircase shall be automatically closing fire proof door satisfying TAC regulations. Access cage ladders shall be given to T.G building roof.</p> <p>4.7 Roof shall be provided with Elastomeric liquid membrane treatment. To protect the liquid membrane, screed of min 25 mm thick shall be provided. HDPE rain water pipe of min 150 dia OD conforming to IS:4985 shall be provided to drain off the rain water from roof. They shall be suitably concealed from the facade.</p> <p>4.8 Thickness of structural RCC floor shall be <u>minimum</u> 150 mm above the steel floor beams for the intermediate floors with an additional 50 mm floor finish which shall be <u>provided</u> later.</p> <p>All the intermediate floors shall be provided with proper drainage. Catch pit with C.I grills shall be provided near the internal column in a regular pattern and the floor shall be sloped towards the catch pit by varying the thickness of the bedding concrete for the floor finish. Catch pits shall be at the same co-ordinate for all floor levels. 80 NB galvanised M.S pipes conforming to IS:1239 shall be provided to carry the drainage down. The pipes shall be clamped on to the intermediate column. Sumps shall be provided in ground floor to receive the water. Proper drainage arrangement shall be provided in the ground floor by means of RCC gravity channels with M.S grills on top. The drainage shall be led to sumps from where the water shall be pumped to plant drainage arrangement. Around equipment liable to frequent drainage, concrete kerb shall be provided to isolate the area and water shall be led through sump and channels to the floor drainage system. Oil water separator should be provided as required to isolate oil from the drainage water where the water is mixed with oil.</p>	
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<p>4.9 In operating floor the design live load shall be painted on the floors prominently showing the extent of the area where such loading is permitted.</p> <p>4.10 Wherever openings are provided in the floor for handling of equipments using EOT cranes such openings shall be covered with gratings provided over removable steel beams.</p> <p>4.11 Expansion joint shall be provided in the building to satisfy the requirements of IS:800 and IS:3414</p> <p>4.12 Foundations for major equipments like Turbo-generator and Boiler feed pump shall be mounted on properly designed vibration isolator system or conventional block / frame type RCC foundation. However, the foundation shall be isolated from the building frame work.</p> <p>5.0 CONTROL ROOM / ELECTRICAL BAY STRUCTURES</p> <p>5.1 The building framing shall be structural steel with moment connection in the transverse direction and bracing in longitudinal direction located by the side of turbine building. It shall be ensured that, in front of control room no cross bracing is provided.</p> <p>5.2 This building shall have minimum five floors. Ground floor houses cable vault, first floor houses LT and HT Switchgear, second floor again houses cable vault, third floor houses control room, electronic cubicle room and UPS room and fourth floor accommodates AC plant room, APRDS, Battery room and with roof above.</p> <p>5.3 A minimum headroom of 2200 mm shall be given in the cable vaults. In control room false ceiling level shall be kept at 3500 mm above the floor level.</p> <p>5.4 All floors shall be of in-situ RCC slab, provided over structural steel beams with conventional shuttering. Minimum thickness of structural concrete shall be 150 mm with an additional 50 mm provided for finish. Roof shall also be of in-situ concrete with conventional shuttering, but the concrete shall be given a slope of min 1 in 100 to effect proper drainage. No openings will be permitted on the roof of control room excepting possibly opening for A/C duct to exercise proper control on air conditioning. No</p>		
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	<p>openings will be permitted on the roof also, as this will interfere with effective water proofing.</p> <p>5.5 Cladding shall be of brickwall. Windows from Switchgear room and control room / electronic cubicle room will not normally be allowed on the Boiler side to avoid coal dust nuisance. Walls shall normally be supported on wall / floor beams. If wall beams cannot be avoided they shall preferably be given at the level of floor beams and shall be encased in concrete.</p> <p>5.6 Portion of the structural steel column projecting into the room shall be encased with brick masonry to shield it from fire hazards. Cable vault in ground and second floor shall be provided with minimum 2 doors per unit. The doors shall be flush steel doors. No windows shall be provided on the turbine bay side.</p> <p>5.7 Switchgear room shall be provided with minimum two steel doors to satisfy statutory requirement. In addition a two leaf sliding doors of flush welded steel construction shall be provided to move the switchgears into the room making use of equipment lifting hatch provided in turbine building.</p> <p>5.8 Main entrance to control room shall be provided with air locked lobby with automatic closing sliding glass doors. Lobby shall be formed of anodised aluminium framing with toughened sheet glass 6 mm thick. Partition between control room and adjoining rooms shall be of glazed aluminium partition with 300 mm high brick wall at bottom for toe protection. All the doors shall be single leaf glazed aluminium doors for all cabins. For movements of panels suitably sized double leaf aluminium glazed doors shall be provided. Control room wall upto the false ceiling level shall be of aluminium glazed partition on either side of air lock. In other area cladding shall be of brick wall. UPS room shall be provided with brick cladding alround to reduce sound nuisance. The Civil & Architectural features / aspects for lighting system, identical to that adopted for Unit -1 & as at Simhadri Power House, shall be provided for unit control room.</p> <p>Battery room shall be provided with PVC doors in PVC framing. For Air washer room steel doors shall be used which shall be airtight. No window shall be provided in Air washer room.</p> <p>5.9 Staircase properly enclosed to satisfy TAC regulations shall be provided at either ends of each unit. All doors leading to staircase</p>	
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<p>shall be automatic closing fireproof doors. Staircase shall not be provided around the passenger lift. Staircase shall extend upto the roof. Toilets shall be provided at the switchgear room level and control room level. Toilet floors shall be sunk and shaft shall be provided to route the soil pipe. Sunken floor shall be provided with damp proofing treatment.</p> <p>5.10 Control room and electronic cubicle room are to be provided with false ceiling. False ceiling shall be designed aesthetically, properly arranging supply air diffuser, return air grill, fire protection sprinklers and light fittings. Aluminium ceiling system shall be provided. Under deck insulation shall be provided on the ceiling, on the walls and beams above false ceiling. Under deck insulation shall be provided for Air washer room also.</p> <p>Roof shall be given a fall of about 300 mm for proper drainage. Elastomeric liquid membrane treatment shall be provided over the roof as in the case of TG building.</p> <p>5.11 Floor above control room where APRDS and other pipes are located as well as floor below the de-aerator area shall be provided with proper drains to prevent any accumulation of water. This is very important to prevent seepage of water into the control room.</p> <p>5.12 All openings in floor for Switchgear and other panels shall be sealed with fireproof material after cables are connected. Adequately designed RCC storm water drains shall be provided to lead the roof drainage on to the plant drainage system. These drains shall have pre-cast RCC slotted cover. Plinth protection shall be given on the side of the drain upto the brick wall.</p> <p>6.0 STEAM GENERATOR/ESP/DUCT SUPPORTING STRUCTURE</p> <p>6.1 Criteria for designing the steel structure are described elsewhere in this section. Roof shall be covered with permanently colour coated galvanised MS trough sheet of approved profile having a minimum of 0.8 mm base metal thickness. Proper drainage of the roof shall be provided for by means of gutters and down comer (water) pipes. Down comer pipe shall conform to IS: 4985</p> <p>6.2 Side cladding shall be permanent colour coated non- insulated metal cladding as per clause No.3.2, part F- Finishes. Extent of cladding has been described elsewhere in the specification. Types of foundation for the structures are covered under separate section</p>		
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<p>based on the subsoil condition and recommendations based on detailed geo-technical investigations. In addition to foundations for structures other major equipment foundation in the area are those for Primary Air fan, Forced draft fan and Induced draft fan. The above foundation shall be designed with vibration isolator system or conventional block / frame type RCC foundation.</p> <p>7.0 MILL AND BUNKER BAY BUILDING</p> <p>7.1 The framing shall be of structural steel. This shall be designed as a moment connected framing in the transverse direction and braced in the longitudinal direction. These structures primarily support coal bunkers, coal feeders and tripper arrangement to feed the coal into coal bunker.</p> <p>7.2 The bunker shall be circular in plan and shall have the capacity as per the requirement of steam generator. A comprehensive flowability study shall be conducted by the CONTRACTOR for the coal bunker hopper to ensure smooth flow of coal in all seasons with different moisture contents and different percentage of fines. Geometric parameter of hopper and lining material shall be decided considering the findings of flowability study. For the cylindrical portion of the bunker 50 mm concrete lining is to be provided using guniting technique, with nominal reinforcement unless the CONTRACTOR recommends use of other types of liners.</p> <p>7.3 Mills are to be located on the ground floor. Mill foundations are to be designed with vibration isolator system or conventional block / frame type RCC foundation. In addition to Mill foundations provision has to be made in the Mill bay ground floor for trenches accommodating Mill reject system conveyors.</p> <p>7.4 A Mill maintenance platform shall be provided at appropriate elevation to attend to routine maintenance. This shall be a platform with chequered plate or gratings over steel framing with handrails around. Above this floor a framing shall be provided to support under slung crane used for handling mill maintenance work. The crane runway girders shall extend to the full length of Mill bay to enable approach to the service bay also.</p> <p>7.5 Above this framing, feeder floor is provided. The extent of the feeder floor shall be decided by the CONTRACTOR based on his maintenance requirements. Feeder floor shall be of RCC supported on structural steel framework. Handrails shall be provided on all</p> <p>BTPS Unit 2 071206</p>		

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<p>the sides. A steel staircase shall be provided for access to feeder floor from ground floor.</p> <p>7.6 Frameworks for supporting the circular bunker are provided above the feeder floor based on geometry of the hopper.</p> <p>7.7 Bunker shall be provided with a top steel cover with slit openings for entry of coal. On sides of the bunker necessary openings shall have to be provided for bunker ventilation / dust extraction.</p> <p>7.8 Tripper floor is immediately above the bunker. This floor is of RCC supported on structural steel framework.</p> <p>7.9 Tripper roof shall be of RCC supported on structural steel framework. A fall of about 300 mm is given for the roof framing to effect proper drainage. Tripper roof supports bunker ventilation / dust supporting structure. An RCC parapet or steel handrail shall be provided for the tripper roof. An access stair / ladder shall be provided from tripper floor to roof in each unit.</p> <p>7.10 In addition to the above, framing arrangement for structural steel platform at various levels around the bunker shall be provided with proper access ladder, for poking, striking and attending to air cannons.</p> <p>7.11 Tripper floor and roof shall be given access through Boiler staircase / Elevators.</p> <p>7.12 Bunker supporting structure is normally left un-cladded upto the bottom of tripper floor. For tripper floor upto 3000 mm above finished tripper floor level, brick wall shall be provided. Above this level permanent colour coated non- insulated metal cladding as per clause No.3.2, Part F- finishes, cladding shall be provided. Fixed steel windows with 6 mm thick wired glass shall be provided in the tripper house as per requirements for conveyor gallery.</p> <p>7.13 Roof slab will be sloped to one side to permit easy drainage. Liquid membrane water proofing treatment is to be provided. As the roof is accessible and maintenance crew is likely to work on this floor, the entire roof shall be provided with min 50 mm thick screed over the water proofing treatment.</p>		
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<p>7.14</p> <p>7.15</p> <p>8.0</p> <p>8.1</p> <p>8.2</p> <p>8.3</p> <p>8.4</p> <p>8.5</p>	<p>Rain water down take pipes of galvanised MS conforming to class- 'medium' of IS:1239, shall be provided.</p> <p>All structural steel work shall be given two coats of primer and minimum 2 coats of synthetic enamel paint of approved brand and shade. All exposed gratings and handrails shall be galvanised. Expansion joint shall be provided in the structure as required by IS:800.</p> <p>STEAM GENERATOR ELEVATOR SUPPORTING STRUCTURE</p> <p>Capacity and number of the elevator shall be as shown elsewhere. (Vol-II, Section-C1) The elevator supporting structure shall be of structural steel braced in both directions. Plan bracings are provided at all the landing locations. Where landing locations are far apart, plan bracings shall be considered at least at every 8 m centres.</p> <p>Elevator shaft shall be constructed with colour coated insulated metal cladding system supported on structural steel work. Lift pit shall be of RCC construction. Ground floor entry shall be kept about 500 mm above general graded / paved level with a ramp for approach. A sump for drainage and Aluminium ladder shall be provided in the lift pit.</p> <p>Machine room floor shall be of RCC, with 300mm kerb wall around. Roof also shall be that of RCC construction with permanently colour coated galvanised MS trough metal sheet decking. Roof shall be sloped to one side for drainage purpose.</p> <p>Side cladding shall be of insulated type as specified for lift cage. Adequate windows shall be provided for admitting natural light. Adequate / designed monorail with equipment hatch in the machine room floor shall be provided to lift heavy machinery. Steel staircase shall be given to the M/C room from last landing. Landing levels are generally governed by the floor levels in the Boiler structure. In addition, landing shall be provided at feeder floor and tripper floor levels. Structural steel gallery shall be provided from the elevator-landing platform to these floors.</p> <p>Windows in the M/C room shall be of steel glazed type using 6 mm thick wired glass. Doors shall be of flush welded hollow steel type.</p>	<p>Deleted: 4985</p>
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<p>All structural steel works shall be provided with 2 coats of primer and a minimum of 2 coats of synthetic enamel paint.</p> <p>9.0 ESP CONTROL ROOM</p> <p>9.1 This shall be a two storied RCC framed structure or as provided for Unit 1. The ground floor shall accommodate cable vault, toilet, and staircase. First floor shall accommodate switchgear rooms, control rooms and AHU room An auxiliary transformer yard with fencing and gate shall be provided adjoining to the building. Side cladding shall be of brick wall with wall in front of transformer yard made sufficiently thick to satisfy fire rating as per TAC / LPA regulations, package air conditioners for EC control room and VFD room.</p> <p>9.2 Staircase area shall be protected from fire safety angle, as per TAC regulations. Main door to switch gear room shall be steel sliding door having adequate area to admit switchgear. There shall be minimum two doors to the switch gear room, of flush welded steel type. Control room should have one swing type aluminium glazed double panel door and one single panel door. Windows shall be steel glazed for switchgear room with wired glass. For control room if window is provided the same shall be of fixed glass type with 6 mm thick sheet glass. Main entrance of the building shall be a rolling shutter with appropriate ramp approach. Aluminium false ceiling shall be provided in the Control room. Underdeck insulation shall be provided above false ceiling.</p> <p>9.3 Roof shall be given access by means of cage ladder. An equipment hatch shall be given in the first floor with lifting beam to lift the switchgear / control panel to the first floor.</p> <p>9.4 Roof shall be given a slope of minimum 1 in 100 towards the side opposite to transformer yard. Roof shall be given Elastomeric liquid membrane water proofing treatment. Adequate number of rain water down take pipe shall be provided using HDPE pipe conforming to IS: 4985. Garland drain as well as plinth protection shall be given around the building.</p> <p>9.5 Transformer yard shall be provided with 3 m high chain link fencing with gates. In case, more than one transformer is being provided, fire wall shall be constructed in between to separate the transformers. Oil soak pit shall be provided below the transformer. Burnt oil pit shall be provided connecting the soak pits with RCC</p>		
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<p>pipes. The transformer area shall be provided with paving using hard stone aggregates of 40 mm single size.</p> <p>10.0 RCC CHIMNEY</p> <p>10.1 Parameters of the Chimney shall be designed based on the <u>exit flue dia</u>, the fuel burnt, quantity of gas generated and probable composition of the flue gas. Minimum height of the Chimney shall be 275 m. <u>Chimney shall be of brick lining</u> and for one unit only. Effect of adjoining tall structures such as boilers, cooling towers etc on magnifying wind loading on the Chimney shall be studied in a wind tunnel before the designs are finalised. Chimney shall be provided with caged ladder with ladder safety device for maintenance. Proper aviation warning signals shall also be provided for the Chimney. Chimney shall also be provided with Rack and Pinion type Lift for access and maintenance.</p> <p>11.0 STEAM GENERATOR AREA PAVING</p> <p>11.1 Entire steam generator area upto the end of Chimney shall be provided with RCC paving over rubble soling.</p> <p>11.2 Paving shall be carefully planned such that maintenance access roads of minimum 4 m wide to all major equipment are available. This area shall be designed for heavy loads similar to design of roads. Such approach road shall be provided to the S.G elevator also to enable handling of equipments at higher level during maintenance. Such roadways shall be clearly identified with kerbs / painting. All drain / trench covers in these areas shall be designed to withstand truck loading.</p> <p>11.3 The drainage of the entire SG area shall be properly planned. Network of RCC drains with RCC cover with slotted holes or MS grills shall be provided covering the entire area which lead the storm as well as process leakage water to the peripheral drains, which in turn will lead to plant drainage system. Where open drains are not permitted, under ground pipes may be provided. In which case, at all junctions and ends proper manholes shall be provided to permit periodic cleaning of the pipes. All structural steel columns in the area shall be provided with encasing to a height of minimum 200 mm above paving level and in addition, the bases also need encasing, if base plate are below paving level.</p>		
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<p>The maximum paved level in SG area shall be kept a minimum 150 mm below the finished ground floor level in Turbine building area.</p> <p>12.0 TRANSFORMER YARD</p> <p>12.1 Generator transformer, station transformer, unit auxiliary transformer and service transformer 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.</p> <p>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.</p> <p>13.0 SWITCH YARD</p> <p>Extent of the Switchyard will depend on the layout of the switchyard, which has been outlined in the Electrical section of this document.</p> <p>13.1 Galvanised steel structure</p> <p>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 gms per square meter of exposed surface. Design criteria of Switchyard structure are furnished elsewhere in this document.</p> <p>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</p> <p>BTPS Unit 2 071206</p>		

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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 equipments

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


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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 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.


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<p>14.0</p>	<p>COAL HANDLING SYSTEM</p> <p>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. Some of the important areas of works are described below.</p> <p>14.1 Crusher houses</p> <p>14.1.1 Crusher houses shall be of steel structure of framed / braced design. Floors and roofs shall be RCC, over structural steel beam. 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 galvanised gutter 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 Isolator system. Handrail shall be provided around all big openings and kerb plates shall be provided around all small openings.</p> <p>14.2.2 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. 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 atleast 500 mm</p>	
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<p>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 access ladder. Toilet shall be provided in the Crusher houses.</p> <p>14.2.3 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 beams. Top of the pedestals for the columns shall be 150 mm above finished ground floor level.</p> <p>14.3 Junction houses</p> <p>Construction details of Junction houses are similar to the Crusher houses except that, Elevator and toilet may not be necessary unless otherwise specified in the Mechanical section of the document.</p> <p>14.4 Conveyor Galleries and Trestles</p> <p>14.4.1 Overhead conveyors shall be housed in a suitably enclosed gallery of structural steel. Maximum span of gallery shall be limited to 24 m unless higher span is necessitated due to site constraints, which shall be subject to approval of OWNER.</p> <p>14.4.2 For double stream conveyor gallery one central and two side walkways shall be provided. For single conveyor, walkways shall be provided on either side. Width of the walkway and clear height of the gallery shall be as specified in Mechanical section of the document. Both sides of the central and side walkways shall be provided with pipe hand rails with kerb plates using pipe of 'medium' class as per IS:1161 having 32 mm nominal size. Handrails shall not be connected to conveyor supporting stringer. Walkway shall be of chequered plate construction with anti skid arrangement. Floors of the conveyor gallery shall be provided with seal plates as specified in Mechanical section.</p> <p>14.4.3 Conveyor gallery shall have permanently colour coated metal sheet on roof and side cladding shall be of permanently colour coated non-insulating metal cladding as per clause No.3.2 Part F-finishes. Roof framing shall be given a slope of 1 vertical: 3 horizontal. A continuous slot opening of 500 mm height shall be provided on both side walls just below the roof sheeting. Adequate provision of windows shall be provided on both sides. Windows shall have grills of wire mesh. Cross-over shall be provided at approximately</p> <p>BTPS Unit 2 071206</p>		


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<p>100 metres interval along the conveyor preferably at 4 legged trestle locations.</p> <p>14.4.4 In between transfer points four legged trestles shall be given at a spacing of about 100 m. In between 4 legged trestles, two legged trestles may be provided. Trestles shall generally be provided using rolled beams only.</p> <p>14.4.5 Sliding PTFE bearing support shall be provided at one end of the gallery for relieving forces due to temperature variation. Accordingly, for the purposes of analysis one end of the gallery shall be treated as hinged and the other end on rollers.</p> <p>14.4.6 End of conveyor gallery, which will be supported over transfer tower, shall be so detailed that, only vertical reaction is transferred from conveyor gallery. This side of the gallery shall therefore be supported on sliding PTFE support. For design criteria for foundation please refer separate section given in the document. The top of pedestal for the foundations shall project 300 mm above the grade level.</p> <p>14.5 Stacker cum reclaimer</p> <p>14.5.1 Stacker cum reclaimer rail shall be supported on RCC foundations giving continuous support to the rails. The beams supporting the rails shall be given expansion joint preferably every 30 metres. Stacker / reclaimer conveyor support shall also be provided connecting the above two beams. The entire coal storage area shall be provided with properly sloped PCC paving over rubble soling with properly compacted subgrade. RCC drains with removable precast RCC slotted cover shall be provided on either sides of each coal stack. These drains shall be so designed to carry the drainage from coal yard to the decantation tank. Decantation tank shall be of RCC with baffles to induce settlement of the coal dust and shall be sized to store about 30 minutes storage. Settled solids shall be removed and dumped to Ash ponds. RCC supports for dust suppression piping system shall also be provided. Beyond the stockpile area till the junction towers on either side, foundations for trestles and short supports will have to be given. The top of pedestal shall project a minimum of 300 mm above the grade level.</p>		
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<p>14.6 Wagon tippler hoppers</p> <p>14.6.1 Hoppers shall be of RCC construction. The pit shall accommodate the hoppers along with feeder and conveyors below. The hopper pit shall be of RCC construction and designed as water retaining structure. During construction, proper provision shall be made to make the pit completely waterproof. Suitable sump shall be provided in the pit to effect surface water drainage. RCC access shaft shall be provided with staircase to the bottom of the pit. Monorail for taking machinery into the pit shall be provided in the access shaft projecting through two leaf steel sliding door. Plinth level of the pit shall be kept at least 500 mm above graded level with RCC sloped paving all round to enable bulldozer movement. Shed above hopper pit shall be of structural steel construction. The columns shall be raised from the four corners of the pit and shall be designed as free standing, supported only by roof framing, to facilitate dozer movement. Roof shall be provided with permanently colour coated galvanized sheeting.</p> <p>14.7 Tunnels, Pent houses and Transfer Houses</p> <p>14.7.1 Tunnels shall be of RCC construction and designed as a water retaining structure. During construction proper provision shall be made to make the tunnel completely waterproof. A PCC screed shall be provided to direct the drainage on to one side of the tunnel. A small trench shall be provided on that side of the tunnel to lead the drainage to the nearest sump. The tunnel shall be provided with RCC / brickwork, for ventilation duct. Brickwork shall be constructed with grills for supply air. Where the tunnel enters the ground level a pent house is provided of RCC construction. Pent house shall be provided with a lifting beam to lift equipments to the tunnel. Tunnel shall be provided with walkway on either side of the conveyor. Single pipe handrail shall be fixed to the tunnel wall to serve as handrail. Tunnel floor shall be provided with PCC steps to facilitate movement of operating / maintenance personnel. In the case of double conveyor, such steps shall be provided in the centre also.</p> <p>14.7.2 Where two tunnels meet a Transfer house is to be provided. Transfer house is by and large a junction tower but the meeting of conveyors takes place below ground level. Transfer house shall be of RCC construction with RCC floors and roof, with RCC access shaft with staircase and monorail arrangement for carrying equipments down. Proper drainage arrangement shall be provided</p> <p>BTSP Unit 2 071206</p>		


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<p>in the bottom-most floor. Handrails shall be provided around all openings. Around access shaft proper plinth protection shall be provided with ramp towards the door. Access shaft should have one equipment entry, which shall be two leaf steel sliding door and a single leaf flush welded steel door for entry of personnel. Transfer house shall be designed, as water retaining structure and provision shall be made during construction to ensure proper water proofing after concreting is over.</p> <p>14.7.3 Portion of the tunnel or transfer house over which railway line or road passes shall be appropriately designed to support the additional imposed load. Tell tale signs shall be provided above graded ground to identify the extent of the underground structure.</p> <p>14.8 Switch gear room</p> <p>14.8.1 Number of switch gear room shall be decided based on the arrangement of various buildings and their electrical load requirement as discussed in the Electrical portion of this document. Switchgear room shall generally be RCC framed structure with cable vault. Other constructional details shall be similar to ESP control room. Roof shall be given proper slope and parapet shall be avoided to prevent the accumulation of coal dust. Similarly, above sunshade, fascia shall be avoided to prevent accumulation of dust.</p> <p>14.8.2 Transformer yard, toilets, equipment hatch, staircase etc., shall be provided similar to ESP control room.</p> <p>14.9 Dust Suppression, Dust extraction and Ventilation system structures</p> <p>14.9.1 Civil works on account of the above system will generally consist of pump houses, RCC reservoirs, slurry sumps, pump foundations, fan foundations etc., spread over the complete Coal handling area. Location and details of these structures will depend on requirement based on system design.</p> <p>15.0 ASH HANDLING SYSTEM</p> <p>15.1 The superstructure of pump houses and compressor house shall be of steel-framed structure with rigid framing in transverse direction and bracing in the longitudinal direction and gable end.</p>		
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<p>The building will support an EOT / semi-EOT crane of adequate capacity. Roof shall be of in-situ RCC, properly sloped, constructed on colour coated permanent metal deck shuttering. Side cladding shall be of permanent colour coated non- insulated metal cladding as per clause No.3.2, Part F- finishes, adequately ventilated with steel windows with 6 mm thick wired glass. Bottom 3 metres of the side cladding shall be of brickwork. Main entrance shall be adequately sized rolling shutter. In addition, a minimum of two steel doors of flush welded construction shall be provided. RCC foundations / pile cap shall be provided to support the structure based on soil condition.</p> <p>15.2 Ash water tank shall be above ground level. The tanks shall be designed as a water retaining structure as per IS:3370. RCC sumps of Ash Slurry Pump house shall be designed as per IS:3370 duly considering water table as well as additional surcharge pressure. RCC staircase shall be provided for access to all the sumps. All basements shall be provided with handrails around.</p> <p>15.3 MCC and Switchgear room shall be a single / two storied RCC framed structure with cable vault on ground floor and switch / control room on the first floor. Control room will be air-conditioned, hence, the same shall be given false ceiling of gypboard and under deck insulation. Air washer room shall also be provided in the ground floor. Under deck insulation shall be provided for Air washer room also. Toilet shall be provided on the ground floor. Walls of the Control / Switch gear room shall be of brick, with wall on the Transformer yard side being designed as per TAC regulations.</p> <p>15.4 Roofs shall be properly sloped and provided with elastomeric liquid membrane water proofing treatment. Rain water down take HDPE pipe conforming to IS:4985 shall be provided. Garland drains shall be provided around the building to carry the storm water to plant drainage system. Plinth protection shall be given all round the building. For roof of control and switch gear room below water proofing course a 50 mm thick foam concrete insulation layer shall be provided.</p> <p>15.5 Windows in switchgear / control room shall be of side hung steel glazed type using wired glass. Switchgear room shall have atleast two steel flush-welded doors. Entry to control room shall be with aluminium swing type glazed door. Size of main entrance door to Switch gear room shall be adequate to allow movement of switchgear panels. This shall preferably be steel sliding door with</p>		
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<p>two leaves. Provision shall be made to lift the Switchgear panel to the first floor with equipment hatch and lifting beam. Staircase shall be provided with fireproof enclosure all round to satisfy TAC regulations. Toilet shall be provided with PVC doors. Roof of all buildings shall be given access through cage ladder. Sewage from toilet shall be disposed off through plant sewage disposal system.</p> <p>15.6 Auxiliary transformer yard may be required near the Switchgear room. The Transformer yard shall provided with chain link fencing and gates along with fire wall, paving, soak pit, burnt oil pit etc similar to ESP control room.</p> <p>15.7 Work shall include bottom ash hopper supports, bottom ash extraction equipment supports, pipeline supports and trenches from Bottom ash hopper to Ash slurry sump. Support for fly ash pipeline from ESP etc. to fly ash silo is also included in the scope of civil works.</p> <p>15.8 Dry fly ash silo alongwith development of the silo area such as paving, fencing, access roads / drainage of the dry fly ash silo area etc., included in the scope. Fly ash silo shall be RCC construction.</p> <p>15.9 Pipe line from Ash slurry pump house to the final disposal area shall be run on piperacks in the main plant area and on RCC pedestals upto & over the bund upto disposal point. All related Civil and structural works shall be included in the scope. At all road / rail crossings pipe bridges are to be provided with bottom of the bridge at least 7m above the road / rail level. If the OWNER permits at road crossings the pipes may be run inside box culverts also.</p> <p>15.10 Dry fly ash storage area shall be provided with fencing and gates. All other Civil / Structural work to ensure smooth functioning of the Ash handling system are deemed to be included in the scope of work under the sub section.</p> <p>16.0 D.M PLANT</p> <p>16.1 Dimension and height of the building shall be decided based on equipment layout and height of the vessels accommodated inside. The DM plant building shall be of RCC framing to result in large column free space. The roof shall be of RCC.</p>		
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<p>16.2 Adjoining control room and laboratory shall be provided in an RCC framed building with brick cladding Control room and switchgear room shall have a cable vault below. Control room and laboratory shall be air-conditioned. False ceiling with gypboard shall be provided in this area. Underdeck insulation shall be provided in the A/C area as well as in the Air washer room. Staircase in the Control static room Complex shall be extended to the roof also. Flooring on Control room shall be of anti-static PVC tiles. Toilet shall be provided in the ground floor. In case a transformer yard is provided the wall in front shall be designed to satisfy fire rating as per TAC. Details / requirements of transformer yard shall be same as those provided for ESP control room.</p> <p>16.3 Floor where acid / alkali spillage are expected shall be isolated with RCC kerb and the flooring inside shall be of acid / alkali resistant brick. The drains inside the building carrying acid / alkali mixed discharge shall be provided with epoxy lining. Outside the building upto neutralising pit these drains shall be provided with AR brick lining. Specification for lining is given elsewhere in this document. Acid / alkali unloading and storage area outside the building shall also be provided with kerb with a sump inside. This area shall also be provided with AR brick lining.</p> <p>16.4 Neutralising pit shall be designed as a water retaining structure with external damp proofing. Floor and walls of the pit shall be given A.R brick lining. Ceiling as well as floor, supporting pumps, pumping the clear water from neutralising pit shall be given epoxy lining. DM water storage tank outside the DM plant shall be supported on sand pad with ring wall.</p> <p>16.5 Walls inside the DM plant area shall be provided with chlorinated rubber based painting. Main door shall be rolling shutter of adequate size to permit entry of the largest vessel. All doors and windows in the DM plant area shall be of aluminium glazed type. Windows shall be of sliding type.</p> <p>17.0 CONDENSER COOLING WATER SYSTEM</p> <p>17.1 <u>Clarified water shall be used for circulating water system.</u> RCC cooling water channel shall be of rectangular shape and designed as a water retaining structure. Depth of channel and width of channel shall match with the width and depth of the cooling water channel from cooling tower. These branch channels shall join together and form common channel leading to the forebay of the pump house. Dimension of the</p>		
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<p>channel shall be decided on the basis of the quantity of water to be carried by the channel. Floor of the channel shall be given a mild slope to ensure necessary velocity of flow. The top of the channel shall be kept at least 500 mm above ground level with suitable galvanised M.S pipe hand railing on either side. Expansion joint shall be given at a spacing of about 30 m. Pedestrian crossover shall be given across the channel at approximately 300 m centres. The channel shall smoothly diverge and form the forebay in front of the pump house. It is suggested that the bottom of the forebay shall be kept flat and the difference in level between the channel and CW pump sump shall be made up in the channel stretch before joining the forebay, using a slope of 1 Vertical : 5 Horizontal.</p> <p>17.2 Depth of the forebay shall generally match with the C.W sump level, which shall be decided based on submergence requirement of the C.W pumps at the lowest water level in the sump. Forebay shall be provided with cage ladder at four corners constructed of galvanised steel. Top of the forebay shall be kept 500 mm above grade level and handrail of galvanised M.S.pipes shall be provided for the entire length on either sides. Water level indicator (float type) shall be provided in the forebay close to the pump sump on either side to observe the depth of water.</p> <p>17.3 Dimension of the pump sumps shall be so selected as to prevent dead water areas, reverse currents, flow separation and eddies. Recommendations of British Hydro-mechanic Research Association (BHRA) and Hydraulic Institute Standards shall be followed. CONTRACTOR shall conduct Hydraulic Physical Model study to demonstrate trouble free operation of the pump sump and forebay for all possible alternatives / combination of pump operation. Pump sump shall be designed as water retaining structure. Each sump shall be provided with stainless steel groove for inserting coarse screen, fine screen and stop logs. Grooves for stop log shall be provided before and after the screens. Where as number of coarse screen and fine screen shall be the same as the number of pump sumps the number of stop log shall be a minimum of two. Top of the sump floor shall be kept same as of the top of forebay. This floor shall have openings for lowering and lifting of stop logs and screens. These openings shall be covered with galvanised mild steel gratings when the screens are placed in position. Provision for handling of the screens and stop logs shall be made. Sufficient paved space shall be provided to keep the stop log when not in use and also for maintenance of screens. Galvanised MS handrails shall be provided on 3 sides of the pump floor</p>		
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<p>(sump roof). Each individual pump sump shall also be provided with a drain sump to empty the sump for attending to maintenance of pump.</p> <p>17.4 Pumps generally have common base plate with the motor and hence the pump foundation is provided at the motor floor level. A thrust block shall be provided connecting the pump and motor floors to resist the pump thrust. Staircase shall be provided from the pump floor to motor floor. Motor floor shall be given handrail on the two sides. Pump maintenance area shall be provided on one side at the pump floor level.</p> <p>17.5 Side of the pump house upto motor floor level on the pump discharge side shall be of RCC. Maintenance bay of the pump house shall have R.C.C grade slab with granolithic finish and non-metallic floor hardener. Motor floor shall also have similar finish.</p> <p>17.6 An annex to the C.W pump house shall be provided in RCC framed structure to accommodate Switchgear and Control room with cable vault below, Chlorinator room, Chlorine cylinder storage room and toilet block. Side cladding shall be of brickwork except in Chlorine cylinder storage area where brick wall is provided only to a height of 1 m. All floors and roofs shall be of RCC. Roof shall be given proper slope and liquid membrane water proofing treatment. Rain water down comers shall be of HDPE pipes conforming to IS:4984. Roofs shall be made accessible by MS cage ladder.</p> <p>17.7 All doors shall be of flush welded steel construction. For Switch gear room, the main entrance door shall be of adequate size to transport the panels. All windows shall be steel glazed side hung. Wall in front of Transformer yard shall be designed to satisfy fire rating as per TAC regulations.</p> <p>17.8 An auxiliary transformer yard may be required in front of the Switch gear room. Civil work similar to the transformer yard in front of ESP control room shall be included in the scope of work.</p> <p>17.9 Outside the pump house support blocks for butterfly valves and pipes along with proper handling facility shall be provided.</p> <p>17.10 Cooling water conduits of adequate size shall be provided from C.W pumps to condenser and hot water conduits from condenser to cooling tower. These conduits shall be formed of structural steel conforming to IS:2062 laid under ground with an earth cushion of 1500 mm above the pipes. The pipes shall be given an epoxy painting on internal</p>		
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<p>surface. The pipe shall be encased in R.C.C with a minimum thickness of 250 mm with reinforcement. Pipe shall be designed for the shut off pressure of the pump or 1.5 times the maximum pump head whichever is higher. A surcharge of 2 t / sq m in addition to backfill may also be considered. Where pipes are not encased the pipe shall be given sand bedding up to the centre line of the pipe. At location of the bends anchor blocks shall be provided. Manholes shall be provided along the length of pipe at about 150 m centres and near locations of bend in each pipe. The pipes shall be line tested before commissioning of the system. At road / rail crossing, the encasement shall be designed adequately to withstand the additional imposed loads.</p> <p>18 COOLING TOWER</p> <p>18.1 Cooling tower shall be Natural draft type.</p> <p>18.2 RCC basin shall be in two compartments with supporting structures and foundations. The basin shall be provided with drain sump, cold water, outlet duct with screen, stop log and all associated handling facilities.</p> <p>18.3 Cold water open channel of RCC leading from cooling tower basin to forebay of CW pump house shall be provided.</p> <p>19.0 MISCELLANEOUS PLANT BUILDINGS</p> <p>19.1 Diesel Generator House</p> <p>19.1.1 This shall be a single storied RCC framed structure with electric hoist. The dimension of the building shall be decided by the CONTRACTOR to suit equipment supplied duly considering the space required for additional D.G.set. D.G set foundation shall be isolated from the floor.</p> <p>19.1.2 All trenches shall be of RCC and shall be designed as water retaining structure. There shall be no entry of cables / pipes to these trenches below grade level from outside. All these trenches shall be covered with chequered plate over steel framing. Adequate number of sumps shall be provided to drain these trenches.</p> <p>BTPS Unit 2 071206</p>		

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<p>19.2</p>	<p>A C Plant</p> <p>This shall be a single storied steel framed building with in-situ RCC roof over colour coated trough shaped permanent metal decking supported on steel beam. Side cladding shall be brickwork. The roof framing shall support an electric hoist of adequate capacity. The dimension of the building shall be decided by the CONTRACTOR to suit the layout and maintenance requirement of the equipment he is supplying. Main entry shall be through a rolling shutter permitting entry of truck with machinery. A minimum of two numbers of single leaf steel flush doors shall be provided for movement of personnel. Steel glazed side hung windows shall be provided for natural lighting and ventilation.</p>	
<p>20</p>	<p>PLANT BUILDINGS</p>	
<p>20.1</p>	<p>Service Water Overhead Tank</p>	
	<p>This shall be of RCC construction with all necessary piping, access stairs, pump room, etc., complete.</p>	
<p>20.2</p>	<p>Potable Water Tanks</p>	
	<p>This shall be standard Polyethylene storage tanks of required capacity conforming to IS-12701 with all necessary piping connection and fittings etc., and fixed over an appropriate base / roof of buildings.</p>	
<p>20.3</p>	<p>Clarified Water Pump House</p>	
	<p>This shall be of single storey structural steel frame structure with RCC concrete roof over permanent decking of colour coated troughed sheets supported on steel beams. Side of pump house shall be permanent colour coated non-insulated metal cladding as per clause No.3.2 Part F-Finishes, except for bottom three metre high brickwork. Ventilation and natural lightning shall be provided with steel-glazed side hung windows. Roof shall be provided with a minimum of 1 in 100 slope for proper drainage. Maintenance bay of pumphouse shall have RCC grade slab with granolithic finish and non-metallic floor hardener. Adequate Handling facilities for pumps shall be provided, supported from the roof beams. Roof shall be given liquid membrane water proofing treatment. Approach to roof shall be provided with steel cage ladder.</p>	
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<p>21 EFFLUENT TREATMENT PLANT</p> <p>21.1 The effluent treatment plant shall be as per the description mentioned elsewhere in the specification.</p> <p>21.2 All sumps and pits in waste water treatment plant shall be of RCC construction with proper acid / alkali liners. Electrical / control panel shall be located in an RCC building with office space for operating personnel as per system requirement.</p> <p>22. PIPE AND CABLE RACKS</p> <p>22.1 All cable and pipe routing in outlying area shall be clubbed and shall run over ground on structural steel pipe / cable racks at a height not less than 3000 mm above grade level. Where the pipes cross roads / railway clear headroom shall be 7000 mm. The racks can be multitiered. Cable shall normally be laid above the pipes.</p> <p>22.2 The racks are generally designed as a rigid frame in the transverse direction and braced in the longitudinal direction. Expansion provision shall be provided wherever there is a change in direction or where length of the rack exceeds 100 metres. Access ladder shall be provided at suitable location. Where so required chequered plate platforms shall be provided for maintenance purpose. Pipe rack columns shall be supported on RCC foundations with bottom of base plate about 300 mm above ground level.</p> <p>23.0 Clarifier and Clarified Water Storage Tank</p> <p>These shall be of RCC construction, Water tight and above ground/ partially under ground. The clarifier of RO – MB shall be of RCC construction. <u>Electromechanical works for drawing water such as providing and erecting pumps, crane arrangement, pipeline from jackwell to Clarifier shall be by Contractor.</u> All requirements enumerated in mechanical section of this document are to be catered for by this facility.</p> <p>The CONTRACTOR shall take up all buildings, structures and facilities as per bid stipulations in respect of type and area to meet the functional requirements adequately.</p> <p>Wherever the requirement of specific area (floor area etc.,) for any building is not specified, the CONTRACTOR shall provide</p>		
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adequate space, as per OWNER's requirement, to avoid congestion in the building for movement of men and material.



DATA SHEET – A
REINFORCED CONCRETE CHIMNEY

REINFORCED CONCRETE CHIMNEY

(Note: Balance data to be furnished by Bidder)

1.0	GENERAL	:	
1.1	NO. OF CHIMNEY	:	ONE SINGLEFLUE
1.2	DISTANCE BETWEEN CHIMNEYS	:	NOT APPLICABLE
1.3	METHOD OF SHELL CONSTRUCTION	:	SLIPFORM ABOVE HOPPER RING BEAM AND SLIP / JUMP FORM BELOW THIS LEVEL
2.0	DIMENSIONS OF CHIMNEY		
2.1	CLEAR INSIDE DIA OF CHIMNEY AT EXIT ELEVATION	:	
2.2	CLEAR INSIDE DIA OF FLUE AT EXIT ELEVATION	:	
2.3	TOP ELEVATION OF CHIMNEY	:	HEIGHT OF CHIMNEY – 275 m
2.4	BATTERY OF EXTERNAL SURFACE FROM EL. TO EL.	:	
2.5	MAXIMUM EXTERNAL DIA OF SHELL AT CHIMNEY GRADE SLAB LEVEL	:	
2.6	SILL ELEVATION OF ACCESS DOOR	:	
2.7	SILL ELEVATION OF CLEAN OUT DOOR	:	
2.8	GRADE SLAB ELEVATION INSIDE CHIMNEY	:	
2.9	GRADE SLAB ELEVATION OUTSIDE CHIMNEY	:	
2.10	GRADED LEVEL OF GROUND	:	
2.11	MINIMUM FOUNDING LEVEL OF RAFT	:	
2.12	MINIMUM EARTH FILLING ON TOP OF FOUNDATION RAFT (REF. 2.10 ABOVE)	:	1000 mm
2.13	NUMBER OF FLUE OPENINGS AND THEIR ORIENTATION	:	ONE
2.14	CENTRE LINE ELEVATION OF FLUE OPENING	:	
2.15	INSIDE DIMENSION OF FLUE GAS DUCT (LXB)	:	
2.16	THICKNESS OF FLUE GAS DUCT	:	
2.17	THICKNESS OF MATING FLANGE	:	



DATA SHEET – A
REINFORCED CONCRETE CHIMNEY

2.18	DISTANCE FROM CL. OF CHIMNEY TO TERMINAL FLANGE OF FLUE DUCT SUPPLIED BY OTHERS	:	
3.0	FOUNDATION DATA	:	
3.1	ALLOWABLE SAFE BEARING CAPACITY OF SOIL AT FOUNDING LEVEL	:	
4.0	FLUE GAS DATA	:	
4.1	MAXIMUM QUANTITY OF FLUE GAS THROUGH EACH FLUE DUCT	:	
4.2	MAXIMUM FLUE GAS TEMPERATURE AT ENTRY TO CHIMNEY	:	
4.3	MINIMUM FLUE GAS TEMPERATURE AT ENTRY TO CHIMNEY DURING OPERATION	:	
4.4	SULPHUR CONTENT IN FUEL	:	
4.5	AVAILABILITY OF FLUE GAS DESULPHURISATION PLANT	:	
4.6	AVAILABILITY OF PREHEATING AFTER DESULPHURISATION	:	
5.0	DESIGN PARAMETERS	:	
5.1	TEMPERATURE	:	
5.1.1	OUTSIDE AMBIENT TEMPERATURE	:	
	MAXIMUM	:	45 DEG. C
	MINIMUM	:	14 DEG. C
5.1.2	THERMAL GRADIENT IN SHELL BELOW HOPPER RING BEAM	:	20 DEG. C
5.2	WIND FORCE (IS – 875)	:	
5.2.1	BASIC WIND SPEED	:	39 m/sec
5.2.2	TERRAIN CATEGORY	:	1
5.2.3	CLASS OF STRUCTURE(k1)	:	1.06
5.2.4	TOPOGRAPHY FACTOR (K3)	:	1.0
5.2.5	Cd = DRAG CO-EFFICIENT	:	
5.3	SEISMIC FORCES	:	
5.3.1	SEISMIC ZONE	:	ZONE – III AS PER IS:1893
5.3.2	SOIL FOUNDATION COEFFICIENT	:	
5.3.3	IMPORTANCE FACTOR	:	



DATA SHEET – A
REINFORCED CONCRETE CHIMNEY

6.0	DESIGN DATA	:	
6.1	MODULAR RATIO FOR STRESS COMPUTATION	:	$m = 280/3 \sigma_{cbc}$
	WHERE σ_{cbc} IS THE ALLOWABLE COMPRESSIVE STRESS IN CONCRETE IN BENDING		
6.2	(a) MAXIMUM GRADE OF CONCRETE IN CHIMNEY SHELL	:	
	(b) MINIMUM GRADE OF CONCRETE IN FOUNDATION	:	
6.3	INCREASE IN CONCRETE STRESS PERMISSIBLE DUE TO AGEING	:	NIL
6.4	DENSITY OF ASH IN HOPPER	:	1.12 T/M ²
6.5	MAXIMUM CO-EFFICIENT OF THERMAL CONDUCTIVITY OF GLASS / MINERAL WOOL INSULATION AT 150 DEG. C MEAN TEMPERATURE	:	0.06 KCAL/HR/DEG. C
6.6	FOR COMPUTATION OF TEMPERATURE STRESS THE MODULUS OF ELASTICITY OF CONCRETE	:	E_s/m - WHERE m IS THE MODULAR RATIO AS PER CLAUSE 6.1 ABOVE AND E_s IS TAKEN AS 210000 N/mm ²
6.7	CO-EFFICIENT OF LINEAR THERMAL EXPANSION OF CONCRETE AND REINFORCEMENT	:	$11 \times 10^{-6} / \text{DEG. C}$
6.8	DESIGN OF REINFORCEMENT IN SHELL AT LOCATION OF CORBEL AND PLATFORM	:	AS PER "REINFORCED CONCRETE CHIMNEYS AND TOWERS" BY PINFOLD GM
6.9	PERMISSIBLE DEFLECTION	:	H/500 WHERE H IS THE HEIGHT OF CHIMNEY ABOVE THE TOP OF FOUNDATION
7.0	ACCESSORIES		
7.1	STRAKES	:	YES
7.2	CAGE LADDER	:	YES
7.3	PROVISION FOR SEPARATE HOISTS FOR MATERIALS AND PASSENGER DURING CONSTRUCTION	:	YES
7.4	PLATFORM – EXTERNAL – ELEVATIONS	:	
7.5	GASKET AND BOLTS FOR FLUE GAS DUCT	:	YES / NO
7.6	SUPPLY OF MATING FLANGE	:	YES / NO

**DATA SHEET – A
REINFORCED CONCRETE CHIMNEY**

- (d) SEMI-AUTOMATIC CONTROL SYSTEM FOR OPERATION OF LIFT FROM INSIDE THE CAGE AS WELL AS ON LANDING WITH AUTOMATIC STOP EQUIPMENT “STOP NEXT LANDING”.
- (e) OVERSPEED GOVERNOR FOR CONTROLLING EXCESSIVE DESCENDING SPEED.
- (f) AN EXTERNAL BRAKE RELEASE MECHANISM LOCATED INSIDE THE CAGE FOR DESCENDING CAGE IN CASE OF POWER FAILURE
- (g) PROGRESSIVE TYPE POSITIVE ACTION SAFETY DEVICE DRIVEN BY A SEPARATE PINION ENGAGED IN THE ROCK (ALIMAK PATENTED OR EQUIVALENT)
- (h) EMERGENCY ALARM SYSTEM



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 leveled 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 / buildings of Unit - 1 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 above objective CONTRACTOR shall employ a qualified architect / architectural firm to carry out all designs and hold all other architectural responsibilities for the project.

1.3 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. 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 consists 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 equipments 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 dia. 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 610 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
Main 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 / Brick masonry shall be provided as provided in Unit 1.

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 corners 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 150 mm lower than the finished floor level of turbine building.

15 STATUTORY REQUIREMENTS

15.1 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.

15.2 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.

15.3 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 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 |


 TITLE
PART – B : LOADS AND LOAD COMBINATION

- 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/electrical 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** : 10 kN/sqm
- 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.


 TITLE
PART – B : LOADS AND LOAD COMBINATION

- 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.

(a) Turbine Building and Bunker : Response spectrum method
Buildings

b) All other Buildings : Seismic Coefficient Method

6.3 The importance factor for all power plant buildings and structures shall be taken as 1.5 and for other minor structures as per IS:1893.

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

9.2.2 Monorail loads

- (a) Impact factor of 10% of lifted load of hoist for monorail and support design
- (b) Impact factor of 25% of the lifted load for electrical pulley and support design

9.2.3 Elevator

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

9.2.4 Pedestals supporting gravity take ups for conveyors and pedestals in elevator pits shall be designed assuming 100% impact factor.

10. OTHER LOADS

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.

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.

10.3 Roof girders / trusses in the service / maintenance bay of Turbine building shall be designed for crane erection loads.



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.

11.0 **BASIC LOAD CASES**

The following basic load cases shall be considered for the analysis:

(a)	Dead load	:	D
(b)	Self weight of permanent equipment	:	EL
(c)	Live load on floor / walkway	:	L
(d)	Live load on roof	:	LR
(e)	Crane load with lift	:	CR1
(f)	Crane load without lift	:	CR2
(g)	Wind load	:	WL
(h)	Seismic load	:	SL
(i)	Load due to soil pressure	:	SP
(j)	Load due to surcharge	:	SCL
(k)	Load due to hydrostatic pressure	:	HP
(l)	Load due to temperature	:	TL
(m)	Special loads	:	SPL

12.0 **LOAD COMBINATIONS**

12.1 The individual members of the frame shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion. Permissible stresses for different load combinations shall be taken as per IS: 875 (Part-V) and other relevant IS codes. Wind and seismic forces shall not be considered to act simultaneously.

12.2 Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loading.

12.3 For design of main plant structures during seismic conditions, the deaerator feed water tank shall be considered full up to operating level. However for other load combinations flooded condition shall be assumed.



TITLE

PART – B : LOADS AND LOAD COMBINATION

12.4 “Lifted load” of crane shall not be considered during seismic condition.

12.5 In case more than one crane is provided and Tandem operation is not envisaged, the load shall be taken as one crane fully loaded and second crane without lifted load but standing idle adjacent to first crane.

13. **LOAD COMBINATIONS FOR UNDERGROUND STRUCTURES**

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

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

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

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

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.

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/Sec 1:1995 (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 conveyors condition : One belt at starting 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



(I) **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.
- 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 main tensile reinforcement 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.



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**PART C : REINFORCED CONCRETE STRUCTURES
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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 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.

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 respectively in soil & disintegrated rock respectively as adopted for Unit- 1.



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 considerations followed for Unit 1. 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. At joints fillet shall be provided as given for Unit 1.

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.



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**PART C : REINFORCED CONCRETE STRUCTURES
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(a) Minimum dia of anchor rod shall be 25 mm and that of anchor hole shall be 75 mm. The dia of anchor hole shall not be less than 2.5 times the dia 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. Frequency and amplitude criteria as laid down by the relevant codes or machine manufacturers shall be satisfied. The Minimum reinforcement shall also be governed by IS: 2974 and IS: 456.



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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 or conventional block/frame type RCC foundations. 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.

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.

2.4 Increase in Stresses

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.

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.

3 Stability of structures

3.1 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.



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- 3.2 All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other relevant IS codes. 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.
- 3.3 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.
- 3.4 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 |



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

- 4.1 From fire resistance point of view minimum thickness of 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 |



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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 and natural draft cooling towers richer mix may be used as per the design requirement.

- | | | |
|-----------|---|--|
| 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, pavement around building including plinth protection work, 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. |
| Grade M30 | | for inertia blocks of spring supported foundation. |

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 M25.

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:

- (a) Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50 mm.
- (b) Clear distance from the face of pocket to the outer edge of pedestal shall be 75 mm.
- (c) Clear distance from the edge of sleeve or anchor plate to the outer edge of pedestal shall be 75 mm.

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	<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 1:2:4 (nominal mix) 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 mix 1:3:6 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. Incase 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>	
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12.0 MAJOR EQUIPMENT FOUNDATIONS

Special requirements for concreting of major equipment foundations shall be as given below:

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.



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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

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.



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.

Deleted: Steel flue for R.C.C chimney


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 1000 mm and above.

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<p>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.</p> <p>2.4 Concrete floors shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However 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.</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</p>		
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<p>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 <u>shop</u> 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> <p>4.2 IS:816 and IS:9595 shall be followed for welding of structures.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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</p>		
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<p>full penetration butt weld. Welding across tension flange will not be permitted. Bearing edges of crane girders shall be machined.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>4.12 Efficiency of site welds to be considered shall be as follows:</p> <table border="0"> <tr> <td>a) Butt weld above 25 m from ground</td> <td>---</td> <td>50%</td> </tr> <tr> <td>b) Others</td> <td>---</td> <td>80%</td> </tr> </table> <p>5. <u>DESIGN METHODOLOGY</u></p> <p>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.</p> <p>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.</p>			a) Butt weld above 25 m from ground	---	50%	b) Others	---	80%
a) Butt weld above 25 m from ground	---	50%						
b) Others	---	80%						
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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 33.33% only under wind and seismic conditions. However, members which are designed primarily to resist wind such as bracing members, no increase in permissible stresses will be permitted. However, permissible stresses in bolts and welds shall be allowed to exceed up to 25 % only under wind and seismic conditions.
- 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 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

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<p>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.</p> <p>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.</p> <p>6 PERMISSIBLE DEFLECTIONS</p> <p>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.</p> <p>6.1 Vertical Deflection</p> <p>6.1.1</p> <table border="0"> <tr> <td>a) For beams supporting dynamic equipment</td> <td>: Span / 500</td> </tr> <tr> <td>b) For beams supporting floors / masonry</td> <td>: Span / 325</td> </tr> <tr> <td>c) For beams supporting pipes (pipe racks)</td> <td>: Span / 400</td> </tr> <tr> <td>d) For roofing and cladding components</td> <td>: Span / 250</td> </tr> <tr> <td>e) For gratings and chequered plates</td> <td>: Span / 200 subject to a maximum of 6 mm</td> </tr> <tr> <td>f) Coal conveyor gallery bridges</td> <td>: Span / 450</td> </tr> </table> <p>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:</p> <table border="0"> <tr> <td>a) For manually operated cranes & monorails</td> <td>: Span / 500</td> </tr> <tr> <td>b) For electric overhead cranes</td> <td></td> </tr> <tr> <td> i) up to 50 t capacity</td> <td>: Span / 750</td> </tr> </table>			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	a) For manually operated cranes & monorails	: Span / 500	b) For electric overhead cranes		i) up to 50 t capacity	: Span / 750
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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 | : | Height / 1000 |

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
- 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 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 shall commence only on the basis of the fabrication drawings approved by the CONTRACTOR'S Consultant. Detailed fabrication drawings are to be submitted to


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<p>OWNER for reference before the commencement of fabrication. However the responsibility for correct detailing rests exclusively on the CONTRACTOR.</p> <p>9.2 Fabrication shall in general follow the provisions of IS:800, and good engineering practice where provisions of IS:800 are not clear.</p> <p>9.3 Tolerance in fabricated steel work shall be as per IS:7215.</p> <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 		
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<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 <p>10.3.2 Ultrasonic testing shall be carried out in accordance with American National Standard ANSI / AWS D1-92 Chapter 6 : Part C.</p> <p>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.</p> <p>10.4 Radiographic Testing (X – ray and Gamma – ray Examination)</p> <p>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:</p> <ul style="list-style-type: none"> i) gas porosity ii) slag inclusions iii) lack of penetration iv) lack of fusion v) cracks <p>10.4.2 Radiographic testing shall be conducted in accordance with American National Standard ANSI / AWS D1.1-92.</p>		
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<p>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 x focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.</p> <p>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.</p> <p>10.6 Acceptable Limits of defects of weld</p> <p>10.6.1 Limits of Acceptability of welding defects shall be as follows.</p> <p style="margin-left: 20px;">i) Visual inspection & Dye Penetration Test</p> <p style="margin-left: 40px;">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.</p> <p style="margin-left: 20px;">ii) Ultrasonic Testing</p> <p style="margin-left: 40px;">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.</p> <p style="margin-left: 20px;">iii) Radiographic Testing</p> <p style="margin-left: 40px;">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.</p> <p>10.7 Rectification of Defects in Welds</p> <p>10.7.1 In case of detection of defects in welds, the rectification of the same shall be done as follows:</p>		
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<p>(i) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld</p> <p>(ii) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.</p> <p>(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.</p> <p>11.0 PAINTING</p> <p>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.</p> <p>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.</p> <p>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 from finish paint. All paints shall be of approved brand and shade as per the OWNER's requirement.</p> <p>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.</p> <p>11.5 Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection</p>		
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<p>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.</p> <p>12. REQUIREMENTS FOR SPECIFIC STRUCTURES</p> <p>12.1 Coal handling system structures</p> <p>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.</p> <p>12.1.2 In case the inclination of the conveyor is more than 10°, walkway shall be given steps.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>12.1.7 Conveyor galleries and trestles having two conveyors belt shall be designed for both conveyors working together.</p> <p>12.1.8 Chute loads on floors of houses shall be considered plugged with material for the entire height of the chute.</p> <p>BTPS Unit 2 071206</p>		

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<p>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.</p> <p>12.1.10 Anchor fasteners shall not be used for supporting equipment imparting dynamic forces.</p> <p>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.</p> <p>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.</p> <p>12.1.13 All foundation bolts shall be provided with double nuts.</p> <p>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.</p> <p>12.1.15 Dynamic analysis shall be carried out for beams supporting screens, vibrating feeder, rotating equipments and conveyor supporting beam in conveyor gallery.</p> <p>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.</p> <p>12.2 Switchyard Structures</p> <p>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.</p> <p>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.</p>		
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<p>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.</p> <p>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.</p> <p>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.</p> <p>12.2.6 Galvanising</p> <p>12.2.6.1 Galvanising of the towers shall be as per IS: 4759 and 2633 and as given in the following paras.</p> <p>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.</p> <p>12.2.6.3 The acceptable values of the coating of zinc on the steel materials shall be in accordance with Table below:</p> <table border="1"> <thead> <tr> <th rowspan="2">KIND OF MATERIAL</th> <th colspan="2">COATING</th> </tr> <tr> <th>Average value</th> <th>Minimum value</th> </tr> </thead> <tbody> <tr> <td>Structural steel members except bolts,nuts and washers</td> <td>Over 750 gm/sq.m</td> <td>610 gm/sq.m</td> </tr> <tr> <td>For bolts, nuts and washers</td> <td>Over 550 gm/sq.m</td> <td>500 gm/sq.m</td> </tr> </tbody> </table> <p>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.</p> <p>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.</p>			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
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<p>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.</p> <p>12.2.6.7 Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted.</p> <p>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.</p> <p>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 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</p>		
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<p>around 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 CONTRACTOR considers essential for the safe and smooth operation of the fuel oil storage and oil handling system.</p> <p>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.</p> <p>12.4 Large diameter steel pipes</p> <p>Design, installation and testing of the pipe shall in general be in accordance with the following provision</p> <p>“ 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</p>		
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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.

Deleted: 12.6 Steel flue for RCC Chimney

Deleted: Design and construction of the chimney liner shall be as per "Design and Construction of Steel Chimney Liners" prepared by "Task committee on Steel Chimney liner" published by ACI. The liner shall be of corrosion resistant steel of minimum 8 mm thick. Top 10 m length or length equal to 1.5 times flue diameter whichever is larger shall be provided in stainless steel grade SS 316L above the support platform for the liner. The liner shall be primarily suspended from the top, with a small length at the bottom near breach elevation supported from the bottom with a suitable expansion compensator in between.



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 300 mm wide of RCC / Masonry construction. 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.

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	<p>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 grade 1:2:4 shall be provided between brickwall and drain with appropriate slope.</p> <p>1.2 Storm Water Drainage System</p> <p>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 a precipitation 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 300 mm wide at the base.</p> <p>1.2.3 For open trapezoidal drains, brick masonry lining on sides and bottom shall be provided. Bricks shall be laid in cement mortar and joints pointed flush. The thickness of lining shall be minimum 115 mm. The lining shall be with bricks of class designation 50 laid in cement sand mortar 1:4 and flush pointed with cement sand mortar 1:2. The side slopes upon which lining has to rest shall be made such that no earth pressure is exerted upon lining in any condition. However, the side slope shall not be steeper than 2 vertical to 1 horizontal. Alternatively, open drains trapezoidal in cross section may be provided in PCC lining of M15 grade. The thickness of PCC lining shall be minimum 100 mm or as per design requirements whichever is higher.</p> <p>1.2.4 All open drains rectangular in cross section shall be in brick / 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>1.2.5 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>	
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- 1.2.6 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.
- 1.2.7 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.
- 1.2.8 The cushion over the pipes for storm culverts shall be minimum 600 mm. Where less cushion is available, pipe shall be encased in RCC M-15. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.
- 1.2.9 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.
- 1.3 **Plant Effluent Drainage (Oily Waste / Process Waster Drainage)**
- 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 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. Catchpits shall have a minimum internal dimension of 600 mm x 600 mm. They shall be of RCC construction and provided with CI grills.
- 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.



1.4 Sewage System

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.

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.

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.

1.4.4 For plant area sanitary sewage disposal, separate septic tanks shall be provided at suitable locations for each building block.. Effluent / Sewage from septic tanks shall be connected to the combined sewage treatment plant of Unit 1 where adequate capacity is taken care of for unit 2 effluent / sewage also. The treated effluent shall conform to the requirements of Pollution Control Board.

2 INTER PLANT TRENCHES

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.

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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.

2.3 As far as possible in the open area trenches shall be provided for running cables.

3.0 PAVING**3.1 R.C.C Paving**

3.1.1 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.

- (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.
- (ii) Ash silo area extending at least 10 m on all sides from outer periphery of the silos.
- (iii) 5 m wide corridor all along the entire width of TG and Deaerator bay at both gable ends.
- (iv) Fuel oil decantation platforms

3.1.2 The underbed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 225 mm with interstices properly filled with grits, followed by a layer of PCC of grade M15, 50 mm thick.

3.2 P.C.C. Paving

3.2.1 PCC paving of nominal grade M15, 100 mm that laid over 150 mm thick compacted rubble soling shall be provided in the following area.

- i) Complete Transformer Yard, covering area between A-row of the turbine building upto the fencing of the Transformer yard.
- ii) Plinth protection around all building to a width of 750 mm or the distance between the brick wall to the garland drain.

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3.2.2 PCC paving of nominal mix 1:3:6, 100 mm thick shall be provided as paving inside fuel oil tank farm; The paving shall be laid over well compacted ground and laid to slope towards peripheral drain.

3.3 **Stone Aggregate paving**

3.3.1 Entire switch yard shall be provided with 75 mm paving of 40 mm 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.

3.3.2 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.



The minimum quality of finishes to be used for various building areas are furnished in this section. Generally finishes provided for Unit-1 shall be adopted. However, the Bidder is at liberty to use superior finishes provided all specific requirements for the finish specified herein below are satisfied.

1. FLOORING

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.

1.1 PVC Floor Finish

Two mm thick pvc as per is:3462 laid as per is:5318 over concrete under bed of 48 mm shall be provided in all control room, electronic cubicle rooms, conference room etc.

1.2 Epoxy coating

This shall be provided for Turbine building operating floor as per the manufacturers requirement.

1.3 Terrazo Tiles

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.

1.4 Granolithic flooring

1.4.1 Granolithic flooring (cement concrete flooring in 1:1:2) 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.



1.4.2 Granolithic flooring without floor hardener shall be provided in all MCC and switchgear rooms, which are not air-conditioned.

1.4.3 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.

1.5 **Heavy Duty Ceramic Tiles**

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.

1.6 **Acid / Alkali resisting Tiles**

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.

1.7 **Integral floor finish**

For cable vaults floor finish integral to the concrete base shall be provided as per IS:2571.

1.8 **Cast-in-situ Terrazo**

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.

1.9 **Acid / Alkali resistant Tiling / Brick lining in D.M Plant**

1.9.1 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.

1.9.2 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.

1.9.3 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.

1.9.4 Special instruction to be followed for acid resistant lining in neutralising pit shall be as follows.

- 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 allround for outdoor installations.

1.10 Miscellaneous

- 1.10.1 Aluminium angle nosing with minimum size (150 x 25 x 3) shall be provided for edge protection of R.C.C. stair treads.



1.10.2 Angles 50x50x6 mm (min) with lugs shall be provided for edge protection of cutouts / 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.

1.10.3 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 terrazo 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.

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 / cu.m for glass wool & 48 kg / cu.m 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 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS:14246 and shall conform to class 3 for the durability.

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.

4. PLASTERING

- 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.
- 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.
- 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.
- 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.
- 4.5 Ceiling of all buildings except in cable vaults and over false ceilings shall be given 6 mm thick cement sand plaster 1:4
- 4.6 All plastering work shall conform to IS:1661.

5. PAINTING

- 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.
- 5.2 Water proof cement based paint as per IS:5410 shall be provided on external faces of walls, sunshades, etc.
- 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.



- 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.
- 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.
- 5.6 All plastered ceilings shall provided with water bound distemper.
- 5.7 Oil resistant paint as per IS:161 shall be provided for oil canal and oil equipment room.
- 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.
- 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 conveyer 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.

7. ROOF DRAINAGE AND WATER PROOFING

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.

7.2 All Roof 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.

- 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.

8. FALSE CEILING AND UNDER DECK INSULATION

- 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.
- 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.
- 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.
- 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.

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.

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.

9.9 All windows and ventilators on ground floor of all buildings located in isolated areas shall be provided with suitable anodised aluminium grill.


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.

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.

10. GLAZING

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.

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.

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	<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> <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>	



- 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.
- 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.
- 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.
- 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 450 mm over window openings, and 750 mm over door openings or as provided for Unit 1.

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.



1.0 SCOPE

1.1 This specification covers the general requirements of engineering by the CONTRACTOR, of material, design, supply, manufacture, construction, testing and commissioning for satisfactory performance of natural draught cooling tower including all associated appurtenances and equipment as well as electrical works.


2.0 APPLICABLE CODES AND STANDARDS


A. Materials

- | | | |
|------|-------------------------|--|
| i. | IS:432
(parts 1 & 2) | Mild steel and medium tensile steel and bars and hard drawn steel wire for concrete reinforcement. |
| ii. | IS:1785
(parts 1&2) | Plain hard drawn steel wire for pre-stressed concrete. |
| iii. | IS:1786 | High strength deformed steel bars and wires for concrete reinforcement. |
| iv. | IS:2062 | Steel for general structural purposes. |
| v. | IS:3589 | Seamless or electrically welded steel pipes for water, gas and sewage (168.3mm - 2032mm). |
| vi. | IS:8112 | 43 Grade Ordinary Portland Cement |
| vii | IS:12330 | Sulphate resistant portland cement |

B. Codes of Practice

- | | | |
|------|------------------------------|---|
| i. | IS:456 | Code of practice for plain and reinforced concrete. |
| ii. | IS:800 | Code of practice for general construction in steel. |
| iii. | IS:875
(part 1 to part 5) | Code of practice for design loads (other than earthquakes for building and structures). |

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iv.	IS:1080	Code of practice for design and construction of simple spread foundations.	
v.	IS:1343	Code of practice for pre-stressed concrete.	
vi.	IS:1893	Criteria for earthquake resistant design of structures.	
vii.	IS:2309	Code of practice for the protection of buildings and allied structures against lightning.	
viii.	IS:2629	Recommended practice for hot dip galvanising on iron and steel.	
ix.	IS:2950 (part 1)	Code for practice for design and construction of raft foundation.	
x.	IS:3043	Code of practice for earthing.	
xi.	IS:3370 (part 1 to 4)	Code of practice for concrete structures for storage of liquids.	
xii.	IS:11504	Criteria for structural design of reinforced concrete natural draught cooling towers.	
xiii.	IS:12200	Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.	
xiv.	BS:4485 (All parts)	Specification for water cooling towers.	
xv.	BS:8007	B.S.Code of Practice for design of Concrete structures for retaining aqueous liquid.	
2.2	The applicability of the provisions for conformity to the various codes and standards stipulated shall be in the following order.		
a.	Bureau of Indian Standards.		
b.	British Standards Institution.		
BTPS Unit 2 071206			

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	<p>2.3 Wherever the above Standards are in conflict with the stipulations of this specification, the latter shall govern.</p> <p>3.0 GENERAL REQUIREMENTS</p> <p>3.1 The cooling tower shall be capable of cooling the rated quantity of water through the specified thermal range at the design wet bulb temperature and it shall conform to the other design parameters as stipulated in Data Sheet – A enclosed in Mechanical section of this document.</p> <p>3.2 The scope of the CONTRACTOR’s work for a cooling tower shall include preparation of detailed designs and construction drawings and execution of work including but not limited to supply of all material for foundations, shell, basin, fill with its supporting structure, staircases/walkways/platforms with handrailing, cold water outlet channels including gates, screens with handling arrangement, painting, access doors, water distribution system, aviation warning system, lighting, lightning protection system, with their associated hardware, etc., complete all as required to give satisfactory performance and as stipulated in various clauses in this document.</p> <p>3.3 CONTRACTOR shall submit detailed design calculations and construction drawings to OWNER for obtaining his approval prior to commencement of work at site.</p> <p>3.4 In the event, CONTRACTOR has quoted in collaboration with another firm (either Indian or foreign), each and every drawing and design calculations submitted shall bear collaborator’s seal and signature indicating their approval. CONTRACTOR shall also furnish, along with the offer, back-up guarantee for the performance of the cooling tower from the collaborator.</p> <p>3.5 QUALITY CONTROL: Shall be as per Section C3, Volume-II.</p> <p>4. CONCRETE</p> <p>4.1 Cement used shall be Ordinary Portland Cement complying IS:8112. Same brand of cement shall be used as far as possible throughout the construction of the entire structure to enable achieve uniform colour and surface finish throughout the shell.</p> <p>4.2 Minimum grade of concrete to be used for all the structural elements shall be as specified below considering environmental conditions as per Table 3 of IS 456.</p>	
BTPS Unit 2 071206		

STRUCTURAL CONCRETEMinimum Grade

a) Foundations	M25
b) Basin	M25
c) Diagonal Columns	M40
d) Shell	M30
e) Precast works (Fill Supporting Structure)	M25

4.3 The minimum cement content per cubic meter of concrete as per Table 5 of IS 456 for severe exposure for super structure and moderate exposure for basin & foundation.:

4.4 In locations where sulphate resisting cement is specified for concrete work below ground level, the minimum cement content per cubic metre of concrete shall be as stipulated in the table 5 of IS 456 as applicable to the type of exposure.

4.5 Materials, design, construction and workmanship of prestressed concrete members shall be in accordance with IS:1343.

5. REINFORCEMENT STEEL

5.1 Reinforcement bars shall be either of mild steel conforming to IS:432 grade I quality or high yield strength deformed bars conforming to IS:1786.

5.2 Steel wires for prestressing shall conform to IS:1785 (part 1&2).

5.3 Reinforcement for the shell shall be corrosion resistant steel.

6. STRUCTURAL STEEL

6.1 Steel for all structural steel works shall conform to IS:2062.



6.2 All exposed steel work shall be protected by hot dip galvanising. The minimum coating of zinc shall be 900 gm/sq.m. and comply with the requirements of IS:2629 and IS:2633. In addition, galvanizing shall be followed by the application of one coat of etching primer conforming to IS:5666 and 2 coats of bituminous paint conforming to IS:9862.

7. LOADINGS

7.1 Wind Load

7.1.1 Basic wind speed as well as factors K1/K2/K3 shall be taken from IS:875. Additional intensification factor to be considered due to natural turbulence in the incident wind / induced turbulence owing to nearby tall structures shall be as per BS4485, Part 4, or based on wind tunnel studies, whichever is higher.

7.1.2 Steady pressure distribution around the shell for the wind loading shall be as per clause 5.1.3 of IS:11504, for cooling towers not more than 120m in height and not more than 100 m in base diameter. The value obtained shall be increased by 10 percent to take into account any geometrical imperfections.

7.1.3 For cooling towers of height more than 120m and/or more than 100m in base diameter, wind pressure distribution shall be as determined by model test in a wind tunnel.

7.2 Earthquake Load

7.2.1 The coefficient of horizontal acceleration shall be for the appropriate seismic zone as per IS:1893

7.3 Dead Load

7.3.1 For assessing the self weight of the structure, the specific weight of the concrete shell shall be taken as 25kN per cubic metre. All other dead loads shall be assessed as per IS:875.

7.3.2 The loadings brought upon the shell by permanent fixings shall be minimised to the greatest extent possible. However, when these attachments are made, their effect upon the structure shall be thoroughly investigated.



7.4 **Constructional Loadings**

Contractor shall be fully responsible for ensuring safety by checking the designs, for all the temporary construction loadings as applicable.

7.5 **Miscellaneous Loads**

Effect on account of the following loads shall also be investigated.

- a) Thermal restraint loads
- b) Subsoil deformation

8.0 **LOAD COMBINATIONS AND PERMISSIBLE STRESSES**

8.1 All structural components except Fill Supporting Structures ,Stairs and Platforms of the cooling tower shall be designed by both working stress and limit state method. The load combinations shall be as follows:

- a. For working stress method
 - i. $DL + WL$
 - ii. $DL + 1/3WL + EQ$
- b. For limit state method
 - i. $1.5DL + 1.5WL$
 - ii. $0.9DL + 1.5WL$
 - iii. $1.5DL + 1.5EQ + 0.5WL$
 - iv. $0.9DL + 1.5EQ + 0.5 WL$

where $DL =$ Dead Load
 $WL =$ Wind Load
 $EQ =$ Earthquake Load

8.2 While considering the above load combinations, the appropriate stress resultants shall be superimposed most unfavourably. Stress due to subsoil deformation, temperature and constructional loads shall also be added to arrive at the most unfavourable load combination.

8.3 Since cooling tower is more a wind predominant structure, increase in permissible stresses as per B – 2.3 Annexure – B of IS 456, shall not be



allowed. Increase in safe bearing capacity for design of foundation under wind load combination shall also not be permitted.

9.0 FOUNDATIONS

9.1 The design and construction of cooling tower foundations shall be in accordance with the requirements stipulated in IS:1080/IS:2911/IS:2950 as applicable. Continuous foundations shall be provided for cooling towers more than 75 m in height.

9.2 The foundation structure shall be designed for loads indicated in clause 8.0 of this specification and shall in addition consider the following:

- a. Thermally induced local loading where supply culverts pass through the foundation structure without structural isolation.
- b. Cold water basin floor loading.
- c. Surcharge load of 15 KN per sq.metre at the ground / grade level.
- d. In case of subsoil with varying degrees of stiffness, non uniform settlements due to the varying stiffnesses have to be determined. The redistribution of stress resulting from interaction effects between the subsoil and the shell structure have to be taken into account.

9.3 For the load combination 0.9DL+1.5WL, uplift of the foundation, not exceeding a sector of 15 degrees is permitted, provided the foundation is a continuous annular raft foundation.

10. BASIN AND COLD WATER OUTLET

10.1 The basin shall be divided into two compartments to facilitate complete isolation of one half of the basin for the purpose of cleaning and maintenance, while the other half is in service.

10.2 The basin floor of each compartment shall be sloped towards a collecting sump for effectively draining the water to permit desilting/desludging. To minimise obstructions to the flow of water, only the columns supporting the Fill structure shall be projected above the basin floor. Water shall be drained from the sump into a drain chamber outside the basin by CI drain pipe embedded below the basin floor. Suitable sluice gates of the rising



spindle type conforming to IS:3042 or sluice valve conforming to IS:780 shall be provided in the drain chamber.

- 10.3 A minimum of 300mm free board shall be provided for the basin over the maximum design water level. The basin wall shall project a minimum of 500 mm over the surrounding grade level.
- 10.4 Each compartment of the basin shall be provided with a concrete channel for outlet of cold water. Cold water outlet channels shall be provided with the stoplogs and screens.
- 10.5 Stoplogs shall be fabricated out of structural steel plate and rolled sections and provided with rubber seals to prevent leakage. Stoplogs shall be hot dip galvanised and provided with etch primer and bituminous paint.
- 10.6 Screens shall be out of 8 gauge 25mm clear opening GI crimped wire netting welded to frame of structural steel section/flats. Screens shall be hot dip galvanised and provided with etch primer and bituminous painting. Two numbers of screens shall be supplied per tower.
- 10.7 Suitable arrangement of monorails with hoist shall be provided for handling stoplogs and screens.
- 10.8 The basin walls, floor slab and outlet channels shall be of reinforced concrete construction. The design and construction of these water retaining structures shall be in accordance with IS:3370 with provision of construction/contraction and expansion joints. Resistance to cracking shall be checked as per cl. 3.3.1 and cl. 3.4.1 of IS:3370 (PART II). Minimum thickness of structural concrete elements shall be 230mm.
- 10.9 The basin and channel walls shall be designed for a minimum surcharge load of 15kN per sq.m. to allow for construction plant operating in the vicinity.
- 10.10 External pressure due to earth and ground water shall not be relied upon to reduce the effect of the internal water pressure, but account shall be taken of the ground water pressure when considering buoyancy or stresses in the empty water retaining structure.
- 10.11 Construction of the basin and channel shall be watertight with the provision of 225mm wide approved quality PVC ribbed water stops at all construction joints and expansion joints. Fillet shall be provided, wherever required, as given for unit 1



- 10.12 The water retaining structures shall be tested for water-tightness in accordance with IS:3370, without the backfill Any rectification measures required to satisfy the test criteria shall be executed by the CONTRACTOR at his own cost all as per the directions of the OWNER.
- 10.13 All round Cold water basin, plinth protection in PCC 1:2:4, 100 mm thick shall be provided for a width of 1000 mm, sloping away from the basin. Dry rubble soling of 150 mm thick shall be provided below the concrete paving.
- 11.0 **TOWER SHELL**
- 11.1 **Shell geometry**
- The shape of the tower shall be hyperboloid in vertical section and circular in plan
- 11.2 **Thickness**
- 11.2.1 The tower shell shall have a minimum thickness of 175mm.
- 11.2.2 A minimum factor of safety of five(5) against buckling shall be ensured at all levels.
- 11.3 **Design**
- 11.3.1 The tower shell shall be designed based on bending analysis and as per elastic theory for thin shells.
- 11.3.2 Consideration shall also be given to the following effects of temperature and moisture variations that occur in the shell :
- a) The strain resulting from a temperature gradient across the shell thickness.
 - b) The strain resulting from moisture content variations through the shell thickness, and
 - c) The strain resulting from variations of conditions (a) and (b) caused by rain and sunshine on one side of the tower or partial operation of the tower.
- 11.3.3 The effect of stress concentration due to any fixtures shall be taken into account.



11.4 Reinforcement and Cover

11.4.1 Reinforcement shall be provided on each face of the shell in both directions.

11.4.2 The shell reinforcement of high yield strength deformed bars, in either direction and on each face shall be not less than 0.15% of the concrete cross-sectional area. Further, the circumferential reinforcement on each face shall be not less than 0.20% of the concrete cross sectional area in the top one third height of the shell.

11.4.3 The maximum spacing of reinforcement in either direction on each face shall be restricted to twice the thickness of the shell or 200 mm whichever is less. Further, not more than one third of the reinforcement at any level or section shall be lapped.

11.4.4 Minimum lap lengths in shell shall be 1.3 times L_d where L_d is the development length as described in cl 26.2.1 of IS:456.

11.4.5 Column reinforcing bars shall be carefully anchored in the shell and in the foundations. The minimum anchorage length in the shell shall be $2L_d$.

11.4.6 Minimum size of deformed bars used shall be 8mm for circumferential reinforcement and 10mm for Meridional steel.

11.4.7 The minimum clear cover to shell reinforcement shall be 30mm.

11.5 Tolerances

The shell should be constructed within the dimensional tolerances stipulated in clause 7.3 of IS:11504. Permissible allowances for survey inaccuracies while checking of shell geometry shall be as per clause 7.4 of IS:11504.

12.0 FILL

12.1 PVC film type fill shall be provided.

12.2 The fill shall be adequately supported to minimize sag, possibility of dislodgment and damage as a consequence of induced vibrations in the fill.



- 12.3 In case of film type of fill, the supporting hanger rods/tubes shall be of stainless steel conforming to ASTM 316L.
- 13.0 **FILL SUPPORTING STRUCTURE**
- 13.1 Fill supporting structure with its foundation shall be of reinforced concrete construction.
- 13.2 Fill supporting structure, where formed of precast concrete units, shall be made stable by the use of either bolted, cast-in-situ or glued joints. Members of precast concrete structure shall be either pre-stressed or reinforced concrete units. Where bolts are used for permanent connections, they shall be of a material highly resistant to corrosion or fully protected by embedment or coating.
- 13.3 The columns and beams supporting the Fill shall be adequately braced in all directions. The design of all members shall be checked for resistance to buckling.
- 13.4 The stability of the Fill support structure shall be checked for its capacity to resist a horizontal force of 2% of self-weight, the Fill and supporting structure, assumed to act horizontally in any direction. The structure shall also be checked for the appropriate earthquake loading as applicable.
- 13.5 During erection, care shall be taken to ensure the stability of the potentially unstable, partially completed structure.
- 13.6 The Fill support structure members shall be designed to cater for the likely loads to be imposed thereon, including:
- a) temporary loadings they are subjected to during handling, transportation and erection at normal design stresses.
 - b) loading due to scaffolding for the erection crew if so envisaged to be supported.
 - c) loading of personnel during maintenance of pipe work and sprinkler system. The appropriate parts of the pack support structure shall be designed to support a point load of 1.5 kN at any position.
- 13.7 Reinforced concrete members shall be designed for self-weight and permanent loadings by working stress method with allowable stresses limited to 80% of those specified in IS:456.



14.0 MAINTENANCE ACCESS FACILITIES

All areas of the cooling tower requiring inspection, cleaning, repairs and/or adjustment shall be easily and safely accessible by suitable provision of stairs, platforms, etc., as per the requirement described herein below :

14.1 Stairs

14.1.1 The cooling tower shall be provided with two numbers external dog-legged reinforced concrete stairs. Stairs shall give access to the water distribution system through hot dip galvanised steel doors.

14.1.2 All access doors shall be of size 800 mm wide and 1800 mm height, minimum.

14.2 Platforms

Reinforced concrete platform of 1.2m clear width shall be provided around the circumference at the top of the cooling tower on the outside for fixing aviation warning beacons.

14.3 Walkways

14.3.1 Walkways having a minimum clear width of 1.20 m shall be provided around the circumference inside the cooling tower above the Fill to provide access for inspection and maintenance of all hot water distribution pipes/ducts and nozzles. Walkways shall be supported independent of the Fill structure.

14.4 Ladders

14.4.1 Four numbers of hot dip galvanised mild steel rung ladders with etch primer and bituminous painting shall be provided equally spaced around the circumference of the tower.

14.4.2 Safety cage for the ladder shall be shall be provided for the ladders located on the external surface of the tower upto the throat level.

14.4.3 Ladders shall be continued along the inside surface of the tower upto the top of the tower and then on to the top platform. At the throat level a reinforced concrete landing of 1.2m minimum width shall be provided with a hot dip galvanised steel access door for the interchange.



14.4.4 Two of the ladders leading to the platform at the top of the tower shall have approach from the reinforced concrete stairs. Other two ladders shall be directly from the ground level itself.

14.5 **Handrailings**

14.5.1 Handrailing shall be provided at the edges of platforms, landing slabs, sides of stairs, walkways and cold water outlet channel.

14.5.2 Handrailing shall be of hot dip galvanised construction and shall be out of 32 mm NB pipes of medium class conforming to IS:1239 and provided with etch primer and bituminous painting.

14.5.3 Handrailing shall be 1300 mm high with two intermediate rails at 450mm and 900 mm with the top rail at 1300 mm above the surface of slab/steps. Handrail posts shall be spaced at not more than 2 m centres.

14.5.4 A toe plate of hot dip galvanised mild steel of size 65 mm x 8 mm shall be provided for all handrailing.

15.0 **PAINTING TO CONCRETE SURFACES**

15.1 Painting to the concrete surfaces specified herein below shall consist of one coat of primer and two finish coats of bituminous paint conforming to IS:3384 and IS:9862 respectively.

- a) Basin floor.
- b) Internal and external surfaces of basin wall including the partition wall.
- c) Diagonal columns over complete height.
- d) Fill support columns and beams for the full height and length respectively.
- e) Internal and external surfaces of hot water duct.
- f) Internal and external surfaces of cold water channel upto the terminal point.
- g) Internal and external surfaces of the drain chamber.



f) Complete internal surface of the shell for atleast 2 metres at the top and bottom and for at least 1 metre on the outside of the shell at top and bottom.

15.2 The preparation of concrete surface for painting shall conform to IS:2395 (Part-I). For new surface, it is preferable that the surface left unpainted for as long as possible to allow drying. Before painting, the surface shall be thoroughly brushed to remove all dirt and remains of loose or powdered materials.

15.3 Painting shall consist of one coat of primer conforming to IS:3384 and two coats of bituminous paint conforming to IS:3384. Rate of application of paint shall be so as to give a dry film thickness of 75 microns per coat and shall be to the satisfaction of OWNER. Manufacturer's instructions for application of paint shall be strictly followed.

15.4 All other exposed concrete surfaces shall be given one coat of cement wash after the surfaces are rubbed down suitably and as approved by the OWNER.

16.0 WATER DISTRIBUTION SYSTEM

16.1 The arrangement of water distribution system shall permit a satisfactory distribution of water over the whole area of the tower at all reasonable loads.

16.2 Hot water Inlet pipe shall conform to the requirements of Class I of IS:3589 and steel shall conform to IS:2062.

16.3 The distribution troughs/pipes shall be independently supported from the structures and shall be easily removable. Provision shall also be made for easy flushing or cleaning of all troughs/pipes.

17.0 LIGHTNING PROTECTION

17.1 The cooling tower shall be protected against damage by lightning. The installation work shall conform to the requirements of IS:2309.

17.2 CONTRACTOR's scope of work includes supply and installation of the complete system upto and including the earth electrodes.



- 17.3 For detailed specification of lightning protection system refer electrical section of this document..
- 17.4 During the construction of tower, temporary lightning protection shall be maintained by connecting the reinforcement bars to two grounding conductors of size 50 mm x 6 mm.
- 18.0 **AVIATION WARNING SYSTEM, LIGHTING AND POWER RECEPTACLES**
- 18.1 CONTRACTOR's scope of work includes supply and installation of the complete aviation warning system, lighting and power receptacles including the cabling between the main incoming 63A switch and aviation warning beacons and 30A receptacles.
- 18.2 CONTRACTOR shall provide and fix aviation warning beacons with their supports at the top platform, at the throat level of the tower and at every 45m height or part thereof, between the ground level and the throat level. The beacons shall conform to the requirement of the civil aviation department, Govt. of India. The beacons at the top of the tower should be atleast 2 metres below the top of the tower to prevent them from being obscured by vapour.
- 18.3 For detailed specification refer to the electrical section of this document.
- 18.4 Temporary warning lights shall be installed during construction suitably located above the top most point of obstruction and shall be shifted up as the construction progresses. These lights need be installed only after the level of obstruction is greater than 45 m above the grade level.
- 19.0 **PERFORMANCE TESTS**
- 19.1 After the cooling tower is completely erected and commissioned, tests on its performance shall be conducted. The method of testing shall generally conform to provisions of BS:4485 : Part 2
- 19.2 CONTRACTOR shall submit the detailed test procedure, correction curves, etc. for performance testing for OWNER's approval.
- 19.3 It shall be the responsibility of the CONTRACTOR to carryout all the tests as specified to the full satisfaction of the OWNER and the cost of such tests including supervision shall be borne by him entirely and is deemed to be



included in the quoted lumpsum price. CONTRACTOR shall be fully responsible to make good any and every deficiency in the guaranteed performance of the cooling tower.

19.4 All the instruments supplied and used shall be calibrated by a National laboratory or by an independent laboratory approved by the OWNER. CONTRACTOR shall furnish necessary test certificates for the same to the OWNER.


20.0 **PERFORMANCE GUARANTEE**


20.1 The performance of the cooling tower shall be guaranteed over the following range as per CT / code /BS 4485

- a) Cooling tower flow 90% to 110% of design flow.
- b) Wet bulb temperature (+) 1.7 deg C to (-) 3.9 deg C of design inlet wet bulb temperature.
- c) Cooling range 80% to 120% of design cooling range.
- d) Relative humidity 30% to 100%

20.2 The results of the above tests shall govern the acceptance or otherwise of the cooling tower commissioned.

20.3 The guarantee period shall be deemed to be 12 (twelve) calendar months from the date of taking over of the complete cooling tower by the OWNER OR the stabilisation of the unit, whichever is later.

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<p>1.0</p> <p>1.1</p> <p>2.0</p> <p>2.1</p>	<p>SCOPE</p> <p>This specification covers the general requirements for design and construction of a reinforced concrete chimney of circular cross section including foundations, RCC shell, brick flue, appurtenances, fixtures, fittings, conduit and other embedments, lift where specified, etc., complete.</p> <p>APPLICABLE CODES, SPECIFICATIONS & REFERENCES</p> <p>The following specifications, standards and codes are made a part of this specification. These shall be the latest edition including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, the former shall govern :</p> <p>IS: 6 Moderate heat duty fire clay refractories</p> <p>IS:158 Ready mixed paint, brushing, bituminous, black, lead free; acid, alkali and heat resisting.</p> <p>IS:456 Code of Practice for plain and reinforced concrete.</p> <p>IS:800 Code of Practice for general construction in steel.</p> <p>IS:875 Code of practice for design loads (other than earthquake) for buildings and structures: Part 3 -- Wind Load.</p> <p>IS:1239 Mild steel tubes, tubulars and other wrought steel fittings: Part-1 - mild steel tubes.</p> <p>IS:1526 sizes and shapes for fire brick</p> <p>IS:1893 Criteria for earthquake resistant design of structures.</p> <p>IS:1904 Code of Practice for design and construction of foundations in soils: General requirements.</p> <p>IS:2042 Insulating bricks.</p> <p>IS:2062 Steel for general structural purposes.</p> <p>IS:3043 Code of practice for earthing.</p>	
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- IS:3346 Method for the determination of thermal conductivity of thermal insulation materials (two slab guarded hot-plate method)
- IS:3677 Unbonded rock and slag wool for thermal insulation
- IS:4860 Acid resistant bricks.
- IS:4998 Criteria for design of reinforced concrete chimneys: Part 1 - Design criteria - 1975
- IS:4998 Criteria for design of reinforced concrete: Part 1 Assessment of loads-1992
- IS:8183 Bonded Mineral wool.

Annexure-14 International Standards and Recommended Practices Aerodromes - International Civil Aviation Organisation.

Indian Electricity Rules

2.2 The following is the list of publications referred to in this specification.

Manohar,S.N "Tall Chimneys-Design and Construction", Tata McGraw Hill Publishing Co.Ltd., New Delhi, 1985.

Pinfold,G.M "Reinforced Concrete Chimneys and Towers", View Point Publication, Cement and Concrete Association, U.K., 1975.


Vickery,B.J "Wind Induced Loads on Reinforced Concrete Chimneys", Paper presented at National Seminar on Tall Reinforced Concrete Chimneys, 25-27 April 1985, New Delhi.


Vickery,B.J "The response of reinforced concrete chimneys to & Basu. R. I. vortex shedding",


Journal of Eng. Struct., 1984, Volume 6


ACI 307 - 88 Standard Practice for the Design and Construction of Cast-in-place reinforced concrete chimneys


Deleted: ASCE – 1975 "Design and Construction of Steel Chimney Liners". Task Committee on Steel Chimney liners, Fossil Power Committee, Power division, ASCE.

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<p>2.1 SI units shall be adopted for all design and drawing work.</p> <p>3.0 DESIGN REQUIREMENTS</p> <p>3.1 The principal design parameters for this chimney are indicated in DATA SHEET- A.</p> <p>3.2 The design shall be based on working stress method.</p> <p>3.3 The design and construction of the chimney and its foundation shall conform to the requirements of all statutory rules and regulations of local and national authorities. Where such requirements are less conservative than the corresponding requirements of this specification, the latter shall govern.</p> <p>3.4 The chimney and its foundation shall be designed to resist stresses due to the most critical combination of any of the following:</p> <ul style="list-style-type: none"> (a) Weight of the chimney with or without lining, platforms, accessories and all other dead loads. (b) Wind loads (both along-wind and across wind) or earthquake forces whichever is governing. (c) Temperature gradient across the chimney shell. (d) Eccentric loads from corbels/platforms supporting the lining, soot hopper, etc. (e) Live loads on platforms. Also weight of equipment and materials and other live loads during construction. Live load of 500 kg / sq.m shall be assumed for platforms. (f) For the foundation and portion of the shell below grade level, appropriate earth pressures, hydro- static forces, surcharge etc., as applicable. (g) Local moments due to ovaling. (h) Forces from the lift and operating equipment. (i) Loads from flue duct supports. (j) Construction loads such as those due to plant and equipment, stacked materials, live loads due to movement of plant, materials and personnel, etc. <p>3.5 The total design stresses at a section shall include all secondary effects, viz. corbel effect, eccentric loading due to platforms, secondary moments due to $p-\Delta$ effect, etc. The total design stress</p>		
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<p>in no case shall exceed the permissible stresses specified in clause 7.0 of IS:4998 (Part-1) 1975 and modified as below.</p> <p>3.5.1 Stress in concrete shall be restricted to $0.275 \sigma_{cu}$ under the combination of “ Dead load + Wind load” against the value specified in Clause 7.11 (a) of IS:4998 Part II-1975.</p> <p>3.5.2 If the circumferential tensile stress in concrete due to wind induced ring moment exceeds the value specified in clause 7.1.1 (g) of IS:4998-Part I, additional reinforcement shall be provided in 2 layers limiting the stress in reinforcement steel to value specified in clause 7.1.2(g).</p> <p>3.6 The safety factor against over-turning under worst combination of loads, shall not be less than 1.5 in any direction during construction and 2.0 after construction is complete. For the purpose of calculating safety factor against overturning, during construction the weight of liner, liner supporting platform, insulation and accessories shall not be considered. Net safe allowable bearing capacity of soil specified in DATA SHEET- A can be increased by 25% under seismic conditions; but no such increase will be permitted due to wind loading. No tension shall be allowed in gross pressure under chimney working condition i.e shell + lining complete.</p> <p>3.7 For estimating the deflections of the chimney in lined and unlined conditions, the modulus of elasticity of concrete shall be as per the mean value specified in clause A-3.1 of IS:4998 (Part-1)-1992.</p> <p>3.8 Stresses in the shell shall be shown to be within permissible limits at 10 metre intervals along the height of the shell or at every corbel level whichever distance is less and in addition at the critical locations across openings.</p> <p>3.9 Air inlets, sloped up towards inside, shall be provided near the base with proper GI wire mesh cover over the openings so as to prevent dirt or tiny creatures entering the air gap.</p> <p>3.10 Air outlets of minimum size 150 mm x 300 mm with proper Stainless steel(SST) wire mesh mounted on SST cover on the outside shall be provided at the top of the shell. These openings shall be suitably spaced and their total area shall not be less than that provided for air inlets.</p>		
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<p>3.11 The maximum width of the openings shall normally be limited to an angle of not more than 60° subtended at the centre of the concrete shell.</p> <p>3.12 The bearing capacity and soil strata furnished with the bid are preliminary based on the findings of preliminary soil investigation conducted at the site. Actual design shall be based on SBC obtained from detailed geotechnical investigation carried out by the CONTRACTOR, duly approved by OWNER. No claim from the CONTRACTOR will be entertained by OWNER on the ground that final SBC is different from the value given in the bid.</p> <p>3.14 The analysis of the windshield for wind and earthquake forces shall be done as per the requirements of IS 4998 and IS 1893.</p> <p>3.15 The foundation shall be designed as a rigid member. The thickness of the foundation below the shell shall not be less than 0.40 times the overhang of the foundation beyond the shell. Foundation diameter to depth ratio shall not exceed 12.</p> <p>3.16 For the purposes of analysis/design, the following shall be assumed:</p> <ul style="list-style-type: none"> a) Stiffness of shell shall not be considered for design of the foundation. b) Shell fixed to foundation for shell design. <p>4.0 REQUIREMENTS IN RESPECT OF CONCRETE</p> <p>4.1 All concrete work shall be carried out strictly in accordance with the IS:456 except as otherwise specified hereunder.</p> <p>4.2 When slipforming is adopted, the slump shall be between 75 mm and 100 mm at the point of placement. If necessary, approved admixtures such as retarders/ plasticizers to maintain the workability shall be used with the prior consent of the ENGINEER. Such admixtures shall be identified after preliminary tests to prove their satisfactory performance and compatibility with the particular type of cement envisaged to be used in the shell construction.</p> <p>4.3 Cement used shall be OPC as per IS:8112. In case geotechnical investigation reveals presence of sulphate in the subsoil, High</p>		
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<p>sulphate resistant cement conforming to IS:12330 shall be used below ground level.</p> <p>4.4 The grade of concrete in chimney shell, baffle wall beam, corbels, platforms and hopper shall be minimum M25 and shall not be richer than M40 if slip forming is used unless otherwise specified in DATA SHEET- A. All other works including grade slab and foundation, unless otherwise specified in DATA SHEET- A, shall be with minimum M25 grade concrete.</p> <p>4.5 The minimum cement content, max water cement ratio and minimum grade of concrete for different exposure shall be as per Table 5 & 6 of IS 456. For structures below ground level which are exposed to sulphate attack requirement of cement shall be as per Table 4 of IS 456.</p> <p>4.6 The minimum thickness of the concrete shall be 300 mm for steel liner/ 200 mm for brick lining chimneys with an internal diameter of 8500 mm or less. For Chimneys having an internal diameter exceeding 8500 mm, the minimum shell thickness shall be increased by 5 mm for every 500 mm (or part thereof) increase in diameter over 8500 mm. However minimum thickness of top 10 m of the shell shall be kept as 300 mm to accommodate large number of openings and to take flue supports.</p> <p>4.7 The nominal concrete cover over the reinforcement including links in the shell shall not be less than 50 mm. In foundations, the clear concrete cover shall be 75 mm. Where stipulation given in Table 16 of IS 456 is more stringent, then the requirement as per IS 456 shall be satisfied.</p> <p>5.0 REQUIREMENTS IN RESPECT OF REINFORCEMENT</p> <p>5.1 The minimum vertical reinforcement on each face with deformed bars shall be 0.125% of the concrete area of the section under consideration. For mild steel bars, the minimum reinforcement to be provided on each face shall be 0.15% of the concrete area of the section under consideration. The minimum diameter of vertical reinforcing bars shall be 12 mm and they shall not be spaced at more than 300 mm centres in each face.</p>		
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- 5.2 Laps for the vertical reinforcement shall be staggered. Not more than one-third of the bars shall be lapped at any one level.
- 5.3 The circumferential reinforcement on each face of shell, for deformed bars, shall not be less than 0.1% of the concrete area of the section. When mild steel bars are used, the percentage on each face shall be 0.125. The minimum diameter of these reinforcing bars shall be 10 mm and they shall be spaced at a centre to centre distance not exceeding 300 mm or the shell thickness whichever is less.
- 5.4 However, for a height from the top equal to half the shell outer diameter or 3 metres whichever is more, the quantity of circumferential reinforcement shall be twice that arrived at as stated above due to design considerations.
- 5.5 Circumferential reinforcement shall be placed around the exterior of the vertical bars and securely wired or welded to the vertical bars at an interval of not more than 600 mm.
- 5.6 In addition to the reinforcement determined from structural considerations as well as to meet temperature and other stresses, extra reinforcement shall be provided around and at corners of openings, generally in line with clause E6 of IS:4998-1975.
- 5.7 Foundation raft of the Chimney shall be provided with a layer of reinforcement at the top and the same shall not be less than 12 mm deformed bars at 250 mm centres placed orthogonally.

6.0 LINER (FLUE)

6.1 BRICK LINING

- 6.1.1 The chimney shall be lined with fire/acid resistant bricks for the full height of the chimney above the hopper. The lining shall be supported on concrete platforms at intervals of not more than 10 metres unless otherwise shown in the DATA SHEET-A.
- 6.1.2 Lining bricks shall be hard, uniformly well burnt, uniform in colour, of correct shape and size, homogenous in texture and free from cracks, voids and other flaws and shall be of material suitable to

Deleted: Steel flue¶

¶ 6.1.1 . General¶

¶ 6.1.1.1 Liner shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liner shall be provided with externally wrapped thermal insulation. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting platform. The height of the stainless steel liners shall be a minimum 1.5 times the exit diameter of the flue.¶

¶ <#>The lining / stiffeners shall be fabricated from corrosion resistance steel type "COR-TEN B" or mild steel having an ultimate tensile strength of not less than 410 N/sq.mm and conforming to the requirement of IS:2062 (Grade-A) unless noted.¶


¶ <#> The portion of liner with stainless steel shall be provided with a grade of steel conforming with the requirements of AISI type 316 L.¶


¶ <#> . The structural steel transition inlet ducting shall be bottom supported. The transition ducting shall be suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluoroelastomeric fabric expansion joints.¶


¶ <#> Design of Steel Liner¶


¶ <#> Steel liners shall, in general, be designed meeting the requirements of the document, " Design and construction of steel chimney liners", prepared by Task committee on steel chimney liners, Fossil power committee, Power division published by ASCE-1975.¶

¶ <#>The flue diameter shall be so sized to ensure that the flue gas exit velocity is of the order of 20 to 25 meters/second at the normal continuous operating load. It should be ensured that the flue gas exit velocity at the lowest continuous unit load is high enough (of the order of 15 meters/second) to enable ... [1]

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<p>withstand the service conditions. No broken bricks shall be allowed to be used except for closing the course. Each brick shall be clearly marked with the MANUFACTURER's name and trade mark.</p> <p>6.1.3 The sizes and shapes of fire clay bricks shall conform to IS : 1526 and shall be of Group-A Type 1 conforming to IS:6. These bricks shall be laid in air setting mortar and cured as per MANUFACTURER's specification. The mortar shall meet the following specifications:</p> <ul style="list-style-type: none"> (i) Fineness grading : 95% passing through 0.5 mm sieve (ii) Service Temperature : 1000°C maximum (iii) Setting : Air setting on drying (iv) Al₂O₃ : 28% minimum (v) Fe₂O₃ : 2.5% maximum (vi) Minimum Bond Strength when tested as per ASTM C 198 for flexure cured at 110°C for 18 hours : 1.0 N/mm² (vii) Refractoriness tested as per IS:1528 : Pyrometric cone ASTM No.28 (min) (b) Prior to despatch of mortar material from MANUFACTURER, at least five (5) samples of the lot to be despatched shall be tested for bond strength as specified above, and the test reports submitted to OWNER/CONSULTANT for approval and permission for despatch of material. Similarly, five (5) samples of the lot to be despatched shall also be tested for chemical resistance as per IS:4456 (Part-1) and loss in weight and loss in compressive strength of the test specimen shall not exceed 5 %. The test reports on chemical resistance shall be reported as per clauses 10.11.2 and 10.11.3 of IS:4456 (Part-1). <p>6.1.4 The acid resistant bricks shall conform to Class I of IS:4860 and the mortar for this brickwork shall conform to IS:4832 (Part 1) - Silica type with potassium silicate liquid binder. The Contractor shall furnish test certificates confirming the coefficient of thermal</p>		
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<p>conductivity of both fire clay bricks and acid resistant bricks from an approved laboratory for ENGINEER's approval before bringing them to site. Similarly, test certificates for acid resisting properties shall also be furnished for acid resisting bricks.</p> <p>6.1.5 In the case of Acid resistant Brick lining, the mortar joints shall be cured with 25% dilute HCl for a minimum period of 3 days and as per MANUFACTURER's specification after which exposed face shall be thoroughly cleaned with water.</p> <p>6.1.6 Thermal Conductivity of Lining Bricks</p> <p>6.1.6.1 The value of the coefficient of thermal conductivity for fire clay and acid resistant lining bricks shall not exceed $K = 1.25 \text{ Kcal/m/hr/}^\circ\text{C}$ and shall be considered as $K = 1.25 \text{ Kcal/m/hr/}^\circ\text{C}$ for the purpose of design of shell for temperature effects.</p> <p>6.1.6.2 Prior to despatch of bricks from MANUFACTURER at least five (5) samples of the lot to be despatched shall be tested for K-value at an approved laboratory and test reports submitted to ENGINEER for approval and permission for despatch of material. While testing, the hot-face temperature of the bricks shall be 300°C. Similarly, test certificates for acid resisting properties shall also be furnished for acid resisting bricks.</p> <p>6.1.6.3 The acid resistant bricks shall conform to Class I of IS:4860 and the mortar for this brickwork shall conform to IS:4832 Part-I – Silica type with Potassium Silicate. Provision shall be made for differential vertical expansion at the lining support.</p> <p>6.1.6.4 The thickness of lining shall be as shown on the bid drawings. The radial joints shall be broken in each course. Lining shall be strapped with circumferential and vertical galvanised mild steel bands having a minimum dimension of 75x6 mm and 50x5 mm respectively, both spaced at one metre centres, on the exterior of the brickwork throughout the full height of the lining.</p> <p>6.1.6.5 The vertical and horizontal bands shall be joined together by either (a) suitable spot welding and all weld joints painted with 2 coats of zinc rich aluminium paint over a coat of compatible primer as per the requirement of the MANUFACTURER, or (b) fixed by bolting arrangement, with counter sunk bolts and slotted holes as indicated in relevant bid drawings.</p>		
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<p>6.1.6.6</p> <p>6.1.6.7</p> <p>6.1.6.8</p> <p>6.1.6.9</p> <p>6.2</p> <p>.2.1</p>	<p>Special care shall be taken to ensure proper laying of bricks to cover the RCC platforms so as to protect them from the action of gases. Glass/mineral wool insulation of 25 mm thick shall be provided between the face of the platform and brick lining with a sealing by 2 Nos. 25 mm dia asbestos chords conforming to Grade 3 of IS:4687. Bricks shall be laid on corbels on 12 mm thick asbestos sheet.</p> <p>Mortar for lining shall be used within the initial setting time and no retempering shall be permitted. Joints shall be properly filled and at a given cross section, the thickness of the joint shall not be more than 2 mm along the inner periphery of the lining and not more than 12mm along the outer periphery. In the case where the inner diameter of the lining is less than 4500, shaped bricks shall be used to maintain the thickness of joints mentioned above.</p> <p>The lining, unless otherwise specified in DATA SHEET-A, shall be of acid resistant bricks laid in acid resistant mortar for the following portions :</p> <p>a) Top most two lifts of the chimney shell (A lift shall mean distance between two successive corbels) but not less than 14 metres.</p> <p>b) Bottom first lift of the chimney shell immediately above the ring beam of the hopper extending a minimum 3 metres above the top of flue gas duct.</p> <p>c) Over the hopper and around the baffle wall.</p> <p>However the lining shall be of acid resistant bricks laid in acid resistant mortar for the whole height if the provision of desulphurisation plant is indicated in Data Sheet A.</p> <p>Flue support arrangement</p> <p>Brick flue shall be supported from RC corbel / Platform.</p>	
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7 INSULATION

7.1 Brick flue

7.2 All insulation and packing shall be of dimensions specified in DATA SHEET-A. The materials for insulation and packing shall be mineral/glass wool, asbestos rope, asbestos mill boards, insulation bricks, etc., of approved quality.

7.3 The mineral/glass wool shall be of resin bonded type conforming equivalent with a maximum coefficient of thermal conductivity of 0.060 Kcal/m/hr°C at a mean temperature of 150°C. The material shall have a minimum density of 0.80 kN/m³

7.4 The diameter of the asbestos rope conforming to Grade 3 of IS:4687 shall be 25 mm unless otherwise specified in DATA SHEET-A. The strands shall be long, well twisted and stranded and no torn fibre shall stick out. The rope of approved quality shall be firmly packed so as to prevent gas leakage at all locations where the lining overlaps.

7.5 Asbestos mill board shall be 12 mm thick, unless otherwise specified in DATA SHEET-A. It shall be plain, dense and have a homogenous texture, without cracks, flaws or any other manufacturing defect. It shall be laid directly over the concrete after removing all loose materials but without any mortar/plaster bedding.

7.6 The base for acid resistant brick lining in hopper portion shall be either cellular concrete or insulating bricks of Grade 'C' conforming to IS:2042 or equivalent unless otherwise specified in DATA SHEET-A.

7.7 22 gauge AC sheet covers shall be provided all around the insulation wrapping around the lining of flues and ducts. The sheeting shall be in three segments with all necessary fixing arrangements with rivets including overlapping and work shall be executed as per drawings and as directed by the ENGINEER.

8.0 Liner Test Ports

8.1 Gas sampling ports fabricated from SST with flanged ends shall be provided for each liner at platform levels where indicated including

Deleted: Steel flue¶

¶
 <#> The flue shall be insulated externally. The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS:8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 80 kg/cum for resin bonded rock wool. Maximum coefficient of thermal conductivity shall be 0.062 Kcal / m hr °C at a mean temperature of 150 °C.¶

¶
 <#> The insulation thickness shall be chosen based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 60°C. The draught of air in the annular space shall be the natural draught by the heating of air by the flue liner and the air being vented out through the opening in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness.¶

... [2]


Deleted: 8.0 EXPANSION COMPENSATOR / JOINTS IN STEEL LINER¶

¶
 The suspended portion of the liner shall be connected to the bottom supported portion of the liner by an expansion joint. The joint shall be able to compensate for the large thermal movements of the steel flue, be gas tight, acid resistant, heat resistant and provide an adequate insulating medium to avoid excessive overheating in the access void. ¶

¶
 The material s used for the fabrication of the expansion joints shall be suitable for the flue gas conditions specified herein, and shall not deteriorate during transit, site handling, storage and installation. ¶

¶
 The expansion joint shall be manufactured by a specialist for similar type of Joints. The CONTRACTOR shall furnish outline proposals for the expansion joint during the bid stage along with the manufacturer's qualifications and experience for the OWNER's review. On award of contract, full details of materials to be supplied along ¶

... [3]

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proper insulation, blank plates nuts, bolts, etc. The location, orientation and level of ports shall be as per the details indicated in the relevant sections of this specification document.

8.2 CONTRACTOR shall provide for the purposes of instrumentation other than the sampling ports mentioned above required number of 38 NB conduits including pull wires, junction boxes and pull boxes, all securely tacked / anchored to internal of shell and S 316 L plates below each pipe insert for fixing of measuring instruments.

9. ACCESSORIES


9.1 Ladder


The chimney shall be provided with a hot dip galvanised steel ladder having access to intermediate resting platforms extending from bottom to top fabricated in 2.4,3.6 or 4.8 m sections. Stringers shall be of flat 75x10 with a clear distance of 400 mm in-between; Rungs shall be of 20 mm dia mild steel rods spaced at 300 mm centres. The ladder and its connection shall be designed for a load of 175 kg at any location. The ladder shall be provided with a safety cage made up of hot dip galvanised steel flats. All inserts shall also be hot dipped galvanised. A ladder safety device shall be provided for the entire height of the chimney. Intermediate landing /resting platforms of length not less than 1500 mm and width 1000 mm shall be provided along the height of the ladder at intervals not exceeding 15 metres. The landing platforms shall be of reinforced cement concrete and designed for a live load of 500 Kg/sq.m

Deleted: <#>Liner Hood/Cap for steel flue¶
¶ The liner hood shall be fabricated from 6 mm thick stainless steel sheets of grade 316L. The hood shall completely cover the annular area packed with insulation material between the stainless steel flue and cladding. All sections of the hood shall be anchored in place with stainless steel bolts/nuts. Slot holes shall be provided to make allowances for differentials expansions/movements.¶

10 Chimney roof cap

10.1 To prevent gas-entrained matter from falling into the space between the liner and the shell and also to prevent the chimney top from chemical attack of flue gases, a sectional grey cast-iron cap of minimum 12 mm thickness over 25 mm thick asbestos shall be provided, unless otherwise specified on the drawing. The cap shall cover the concrete shell, brick lining and air space between them. The cap shall slope towards the inside of the chimney at approximately 30° to the horizontal. All sections of the cap shall be anchored in place with bronze bolts and bronze rag bolts respectively.

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<p>10.2</p> <p>10.2.1</p> <p>10.2.2</p> <p>10.3</p> <p>10.3.1</p> <p>10.3.2</p> <p>10.3.3</p> <p>10.3.4</p> <p>10.4</p> <p>10.4.1</p> <p>10.4.1.1</p>	<p><u>Soot Hopper for Brick flue chimney</u></p> <p>This shall be of reinforced concrete and lined with acid resistant brickwork laid in acid resistant mortar. Only shaped acid resistant bricks shall be used in the hopper portion. The bricks, mortar and details of laying and joining shall conform to the requirements laid down for acid resistant brick lining.</p> <p>Between the reinforced concrete hopper and acid resistant brick lining, 75 mm thick (unless otherwise specified on the drawing) insulation bricks of Grade C conforming to IS:2042 or equivalent cellular concrete shall be provided. At the bottom of the hopper, CI flanged pipe with puddle flange of specified dia and length shall be embedded as shown on the drawing. Inside of this pipe sleeve shall be coated with sodium silicate.</p> <p>Strakes</p> <p>Strakes shall be provided if necessary from design point of view for controlling effect from vortex excited oscillation.</p> <p>The strakes shall be designed for a pressure of not less than four times the wind pressure computed at top of chimney.</p> <p>Strakes, if specified, shall be made up of mild steel plates and rolled sections of thickness not less than 6 mm. A corrosion allowance of 1.5 mm in the structural members shall be provided for, beyond the design values.</p> <p>Fixing arrangement of strakes to the chimney shell shall ensure full fixity for the design load. All strakes, embedded parts, bolts, nuts, washers, etc., shall be hot dip galvanised.</p> <p>Doors</p> <p>Clean out Doors</p> <p>Each flue shall be provided with clean out doors having clear dimension fo 650 mm x 825 mm at appropriate location with proper access for operating the door. The edges of the doors shall be properly sealed to prevent escape of hot flue gases. The door shall be of hollow steel construction with inner plate of 8 mm and outer plate of 6 mm with suitable infill of stiffeners. The hollow space</p>	
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shall be filled up with insulation of the type used around flues. In addition around the door openings, removable type of insulation similar to the insulation provided around flue shall be provided. The door shall be of hinged type and provided with locking device in addition to Swivel studs with wing nuts on the remaining 3 edges. The door shall be openable both from inside and outside.

10.4.2 Removable cladding / Access door

Opening provided near the base of the wind shield for the purposes of flue can erection shall be closed using a removable type of colour coated galvanised aluminium sheet min 0.6 mm thick on structural steel framing which also can be dismantled if required. Within the cladding area, an access door of size 2100 x 1000 mm shall be provided with sill level at 300 mm from paved level. This door shall be similar to hollow steel doors provided in other buildings. The door shall be provided with a minimum two coats of acid and alkali resistant paint conforming to IS:158 type I to give a DFT of 75 microns. The outside surface shall be provided with 2 coats of zinc red oxide primer and two coats of synthetic enamel paint. The door shall be provided with suitable locking arrangement.


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10.5 Louvres


Air inlet and outlet louvres shall be provided as per the requirement of this specification near the top. The louvre fins shall be of Z-shape in cross section and made from anodised aluminium plates of a minimum thickness of 4 mm. The frame work supporting the louvre fins shall be made from extruded aluminium sections of minimum thickness 6 mm. The louvres shall be mounted in the form of panels. The fins shall be closely spaced to cut off any driving rain entering the chimney wind shield. All panels must be approved by the ENGINEER before installation. To outside face of louvers ST mesh on SST mesh frame work shall be provided.


10.6 Maintenance Provisions


10.6.1 The outer face of the chimney wind shield shall be provided with adequate number of stainless steel insert plates of grade 316 L at the top to enable fixing and supporting painter's trolleys and other accessories. The insert plates shall be provided with suitable


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<p>number of threaded holes and nuts welded at the rear end to enable bolting of the assembly when desired.</p> <p>10.6.2 Similar arrangement shall be made at each platform level but to fix the painting trolley arrangement directly on the platforms for the purpose of painting the internals of the chimney.</p> <p>10.6.3 A lifting beam shall be provided at platform level to cater for lifting of materials during maintenance and painting. The size and capacity of the lifting beams shall be as indicated in relevant drawings.</p> <p>10.7 Electrical Requirements</p> <p>10.7.1 Electrical requirements are generally listed in Data sheet A. Detailed specification for various electrical components are covered in the Electrical section of this document. This shall essentially include Aviation Warning beacons, Lighting system, Lightning protection systems, embedment all GI conduits cabling and all Electrical installation work in the chimney from the Junction box provided near the base of chimney. Cabling for instruments are also included in the scope of the CONTRACTOR.</p> <p>10.7.2 The temporary lighting to meet the requirement of Civil Aviation Department and lightning protection and earthing required during the construction stage of the chimney shall also be provided by the CONTRACTOR.</p> <p>10.7.3 The installation of Electrical system shall be in strict accordance with the latest edition of Indian Standard Code of Practice and regulations existing in the locality where the system is installed. In particular the following standards shall apply.</p> <ul style="list-style-type: none"> i) IS:3043 --- Code of Practice for Earthing ii) IS:2309 --- Code of practice for the protection of building and allied structures against lightning. iii) Indian Electricity Rules. <p>10.8 INSTRUMENTATION REQUIREMENT</p> <p>10.8.1 Details of instrument to be installed are furnished in the instrumentation section of this document. Generally the following instruments are mounted on the chimney.</p>		
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<p>i) Anemometer</p> <p>ii) Accelerometer</p> <p>iii) Flue gas analyser</p> <p>10.8.2 Necessary embedment in stainless steel to install the above instruments (to be supplied by the owner as specified in data sheet) along with embedded conduits including JB's for running cables to these instruments from JB provided by OWNER outside the chimney are included in the scope of the CONTRACTOR.</p> <p>10.9 <u>External Platforms</u></p> <p>10.9.1 Unless otherwise stated in Data Sheet-A. external platforms shall be provided, one at 2300 mm below the exit level of flue and others at intervals of 45 m along the chimney height, platforms shall be of reinforced concrete and be 1000 mm clear width between shell and 150 high kerb and with 32 mm dia hot dip galvanised pipe ceiling consisting of three rails, the two intermediate ceils being about 450 mm and 900 mm above platforms level and 32 mm NB pipe pots spaced not more than 1000 mm centres. Top handrail shall be 1300 mm above than 1000 mm centres. Top handrail shall be 1300 mm above platform level. All pipes for railings and posts shall conform to medium class as per IS: 1239 (Part-I). For the topmost platforms, access for passenger lift (if specified) shall be ensured by provision of a landing platform with steps/ladder if necessary.</p> <p>10.9.2 Radial gaps of 12 mm wide shall be provided in the platform floor at 45° for shell diameter less than 7.5m, 30° for shell diameter between 7.50 m and 12.5 m. 22.50° for shell diameter between 12.5 m and 15.0 m and 15° for shell diameter between 12.5 m and 15.0 m and 22.0 m. At the centre of each circumferential segment of each platform and located 100 mm and 750 mm from the face of the chimney shell, 2 nos. of puddle flanged cast iron pipe sleeves of 75mm internal diameter shall be provided. In addition, One MS plate of size 400 x 150 x 16 mm located centrally between the CI pipe sleeves with 400 mm dimension radially shall be embedded in each of the external platforms for passing ropes during maintenance of the chimney. These embedded plates for pulley block shall be provided with 4 nos. tapped holes to receive 20 mm dia bolts in rectangular pattern of dimension 300 x 80 mm concentrically. One number of hot dip</p>		
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<p>galvanised pulley block with a lifting capacity of 300 kg for a painters trolley with all fixtures shall be supplied by CONTRACTOR. A mild steel drain pipe of 100 mm internal dia flush with concrete shall be provided near the kerb for each segment of external platform. Care shall be taken to avoid radial joints in front of clean out doors.</p> <p>10.9.3 External platforms shall be designed for a live load of 500 kg per sq.m or for a live load of 150 kg per sq.m and reaction from the mounting arrangement of pulley block/bracket, whichever is critical . They shall also be designed for dead load, wind forces, etc.</p> <p>10.9.4 All bolts,nuts,pipe railing posts,etc., shall be hot dip galvanised. The railings posts, beacon supports, etc., shall be fitted to the chimney platforms by GI nuts on to GI inserts left projecting from the concrete shell.</p> <p>10.9.5 Details of intermediate platforms are as specified under the requirements of ladder</p> <p>11.0 PAINTING</p> <p>11.1 Two coats of acid and heat resisting paint conforming to IS:158 over a coat of compatible primer shall be given to the following surfaces as per MANUFACTURER's recommendations :</p> <p>i) Internally full height of the chimney shell including top of wind shield, including all faces of corbels before constructing the liner.</p> <p>ii) From the top to a distance of 1.5 times the diameter of the chimney shell at the top, externally.</p> <p>11.2 Painting the external surfaces of the chimney shell with two coats of synthetic enamel paint over 2 coats of primer as per MANUFACTURER's recommendations in alternate bands of Orange or Red and White shade, each band with a band width of H/7 metres for Chimneys less than 210m height or H/9 for chimneys more than 210m height or 30 metres whichever is smaller (H = Height of chimney in metres) and bands at the extremities being of Orange or Red shade. This shall be done after</p>		
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<p>removing all loose and foreign matter to give a smooth and uniform finish.</p> <p>11.3 External painting shall commence immediately after the shell construction/platform is completed and the concrete is well cured. The painting shall preferably be started from the top. This is to ensure visibility of stack to low flying aircraft at day time even during the period of construction of the internals of the chimney.</p> <p>12.0 DESIGN AND DRAWINGS</p> <p>12.1 The CONTRACTOR shall submit his method of analysis, design parameters, allowable stresses, method and sequence of construction including staging, details of proposed site testing facilities, etc., strictly as per specifications for the OWNER's review and approval within 30 days from the date of Purchaser Order.</p> <p>12.2 The CONTRACTOR shall submit, based on the approved concept, detailed working drawings/design for the foundation (with dowels for the shell), complete and detailed general arrangement drawing for the ENGINEER's approval within 45 days from the date of purchase order. The remaining drawings shall be submitted in a progressive manner within six months from the date of award of contract.</p> <p>12.3 In case the CONTRACTOR adopts computerised designs, only validated computer programs shall be used for the analysis and design. The computer output listing should include all input data covering the loads and load combinations.</p> <p>12.4 All modifications suggested by the OWNER to meet specification requirements and sound engineering practice, shall be incorporated by the CONTRACTOR at no extra cost to the OWNER.</p> <p>12.5 Any modifications/change in subsequent revisions of design/drawings shall be clearly marked and identified with a revision for the OWNER's review/approval.</p> <p>12.6 Construction of work shall commence only after the written approval of drawings by the OWNER. However, the OWNER's approval of the design/drawings shall not absolve the CONTRACTOR of his responsibility for correctness of design, accuracy of dimensions, loadings, details, etc., or safety and</p>		
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<p>stability of the structure including foundations, accessories, appurtenances, etc.</p> <p>13.0 CONSTRUCTION</p> <p>13.1 Staging</p> <p>13.1.1 Design and erection of staging shall conform to the requirements of all relevant IS Codes and National safety standards/regulations.</p> <p>13.1.2 As the staging serves a dual purpose, viz., as an access tower and as a bearing structure to support construction loads, it shall be designed for all possible loads that could be imposed on it such as self-weight, weight of ladder and timber platforms at all levels, weight of men, weight of construction materials and equipment, wind loads, seismic loads, etc.</p> <p>13.1.3 Minimum live load on staging due to labour and personnel movement shall be considered at 300 kg/m². It may be taken as 150 kg/m² when earthquake loads are also taken into account. No increase in stresses shall be considered for wind and seismic conditions.</p> <p>13.2 Shell Construction</p> <p>13.2.1 The CONTRACTOR shall prepare and submit a detailed quality assurance plan within one month of award of work. This plan shall include the following :</p> <p>a) Design criteria</p> <p>The CONTRACTOR shall give the criteria to be adopted for design of various temporary works and the slipforms.</p> <p>The CONTRACTOR's design calculations shall be based on normally accepted practice for the structural forms which the CONTRACTOR adopts for staging.</p> <p>b) 'Construction Method'</p> <p>This shall include atleast the following :</p>		
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<p>i) Structural analysis proving adequacy of jacks, slipforms, and their supports and staging.</p> <p>ii) Planned interruptions. Also the operations during planned interruptions such as retrieval of jack rods, resetting of form panels, etc., shall be stipulated.</p> <p>iii) Method of preparing, transporting, pouring, vibrating and finishing concrete.</p> <p>iv) Treatment at construction joints during unplanned interruptions.</p> <p>c) Construction Equipment</p> <p>The CONTRACTOR shall furnish a detailed description of the following :</p> <p>i) The type and number of equipment and facilities to be used for slipforming such as jacks, working platforms at various levels, yokes, walers, etc. There shall be atleast a 50% standby capacity of jacks, jack rods, hydraulic pump, hose pipes, etc.</p> <p>ii) Provision, including standby, of concrete mixing units and pumps to cater to the planned rate of progress of slipping.</p> <p>iii) Material hoists and buckets for transport of concrete, reinforcement, scaffolding components, etc.</p> <p>iv) Curing arrangements consisting of pumps, pipelines, etc. There shall be atleast 50% standby pumps</p> <p>v) Provision of precision survey instruments including lasers for verticality check. The laser instrument shall emit a long range visible laser which has a self-levelling platform which electronically levels the instrument and has a</p>		
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<p>fail-safe system that shuts off the beam when out of level. There shall be a standby.</p> <p>vi) Stipulation of power requirement for operation and the CONTRACTOR shall provide adequate standby diesel generating sets. Details of night lighting shall also be specified.</p> <p>vii) Communication arrangements between ground and working deck.</p> <p>13.2.2 Concreting</p> <p>a) Particular attention must be given to concrete placement because of the thin wall section and the presence of reinforcing steel. Compaction of concrete shall be by vibration.</p> <p>b) Under no circumstances shall the point of discharge of the concrete into the forms be more than 1.5 m above the concrete surface on which it is to be deposited. Also, not more than 2 metres height of chimney shall be concreted on any one day if permission is given to proceed with jump forms.</p> <p>c) The slipping rate of the forms shall be such that the concrete, when exposed has already achieved enough strength to support the vertical pressure from the concrete still in the forms as well as to withstand lateral pressure caused by wind, inclination of walls, etc. The slipping rate shall be limited to 200mm/hour.</p> <p>d) Small openings and pockets less than 600 x 300 mm can be formed by inserting blocks. Larger openings shall be formed using frames which shall be formed well in advance of the sliding.</p> <p>e) Horizontal bars should be fixed nearest to the face of the wall. These bars should be pre-bent.</p> <p>f) The interior and exterior surfaces of the shell shall be kept moist for 14 days after exposure from the forms as the chimney construction progresses upwards. For this purpose, circumferential perforated pipes shall be hung</p>		
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<p>from immediately below the forms and raised along with them.</p> <p>g) If the ENGINEER so requires, the CONTRACTOR shall make immediate arrangements, through an approved agency, to undertake ultrasonic tests to prove the quality of concrete. The quality of concrete shall be considered as satisfactory if it meets specification requirements and the sonic velocity is atleast 4000 m/s. If the tests prove that the quality of concrete is not satisfactory, then all costs associated with the tests and any rectification shall be borne by the CONTRACTOR.</p> <p>13.2.4 Physical Checks</p> <p>Some of the mandatory physical checks to ensure that construction tolerances are met with shall be carried out by the CONTRACTOR, as under :</p> <p>a) The twist or rotation of the slipform every 60 minutes.</p> <p>b) Level of top of jacks every thirty minutes.</p> <p>c) Verticality with the help of lasers atleast once in four hours.</p> <p>d) Inside and outside diameters/dimensions and wall thickness, once in each shift of 8 hours.</p> <p>e) Condition of jack rods for ovality, indentation, buckling, moving out of alignment, etc., before fixing each rod.</p> <p>f) Live load on working deck to avoid accidental overloads.</p> <p>g) Workability of concrete at mixer and at point of placement, once an hour.</p> <p>13.2.5 Construction Tolerance</p> <p>The following shall be the limiting construction tolerances to be strictly adhered to by the CONTRACTOR.</p> <p>a) Verticality : 1 in 1000 subject to a maximum of 75 mm. In addition, no two points 10 m</p>		
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<p>apart vertically shall be more than 20 mm out of plumb wrt each other</p> <p>b) Wall thickness : ± 10 mm, - 0.</p> <p>c) Shell diameter : ± 10 mm for every 3m diameter without any abrupt changes but in no case more than ± 40 mm.</p> <p>d) Spiralling : Rate of spiralling of forms not greater than 10 mm cir- cumferential rotation at the outer face of the concrete per metre of vertical travel.</p> <p>e) Openings, inserts, pocket : ± 12 mm</p> <p>f) Cover : + 5 mm, - 0.</p> <p>g) Level of any part of structure : ± 20 mm</p>		
<p>13.3 Construction Tools And Materials</p>		
<p>13.3.1</p>	<p>CONTRACTOR shall provide and maintain at the site necessary number and type of machinery and equipment including survey instruments in good working condition for proper setting out and timely completion of the works covered under this specification. All arrangements for transporting the equipment to and from the site shall be done by the CONTRACTOR at his own expense.</p>	
<p>13.3.2</p>	<p>It shall be ensured by the CONTRACOR that work shall proceed uninterrupted even in the event of power failures. As such, adequate number of diesel generator sets and diesel operated equipment</p>	
<p>13.3.3</p>	<p>CONTRACTOR shall furnish MANUFACTURER's test certificate for the materials supplied by him.</p>	
<p>13.3.4</p>	<p>Climbing or slip-forms shall be controlled by linked hydraulically operated jacks that are reversible, driven by an electrically operated pump and with provision for manual operation in the event of a break down.</p>	
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<p>13.4 Work Execution And Supervision</p> <p>13.4.1 CONTRACTOR shall have at the site accredited and qualified engineers and foremen / supervisors with adequate number of years of experience in execution of similar works and operators of machinery and equipment, for satisfactory progress and timely completion of the works.</p> <p>13.4.2 All temporary electrical installation shall be supervised by a qualified electrical supervisor of the CONTRACTOR.</p> <p>13.4.3 One hoist for passengers / supervisory staff and one for transport of goods shall be provided by the CONTRACTOR. These hoists shall be operational not later than the time when construction first reaches 30 m and should be available throughout the construction period.</p> <p>13.4.4 Quality of ingredients of concrete and the concrete produced and placed shall be controlled as per the relevant codal provisions. For this purpose, samples shall be collected and tested as per relevant IS codes and quality ensured. The defects and inadequacies in the quality of concrete shall be rectified, as per standard practice.</p>		
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Steel flue

6.1.1 General

- 6.1.1.1 Liner shall essentially be constructed from structural steel and shall be of the hung type (i.e. of tension type). The liner shall be provided with externally wrapped thermal insulation. The portion of the liners projecting above the chimney roof shall be constructed of stainless steel. Stainless steel liner shall commence immediately above the flue supporting platform but below the roof supporting platform. The height of the stainless steel liners shall be a minimum 1.5 times the exit diameter of the flue.

The lining / stiffeners shall be fabricated from corrosion resistance steel type “COR-TEN B” or mild steel having an ultimate tensile strength of not less than 410 N/sq.mm and conforming to the requirement of IS:2062 (Grade-A) unless noted.

The portion of liner with stainless steel shall be provided with a grade of steel conforming with the requirements of AISI type 316 L.

The structural steel transition inlet ducting shall be bottom supported. The transition ducting shall be suitably profiled from a rectangular shape at the chimney inlet to a circular shape up inside the chimney where it shall be connected to the suspended circular steel liners through suitable (non-metallic) fluoroelastomeric fabric expansion joints.

Design of Steel Liner

Steel liners shall, in general, be designed meeting the requirements of the document, “ Design and construction of steel chimney liners”, prepared by Task committee on steel chimney liners, Fossil power committee, Power division published by ASCE-1975.

The flue diameter shall be so sized to ensure that the flue gas exit velocity is of the order of 20 to 25 meters/second at the normal continuous operating load. It should be ensured that the flue gas exit velocity at the lowest continuous unit load is high enough (of the order of 15 meters/second) to enable adequate dispersion of the flue gases. For this purpose, 100% turbine MCR condition with design coal firing shall be considered as normal continuous operating condition, and 60% turbine MCR condition with design coal / worst coal firing (whichever yields lesser flue gas quantity) shall be considered as the lowest continuous load condition.

The plate thickness of the liner shall be arrived at from minimum (i.e. codal) requirements, structural considerations and corrosion allowances. The minimum installed thickness of the mild steel liners shall not be less than 10mm in any case.

The supporting / restraining arrangements of the liners should be such that expansion of the liners longitudinally or circumferentially is not restrained.

6.1.3 **Design of Transition Ducting**

6.1.3.1 The number, size and location of flue opening in the shell shall be as shown on the bid drawings. The CONTRACTOR shall make arrangement for the proper support of ducting on the shell, provision of restraint / support arrangement as required.

The CONTRACTOR shall be responsible for furnishing, fabricating, shop painting and delivery of ducting which shall run from the chimney liner to the flange of the boiler vendor's duct including all necessary auxiliary ducting as well as soot collecting hoppers located outside the chimney shell. Soot hoppers shall be lined with SS grade 316L. Suitable flange connection shall be provided at the exit of the hopper to provide SS / CI pipe connection to drain ash / condensed acid mixed water.

The duct work profile and the guide vanes shall be so configured and sized to achieve the desired flue gas flow characteristic and to minimise flue gas pressure losses.

The duct work and its supporting structures shall be designed for the most onerous of the possible combinations of gravity loading (accounting for ash accumulation) , seismic loading, flue gas pressure loading and thermal loading.

The plate thickness of the ducts shall be arrived at from minimum (i.e.codal) requirements, structural considerations and corrosion allowances. The minimum installed thickness of the mild steel ducts shall not be less than 10 mm in any case. Material of construction shall be mild steel conforming to IS:2062.

The duct work shall be insulated as per the requirements of clause 7.0 with 75 thick insulation (3 layers of 25 thick sheets) and protected with aluminium foil of minimum 1 mm thickness. Access doors shall be provided for the ducting where required for inspection and cleaning.

6.1.4 **Fabrication and Erection**

The CONTRACTOR shall establish a full fledged fabrication shop at site including proper cutting, bending, welding, testing and proper handling facilities. Complete fabrication shall be carried out at site.

The individual cans of the liner shall be joined together by butt welding internally around for full strength after connecting the flanged portion of the cans with high tensile steel threaded fasteners conforming to IS:1367. It shall be ensured that the joints are accessible from internal platform during erection to facilitate welding.

The CONTRACTOR shall arrange testing of welds in the presence of OWNER's representative as described below.

6.1.4.3.1 100% of the welds shall be subjected to visual inspection to detect visual imperfection.

At least 10% fillet welds shall be subjected to Dye penetration tests (DPT) at random.

6.1.4.3.3 100% of the root welds for butt welding shall be subjected to DPT after back gauging.

10% of butt welds chosen at random shall be subjected to radiographic / ultrasonic tests. All welding / weld testing procedure shall in general follow AWS standards.

6.1.5 **Erection**

6.1.5.1 CONTRACTOR shall submit to the ENGINEER the scheme for erection of the steel flue, erection equipment to be deployed, equipment and accessories complete for approval by OWNER. CONTRACTOR shall make sure that there are adequate spares for the erection equipments and at no cost will a delay be permitted due to inferior or faulty erection equipment.

CONTRACTOR shall furnish necessary details such as number of jacks he proposes to use, their supporting arrangement, collars, rod hangers, high tensile steel cables/rods to lift or suspend the flue, temporary staging arrangement and fixing details. The capacity of the jacks, cables etc. shall be double the actual load proposed to be lifted / borne by them.

It is suggested that the liner is installed in heights of approximately 45 m. This height is indicated so as to facilitate welding at each access

platform level. The top portion of liner is first installed at ground level, hoisted and placed on the support platform. After ensuring that this portion is well supported, the second set of linear is erected at ground level, hoisted and welded to the already placed linear portion and so on. This would enable requirement of jacks and cables of smaller capacity and easier handling.

CONTRACTOR shall ensure that deviations shall not exceed the specified tolerances spelt out herein below for fabrication and erection of steel flues. The permissible deviations from the true form are as under:

Internal diameter shall not differ from the true or design diameter by more than +20mm in the horizontal plane.

Horizontal centre of any section shall not deviate more than 12 mm from the shell vertical centre line in any 15 m height and never more than 1:2500 of height plus 12 mm at any level considered.

Locally, the variation of the bent plates from true circular form (flat spots) should not exceed the plate thickness. All measurement/ checking shall be done by a segmental circular template having the design radius and a chord length of 0.15 times the design radius.

6.1.6 Flue Support Arrangement

The support brackets and bearing assembly shall be welded to the locally thickened portion of the flue and in turn support the flue on the support platform. The arrangement shall cater for thermal movements of liner elements in a smooth and easy manner.

The support arrangement shall typically consist of the flue support bracket which is connected to the shoe by a precision bolted connection. The bracket in turn is welded to a bearing assembly. The bearing assembly is later bolted to the support beams. The arrangement shall cater for thermal movements of linear elements in a smooth and easy manner.

6.1.6.3 The bearing assembly shall consist of 3 units and shall be fabricated as described herein.

The first unit shall consist of a MS base plate on which a MS sole plate shall be welded & interfaces shall be machined. The sole plate shall be provided with a recess to seat a PTFE film conforming to BS:5400 dimpled on the upper surface and lubricated with silicon

grease. This unit shall be bolted to the support beam, using restraint brackets. Four slotted holes shall be provided through base and sole plate to connect brackets which restrains movement of second and third units to 5 mm on either side.

The second unit shall consist of a MS plate of adequate size and thickness connected to stainless bearing plate of adequate thickness with c/sk screws connected at the bottom. The stainless steel surface shall be placed on the PTFE surface of the first unit. On top of MS plate 3 mm thick lead sheet shall be provided.

The third unit consisting of two layers of load bearing insulation blocks each with a minimum thickness of 50 mm, factory bonded by 100 mm long load bearing insulation dowels. MS cover plates of adequate size and thickness shall be provided at top and bottom of the insulation block with appropriate restraining guides of MS both at top and bottom to prevent movement of insulation block. An MS bearing plate of adequate thickness shall be welded to the bottom of the bottom cover plate, with exposed bottom surface machined. This plate will rest on the lead sheet provided on the top of second unit.

The bearing assembly shall be levelled by use of suitable MS shims as required

Suitable restraint brackets and stop plates of MS shall be provided to avoid excessive movement, and keep the different units of the bearing assembly in position.

The insulation blocks shall be of natural grade fibre reinforced asbestos or an equivalent material which shall primarily consist of the following physical properties:

Minimum compressive stress prior to onset of compression yield of not less than 12 N/sq.mm.

Minimum shear strength of 30 N/sq.mm when tested in accordance with BS:3497-1979.

Thermal conductivity shall not exceed 0.6 kcal/m.hr °C to a mean temperature of 200°C and coefficient of linear expansion not to exceed 1.2×10^{-5} per °C.

Adhesive used for bonding purpose shall be material with equivalent high temperature properties as approved by the ENGINEER.

- 6.1.6.9 At flue restraint platforms, necessary restraint arrangement with load bearing insulation blocks and stainless steel bearing plates fixed to the insulation blocks shall be provided.
- 6.1.6.10 Restraint and support brackets shall be provided for the bottom supported portion of the flue which rests on the support platform provided at the base to cater for bearing and restraint requirements.

Steel flue

The flue shall be insulated externally. The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS:8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 80 kg/cum for resin bonded rock wool. Maximum coefficient of thermal conductivity shall be 0.062 Kcal / m hr °C at a mean temperature of 150 °C.

The insulation thickness shall be chosen based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 60°C. The draught of air in the annular space shall be the natural draught by the heating of air by the flue liner and the air being vented out through the opening in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness.

The insulation shall be tightly secured to the exterior surface of the liner by impaling them on studs welded to the surface at 450 mm c/c both horizontally and vertically. The studs shall be plated and be of a minimum thickness of 10 gauge. The studs shall extend a minimum of 25 mm beyond the thickness of insulation and 63 mm. Circular or square metal plate speed washers of standard thickness shall be placed on the extended portion of the studs to hold the impaled insulation material well in place. Further, 20 gauge galvanised wire mesh with a 25 mm hexagonal pattern conforming to IS:3150 shall be wrapped around. Where the wire mesh is jointed, a minimum 150 mm overlap shall be provided. The mesh shall be bound and tied in place with a 16 gauge GI wire at 300 mm centres. Any form of lacing the mesh fibres together will not be permitted.

Insulation for the exposed portion of flue at the top shall consist of 6 layers of insulation material each of a minimum thickness of 25 mm and all joints shall be staggered. The material shall have a minimum density of 200 kg/cu.m. This shall be protected from the elements by means

of a stainless steel cladding, flashing and hood of grade 316 L stainless steel.

8.0 **EXPANSION COMPENSATOR / JOINTS IN STEEL LINER**

The suspended portion of the liner shall be connected to the bottom supported portion of the liner by an expansion joint. The joint shall be able to compensate for the large thermal movements of the steel flue, be gas tight, acid resistant, heat resistant and provide an adequate insulating medium to avoid excessive overheating in the access void.

The materials used for the fabrication of the expansion joints shall be suitable for the flue gas conditions specified herein, and shall not deteriorate during transit, site handling, storage and installation.

The expansion joint shall be manufactured by a specialist for similar type of Joints. The CONTRACTOR shall furnish outline proposals for the expansion joint during the bid stage along with the manufacturer's qualifications and experience for the OWNER's review. On award of contract, full details of materials to be supplied along with fabrication drawings shall be supplied by the CONTRACTOR for the OWNER's approval. The CONTRACTOR shall procure the units only after obtaining the ENGINEER's approval.

The expansion joints shall be made of flexible fibre. They should be air tight and impermeable and should withstand the maximum serviceable temperatures of the flue gas.

The CONTRACTOR shall furnish in complete a installation, dismantling and maintenance user hand-book. A draft of the hand-book shall be submitted to the ENGINEER for his approval well before the installation commences.



*

1. IS CODES & REFERENCES

- 1.1 All the Indian Standards referred to shall be the latest revision (including all amendments issued thereto) at the time of execution.
- 1.2 Reference to only some of the codes in this document and various clauses of design criteria shall not limit or restrict the scope or applicability of other relevant codes. It shall be ensured that all other codes relevant to a specific job, in addition to those already mentioned, are followed wherever applicable.
- 1.3 Where British / American / DIN or other codes and standards are referred to in this document, equivalent Indian Standards may be substituted if available.
- 1.4 In case of any deviation / conflict between provisions of IS codes and the design criteria, the provisions that are more stringent shall followed unless specifically directed otherwise.
- 1.5 The Codes and Standards listed below are applicable for the design and construction of structures and buildings in general. Codes and Standards applicable for specific design and construction are listed elsewhere in reference sections.
- 1.6 Specifications for materials supplied from India follow the Indian Standard Specifications.
- 1.7 Field and laboratory testing procedures for materials follow Indian Standard Specifications.
- 1.8 Working stress design can be used as alternative but the approval of OWNER is a prerequisite.

2. LOADS

IS:875	Code of Practice for design loads (other than earthquake) for Buildings and structure (All parts)
IS:1911	Schedule of unit weights of building materials
IS:1893	Criteria for earthquake resistant design of structure



3. FOUNDATIONS

IS:1080	Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
IS:1904	Code of Practice for design and construction of foundations in soils general requirement
IS:2911	Code of Practice for design and construction of pile foundations: (All parts)
IS:2950	Code of Practice for design and construction of raft foundations
IS:2974	Code of Practice for design and construction of machine foundations (all parts)
IS:4091	Code of Practice for design and construction of foundations for transmission line towers and poles
IS:8009	Code of Practice for calculation of settlement of foundations: (All parts)
IS:9556	Code of Practice for design and construction of diaphragm walls
IS:11089	Code of Practice for design and construction of ring foundation
IS:13301	Guidelines for vibration isolation for machine foundations

4. RCC

IS:456	Code of Practice for plain and reinforced concrete
IS:458	Specification for precast concrete pipes
IS:3370	Code of Practice for concrete structures for the storage of liquids: (All parts)
IS:3414	Code of Practice for design and installation of joints in buildings



IS:3935	Code of Practice for composite construction
IS:4326	Code of Practice for earthquake resistant design and construction of buildings
IS:4995	Criteria for design of reinforced concrete bins for storage of granular (all parts) and powdery materials
IS:4998	Criteria for design of reinforced concrete chimneys: (All parts)
IS:5525	Recommendation for detailing of reinforced concrete works
IS:1786	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS:10262	Recommended guidelines for concrete mix design
IS:11384	Code of Practice for composite construction in structural steel and concrete
IS:11504	Criteria for structural design of Reinforced concrete Natural Draft Cooling Tower
IS:11682	Criteria for design of RCC staging for overhead water tanks
IS:13920	Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

5. **STRUCTURAL STEEL**

IS:800	Code of Practice for general construction in steel
IS:802	Code of Practice for use of structural steel in overhead transmission line towers: (All parts)
IS:806	Code of Practice for use of steel tubes in general building construction
IS:808	Dimensions for hot rolled steel beam, column channel and angle section



IS:813	Scheme of symbols for welding
IS:816	Code of Practice for use of metal arc welding for general construction in mild steel
IS:1024	Code of Practice for use of welding in bridges and structures subjected to dynamic loading
IS:1161	Steel tubes for structural purposes
IS:2062	Structural steel (fusion welding quality)
IS:4000	High Strength bolts in steel structures – Code of Practice
IS:7215	Tolerances for fabrication of steel structures
IS:8640	Recommendations for dimensional parameters for industrial building
IS:9178	Criteria for design of steel bins for storage of bulk material (all parts)
IS:9595	Recommendation for Metal arc welding of carbon and carbon manganese steel
IS:12843	Tolerances for erection of steel structures

6. MISCELLANEOUS

IS:1038	Specification for steel doors, windows and ventilators
IS:1172	Code of basic requirements for water supply, drainage and sanitation
IS:1346	Code of Practice for water proofing of roofs with bitumen felts
IS:1742	Code of Practice for building drainage
IS:1905	Code of Practice for structural use of unreinforced masonry



IS:2210	Criteria for design of reinforced concrete shell structures and folded plates
IS:2470	Code of Practice for installation of septic tank: (part 1) Design criteria and construction (part 2) Secondary treatment and disposal of septic tank effluent
IS:3067	Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
IS:10440	Code of Practice for construction of reinforced brick and reinforced brick concrete floors and roofs SP:6 Handbook for structural engineers (all parts)
SP:7	National Building Code of India
SP:16	Design Aids for reinforced concrete to IS:456-1978
SP:20	Handbook on masonry design and construction
SP:22	Explanatory handbook on codes for earthquake engineering (IS:1982-1975 and IS:4326-1976)
SP:24	Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete
SP:25	Handbook on causes and prevention of cracks in buildings
SP:32	Handbook on functional requirements of industrial buildings
SP:34	Handbook of concrete reinforcement and detailing (SCIP)
IRC:37	Guidelines for design of flexible pavements
IRC:73	Geometric design of roads Bridge rules of Government of India, Ministry of Railways (Railway Board)
BS:4485	Structural design of Cooling Towers (part 4)

TENDER SPECIFICATION

BHEL PSSR SCT 1270

**CONSTRUCTION OF FOUNDATIONS FOR BOILER, ESP,
MILL, MILL BAY, TG Etc.**

FOR

1 X 500 MW TPS

FOR

KPCL

BELLARY, KARNATAKA

**VOLUME – II
BOOK 2**

**TECHNICAL SPECIFICATION
BOOK NO**



**BHARAT HEAVY ELECTRICALS LIMITED
(A GOVERNMENT OF INDIA UNDERTAKING)
POWER SECTOR – SOUTHERN REGION
690,ANNA SALAI, NANDANAM, CHENNAI – 600 035**

**CONSTRUCTION OF FOUNDATIONS FOR BOILER, ESP,
MILL, MILL BAY, TG Etc.**

FOR

1 X 500 MW TPS

VOLUME: II

**BHEL STANDARD TECHNICAL
SPECIFICATION**



**TECHNICAL SPECIFICATION FOR
EARTHWORK IN EXCAVATION
AND BACKFILLING**

SPECIFICATION NO. PE-TS-234-600-C001

VOLUME - II B

SECTION - D (PART - I)

REV.NO. 0 DATE 14.12.2004

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1X500 MW BELLARY TPS – UNIT 2

VOLUME: II B

**SECTION - D
(PART I)**

SUB-SECTION – D I

EARTHWORK IN EXCAVATION AND BACKFILLING



**TECHNICAL SPECIFICATION FOR
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**STANDARD TECHNICAL SPECIFICATION
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING**

1.00.00 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

1.01.00 Work To Be Provided By The Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services including as required under statutory labour regulations, materials, scaffolding, equipments, tools and plants, transportation etc required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

1.02.00 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.00.00 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200 Method of measurement of building and civil engineering



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	works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.02.00 Materials

2.02.01 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.02.02 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, the following classification are to be followed.

a) Soil

It include all type of soil including laterite and moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under clause 2.02.02 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock



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It include the rocks which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

2.02.03 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.03.00 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl.	Activity	Check
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No.		
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

3.00.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms and compaction etc within 15 days of award of the contract to the engineer for approval.

3.01.00 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.02.00 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.



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3.03.00 Excavation for Foundations and Trenches

3.03.01 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete



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blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.03.02 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.03.03 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.03.04 Blasting



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a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be



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erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

- * not to put their feet on the clean floor unless the magazine shoes on.
- * not to touch the magazine shoes on ground outside the clean floor.
- * not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have



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been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out



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it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

f) Restrictions in Blasting

- a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
- b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
- c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.



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d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.

e) The last blast shall not be more than 0.50 m in depth.

f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.03.05 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or

ii) By spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.03.06 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer. All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.03.07 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed



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during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.03.08 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.03.09 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

a) Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the



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collapse of the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

b) Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.03.10 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.04.00 Backfilling

3.04.01 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.04.02 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required



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degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.04.03 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.04.04 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.04.05 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.05.00 Approaches and Fencing



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The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.06.00 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.02.00 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS:4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the



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description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

e) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.02.00 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of



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each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

6.00.00 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.01.00 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.02.00 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.



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CEMENT CONCRETE (PLAIN &
REINFORCED)**

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SUB-SECTION – D II

CEMENT CONCRETE (PLAIN & REINFORCED)

SPECIFICATION NO. PE-TS-234-600-C001

Bharat Heavy Electricals Limited



Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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SUB-SECTION – D II

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

- a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.
- b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.
- c) Prepare working drawings of formworks, scaffolds, supports, etc.
- d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.
- e) Prepare detailed drawings of supports, templates, hangers, etc. required for



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installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

- f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.
- g) Design and submit for approval concrete mix designs required to be adopted on the job.
- h) Furnish samples and submit for approval results of tests of various properties of the following:
 - i) The various ingredients of concrete
 - ii) Concrete
 - iii) Embedments
 - iv) Joint seals
- i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.
- j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

- a) Source and arrangement of processing of aggregates proposed to be adopted.



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- b) Type of plant and equipment proposed to be used.
- c) Names of firms with which association is sought for to execute the special items of work in the contract.
- d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

- i) Coarse and fine aggregates.
- ii) Admixtures.
- iii) Plywood for Formwork.
- iv) Embedded and anchorage materials as may be desired by the Engineer.
- v) Joint sealing strips and other*waterproofing materials.
- vi) Joint filling compounds.
- vii) Foundation quality Rubber Pads.



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c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Bending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment
As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00

Conformity with Design

The Contractor will prepare checklists in approved Form, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour



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Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

- a) TG foundation top deck and sub structures including raft.
- b) Spring Supporting decks of all machine foundations.
- c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.

For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as



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Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

- a) Accelerating admixture
- b) Retarding admixture
- c) Water reducing admixture
- d) Air entraining admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or



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ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars above 10 mm dia. shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.



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2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture: Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete.

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.

b) Aggregate: Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.

c) Water: Impurities tests.

d) Cement: Tests to satisfy relevant IS Specifications.

e) Formwork: Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

f) Reinforcement: Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.



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- h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.
- i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.
- j) Embedded and Anchorage Items: Material, shape, location, setting.
- k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
- l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
- m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.
- n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
- o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates



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Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

“Design Mix Concrete” and “Nominal Mix Design” is defined as follows for use in this specification:

- a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".
- b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.



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3.04.02

Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

- a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.
- b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.
- c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.
- d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.
- e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00

Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS: 456. All other relevant clauses of IS: 456 shall also apply.

3.06.00

Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at site. Based on various tests results and as per Engineer, the environment



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condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

- a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.
- b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.
- c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

- a) The requirement of strength.
- b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible



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from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.



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Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm
Lean concrete	- 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of



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TGs, BFPs, Fans and Mills):

The temperature of fresh concrete shall not exceed 25°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 25°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 25°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 **Mixing of Concrete**

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight



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platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

- a) Earth foundation
- b) Rock foundation
- c) Formwork
- d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.



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Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid



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concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

- a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.
- b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the



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middle of the span.

- c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.
- d) Feather-edges in concrete shall be avoided while forming a joint.
- e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.
- f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

- a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces



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3.14.01

Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

- a) Sack rubbing with mortar and stoning with carborundum stone.
- b) Cutting away the defective concrete to the required depth shape.
- c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.
- d) Roughening by sand blasting or chipping.
- e) Installing additional reinforcement/welded mesh fabric.
- f) Dry packing with stiff mortar.
- 9) Plastering, guniting, shotcreting etc.
- h) Placing and compacting concrete in the void left by cutting out defective concrete.
- i) Grouting with cement sand slurry of 1:1 mix.
- j) Repairing with a suitable mortar either cement or resin modified mortars.
- k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02

Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can



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be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of



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concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00

Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn



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steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed



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soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Drawings. Welding of cold twisted High yield strength deformed bar shall not be allowed.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting



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When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the



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formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing



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of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

- For -
- a) Sectional dimension - ± 5 mm
 - b) Plumb - 1 in 1000 of height
 - c) Levels - ± 3 mm before any deflection has



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taken place

The tolerance given above are specified for local aberrations in the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

- a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.
- b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.
- c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures



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The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti-corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer.

Items to be embedded

- a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.
- b) Anchor bolts and plates for machinery, equipment and for structural steel work.
- c) Steel structurals to be left embedded for future extension, special connection etc.
- d) Dowel bars, etc. for concrete work falling under the scope of other contractors.
- e) Lugs or plugs for door and window frames occurring in concrete work.
- f) Flashing and jointing in concrete work.
- g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All



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materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make



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and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb



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- iii) Dumb-bell or flattened ends
- iv) Ribbed and Corrugated Wings
- v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
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Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's



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approval for important machineries.

3.25.00

Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00

Waterproofing of Concrete Structure

3.26.01

General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the



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relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the



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owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasticizer will be preferable.

- a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.
- b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing



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a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1 : 4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given



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hereunder

- i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.
- ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum
- iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,
- v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.
- vi) Lay 250-micron polyethylene film as second layer similar to
- vii) above.
- viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.
- x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation



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The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents



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Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.



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5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.

If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

- a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall also include the cost of using curing compound, whenever used.
- b) The unit rates shall include for all working conditions including in or under water, liquid, mud, in or under foul positions, under tides, and extreme weather conditions.
- c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.
- d) The unit rates shall include for maintaining stability of structure during execution.
- e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.
- f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity tests or other relevant tests to ascertain grade and quality, etc. of the concrete, if required. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.



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- g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.
- h) The quoted rate shall include the cost of making additional trial mixes, using the superplasticizer and mixing in concrete etc.

6.01.02 Measurements

- a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres.
- b) No deductions shall be made for the following:
 - i) Opening upto 0.1 sq.m.
 - ii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.
 - iii) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.
- c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.
- d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 25⁰C.

6.02.00 Reinforcement

6.02.01 Rates

- a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.
- b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the



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store, etc.

- c) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).
- d) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

- a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.
- b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

- a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.
- b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.
- c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.
- d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.
- e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.



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- f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

- a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.
- b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

- c) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.
- d) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.
- e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

- a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.
- b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.
- c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts.

6.04.02 Measurements

- a) The measurement of the embedded steel parts fabricated and installed by



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the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

- b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.
- c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.
- d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.
- e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.
- f) The expansion fasteners shall be measured in number according to tension capacity.
- g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

- a) Measurement shall be in cubic decimeters.
- b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.
- c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.
- d) No deduction shall be made for shims, bolts, shear keys and such other embedments.



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6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.



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6.07.02 Measurements

- a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be on the same basis as that employed for construction work.
- b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).
- c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

- a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.



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7.00.00

LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

- IS: 73 - Indian Standard Specification for Paving Bitumen
- IS: 216 - Indian Standard Specification for Coal Tar Pitch
- IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
- IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement
- IS: 455 - Indian Standard Specification for Slag Cement
- IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete
- IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
- IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete
- IS: 702 - Indian Standard specification for industrial bitumen.
- IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete



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- IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
- IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement
- IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
- IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts
- IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.
- IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.
- IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type).
- IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks
- IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates
- IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
- IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
- IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type
- IS: 2506 - Indian Standard Specification for Screenshot Board Concrete Vibrators
- IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables
- IS: 2571 - Code of practice for laying in-situ cement concrete floors.
- IS: 2645 - Integral cement water proofing compound
- IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)



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- IS: 2750 - Indian Standard Specification for steel scaffoldings.
- IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
- IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete
- IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry
- IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.
- IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses
- IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids
- IS: 3414 - Code of practice for design and installation of joints in buildings.
- IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
- IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete
- IS: 3696 - Safety Code for Scaffolding and Ladders
- IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete
- IS: 4014 - Code of practice for steel tubular scaffolding.
- IS: 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement
- IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
- IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches
- IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes



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- IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete
- IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant
- IS: 4926 - Indian Standard Specification for Ready Mixed Concrete
- IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work
- IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground
- IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials
- IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.
- IS: 5256 - Code of practice for sealing joints in concrete lining on canals.
- IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials
- IS: 5513 - Indian Standard Specification for vacate Apparatus.
- IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.
- IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
- IS: 5624 - Indian Standard Specification for foundation bolts.
- IS: 5751 - Indian Standard Specification for Precast Concrete Coping Blocks.
- IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.
- IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.
- IS: 5892 - Indian Standard Specification for transit mixer and agitators.



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- IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use
- IS: 6909 - Indian Standard Specification for Super sulphated Cement
- IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.
- IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.
- IS: 7242 - Indian Standard Specification for Concrete Spreaders.
- IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.
- IS: 7251 - Indian Standard Specification for Concrete Finishers.
- IS: 7293 - Safety code for working with construction machinery.
- IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.
- IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.
- IS: 7969 - Safety Code for Storage and Handling of Building Materials.
- IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.
- IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.
- IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.
- IS: 8989 - Safety Code for Erection of Concrete Framed Structures.
- IS: 9012 - Recommended method for shortcreting.
- IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS: 9077 - Code of Practice for Corrosion Protection of Steel



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Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.



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1X 500 MW BELLARY TPS – UNIT 2

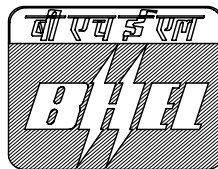
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CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-234-600-C001



Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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CARPENTRY AND JOINERY**1.00.00 SCOPE**

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION**2.00.01 Materials**

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848.



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The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish



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All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA**3.00.01 Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmets, Furniture, etc.**3.03.01 General**

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.



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3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848 - Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)

IS: 1003 - Timber panelled and glazed shutters.

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

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

IS: 4021 - Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates shall include of all activities mentioned in "Schedule of Item" for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges, holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement



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Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.



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STRUCTURES WATER PROOFING,
INSULATION AND ALLIED WORKS**

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1X 500 MW BELLARY TPS – UNIT 2

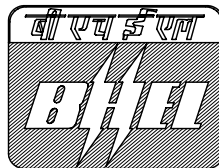
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**ROOF AND UNDERGROUND STRUCTURES WATER
PROOFING, INSULATION AND ALLIED WORKS**

SPECIFICATION NO. PE-TS-234-600-C001



Bharat Heavy Electricals Limited

**Project Engineering Management
Power Sector, BHEL House
Asian Games Village Complex
Siri Fort, New Delhi-110049**



TITLE:
**STANDARD TECHNICAL SPECIFICATION
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ROOF AND UNDERGROUND WATER PROOFING, INSULATION AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof and underground water-proofing, insulation and allied works for buildings and at locations covered under the scope of this package.

2.00.00 INSTALLATION

2.01.00 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be.

2.01.01 Cement Mortar Underbed

The underbed grading plaster shall be average 25 mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The sand and cement shall be thoroughly mixed dry and then water added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.01.02 Cement Concrete Underbed

The underbed cement concrete shall be used where the subgrade is more than average 25 mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12 mm down stone chips and coarse sand. The aggregate



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shall be mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.02.00 INSULATION

The Tenderer shall, along with the tender, send specifications of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation, the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12 mm and it shall be cured for seven days.

2.02.01 Foam Concrete

This shall be of lightweight foam concrete of average 50 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl/sq.m. hr degree C. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to withstand the usual workload and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.02.02 Expanded Polystyrene Blocks

The expanded polystyrene block Insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 Kcl m/sq.m h °C. It must be strong enough to withstand without any deformation under the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used



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for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall secure manufacturers supervision at no extra cost to the Owner.

2.03.00 Fillets

Fillets at Junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix volume.

2.04.00 Waterproofing Treatment

2.04.01 Bitumen Felt Treatment

Waterproofing treatment shall be laid by a specialist firm with long experience in the particular trade.

The waterproofing treatment for roofs with bitumen felts shall be done following relevant IS: 1346. Bitumen felt shall conform to IS: 1322 and Bitumen primer to IS: 3384.

The bonding materials shall consist of blown type conforming to IS: 702 or residual bitumen conforming to IS: 73 or a mixture of the two to withstand local conditions of prevailing temperature or gradient of roof surface. The Contractor shall convince the Engineer that the bonding material proposed to be used is suitable for the particular job.

The Contractor shall state the source from where he proposed to procure the materials. Samples of the self-finished felt shall be submitted in advance to the Engineer along with test certificates for his review. Test certificates for the bonding materials shall also be submitted and samples, if desired by the Engineer, shall be provided for confirmatory tests. Samples shall be submitted if instructed by the Engineer.

Minimum overlaps of 100 and 75 mm shall be given at the end and sides of strips of felt and properly bonded with bitumen. Joints in successive layers of felt shall be staggered.

Normal treatment with one layer of felt, heavy treatment with two layers of felt or Extra Heavy treatment with three layers of felt shall be indicated. Brief details of the various treatments shall be as follows:

- a) Normal Treatment - Five courses



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- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 3) Hessian base self finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m. (min.)
- 5) 20 mm thick pressed precast concrete tiles with 15 mm, thick 1:4 cement-sand mortar underbed.

b) Heavy Treatment - Seven Courses

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Hessian base self-finished felt, type 3, grade I.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With fiber base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Not applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 3) Fiber base self-finished felt, type 2, grade 2.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)
- 5) Fiber base self-finished felt, type 2, grade 2.
- 6) Hot applied bitumen at the rate of 1.2 kg/sq.m (Min.)



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7) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

c) Extra Heavy Treatment – Nine courses

With fiber based felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Fiber-base self-finished felt type 2, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sq.m (min.)
- 5) Fibre base self-finished felt type 2, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 7) Fibre base self-finished felt type 2, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 9) 20 mm thick pressed precast concrete tiles with 15 mm thick 1:4 cement: sand mortar underbed.

or

With Hessian base felt

- 1) Primer coat conforming to IS:3384 applied at the rate 0.27lits/sqm min.
- 2) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 3) Hessian base self-finished felt, type 3, grade 1.
- 4) Hot applied bitumen at the rate of 1.2 kg/sqm. (min.)
- 5) Hessian base self-finished felt, type 3, grade 1.
- 6) Hot applied bitumen at the rate of 1.2 kg/sqm. min.
- 7) Hessian base self-finished felt, type 3, grade 1.
- 8) Hot applied bitumen at the rate of 1.2 kg/sqm. min.



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- 9) 20 mm thick pressed precast concrete tiles with 15 thick 1:4 cement: sand mortar underbed.

However, in special cases, more courses, or a combination of fibre base and hessian base felts may be asked for.

The surface to receive the waterproofing treatment must be cleaned and dried satisfactorily and the Engineer's approval taken before starting the work. If any existing waterproofing treatment is being augmented the existing top course shall be completely removed and all damaged felts or other defects repaired.

The Engineer may instruct the Contractor to lay part of the stipulated courses at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance again hot bitumen shall be applied to start with after repair of all damages to the already laid course.

After completion the surface shall be cleaned taking care that felt cuttings etc. do not find their way into rainwater down comers.

2.04.02 Elastomeric Membrane

a) Material

The material shall consist of high solid content Polyurethane based cold liquid applied coatings as per ASTM C836-89a comprising of urethane pre-polymers extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic or any other equivalent material permitted as per ASTM and approved by the Engineer. The material shall consist of high solid coating designed to give a high-build film. The material shall not be diluted. The coating shall have physical feature like high viscosity, 90% solids, high resistance to impact, abrasion and cracking, superior tensile strength, application limit of 70⁰C minimum, 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to roof substrates (RCC, tiles, brick, and metals), having a minimum life of 10 years. It should also be resistant to acid (mild concentrated), alkalies and have a very low water absorption rate (0.5%) max. at ambient temp. after 7 days.

The pack shall not be older than 9 months after the date of manufacture and packing.



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b) Primer coat

It shall consists of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush over the prepared bed as an adhesion coat of an application rate of minimum 6 sq.m per litre.

The primer shall be allowed to dry for minimum of 2hrs. time before the successive finishing coats of P.U. liquid membrane are applied.

c) Finishing coats :

The finishing coats shall consist of two successive liquid coatings of high solids content urethane pre-polymers or equivalent material to form an elastomeric membrane. The overall dry film thickness shall be 1.5mm subject to minimum 500 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

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

The final coat of P.U. liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a later of polyscrim cloth /fabric to be embedded between 2 finishing coats.

d) Surface Finish :

Areas of roof treatment which are vulnerable to accidental damage shall be provided with wearing course consist of minimum 20 mm thick PCC of Grade M15 (using 12.5mm size aggregate) cast in panel of maximum size of 1.20m x 1.20m and reinforced with 0.56mm diameter galvanised chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS:1443.

2.04.03

Waterproofing By Epoxy Resin Based Application



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Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin-based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration fire, sun exposure, and light duty traffic. The application shall be resistant to growth of fungus and proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for waterproofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labour for the application as free of cost to Owner. This item shall carry a guarantee as specified.

2.04.02 Flashing

Unless otherwise stated flashing shall be done in the same way as the waterproofing except that the last layer shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified or directed by the Engineer, metal flashing shall be provided. The materials shall be 18 Gage or 22 G G.I. sheets, as specified or as directed by the Engineer.

2.05.00 WATER-PROOFING OF UNDERGROUND STRUCTURES

Basements, ducts, pits, tunnels (excluding tanks) etc below the ground water table and in contact with soil are covered under this. Bonding material shall be blown bitumen of 65/25 grade conforming to IS: 702.

Waterproofing shall be provided on the outside of walls and top of RCC slab and shall be carried out upto 150mm above ground level. The number of layers of bitumen felt to be used for walls and floor unless otherwise shown in the drawing shall be:

- a) 2 layers - for depths up to 5m below ground level
- b) 3 layers - for depths beyond 5m below ground level

2.05.01 Method of laying the bitumen felts and workmanship shall be as per IS: 1609 and IS: 3067. Water proofing work shall be taken in hand only when the sub-soil water level is at its lowest; the site shall be kept dry by adequate arrangements for pumping out water till the work has been completed.



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For this purpose drains shall be formed along the edges of the excavation but beyond the building line, with suitable collecting sumps.

In case of large excavation areas where it is necessary to dewater under the floor, additional land drains shall be formed across the excavation, to adequately drain the area.

Adequate arrangement shall be made to protect the sides of excavation from slipping while the work is in progress.

The base concrete or mud-mat shall be rendered smooth by a 20mm thick sand-cement plaster (6:1). Any sharp edges/corners, over which the waterproofing course is to be laid, shall be eased out by means of cement.

The surface must be dry before the next operation is carried out.

Water proofing/damp proofing treatment:

A) Heavy Treatment (Two layers of felt)

- i) Primer (For vertical faces only), as per I.S. 3384.
- ii) Hot applied blown bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base, bitumen felt type 3 grades 2
- iv) Hot applied blown bitumen @ 1.2 Kg/m²
- v) Hessian base, bitumen felt type 3 grade 2
- vi) Hot applied blown bitumen @ 1.2 Kg/m²

B) Extra Heavy treatment (Three layers of felt)

- i) Primer (for vertical faces only) as per I.S. 3384
- ii) Hot applied bitumen at the rate of 1.2 Kg/m²
- iii) Hessian base bitumen felt type 3 grades 2
- iv) Hot applied bitumen at the rate 1.2 Kg/m²
- v) Hessian base bitumen felt type 3 grades 2
- vi) Hot applied bitumen at the rate of 1.2 Kg/m²
- vii) Hessian base bitumen felt type 3 grades 2



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viii) Hot applied bitumen at the rate of 1.2 Kg/m²

The surface must be dry before the next operation is carried out at each stage said above.

The laying of felt over the bitumen so applied that it shall always commence on the floor, and shall be carried over to the walls only after treatment of the floor is complete. The minimum over lapping at sides and ends of strips shall be 10cm. Point for subsequent layers completely sealed by blow lamp.

A protective flooring of either brick flat in cement mortar (1:3) or 6cm thick cement concrete (M 15) or a coat of cement plaster (1:3) 4 cm thick shall be constructed over the bitumen layers to prevent damage to the latter during subsequent construction of the structural floor.

The walls shall be treated in a similar way; the bitumen felts joining at the base with the projecting felt laid over the mud-mat. The wall surface shall be made smooth where necessary with a coat of cement plaster (1:3), the felts laid as for the floor, ensuring that the surface to be treated is dry and then a protective brick wall, 12.5 cm nominal thickness shall be built in cement mortar (1:3) over the projecting mud-mat, the space between the wall and felt being grouted with cement.

3.00.00 ACCEPTANCE CRITERIA AND GUARANTEE

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

The contractor shall give a guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof waterproofing treatment work. The guarantee shall be for materials and workmanship for 5 years in case of normal treatment, 10 years for heavy treatment and 20 years for extra heavy treatment. The mode of execution of the guarantee shall be such, which shall be acceptable to the Owner.

4.00.00 I.S. CODES AND STANDARDS

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.



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- a) IS: 73 - Paving Bitumen
- b) IS: 702 - Industrial Bitumen
- c) IS: 1203 - Methods of testing tar and bitumen
- d) IS: 1322 - Bitumen felts for waterproofing and damp proofing.
- e) IS: 1346 - Code of practice for waterproofing of roofs with bitumen felts.
- f) IS: 1609 - Damp-proofing Treatment using Bitumen Felts – Code of Practice
- g) IS: 3067 - Code of practice for General design details and preparatory work for Damp-proofing and water-proofing of buildings
- h) IS: 3384 - Bitumen primer for use in waterproofing and damp proofing.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for complete work, including the cost of all materials and labour, as detailed in the specification unless any portion is specifically excluded in the “Schedule of Items”.

No extra shall be paid for finishing around opening, sleeves, pipes, ducts, inserts, etc.

No separate payments shall be made for cleaning of surface, treating of cracks and surface preparation.

5.02.00 Measurement

The finished work shall be measured in Sqm of actual surface area for the purpose of payment.

No deduction shall be made and no extra shall be paid for openings upto 0.4 sqm.



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1X 500 MW BELLARY TPS – UNIT 2

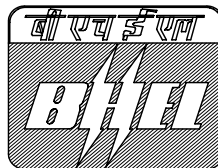
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MISCELLANEOUS METAL

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Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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MISCELLANEOUS METAL**1.00.00 SCOPE**

This section covers supply, fabrication and erection of miscellaneous metal items of light nature in gates, balcony and stair hand rails, structural works, ladders, hangers, masonry anchors, anchor bolts, fasteners, chain link fencing, barbed wire fencing etc. as specified or shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast of mild steel, aluminium, brass, cast iron, M.S.& galvanized M.S. sheets, aluminium sheets, expanded metal, wire mesh as shown on drawings or specified.

2.00.00 INSTALLATION**2.01.00 Fabrication/casting****2.01.01 General**

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.01.02 Shop Connections

- a) All shop connections shall be riveted or welded except when noted otherwise on drawings.
- b) Welding of steel shall be done in accordance with IS: 816.
- c) Welding of aluminium shall be done accordance with IS: 2812, "Arc welding of Aluminium and Alloys." Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.01.03 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill seals, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. When specified steel work shall be galvanised or painted with a coat of zinc chromate primer. Aluminium surfaces, which shall come in contact with masonry, shall be given one coat of bituminous paint.



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2.02.00 Erection**2.02.01 Bracing**

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected, including erection of equipment and operation of the same.

2.02.02 Temporary Bolting-Up

As erection proceeds the Contractor shall plum up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever erection equipment or other loads are carried by members during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.02.03 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.02.04 Welding

Where specified on drawings, welding shall be done in accordance with IS: 816 for steel and IS: 2812 for Aluminium & Alloys.

2.02.05 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.02.06 Drifting

Correction minor misfits and a reasonable amount of reading and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections, reaming that weakness the members or make it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount or reaming and slight



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chipping and cutting shall immediately be called to the attention of the Engineer-and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.02.07 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials and used for the shop paint or equivalent.

2.02.08 Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

2.02.09 Grouting

All bearing plates, loose, lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1 | :3 concrete with 6 mm down stone chips or as specified in schedule of items.

2.02.10 Anchor Fasteners

The anchor fasteners shall be of two type viz. light duty for carrying tensile load upto 0.5MT per fasteners and heavy duty for carrying tensile load of 0.5MT to 5.0MT per fasteners. These anchor fasteners shall be fixed into concrete. The Contractor shall submit the Manufacture's literature showing the average pull out and average shear value for anchor of various sizes. Anchors shall be fixed in position strictly as per the manufacturers instructions and as approved by the Engineer.

Heavy Duty Anchor Fasteners

The safe tensile load carrying capacity of the anchors shall be arrived by providing the minimum factor of capacity of 2.5 for the characteristic load of the anchor. Minimum size of anchor shall be M8 (8mm). All anchors shall be from the approved manufacturers like HILTI or equivalent.

- a) Anchor fasteners shall be supplied and fixed in position by the contractor. Anchor fasteners can be of mechanical bonding or chemical bonding.
- b) Capacity of the anchor shall be established after considering the effect of concrete grade, embedment depth, concrete thickness, anchor spacing and edge distance from the concrete edge.
- c) The selection for the particular type of bonding for the anchors shall be made after considering the concrete grade, available embedment depth, load to be transferred, space available for installing anchors.
- d) The mechanical bonding anchor are torque controlled anchors made from carbon steel of grade 8.8 as per IS:1367 part 3. Anchors in bolt as well as



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nut version are acceptable. The bolt version anchors consists of bolt washer, sleeves, plastic section, expansion sleeves and a cone. Nuts version anchor consists of nuts, threaded rod, washer, sleeves, plastic section, expansion sleeves and a cone. All steel component of anchor shall be electro galvanised to minimum 5 micron coating thickness. The plastic section shall be of polyacetal Derlin 100 or equivalent.

- e) Chemical bonding anchor shall consist of foil capsule and threaded rod. The foil capsule shall contain the resin and hardener. The threaded rod shall have chiselled tip. The behaviour of anchors under fire shall conform the heating curves as per ISO:834. Anchors of size M8 to M24 shall conform to grade 5.8 and anchors of size M27 to M39 shall conform to grade 8.8 as per IS:1367 part 3. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness.

Light Duty Anchors

This anchor shall comprise of stud, nut, washers, expansion sleeve. The one end of the stud shall have thread and the other end shall have cold formed conical head. All steel components of the anchors shall be electro-galvanised to minimum 5 micron thickness. The expansion sleeve shall preferably be of stainless steel of SS316. The anchors shall conform to minimum grade 5.8 as per IS:1367 part 3.

2.02.11 Pipe Joints

MS pipes or GI pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot joined and caulked with hemp and molten head.

2.03.0 FENCING**2.03.01 Chain Link Fencing**

The material requirement shall conform to IS: 2721 latest edition. The chain link fencing shall be woven from 3.15mm dia. wire with mesh size of 50mm. The mesh wire shall not vary from specified dia. by more then ± 0.05 mm. all steel wire shall be hot dipped galvanised wire. The dia shall be measured over the galvanised coating. The line wire shall be 4.0mm dia. mild steel. The stirrup wire for securing the line wire to the intermediate post (RCC/structural steel) shall be 2.5 mm diameter mild steel. The tying wire for securing the chain link fencing to the line wire shall be 1.6mm diameter mild steel. Hair pin chain staples for fastening down the bottom of galvanised chain line fencing to the concrete sill shall be 3.15mm wire. The ends shall be bent outwards for securing anchorage.

Cleat for eye bolts shall be of uniform size and shall consist of mild steel angle of 75 x 50 x 8 mm. The eye bolts strainer shall consist of bolt with welded eye



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sufficiently threaded and fitted with a nut and washer. Two-way eye bolt strainer shall have suitable ring nuts fitted after the wires have been strained on one side. Stretcher bar shall consist of mild steel flats 25 x 4.75 mm. They shall be secured to the cleats by steel bolts.

The chain link fencing shall be strained between each pair of straining posts and secured to each straining posts by means of a stretcher bar. One of top line wire shall be threaded through appropriate adjacent row of mesh, care being taken that no meshes in the row are bypassed by the line wire except where deviation is necessary at the straining posts. The second top line wire shall be strained in front of the fencing. The fencing shall be attached to the top and bottom line wire by wire ties spaced at 150mm apart and to the other middle line wire by wire ties spaced at 450mm apart.

The bottom of fencing shall be treated as follows:

Continuous concrete sill 125mm wide x 225mm high for full length between posts shall be cast with the top 25mm above GL and 25mm below the chain link fencing. Hair pin staples shall be threaded through the bottom row of mesh at 750mm c/c and set in the sill to a depth of 150mm.

2.03.02**Barbed Wire Fencing**

The barbed wire shall be conform to IS:278 latest edition. The barbed wire shall be galvanised and galvanising shall conform to the requirement laid down for 'light-coated wire' of IS:4826 and it shall be smooth and relatively free of lumps etc. Wire with excessive roughness blisters, salammoniac spots shall be rejected. The barbed wire shall be made from two line wire and two point wire of 2.5 mm thickness each. The barbs shall have four point and shall be formed by twisting two point wires, each two turns, tightly around both or one line wire (Type A - around both line wire, Type B - around one line wire) making altogether four complete turns. The barbs shall be so finished that four points are set and located or locked as far as possible at right angle to each other. The barbs shall have a length of not less than 13mm and not more than 18mm. The distance between two barbs shall be 75 ± 12 mm.

Straining posts shall be provided at all ends and corners of fences or at changes in direction or acute variation in level and at intervals not exceeding 66 M on straight lengths of fence. Intermediate posts shall be spaced at regular intervals not exceeding 3.0m. Struts shall be fitted to all straining posts behind the chain link fabric in the direction of line of fence. There shall be four evenly spaced row of line wire in all. The top line wire shall be doubled, making five line wire in all. The bottom wire shall be closed to the ground. Each line wire shall be strained tightly by means of eyebolts strainers or winders at each straining points. Each line wire shall be secured to each intermediate post by a wire stirrup passed through a hold in the post and secured to the line wire by three complete turns on each sides of the post. The barbed wire shall be fitted with one dropper at the centre of each bay, secured



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to the wire so that they could not be bunched together. Droppers for barbed wire shall be of mild steel of not less than 25 x 4.75 mm thick with 38 x 4.85 mm half round staples for fastening the barbed wire to them. Bracing for the rows of barbed wire shall be approved by the Engineer.

3.00.00 ACCEPTANCE CRITERIA

- a) All items shall be correct shape, size, weight etc. shown on drawings and schedule of items.
- b) For installed items, the tolerances shall be as follows
 - i) Permissible deviation from, straightness – 1 in 1000.
 - ii) Seats, stiffener connections etc. shall be as per approved drawings and shall not interfere with architectural clearances.
- c) All castings shall be free from blowholes, cracks, and other blemishes.
- d) All MS wire fencing shall be in true vertical plain, and shall not bulge.

4.00.00 IS CODES

- IS:278 Specification for Galvanised Steel Barbed wire for fencing.
- IS:816 Code of practice for use of Metal Arc welding for general construction in mild steel.
- IS:1367 Industrial Fasteners – Threaded steel fasteners - Technical supply condition.
- IS:2721 Specification for Galvanised Steel Chain Link fence fabric.
- IS:2812 Arc welding of Aluminum and Alloy

5.00.00 RATES AND MEASUREMENTS**5.01.0 Rates**

Rates shall include supply, fabrication and installation for misc. metals works as required for completion of works like gates, fencing, handrails, ladders, hangers, anchors etc., unless otherwise specified in Schedule of Items. Rate for fencing shall also include excavation, concreting and supply, erection & fabrication of post (post made of either structural steel or reinforced cement concrete), unless any specific item is excluded.

5.02.0 Measurements



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Measurement for MS gates shall be in MT.

Measurement for galvanised MS wire fencing shall be in Sqm.

Measurement for Anchors shall be in nos. for the type as specified in schedule of items.

Measurement of other misc. metals shall be done in MT unless otherwise specified in schedule of items.



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1X 500 MW BELLARY TPS – UNIT 2

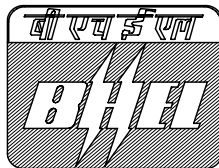
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Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor



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and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.

Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked



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separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each



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layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.



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Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.



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3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and



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filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overburnt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.



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Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00

I.S. CODES

Some of the important relevant codes for this section are:

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

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.



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5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

- a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.
- b) Preparing top sand sides of existing wall for joining old with new work.
- c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

- a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.
- b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.
- c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.



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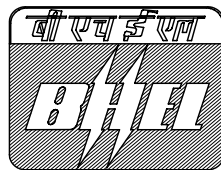
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SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-234-600-C001



Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



TITLE:

**STANDARD TECHNICAL
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FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry, on a watertight platform and minimum water added to achieve



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working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambes etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.



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b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the



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g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on



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the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and



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approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates



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Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.



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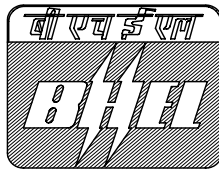
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PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 Installation

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.



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a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and shall conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint



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Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.



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2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.



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2.02.00 Application**2.02.01 General**

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.



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One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint



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Shall be applied on properly primed surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flattening varnish. This shall be allowed to dry hard and be flattened down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with



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polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

- a) All painted surfaces shall be uniform and pleasing in appearance.
- b) All varnished surfaces shall be of uniform texture and high glossy finish.
- c) The colour, texture etc. shall match exactly with those of approved samples.
- d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.



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Testing

- a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.
- b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.
- c) Material/workmanship unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00**I.S. CODE**

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348 Specification for French polish

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

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

IS: 1477 Code of Practice for painting of ferrous metal
(I & II) in buildings.

IS: 2338 Code of Practice for finishing of wood and



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(I & II) wood based materials.

IS: 2339 Specification for Aluminium, Paints for general purposes in dual containers.

IS: 2395 Code of Practice for painting concrete, masonry, and Plaster surface.

IS: 2932 Specification for enamel, exterior type-1.

IS: 5410 Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT**5.01.00 Rates**

Rates shall be unit rates for complete items described in the "Schedule of Items".

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. unless specified otherwise.



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1X 500 MW BELLARY TPS – UNIT 2

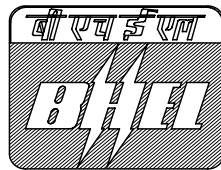
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Bharat Heavy Electricals Limited

Project Engineering Management

Power Sector, BHEL House

Asian Games Village Complex

Siri Fort, New Delhi-110049



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FLOOR FINISH AND ALLIED WORKS

1.00.0 SCOPE

This section covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes, and allied items of work as listed below

- a) In Situ Finishes
 - i) Integral finish to concrete base
 - ii) Terrazzo finish
 - iii) Granolithic finishes
 - iv) Patent Stone
 - v) Metallic Hardener like “Ironte”/Hardonate Finish
 - vi) Mastic Asphalt finishes
 - vii) Chemical Resistant finish
- a) Tiled Finishes
 - i) Terrazzo tile
 - ii) Chequered tile
 - iii) Glazed tile
 - iv) Tesse rae (Mosaic etc.)
 - v) Chemical Resistant
 - vi) Rubber, Vinyl etc.
 - vii) Stone Slab including Kota Stone.

1.01.00 Base

The base to receive the finish is covered under other relevant specifications.

1.01.01 Sequence



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Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damages whatsoever till handing over.

2.00.00 INSTALLATION

2.00.01 Special Materials

Basic materials are covered elsewhere under the Specification. In general, all such materials shall be as per relevant Codes where available. In all cases these materials shall be of the best quality available indigenously unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.00.02 Workmanship

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisors recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.00.03 Preparation of the Base Surface

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirt, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be bone dry where adhesives are used for fixing the finishes.



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Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.01.00 In Situ Finishes

2.01.01 Integral Finish To Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' thick slurry, made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations. This finish shall be as thin as possible by using 2.2 kg. of cement per Sq.M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.01.02 Terrazzo Finish in Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

a) Thickness

Unless otherwise specified the total thickness of the 'finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to acc ate the specified thickness. All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

b) Mix

i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 parts cement, 1 | parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips



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shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

ii) Topping

The mix for the topping shall be composed of cement, colour Pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or gray or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3 parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1 parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and nonfading. It must be very finely ground. The marble powder shall be from White marble and shall be finer than IS Seive No.: 30. The size of marble chips shall be between 1 mm to 20 mm. Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 Sq.M. in area of which no side shall be more than 2.5 M. long. For exposed locations the maximum area of a panel shall be 2.0 Sq.M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbeds plus topping.

After laying, the underbed shall be levelled compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. A slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even pattern of distribution.



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d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

e) Grinding and Polish

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.80) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. A suitable machine shall do the grinding. Where grinding machine can not be used hand grinding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.:60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried, and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be postponed till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M., water sprinkled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy, but not slippery.

2.01.03 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand 2 parts coarse aggregate by volume. The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.



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c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully -green- the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall be roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then be lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stone chips.

For large areas the laying shall be in panels of maximum 25 Sq.M. area. The panels shall be laid in chequered board pattern.

d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.00.03 and a slurry of neat cement applied just prior to laying the granolithic concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

d) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface has hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or ponding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.01.02 (e) shall be followed. However, the Engineer shall decide upon the ultimate polish required.

g) Finishing



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Where specified, sodium, silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as per approved drawings or as instructed. The concentration and method of application of the solutions shall be as specified in IS: 5491.

2.01.04 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.01.02 (a) except that the topping shall be 12 mm thick.

b) Mix

i) Underbed

The mix shall be as stipulated under clause 2.01.02 (b).

ii) Topping

The mix for the topping shall consist of 1 part cement and 2 part stone aggregate 6mm nominal size by volume.

c) Laying

The Patent Stone finish including the underbed shall be laid in alternate bays or in Chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M. of which no side shall be more than 2 M. long.

A cement grout shall be applied and worked into the surface to receive the finish; the underbed then laid, compacted, and leveled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond. The topping shall be trowelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.



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2.01.05 Metallic Hardener Like 'Ironite'/'Hardonate' Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is 'green'.

a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials when desired by the engineer, actual samples shall be tested.

c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry, with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

d) Laying

The concrete floor shall be laid as per specification 'Cement Concrete' and levelled upto required grade. The forms, if any, shall remain sufficiently projecting to make the finish. The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very 'green' within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigourously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished smoothed with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.01.06 Mastic Asphalt Finish

This is a one-layer treatment on concrete or brick base.



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a) Thickness

The thickness shall be as specified in the drawing.

b) Materials

Bitumen shall be industrial Bitumen of the grade 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75 micron IS Sieve.

Fine aggregate shall be crushed and graded natural limestone or other hard work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

c) Composition

Bitumen mastic shall conform IS: 1195 and shall be either brought to site in blocks weighing about 25 Kg or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly, incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be leveled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 1.5 Sq.M. in area each formed by formers. Succeeding panels shall be laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.01.07

Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence. The contractor shall get



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it done by a specialized Manufacturer and get guarantee of performance from the organization and pass it on to the Owner in addition to his own guarantee.

2.02.00 Tiled Finish

These shall include finish tiles, stone slabs, and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.02.01 Terrazzo Tile Finish

The finish will consist of manufacture terrazzo and an underbed.

a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

b) Tiles: Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trademark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be ± 1 mm and the thickness ± 3 mm. Face of the tile shall be plane, free from pinholes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm.

The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary gray cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.01.02 (b).



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The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

c) Mix: Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi: 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.



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If desired dividing strips as specified under Clause 2.01.02(c) may be used for dividing the work into suitable panels.

e) Grinding and Polishing

Procedure shall be same as Clause 2.01.02(e). Grinding shall not commence earlier than 14 days after laying of tiles.

2.02.02 Chequered Tile Finish

The finish shall consist of manufactured gray or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

a) Thickness

Thickness shall be same as in clause 2.02.01 (a).

b) Tiles: Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm. c/c. Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.02.01 (b) except that these may have the topping in terrazzo or plain gray cement or colour pigment added to cement.

c) Under-bed

As per clause 2.02.01 (c).

d) Laying

As per clause 2.02.01 (d).

e) Grinding and Polishing

As per clause 2.02.01 (e) except that the tiles shall be ground and polished by hand and after laying taking special care in polishing the grooves properly and uniformly.

2.02.03 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

a) Thickness



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The total thickness shall be between 20mm and 25mm including the underbed.

The tile finish on vertical surface shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

b) Tiles: Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 5.5 mm to 6 mm on thick unless otherwise specified. The tolerance shall be ± 1.5 mm for length and breadth and ± 0.5 mm for thickness specials like internal and external angles; beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt, unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in textures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

c) Mix: Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.



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- d) Laying
Same as clause 2.02.01 (d).

- e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully, and wiped with soft cloth to prevent scratching before handing over.

2.02.04 Tesseræ Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

- a) Thickness

The total thickness including the underbed shall be between 16 mm & 25 mm.

- b) Tesseræ Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass, or similar hard wearing, strong, and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

- c) Mix: Underbed
Same as clause 2.02.03 (c)

- d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.02.03 (d) shall generally be followed. However, instead of gray cement the slurry shall be made with white cement to fix the panels. The paper-mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.



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2.02.05

Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

a) Tiles

The chemical resistant tiles shall be of the best indigenous Manufacture unless otherwise specified and shall be resistant to the chemical (both acid and alkali). The tiles shall have straight edges, uniform thickness, plain surface, uniform nonfading colour, and textures.

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm². The surface shall be abrasion resistant and durable.

b) Laying

The mortar used for setting or for underbed these tiles shall be durable, strong and chemical resistant epoxy mortar. The grout, which shall be to the full depth of tile, shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.02.06

Rubber, Vinyl, or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl etc. set with an adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

a) Thickness

The thickness of the tiles shall be as incorporated in drawing.

b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be ± 1.5 mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be nonfading and uniform in appearance, insoluble in water and resistant to alkalis, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trademark, the thickness, sizes, batch number, and date of



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manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

c) Mix: Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty:1 part cement: 3 parts coarse sand mixed with just sufficient water to make it workable.

d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air-conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried, and polished with an approved type of polish just before handing over.



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2.02.07

Stone Slab Finish: Marble, Stone, and Similar Fine Grained Stone including Kota stone

a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs will be 20 mm thick.

b) Stone Slab

The stone slabs shall be made from selected stock, which is hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

c) Mix: Underbed

Same as clause 2.02.01 (c).

d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed, and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, gray / white / mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually



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exist at the joints. The polishing and finishing shall be done as specified under clause 2.02.01 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.02.08 Stone Slab Finish: Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.02.07 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiselled or fine chiselled as specified. Tolerance may be allowed upto ± 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiselling the unevenness shall be limited to ± 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement. If fine joints in the flooring are specified, the edges of slabs shall be cut in such a way that it shall form a inverted 'Y'.

3.00.00 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

- a) Level, Slope, Plumb as the case may be
- b) Pattern and Symmetry
- c) Alignment of joints, dividing strip etc.
- d) Colour, texture
- e) Surface finish
- f) Thickness of joints
- g) Details at edges, junctions etc.
- h) Performance
- i) Precautions specified for durability

4.00.00 I.S. CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian



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Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

- IS: 777 : Glazed earthenware tiles
- IS: 1196 : Code of practice for laying bitumen mastic flooring.
- IS: 1197 : Code of practice for laying of rubber floors
- IS: 1237 : Cement concrete flooring tiles
- IS: 1443 : Code of practice for laying and finishing of cement concrete flooring tiles.
- IS: 2114 : Code of practice for laying in situ terrazzo floor.
- IS: 3461 : PVC asbestos floor tiles
- IS: 4860 : Specification for acid resistant bricks
- IS: 5518 : Code of practice for laying of flexible PVC Sheet and tile flooring.
- IS: 5491 : Code of practice for laying in situ granolithic floor topping.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be for the complete work (including dividing strips, ironite, metals, tiles etc. if any) as per the schedule of items. Rates shall be applicable for application on horizontal and vertical surfaces at all elevations and for all types of work including stairs tread and riser, laying in desired pattern and panels, cost of specials (if any) rounding of corners, mouldings etc.

Rates shall be including provision of side shuttering (if required) for casting of floor in alternate panels and or without dividing strips.

5.02.00 Measurement

The finished surface shall be measured in Sqm for area unless otherwise specified. Deduction shall not be made for opening or embedded articles having area not exceeding 0.1 Sqm.