


SECTION - 3


ENCLOSURES TO THE SPECIFICATION CUSTOMER SPECIFICATION

1 PART C : SECTION:D4.6

2 PART D : SECTION:D4.6

3 PART E : SECTION:D4.6

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD	VOLUME C 1- V
	TITLE PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	SECTION: D4.6 SHEET 1 of 11
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.		
BTPS Unit 2 071206		

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD TITLE PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	VOLUME C 1- V SECTION: D4.6 SHEET 2 of 11
<p>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.</p> <p>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.</p> <p>2.2.2 Liquid retaining structures</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>		
BTPS Unit 2 071206		



(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.



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 code 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.

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1- V
	TITLE	PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	SECTION: D4.6 SHEET 5 of 11
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	
BTPS Unit 2 071206			



(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 |



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 .

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD		VOLUME C 1- V
	TITLE PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	SECTION: D4.6 SHEET 8 of 11	

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:

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

BTPS Unit 2 071206

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD	VOLUME C 1- V
	TITLE PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	SECTION: D4.6 SHEET 9 of 11
11.0	MISCELLANEOUS REQUIREMENT	
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.	
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.	
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.	
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	
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.	
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.	
11.7	Tolerance for formed and concrete dimension shall be as per IS:456	
BTPS Unit 2 071206		



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.


TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD	VOLUME C 1- V
	TITLE PART C : REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS	SECTION: D4.6 SHEET 11 of 11
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.	
BTPS Unit 2 071206		

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	SECTION: D4.6
			SHEET 1 OF 18
1.			
<u>GENERAL</u>			
1.1			
Design of structural steel work shall include generally but not be limited to the steel constructions listed below:			
i)			Steel building structure and open structures:
This shall include beams, columns, bracings, supporting structures for floors, roof slabs, cladding etc.			
ii)			Crane gantry girder, monorails etc.
iii)			Coal bunkers
iv)			Coal conveyor galleries and trestles
v)			Large diameter oil tanks
vi)			Large diameter pipe line for cooling water
vii)			Galvanised latticed structures for switchyard
viii)			Pipe and cable racks
ix)			Platforms and walkways
x)			Ladders, staircases, handrails etc.
2.			
<u>FRAMING</u>			
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.			
BTPS Unit 2 071206			

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE PART D : STEEL STRUCTURES		SECTION: D4.6 SHEET 2 OF 18
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.		
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.		
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.		
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.		
3	MATERIALS		
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.		
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		

BTPS Unit 2 071206

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	
		SECTION: D4.6	SHEET 3 OF 18
<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 shop fabrication and joints. For site connections, welding or high strength friction grip (HSFG) type bolts shall be used, except in few cases for shear connections of lighter members or removable beam connections where bolted joints may be adopted e.g. purlins, side girts etc. A minimum of two bolts per connection shall be used.</p> <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>			
BTPS Unit 2 071206			

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	SECTION: D4.6 SHEET 4 OF 18

full penetration butt weld. Welding across tension flange will not be permitted. Bearing edges of crane girders shall be machined.

4.8 The working point of the bracing connection shall be the center of column and girder to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. The double angle back-to-back with gusset plate in between shall not be used in dust laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

4.9 Horizontal bracings shall be angle / tee section located at the bottom of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at column locations.

4.10 For Major columns of main building, column splices shall be designed to resist the greater of the design axial tension load and moments or an axial tension load of 45 t plus 50% of the member capacity in bending in either the major or minor axis, whichever produces the greatest number of bolts.

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

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

a) Butt weld above 25 m from ground	---	50%
b) Others	---	80%

5. **DESIGN METHODOLOGY**

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

5.2 All buildings/structures shall be framed structure. Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy.

BTPS Unit 2 071206



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



the column is subjected to a net uplift load, the total force shall then be transmitted through shear bars / shear keys welded to the base plate. Anchor bolts are not assumed to resist any horizontal shear force. Necessary recesses shall be kept in the foundation concrete for shear lugs.


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

6 PERMISSIBLE DEFLECTIONS

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

6.1 Vertical Deflection

- 6.1.1
- | | |
|--|--|
| a) For beams supporting dynamic equipment | : Span / 500 |
| b) For beams supporting floors / masonry | : Span / 325 |
| c) For beams supporting pipes (pipe racks) | : Span / 400 |
| d) For roofing and cladding components | : Span / 250 |
| e) For gratings and chequered plates | : Span / 200 subject to
a maximum of 6 mm |
| f) Coal conveyor gallery bridges | : Span / 450 |
- 6.1.2 For crane gantries or any member subjected to working loads, the maximum deflection under dead load and live load excluding impact shall not exceed the following values:
- | | |
|---|--------------|
| a) For manually operated cranes & monorails | : Span / 500 |
| b) For electric overhead cranes | |
| i) up to 50 t capacity | : Span / 750 |

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	SECTION: D4.6
			SHEET 7 OF 18
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 : Height / 2500 limited to level due to action of crane surge load only maximum of 10 mm			
g) Open gantry columns at crane rail level : Height / 4000 limited to due to action of crane surge load only 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			
BTPS Unit 2 071206			



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


9. FABRICATION AND ERECTION

- 9.1 CONTRACTOR shall prepare detailed fabrication drawings and erection scheme based on the design drawings approved by OWNER. Fabrication shall commence only on the basis of the fabrication drawings approved by the CONTRACTOR'S Consultant. Detailed fabrication drawings are to be submitted to

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD	VOLUME C 1 –V
	TITLE PART D : STEEL STRUCTURES	SECTION: D4.6 SHEET 9 OF 18
	<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 	
	BTPS Unit 2 071206	

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	SECTION: D4.6 SHEET 10 OF 18
10.2.2 Dye Penetration Test shall be carried out in accordance with American National Standard ASTM E165.			
10.3 Ultrasonic testing			
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:			
(i) Cracks			
(ii) Lack of fusion			
(iii) Slag inclusions			
(iv) Gas porosity			
10.3.2 Ultrasonic testing shall be carried out in accordance with American National Standard ANSI / AWS D1-92 Chapter 6 : Part C.			
10.3.3 Before Ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.			
10.4 Radiographic Testing (X – ray and Gamma – ray Examination)			
10.4.1 This test shall be limited to 2% of length of welds for welds made by manual or semi-automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by OWNER to detect the following defects:			
i) gas porosity			
ii) slag inclusions			
iii) lack of penetration			
iv) lack of fusion			
v) cracks			
10.4.2 Radiographic testing shall be conducted in accordance with American National Standard ANSI / AWS D1.1-92.			
BTPS Unit 2 071206			

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD	VOLUME C 1 –V
	TITLE PART D : STEEL STRUCTURES	SECTION: D4.6 SHEET 11 OF 18
<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>i) Visual inspection & Dye Penetration Test</p> <p>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>ii) Ultrasonic Testing</p> <p>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>iii) Radiographic Testing</p> <p>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>		
BTPS Unit 2 071206		

<p>TDBT2 EPC / S</p> 	<p>KARNATAKA POWER CORPORATION LTD</p>	<p>VOLUME C 1 –V</p>
	<p>TITLE</p> <p>PART D : STEEL STRUCTURES</p>	<p>SECTION: D4.6</p> <p>SHEET 12 OF 18</p>
	<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>	
	<p>BTPS Unit 2 071206</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.

12. REQUIREMENTS FOR SPECIFIC STRUCTURES

12.1 Coal handling system structures

- 12.1.1 Toe guards shall be provided on sides of conveyor gallery, toe guard shall have a minimum size of 65 x 6 mm.
- 12.1.2 In case the inclination of the conveyor is more than 10°, walkway shall be given steps..
- 12.1.3 For the design of conveyor gallery, load due to cables, light fittings and pipes as well as effect of gravity take up loads shall also be considered, in addition to dead load, wind load and imposed load.
- 12.1.4 Lattice girders supporting the conveyor shall be suitably braced at top and bottom chord levels to transmit the wind load to the end portals connected to trestles. Roof purlins and walkway runners shall also be suitably braced at both ends.
- 12.1.5 In the case of galleries, temperature expansion joint shall be introduced at intervals less than 180 m to divide the galleries into temperature block. In each block at least one number four legged rigid support guaranteeing stability of structure in the longitudinal direction shall be provided. This shall also take care of all longitudinal forces in the given block. Effect of wind load acting on 2-legged trestle shall also be considered while designing the 4-legged trestle.
- 12.1.6 Base plates for trestles shall be designed as gusseted bases with shear lugs to transfer horizontal forces. Anchor bolts shall be designed only for uplift forces.
- 12.1.7 Conveyor galleries and trestles having two conveyors belt shall be designed for both conveyors working together.
- 12.1.8 Chute loads on floors of houses shall be considered plugged with material for the entire height of the chute.

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD	VOLUME C 1 –V
	TITLE PART D : STEEL STRUCTURES	SECTION: D4.6 SHEET 14 OF 18
12.1.9	In case chequered plates are used as floor covering the thickness of plate o/p shall be 8 mm. Suitable plan bracings shall be provided 75 mm from top of steel to transfer all the horizontal forces.	
12.1.10	Anchor fasteners shall not be used for supporting equipment imparting dynamic forces.	
12.1.11	Bracing patterns and locations shall be so planned such that they do not hinder movement of personnel and movement of equipment during maintenance. When floor beam form part of vertical bracing system, additional loads from the floor beams transferred to the bracing shall be taken into account.	
12.1.12	Angle section shall not be used as flexural members except for purlins, side girts and walkway runners. Minimum angle size used shall be L50x50x6.	
12.1.13	All foundation bolts shall be provided with double nuts.	
12.1.14	End connection for rolled beams and channels shall be designed for a minimum of 60% of their shear capacity and built up beams for 80% of their shear capacity in addition to axial load.	
12.1.15	Dynamic analysis shall be carried out for beams supporting screens, vibrating feeder, rotating equipments and conveyor supporting beam in conveyor gallery.	
12.1.16	To admit proper light into the conveyor gallery perspex sheet shall be provided at the rate of 0.1 square metre per metre length of gallery on the roof and 0.2 square metre per metre length of gallery per side on the sides of conveyor gallery.	
12.2	Switchyard Structures	
12.2.1	All switchyard structures comprising of towers, gantries, lightning masts, lighting towers, equipment structures etc shall be galvanised steel with bolted site connection.	
12.2.2	Three dimensional analysis shall be carried out for structures like towers and gantries whereas two dimensional approach may be followed for equipment support structures.	
BTPS Unit 2 071206		



12.2.3 All structural steel shall be of tested quality and shall conform to IS:2062. Steel tubes where used for equipment support structures shall conform to IS:1161.

12.2.4 All bolts and nuts shall be galvanised. In addition to heavy washers conforming to IS:6610, spring washers conforming to IS:3063 shall be provided at all bolted connections. Bolts shall conform to IS:12427.

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

12.2.6 Galvanising

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


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


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


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


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


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


TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	SECTION: D4.6
			SHEET 16 OF 18
12.2.6.6 All galvanised members shall be treated with sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.			
12.2.6.7 Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted.			
12.2.6.8 Wherever galvanised bolts, nuts, washers, accessories etc are specified, these shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.			
12.2.6.9 CONTRACTOR shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damage, CONTRACTOR shall at his own cost adopt scrapping and reglavanising the member to satisfy the specific requirements.			
12.3 Large diameter Oil tanks			
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.			
12.3.2 Wind and internal vacuum loads shall be considered together to check the stability of tank.			
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.			
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.			
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			
BTPS Unit 2 071206			


TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	
			SECTION: D4.6
			SHEET 17 OF 18
<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>			


TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 –V
	TITLE	PART D : STEEL STRUCTURES	
<p>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.</p>			SECTION: D4.6
<p>12.5 Circular Coal bunkers</p> <p>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.</p>			SHEET 18 OF 18
<p>BTPS Unit 2 071206</p>			

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 - V
	TITLE	PART E : OUTDOOR CIVIL WORKS	
			SECTION: D4.6
			SHEET 1 OF 6
<p>1. DRAINAGE AND SEWERAGE</p> <p>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.</p> <p>1.1 Surface Drainage</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>1.1.4 The interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.</p> <p>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.</p> <p>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.</p> <p>1.1.7 Minimum earth cover of 450 mm shall be provided over drainage pipes in paved areas.</p>			
BTPS Unit 2 071206			

<p>TDBT2 EPC / S</p> 	<p>KARNATAKA POWER CORPORATION LTD</p>	<p>VOLUME C 1 - V</p>
	<p>TITLE</p> <p>PART E : OUTDOOR CIVIL WORKS</p>	<p>SECTION: D4.6</p> <p>SHEET 2 OF 6</p>
	<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>	
	<p>BTPS Unit 2 071206</p>	

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 - V
	TITLE	PART E : OUTDOOR CIVIL WORKS	
			SECTION: D4.6
			SHEET 3 OF 6
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.			
BTPS Unit 2 071206			

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 - V
	TITLE	PART E : OUTDOOR CIVIL WORKS	
			SECTION: D4.6
			SHEET 4 OF 6
<p>1.4 Sewage System</p> <p>1.4.1 Cement concrete pipes shall be used below ground level for sewage disposal. Pipes connecting toilet facilities to manholes shall be minimum 100 mm NB. Pipes connecting various manholes shall be minimum 150 mm NB. However salt glazed stoneware pipes of diameter not exceeding 150 mm can be used in localised areas not subject to any traffic loads. For main power block below paved area, cast iron spun pipe of Class LA conforming to IS:1536 shall be used.</p> <p>1.4.2 Sewers shall have such slopes so as to have effective discharge. Sewers shall be designed for a minimum self cleansing velocity of 0.75 m/sec for peak flow condition (assumed as 3 times the average flow) and pipes flowing half full. The maximum velocity shall not exceed 2.4 m/sec.</p> <p>1.4.3 Suitable manholes shall be provided to piped sewage lines at every 30 m intervals, at junctions and at change of gradient, alignment & diameter of pipe and shall be of masonry or RCC construction. Details of manholes shall be as per IS:4111 (Part-I). Minimum size of manholes shall be 1.0m x 1.0 m for square section or 1 m dia for circular. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.</p> <p>1.4.4 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.</p> <p>2 INTER PLANT TRENCHES</p> <p>2.1 All cable and pipe trenches shall be of RCC with minimum M20 grade. Trenches located outside buildings shall be projecting at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.</p>			

TDBT2 EPC / S 	KARNATAKA POWER CORPORATION LTD		VOLUME C 1 - V
	TITLE	PART E : OUTDOOR CIVIL WORKS	SECTION: D4.6 SHEET 5 OF 6

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.

BTPS Unit 2

071206

TDBT2 EPC / S	KARNATAKA POWER CORPORATION LTD	VOLUME C 1 - V
	TITLE PART E : OUTDOOR CIVIL WORKS	SECTION: D4.6 SHEET 6 OF 6
	<p>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.</p> <p>3.3 Stone Aggregate paving</p> <p>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.</p> <p>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.</p>	
	BTPS Unit 2 071206	