

SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & QUANTITIES

1.1.0 SCOPE

The scope of work under this specification is Civil Works of 400kV GIS Substation at 2x660 MW STPP at Udangudi by Bharat Heavy Electricals Ltd. The Customer is TAMILNADU STATE GENERATION AND DISTRIBUTION CORPORATION LTD.

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

- (i) Control room building works.
- (ii) GIS building works.
- (iii) Tower Foundations.
- (iv) Equipment foundations.
- (v) Cable trenches including precast covers & cable trench crossings.
- (vi) Drainage including Sump Pits
- (vii) Stone spreading including antiweed treatment,
- (viii) Fencing and gates
- (ix) Roads & Culverts
- (x) Any other work required for the project.

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

1.2.0 SPECIFIC TECHNICAL REQUIREMENT

1.2.1 The specific technical requirements for the execution of civil works shall be as per Customer Technical Specification/IS code. In case of any conflict between Standard Code and Technical Specifications, the provisions of Technical Specification shall prevail.

1.2.2 **Ordinary Portland cement with C3A content from 5 to 8 percent shall be desirable to be used in concrete. Alternatively, Portland slag cement conforming to IS 455 having more than 50 percent slag or a blend of ordinary Portland cement and slag may be used.**

1.3.0 BILL OF QUANTITIES

1.3.1 The Bill of Quantity (Pkg-A& B) shall be as per pages from 1.3 to 1.21

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

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

1.3.4 Method of measurement:
Method of measurement as described in 'Method of Measurement of Building and Civil Engineering Works'-IS 1200(Part I to XXV) latest edition of BIS shall be followed
Clause No. 2.1.0 of CPWD Specification Volume-I shall be followed for classification of soils.

BILL OF QTY. CUM PRICE SCHEDULE

PKG-A

Name of Project
Name of Work

:400KV GIS SUBSTATION AT UDANGUDI
:CIVIL WORKS OF SWITCHYARD

ST. No.	Description of Item	Quantity	Unit	Unit Rate (Rs)	Amount (Rs)
1	Earth work in excavation in all types of soil which can be excavated by any means including setting out, levelling, dewatering (but excluding special type of dewatering viz. well point method), shoring & strutting (wherever required), dressing the sides & bottom, all lifts, ramming/compacting the excavated bottom, stacking, disposal of surplus excavated materials within a lead upto 500 m, spreading/levelling of disposed materials etc all complete for following depths below ground level.				
(a)	Depth from ground level but not exceeding 2 m	7500	cum	76.45	573375.00
(b)	Depth exceeding 2 m but not exceeding 4 m	7500	cum	88.57	664275.00
(c)	Depth exceeding 4 m but not exceeding 6 m	4000	cum	113.74	454960.00
A1	Extra over ST No. 1 for dewatering of ground water by well point method as per IS 9759.	7500	cum	312.31	2342325.00
2	Back filling upto any depth below ground level around foundations, plinths, trenches, drains etc to proper grade and level in layers not exceeding 250 mm thickness using/with selected materials from excavated soil available within a lead upto 500m and compacted as specified including re-excavation of stacked earth, watering, ramming/compaction by manual/mechanical				
(a)	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	14000	cum	108.14	1514016.00
3	Extra over ST No. 1 & 2 for carriage of excavated earth/selected materials	5000	cum	14.92	74600.00
4	Supplying and filling sand upto any depth under floors, around foundations, plinths etc.in layers not exceeding 250 mm thickness and compacted so as to achieve at least 80%relative density as per IS-2720 (Part-XIV) including spreading, watering,ramming/compaction by manual / mechanical means, dressing, royalty (if any) etc. all complete.	100	cum	810.82	81082.00
5	Providing and laying rubble soling with specified sizes of approved quality hard rock rubble or hand broken hard metal of sizes ranging from 100mm to 230mm, at all position and depths below or above finished ground floor level, below foundations, below flooring, and for providing hard standing etc in one or more layers each of approximately 230mm thickness, hand packing, filling in interstices with quarry spalls, grits and providing a layer of 50mm. thickness (consolidated) of moorum/equivalent locally available approved material over each layer of soling including watering, thoroughly compacting each layer with 10 tonne power roller with minimum 6 passes (or with vibrating plate of approved capacity at places not approachable by power roller) all as per the direction of the Engineer and as per specification.	100	cum	1514.96	151496.00
6	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work				
(a)	M15 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size)	1160	cum	4943.8	5734808.00
(b)	M10 (1 cement : 3 coarse sand : 6 graded stone aggregate 20mm nominal size)	100	cum	4522.52	452252.00
(c)	M7.5 (1 cement : 4 coarse sand : 8 graded stone aggregate 40mm nominal size)	390	cum	4148.54	1617930.60
7	Extra for providing and mixing water proofing material of zydex,sika or similar make in cement concrete work @ 1kg per	300	kg	41.73	12519.00
8	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/cum. Excess/less cement used as per design mix is				
(a)	All works upto plinth level	5000	cum	5887.43	29437150.00
(b)	All works above plinth level upto floor V level	10	cum	6691.00	66910.00
9	Extra for Providing M-30 grade concrete instead of M-25 grade BMC/RMC. (Note:- Cement content considered in M-30 is @ 340 kg/cum) .Excess/less cement used as per design mix is payable/recoverable separately).	4900	cum	55.26	270774.00
10	Add for using extra cement in the items of design mix over and above the specified cement content therein.	2450	quintal	533.82	1307859.00
11	Providing and laying M20 reinforced cement concrete in ground floor grade slab excluding the cost of centring,shuttering, finishing and reinforcement.	40	cum	5570.21	222808.40
12	Providing and mixing approved Bipolar Concrete penetrating Corrosion inhibiting admixture phenolic base (krishna chonchem or equivalent) in concrete as per detail specification of manufacturer etc. all complete. Payment shall be made per cum of	500	cum	216.00	108000.00
13	Centering and shuttering including strutting, propping, etc., and removal of form at all heights for.				
(a)	Foundations, footings, bases of columns, etc., for mass concrete.	2300	sqm	184.42	424166.00
(b)	Columns, Pillars, Piers, Posts and Struts .	8000	sqm	454.41	3635280.00
(c)	RCC walls at all levels (any thickness).	3300	sqm	369.24	1218492.00
(d)	Lintels, beams, plinth beams, girders, bressumers and cantilevers	100	sqm	333.23	33323.00
14	Steel reinforcement -Corrosion resistant steel				
(a)	Including supply (Corrosion resistant steel of approved make with steel of grade Fe-500 confirming to IS:1786) , straightning, cutting and bending, binding (i/c cost of binding wire), placing in position, etc., all labour & material, complete.	10000	kg	69.09	690900.00
(a)	Excluding supply but including unloading, storing, watch & ward, testing, straightning, cutting, bending, binding (i/c cost of binding wire), placing in position, etc., all labour & material, complete. (Reinforcement steel shall be supplied by BHEL free of	309000	kg	11.11	3432990.00
15	12mm cement plaster internal of the walls in the mix:				
(a)	1:4 (1cement :4coarse sand)	300	sqm	164.71	49413.00
16	Structural steelwork welded in built up sections like edge protection angles,insert plates with lugs & framed work including providing, cutting, hoisting, fixing in position/ embedding in concrete and applying a priming coat of approved steel primer all complete.	35000	kg	72.00	2520000.00
17	Steelwork welded in built up sections/framed work including providing ,cutting, hoisting, fixing in position and applying a priming coat of approved steel primer using structural steel etc., as required.				
(a)	In gratings, rails ,mono rails, frames, ladders, stair railings, gates (including pipe), crane girder/rails (beams,channels etc), and similar works.	8500	kg	93.65	796025.00
18	Providing & fixing in position design mix M30 precast cement concrete trench covers or perforated covers wherever necessary at various elevations in all kinds of work including moulding, formwork, mixing, laying out, compacting and curing, storing, transportation, erection without damage, setting in position with cement and sand mortar, grouting etc all as per specs, drawings and directions of Engr-in-Charge but excluding the cost of reinforcement, inserts, edge angles, etc. (Note:- Cement content considered in M-30 is @ 340 kg/cum) .Excess/less cement used as per design mix is payable/recoverable separately).	90	cum	10392.15	935293.56

BILL OF QTY. CUM PRICE SCHEDULE

PKG-A

Name of Project
Name of Work

:400KV GIS SUBSTATION AT UDANGUDI
:CIVIL WORKS OF SWITCHYARD

ST. No.	Description of Item	Quantity	Unit	Unit Rate (Rs)	Amount (Rs)
19	Providing and fixing at or near ground level factory made kerb stone of M-20 grade cement concrete in position to the required line, level and curvature, jointed with cement mortar 1 : 2 (1 Cement : 2coarse sand) including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm), including making drainage opening wherever required complete tec. as per direction of Engineer-in-charge (length of finished kerb edging shall be measured for	20	cum	5179.43	103588.60
20	Providing and fixing (all dia & length) foundation bolts in position with help of proper templates (template to be arranged by contractor free of cost),nuts and washers all complete as per specs, drawings & directions of Engr-in-Charge.Template shall	15000	kg	87.19	1307850.00
21	Extra over item above for providing galvanised bolts (Mass of zinc coating =910 gms /sqm),nuts & washer	15000	kg	11.01	165150.00
22	Fixing (all dia & length) galvanised foundation bolts in position with help of proper templates(template to be arranged by contractor free of cost) including nuts and washers all complete as per specs, drawings & directions of Engr-in-Charge .Template shall not be measured for payment purpose. (Foundation bolts shall be supplied by BHEL.)	10000	kg	9.20	92000.00
23	Preparation and consolidation of subgrade with power road roller of 8 to 12 tonne capacity after excavating earth to an average of 22.5cm depth, dressing to camber and consolidating with road roller including making good the undulations etc., and re-rolling the sub grade and disposal of surplus earth lead upto 50m.	600	sqm	90.10	54060.00
24	Supplying and stacking of graded stone aggregate at site of size range				
(a)	90 mm to 45 mm size stone aggregate	200	cum	1278.69	255738.00
(b)	63 mm to 45 mm size stone aggregate	100	cum	1386.53	138653.00
(c)	53mm to 22.4 mm	10	cum	1475.02	14750.20
(d)	Stone screening 13.2 mm nominal size (type A)	10	cum	1439.66	14396.60
(e)	11.2 mm nominal size (Type B)	10	cum	1398.19	13981.90
(f)	Moorum	10	cum	563.01	5630.10
25	Laying spreading and compacting stone aggregate of specified sizes to WBM specifications including spreading in uniform thickness, hand picking, rolling with 3 wheeled road/vibratory roller 8-10tonne in stages to proper grade and camber, applying and brooming requisite type of screening/binding material to fill up interstices of coarse aggregate water and compacting to the required density (payment for stone aggregate, screenings, kankar, moorum and red bajri etc., to be made separately)	150	cum	449.10	67365.00
26	Providing and laying cement concrete of grade M30 using 20 mm nominal size stone aggregate with approved admixture (Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA). CPCIA shall be free from nitrites, chromates and non-migrating types and having 7-8 years of usage history in Indian conditions conforming to ASTM-G-109 with an efficiency factor of minimum 25 times. Dosage as per manufacturer specifications shall be compatible with the type of cement used.),provision for necessary joints including compaction, finishing to lines and grades, curing and providing & fixing for work etc. all complete. (Excluding the cost of reinforcement and dowel bar) (Note:- Cement content considered in M-30 is @ 340 kg/cum)	150	cum	7136.62	1070493.00
27	Providing & laying dry lean cement concrete of grade M15 with 20 mm nominal size graded stone aggregate over a prepared sub-grade including compaction, finishing, curing etc all complete.	60	cum	3030.14	181808.40
28	Providing and fixing in position MS dowel bar reinforcement including surface painted with bitumen and greasing, dowel end caps with cotton fills etc all complete as perspecification, drawing and as directed by Engineer.	800	Kg	67.72	54176.00
29	Providing and laying non-pressure NP2 class (light duty) RCC pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine sand) including testing of joints etc., complete.				
(a)	150mm dia. RCC pipe	10	RM	315.70	3157.00
(b)	250mm dia. RCC pipe	20	RM	429.98	8599.60
(c)	300mm dia. RCC pipe	20	RM	459.59	9191.80
(d)	450mm dia. RCC pipe	20	RM	639.06	12781.20
30	Providing and laying non-pressure NP3 class (Medium Duty) RCC pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine sand) including testing of joints etc., complete.				
(a)	150mm dia. RCC pipe	10	RM	533.37	5333.70
(b)	250mm dia. RCC pipe	10	RM	922.28	9222.80
(c)	300mm dia. RCC pipe	10	RM	830.05	8300.50
(d)	450mm dia. RCC pipe	10	RM	1660.11	16601.10
(e)	600mm dia. RCC pipe	10	RM	2159.04	21590.40
31	Providing and placing in position suitable PVC water stops conforming to IS 12200 or equivalent for construction/expansion joints between two RCC members and fixed to the reinforcement with binding wire before pouring concrete etc. complete. Serrated with central bulb(225mm wide,8-11mm thick)	940	meter	216.54	203547.60
32	Antiweed treatment in switchyard area including rolling/compacted to the lines & grades using half ton roller/surface vibrator with suitable water sprinkling arrangement ,surface dressing of earth to a extent of ± 200 mm & micro levelling etc as per Technical specification.	11600	sqm	18.98	220181.55
33	Supplying and spreading 100 mm thk stone aggregate of size 20 mm in switchyard as per drawing and specification all complete but excluding micro leveling, dressing & antiweed treatment .	50	sqm	166.20	8310.00
34	Providing and fixing PVC coated G.I chain link fence of 8 gauge (excluding PVC coating) with mesh size 75x75 mm and of height 2400 mm above the toe wall including stretching and attaching by clips at 0.5m interval (or as per drg.) to 3 strands of HTSS wire of 12 guage interwoven in chain link wire mesh and attaching to the fence post with nuts and bolts all complete as per approved drawing and direction of Engineer-in-Charge. (The rate quoted against this item shall be inclusive of all items like chain link fence, clips, HTSS wire, nuts and bolts etc. all complete as per drawing /technical specification).	570	Sqm	623.92	355634.40
35	Supplying, fabricating and fixing angle galvanised iron posts,struts, flats of required size including bottom of post to be split and bent and top to be made Y shaped by cutting, bending and welding including drilling holes etc. all complete.(Cost of excavation, shuttering, concrete work, toe wall to be paid separately). Rate of zinc coating shall not be less than 910 g/m2	5000	Kg	83.01	415050.00
36	Supplying and fixing 600 mm high G.I. barbed wire fencing on top of switchyard fencing post (Y shaped angle) consisting of 8 rows of barbed wire of 6 guage with anticlimbing arrangement including GI clips,anchors,accessoriesetc.allcomplete. (Structural post shall be separately)	570	RM	1179.34	672223.80

BILL OF QTY. CUM PRICE SCHEDULE

PKG-A

Name of Project
Name of Work

:400KV GIS SUBSTATION AT UDANGUDI
:CIVIL WORKS OF SWITCHYARD

ST. No.	Description of Item	Quantity	Unit	Unit Rate (Rs)	Amount (Rs)
37	Supply, fabrication and installing in position and testing hot dipped galvanised MS Gates out of channels, joists, angles, flats, plates, pipes, tubular sections (conforming to IS:1161), square welded mesh with 4 mm dia GI wire fabric & sheets including stiffeners, bracings, fabricated hinges, MS Aldrops with locking arrangement, tempered steel pivot, guide track of MS Tee, bronze aluminium ball bearing arrangements, 20 mm wide x 80mm dia flat MS roller at the bottom, paintings, fixing to post	1	MT	106068.55	106068.55
38	Supply and laying approved quality Stone aggregate 40mm size in transformer yards.	140	cum	2012.80	281792.00
39	Providing & grouting of pocket holes, pipe sleeves and under base plates of structural steel work/ machinery/ pipe supporting structures including roughening of surface, cleaning, ramming, curing, etc. all complete with Conbextra GP-2 or equivalent. (Cost of all material and cleaning of the	1	cum	42802.01	42802.01
40	Supplying and installation of Dura board HD100 or its equivalent as approved by the Engineer, as filler material in joints including nailing, installation as per manufacturer's recommendation etc. all complete. - 20mm wide joints	25	RM	836.26	20906.50
41	Providing and filling in position hot applied bitumen sealing compound (GradeA) of specified thick confirming to IS1834 including cleaning, mixing, heating, pouring/injecting sealing compound in gaps in joints, sealant primer etc all complete as per specification, drawing and as directed by Engineer.	200	RM	10.80	2160.00
42	Providing and laying polythene sheet of 125 microns between the PCC and RCC slab all complete as per direction of Engineer in charge.	600	sqm	14.76	8856.00
43	Providing & Laying 80 mm thick M20 Grade precast interlocking concrete pavers of approved colour and pattern as per specification and recommendation of manufacturer.	300	sqm	516.12	154836.00
44	Providing & laying 100 mm thick sand layer below concrete pavers including compaction etc all complete as per specification, drawing and as directed by Engineer.	300	sqm	238.66	71598.00
45	Providing and applying two coats of bitumen grade 85/25 as per IS 702 (@ 1.7kg/sqm) with 1% antistripping compound conforming to IS 6241 in foundation, wall, column etc on concrete surfaces exposed to soil / ash including surface preparation	4000	sqm	111.87	447480.00
TOTAL					65468887

BILL OF QTY. CUM PRICE SCHEDULE

PKG-B

Name of Project
Name of Work

: 400KV GIS SUBSTATION AT UDANGUDI
: CIVIL WORKS OF GIS & CRB BUILDING

ST.No.	Description of Item	Quantity	Unit	Unit Rate (Rs.)	Amount (Rs)
1	Earth work in excavation in all types of soil which can be excavated by any means including setting out, levelling, dewatering (but excluding special type of dewatering viz. well point method), shoring & strutting (wherever required), dressing the sides & bottom, all lifts, ramming/compacting the excavated bottom, stacking, disposal of surplus excavated materials within a lead upto 500 m, spreading/levelling of disposed materials etc all complete for following depths below ground level.				
(a)	Depth from ground level but not exceeding 2 m	17000	cum	76.45	1299650.00
(b)	Depth exceeding 2 m but not exceeding 4 m	14000	cum	88.57	1239980.00
(c)	Depth exceeding 4 m but not exceeding 6 m	11000	cum	113.74	1251140.00
A1	Extra over ST No. 1 for dewatering of ground water by well point method as per IS 9759.	14000	cum	312.31	4372340.00
2	Back filling upto any depth below ground level around foundations, plinths, trenches, drains etc to proper grade and level in layers not exceeding 250 mm thickness using/with selected materials from excavated soil available within a lead upto 500m and compacted as specified including re-excavation of stacked earth, watering, ramming/compaction by manual/mechanical means, dressing etc all complete for the following.				
(a)	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	28000	cum	108.14	3027920.00
3	Extra over ST No. 1 & 2 for carriage of excavated earth/selected materials for every 1 km or part thereof beyond an initial lead of 500m .	10000	cum	14.92	149200.00
4	Supplying and filling sand upto any depth under floors, around foundations, plinths etc. in layers not exceeding 250 mm thickness and compacted so as to achieve at least 80% relative density as per IS-2720 (Part-XIV) including spreading, watering, ramming/compaction by manual / mechanical means, dressing, royalty (if any) etc. all complete.	780	cum	810.82	632439.60
5	Providing and laying rubble soling with specified sizes of approved quality hard rock rubble or hand broken hard metal of sizes ranging from 100mm to 230mm, at all position and depths below or above finished ground floor level, below foundations, below flooring, and for providing hard standing etc in one or more layers each of approximately 230mm thickness, hand packing, filling in interstices with quarry spalls, grits and providing a layer of 50mm. thickness (consolidated) of moorum/equivalent locally available approved material over each layer of soling including watering, thoroughly compacting each layer with 10 tonne power roller with minimum 6 passes (or with vibrating plate of approved capacity at places not approachable by power roller) all as per the direction of the Engineer and as per specification.	1000	cum	1514.96	1514960.00
6	Anti termite chemical treatment of soil with Chloropyrifos emulsifiable concentrates (1%) conforming to IS :8944 all complete. (Plinth area of building at ground floor only shall be measured for payment)	3120	sqm	87.63	273405.60
7	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work upto plinth level.				
(a)	M15 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size)	40	cum	4948.80	197952.00
(b)	M10 (1 cement : 3 coarse sand : 6 graded stone aggregate 20mm nominal size)	240	cum	4522.52	1085404.80
(c)	M7.5 (1 cement : 4 coarse sand : 8 graded stone aggregate 40mm nominal size)	180	cum	4148.54	746737.20
8	Providing and laying Screed concrete conforming to IS 456 with coarse sand and graded hard stone aggregate 12.5mm/6 mm nominal size on the roof at any level or thickness, drains etc complete.				
	1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6/12.5mm nominal size)	160	cum	6432.75	1029240.00
9	Providing Damp Proof Course 50mm thick 1:1.5:3 concrete (10mm and down graded aggregate) with 2% of approved admixture of water proofing compound all complete. Two layers of hot bitumen coating 85/25 grade as per IS:702 @ 1.7Kg./sqm shall be applied one before & one after the DPC.	180	sqm	444.70	80046.00
10	Providing and laying in position machine batched and machine mixed design mix M-25 grade cement concrete for reinforced cement concrete work, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer-in-charge. (Note :- Cement content considered in this item is @ 330 kg/cum. Excess/less cement used as per design mix is payable/recoverable separately).				
(a)	All works upto plinth level	2500	cum	5887.43	14718575.00
(b)	All works above plinth level upto floor V level	2000	cum	6691.00	13382000.00
11	Extra for providing M-30 grade concrete instead of M-25 grade BMC/RMC. (Note:- Cement content considered in M-30 is @ 340 kg/cum) Excess/less cement used as per design mix is payable/recoverable separately).	4100	cum	55.26	226566.00
12	Add for using extra cement in the items of design mix over and above the specified cement content therein.	2040	quintal	533.82	1088992.80
13	Providing and laying M20 reinforced cement concrete in ground floor grade slab excluding the cost of centring,shuttering, finishing and reinforcement.	60	cum	5570.21	334212.60
14	Extra for providing and mixing water proofing material of zydex,sika or similar make in cement concrete work @ 1kg per 50kg of cement.	440	Kg	41.73	18361.20
15	Centering and shuttering including strutting, propping, etc., and removal of form at all heights for.				
(a)	Foundations, footings, bases of columns, etc., for mass concrete.	2850	sqm	184.42	525597.00
(b)	Columns, Pillars, Piers, Abutments, Posts and Struts	4170	sqm	454.41	1894889.70
(c)	RCC walls at all levels (any thickness).	1730	sqm	369.24	638785.20
(d)	Suspended floors, roofs, landings, balconies and access platform	3950	sqm	413.62	1633799.00
(e)	Lintels, beams, plinth beams, girders, bressumers and cantilevers	5150	sqm	333.23	1716134.50
(f)	Stairs (excluding landing)	80	sqm	391.50	31320.00
(g)	Extra for additional height in centering, shuttering where ever required with adequate bracing, propping etc., including cost of de-shuttering and decentering at all levels, over a support height of 5 m, for every additional height of 1.5 metre or part thereof -- Suspended floors, roofs, landing, beams and balconies (Plan area to be measured)	9850	sqm	169.97	1674204.50
16	Steel reinforcement -Corrosion resistant steel				
(a)	Including supply (Corrosion resistant steel of approved make with steel of grade Fe-500 conforming to IS:1786) , straightning, cutting and bending, binding (i/c cost of binding wire), placing in position, etc., all labour & material, complete.	10000	kg	69.09	690900.00
(b)	Excluding supply but including unloading, storing, watch & ward, testing, straightning, cutting, bending, binding (i/c cost of binding wire), placing in position, etc., all labour & material, complete. (Reinforcement steel shall be supplied by BHEL free of cost)	300000	kg	11.11	3333000.00
17	Brickwork with common burnt clay bricks of class designation 75 in foundation and plinth in:				
(a)	Cement mortar 1:6 (1 cement : 6 coarse sand)	110	cum	4697.59	516734.90
18	Brick work with flyash bricks of class designation 75 in in foundation and plinth in				
(a)	Cement mortar 1:6 (1 cement : 6 coarse sand)	30	cum	4154.58	124637.40
19	Brickwork with common burnt clay bricks of class designation 75 in superstructure above plinth level upto V level in all shapes and sizes:				
(a)	Cement mortar 1:6 (1 cement : 6 coarse sand)	1740	cum	5355.29	9318204.60

BILL OF QTY. CUM PRICE SCHEDULE

PKG-B

Name of Project
Name of Work

: 400KV GIS SUBSTATION AT UDANGUDI
: CIVIL WORKS OF GIS & CRB BUILDING

ST.No.	Description of Item	Quantity	Unit	Unit Rate (Rs.)	Amount (Rs)
20	Brick work with clay flyash bricks of class designation 75 in superstructure above plinth level up to floor five level in :				
(a)	Cement mortar 1:6 (1 cement : 6 coarse sand)	50	cum	4812.28	240614.00
21	Half brick masonry with common burnt clay bricks of class designation 75 in foundation and plinth in:				
(a)	Cement mortar 1:4 (1 cement : 4 coarse sand)	10	sqm	562.70	5627.00
22	Half brick masonry with common burnt clay bricks of class designation 75 in superstructure above plinth upto floor V level.				
(a)	Cement mortar 1:4 (1 cement : 4 coarse sand)	90	sqm	653.36	58802.40
23	20 mm cement external (on rough side) plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement : 5 coarse sand) finished with a top layer 8 mm thick cement plaster 1:3 (1 cement :3 fine sand) with water proofing compound.	5450	sqm	259.23	1412803.50
24	18mm cement plaster internal (on rough side) of the walls in the mix:				
(a)	1:4 (1cement :4coarse sand)	2060	sqm	190.40	392224.00
25	12mm cement plaster internal (on even side) of the walls in the mix:				
(a)	1:4 (1cement :4coarse sand)	7230	sqm	164.71	1190853.30
26	6mm cement plaster to ceiling of mix.				
(a)	1:3 (1 cement : 3 fine sand)	4160	sqm	138..39	575702.40
27	Providing and applying plaster of paris putty of 2 mm thickness over plastered surface to prepare the surface even and smooth complete.	10500	sqm	117.08	1229340.00
28	Plaster drip course /groove in plastered surface or moulding to RCC projections:	1670	metre	34.15	57030.50
29	Applying priming coat				
(a)	With ready mixed red oxide zinc chromate primer of approved brand and manufacture on steel galvanised iron/ steel works	440	sqm	28.47	12526.80
30	Structural steelwork welded in built up sections like edge protection angles,insert plates with lugs & framed work including providing, cutting, hoisting, fixing in position/ embedding in concrete and applying a priming coat of approved steel primer all complete.	3700	kg	72.00	266400.00
31	Steelwork welded in built up sections/framed work including providing ,cutting, hoisting, fixing in position and applying a priming coat of approved steel primer using structural steel etc., as required.				
(a)	In covering of floors/trenches inside the buildings with chequered plates, stringers, treads, landings etc of staircases involving use of chequered plates, wherever required, all complete.	6900	kg	80.80	557520.00
(b)	In gratings, rails ,mono rails, frames, ladders, stair railings, gates (including pipe), crane girder/rails (beams,channels etc), and similar works.	16900	kg	93.65	1582685.00
32	Providing and fixing stainless steel (Grade 304) railing made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners , stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge, (for payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc.).	500	kg	418.68	209340.00
33	Supply, fabrication and fixing of GI pipe hand railing of 32 mm/40 mm/50 mm dia (Medium Grade) including transportation, loading/unloading, painting etc. all complete..	2	MT	112308.32	224616.64
34	Providing and laying 50 mm thick granolithic heavy duty cement concrete in flooring with non-metallic hardener pigmented topping 12mm thick in flooring. Under layer of 38mm thick cement concrete mix 1:1:2 (1 cement: 1 sand : 2 stone aggregates 12.5mm well graded) and top layer of 12mm thick non-metallic concrete of mix 1:2 (1cement hardner mix with approved quality non-metallic hardening compound :2 stone aggregate 6mm nominal size) by volume including cement slurry, rounding off edges, aluminium strips etc. all complete for following (Quoted item rate shall be inclusive of providing glass joint strips)	2810	sqm	566.83	1592792.30
35	Providing and laying 25 mm thick granolithic heavy duty cement concrete mix 1:1:2 (1 cement: 1 sand : 2 stone aggregates) flooring in skirting and dado complete as per specification.	60	sqm	266.63	15997.80
36	Providing and applying two coats of Epoxy coating with suitable pigments of approved shade as per specification and direction of Engineer. The epoxy paint shall be a two pack material and shall be resistant to water, oil, splash, spillage & acidic environment. The epoxy paint coating shall be of minimum 150 micron thickness over epoxy primer.	2290	sqm	405.54	928686.60
37	Providing and laying heavy duty anti skid ceramic tiles of matt finish of size 300x300mm from reputed / approved manufacturer including under bed of cement mortar 1:3 (1 cement: 3 sand) including pointing in white cement mixed with pigment of matching shade complete. for following.				
	7mm thick tiles In flooring	50	sqm	931.35	46567.50
	7mm thick tiles In skirting and dado upto specific height	120	sqm	1559.71	187165.20
38	Providing & fixing 25mm thick Acid / Alkali resistant (Chemical resistant) tiles conforming to IS:4457 in flooring/Dado and shall be laid over bitumastic lining of min 12mm thick (to be laid in layers of 6mm each). The tiles shall be applied with 13 mm thick Potassium Silicate bedding mortar as per IS:4441, 4443 & 4832 and including preparation of surface, application of bitumen primer, curing etc. all complete for following thicknesses. The tiles should be abrasion resistant & durable. Total thickness of flooring shall be 50 mm.	280	sqm	3306.81	925906.80
39	Providing and laying 60mm thick factory made cement concrete interlocking paver block of M -30 grade made by block making machine with strong vibratory compaction, of approved s:ze, design & shape, laid in required colour and pattern over and including 50mm thick compacted bed of coarse sand, filling the joints with line sand etc. all complete as per the direction of Engineer-in-charge.	20	sqm	549.38	10987.60
40	Providing and laying vitrified ceramic tiles of polished variety of size 600x600 from reputed / approved manufacturer, complete including underbed of cement mortar 1:3 with neat cement slurry etc. all complete for following				
(a)	7.5 mm thick tiles In flooring	700	sqm	977.96	684572.00
(b)	7.5 mm thick tiles in skirting and dado upto specific height	50	sqm	1028.31	51415.50
41	Providing and fixing 18-20mm thick gang saw cut, mirror polished, premoulded and prepolished, machine cut for kitchen platforms, vanity counters, window sills , facias and similar locations of required size, approved shade, colour and texture laid over 20 mm thick base cement mortar 1:4 (1 cement : 4 coarse sand), joints treated with white cement, mixed with matching pigment, epoxy touch ups, including rubbing, curing, moulding and polishing to edges to give high gloss finish etc. complete at all levels.				
(a)	Raj Nagar Plain white marble/ Udaipur green marble/ Zebra black marble	30	sqm	1949.45	58483.50
(a)	Granite of any colour and shade	220	sqm	3010.10	662222.00

BILL OF QTY. CUM PRICE SCHEDULE

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Name of Project
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: CIVIL WORKS OF GIS & CRB BUILDING

ST.No.	Description of Item	Quantity	Unit	Unit Rate (Rs.)	Amount (Rs)
42	Finishing with Epoxy paint (two or more coats) at all locations prepared and applied as per manufacturer's specifications including appropriate priming coat, preparation of surface, etc. complete.				
(a)	On steel work	550	sqm	116.30	63965.00
(b)	On concrete work	110	sqm	118.46	13030.60
43	Providing wood work in frames of doors, windows, clerestory windows and other frames, wrought framed and fixed in position with hold fast lugs or with dash fasteners of required dia & length (hold fast lugs or dash fastener shall be paid for separately).				
(a)	Second class teak wood	3	cum	92743.05	278229.15
44	Providing and fixing 35mm thick shutters of Pre-laminated Medium density Fiber Board (MDF Exterior grade) with one side decorative lamination and other side balancing lamination conforming to IS: 12823 Grade I Type II, of approved design, and edges sealed with water resistant paint and lipped with 2nd class teakwood beading of 35mmx12mm allround the shutter, including fixing with angle cleat, grip strip, cadmium plated steel screws, including fixing of bright finished steel piano hinges 100x63x4 mm etc. complete as per architectural drawing and direction of Engineer-in- Charge (Cost of lipping will be paid for separately).	25	sqm	1545.08	38627.05
45	Extra for providing lipping with 2nd class teak wood battens on all edges of flush door shutters (over all area of door shutter to be measured).	25	sqm	309.54	7738.50
46	Providing and fixing pressed galvanised steel door frames confirming to IS:4351 manufactured from commercial mild steel sheet of 1.25mm thickness, factory galvanised including hinges, jamb, lock jamb, bead and if required angle threshold of mild steel angle of section 50X25mm, or base ties of 1.25mm pressed mild steel welded or rigidly fixed together by mechanical means, adjustable lugs with spit end tail to each jamb including steel butt hinges 2.5mm thick with mortar guards, lock strike plate and shock absorbers as specified and applying a coat of approved steel primer shop and final painting etc all complete.	55	RM	444.70	24458.50
47	Providing and fixing galvanised double plate steel door shutters with 45mm thk flush design shutter, comprising of two outer sheets of 18 gauge steel sheets rigidly connected and reinforced inside with continuous vertical 20 gauge stiffeners, spot welded in position at not more than 150mm on centres, reinforced with 18 gauge continuous pressed channel on sides, top and bottom, including void filled with mineral wool (density as per specification), all fittings, Godrej or equivalent make mortice lock with handle on both sides, shop and final painting etc all complete.	35	sqm	4530.33	158561.55
48	Providing and fixing aluminium work for doors, windows, ventilators and partitions with extruded built up standard tubular sections/ appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately) : Powder coated aluminium (minimum thickness of powder coating 50 micron)				
(a)	For fixed portion	380	kg	334.55	127129.00
(b)	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately)	3375	kg	391.32	1320705.00
49	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, with decorative lamination on both sides, in panelling fixed in aluminium doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of Engineer-in-charge.	25	sqm	755.05	18876.25
50	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions, etc., with PVC/neoprene gasket, etc., complete as per the architectural drawings and directions of Engineer-in-charge. (Cost of aluminium snap beading shall be paid in basic item).				
(a)	With float glass panes of 6 mm thickness.	60	sqm	967.10	58026.00
(b)	With float glass panes of 4 mm thickness.	210	sqm	664.04	139448.40
51	Providing and fixing fire proof steel doors (single or double shutter) with panic devices shall be 45mm thk flush design comprising of two outer sheets of 18 gauge steel sheets rigidly connected and reinforced inside with continuous vertical 20 gauge stiffeners, spot welded in position at not more than 150mm on centers including all fittings, shop painting with approved post offcelsignal red color fire resistant paint and mineral wool insulation (64 kg/cum density) complete and shall be fire proof as per IS:3614, TAC requirements and as per specification. Minimum ratings shall be 2 Hrs.	15	sqm	7494.62	112419.30
52	Providing & fixing double glazed hermetically sealed glazing in aluminium windows, ventilators and partitions, etc, with 6mm thick toughened safety glass conforming to IS: 2553 on both sides having 12mm air gap including providing EPDM gasket, perforated aluminium spacers, dessicants, sealants (both primary & secondary sealant) etc. as per specifications, drawings & direction of Engineer-in-charge complete.	75	sqm	2741.55	205616.25
53	Providing and fixing factory made P.V.C. door frame of size 50x47 mm with a wall thickness of 5 mm, made out of extruded 5 mm rigid PVC foam sheet, mitred at corners and joined with 2 nos of 150 mm long bracket of 15x15 mm M.S. square tube, the vertical door frame profiles to be reinforced with 19x19 mm M.S. square tube of 19 gauge, EPDM rubber gasket weather seal to be provided through out the frame. The door frame to be fixed to the wall using M.S. screws of 65/100 mm size, complete as per manufacturer's specification and direction of Engineer-in-charge.	25	metre	438.75	10968.75
54	Providing and fixing factory made panel PVC door shutter consisting of frame made out of M.S. tubes for styles, top & bottom rails. M. S. frame covered with 5 mm thick heat moulded PVC 'C' channel of size 30 mm thickness forming styles, top & bottom rail and 115 mm wide lock rail on both side of the panel. panelling of 5 mm thick both side PVC sheet to be fitted in the M.S. frame welded/ sealed to the styles & rails with 7 mm (5 mm + 2 mm) thick x 15 mm wide PVC sheet beading on inner side, and joined together with solvent cement adhesive. An additional 5 mm thick PVC strp of 20 mm width is to be stuck on the interior side of the 'C' channel using PVC solvent adhesive etc. complete as per direction of Engineer-in-charge, manufacturer's specification & drawing.				
(a)	30 mm thick plain PVC door shutters	15	sqm	2763.09	41446.35
(b)	30 mm thick pre laminated PVC door shutters	15	sqm	3227.69	48415.35
55	Providing and fixing double action hydraulic floor spring of approved brand and manufacture conforming to IS : 6315, having brand logoembossed on the body / plate with double spring mechanism and door weight upto 125 kg, for doors, including cost of cutting floors, embedding in floors as required and making good the same matching to the existing floor finishing and cover plates with brass pivot andsingle piece M.S. sheet outer box with slide plate etc. complete as per the direction of Engineer-in-charge.	15	each	1777.08	26656.20
56	Providing and fixing M.S. grills of required pattern in frames of windows etc. with M.S. flats, square or round bars etc. including priming coat and two coats of approved shade synthetic enamel paint all complete.	3000	kg	97.51	292530.00
57	Providing and fixing aluminium sliding door bolts anodised (anodic coating not less than grade AC 10 as per IS: 1868) transparent or dyed to required colour or shade with nuts and screws etc., complete.				
(a)	300 X 16mm	20	each	184.35	3687.00
(b)	250 X 16 mm	20	each	164.68	3293.60
58	Providing and fixing aluminium tower bolts anodised (anodic coating not less than grade AC 10 as per IS: 1868) transparent or dyed to required colour or shade with necessary screws etc., complete.				
(a)	300 X 10mm	15	each	85.64	1284.60
(b)	250 X 10 mm	20	each	75.81	1516.20
(c)	200 X 10 mm	25	each	65.63	1640.75
(d)	150 X 10 mm	85	each	55.22	4693.70

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ST.No.	Description of Item	Quantity	Unit	Unit Rate (Rs.)	Amount (Rs)
59	Providing and fixing aluminium handles anodised (anodic coating not less than grade AC 10 as per IS: 1868) transparent or dyed to required colour or shade with necessary screws etc., complete. 125mm	30	each	43.86	1315.80
60	Providing and fixing aluminium extruded section body tubular type universal hydraulic door closer (having brand logo with IS : 3564, embossed on the body, door weight upto 36 kg to 80 kg and door width from 701 mm to 1000 mm), with double speed adjustment with necessary accessories and screws etc. complete.	12	each	336.80	4041.60
61	Supplying and fixing rolling shutters of approved make, made of required size MS laths interlocked together through their entire length and jointed together at the end by end locks mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with mechanical arrangement for operation complete including the cost of providing and fixing necessary 27.5cm long wire springs grade no. 2 and MS top cover of required thickness for rolling shutters. 80X1.20 mm MS laths with 1.2mm thick top cover.	55	sqm	1618.05	88992.75
62	Providing and fixing ball bearing for rolling shutters.	5	each	329.39	1646.95
63	Extra for providing mechanical device chain and crank operating rolling shutters Operation.	4	each	724.05	2896.20
64	White washing with lime to give an even shade - New work (3 or more coats)	200	sqm	16.97	3394.00
65	Distempering with 1st quality acrylic distemper (ready mixed) of approved manufacturer, of required shade and colour complete, as per manufacturer's specification. Two or more coats on new work	8500	sqm	51.95	441575.00
66	Applying one coat of water thinnable cement primer of approved brand and manufacture on wall surface :	8500	sqm	36.27	308295.00
67	Wall painting with acrylic emulsion paint of approved brand and manufacture to give an even shade : Two or more coats on new work.	1800	sqm	80.15	144270.00
68	Finishing walls with Acrylic Smooth exterior paint of required shade. New work (Two or more coat applied @ 1.67 ltr/10 sqm over and including priming coat of exterior primer applied @ 2.20 kg/10 sqm)	5700	sqm	80.15	456855.00
69	Finishing walls with water proofing cement paint of required shade : New work : Two or more coats applied @3.84kg/10sqm.	400	sqm	56.21	22484.00
70	Painting with synthetic enamel paint of approved brand and manufacture to give an even shade: Two or more coats on new work.	400	sqm	74.91	29964.00
71	Painting with chlorinated rubber based acid proof paint of approved brand and manufacture of required colour to give an even shade. Two or more coats on new work.	430	sqm	243.33	104631.90
72	Providing and fixing white vitreous china indian type water closet squatting pan (size 580 x 440 mm with integral type foot rests) as per IS 2556 with 100 mm sand cast iron P or S trap, 10 litre low level P.V.C. flushing cistern (of approved make) with fittings, C.I./R.S. brackets, 32 mm CP flush pipe with fittings and clamps, overflow arrangement with specials and mosquito proof coupling of approved municipal design including painting of fittings and brackets, cutting and making good the walls and floors wherever required.	2	each	3192.12	6384.24
73	Providing and fixing white vitreous china pedestal type water closet (European type W.C. Pan) as per IS 2556 with double plastic seat cover as per IS:2548, C.P. Brass hinges and rubber buffers, 10 litre low level PVC flushing cistern with fittings & CI/RS brackets 40mm dia CP flush pipe , overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design compete including painting of fittings and brackets, cutting and making good the walls and floors wherever required :	3	each	4173.15	12519.45
74	Providing and fixing white flat back glazed vitreous china urinals of size 440x265x355 mm with photo voltaic control flushing system as per IS:2556 (part 6, section 1) with flush pipes, lead pipes, gratings, traps and necessary C.P. fittings etc. all complete.	4	each	8735.49	34941.96
75	Providing and fixing granite stone slab with table rubbed, edges rounded and polished, of size 75x50 cm deep and 1.8 cm thick, fixed in urinal partitions by cutting a chase of appropriate width with chase cutter and embedding the stone in the chase with epoxy grout or with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) as per direction of Engineer-in-charge and finished smooth.	2	each	2719.15	5438.30
76	Supply and fixing glazed vitreous china Wash Basin with photo voltaic control fittings conforming to IS:2556 part 4 of oval shape with R.S. or C.I. brackets painted white, 15mm chromium plated brass hot & cold faucets with nylon washers, chromium plated brass chain with rubber plug, 32mm chromium plated brass bottle trap and waste of standard pattern, 32mm dia chromium plated brass trap unions, plastic connection pipe with chromium plated nuts, fittings, cutting and making good the walls where required etc all complete.	5	each	4367.74	21838.70
77	Providing and fixing stainless steel kitchen sink of size 750x510x200mm conforming to IS: 13983 including all fittings etc. all complete.	1	each	2197.71	2197.71
78	Providing and fixing C.I. floor traps size 100 mm Inlet and 100 mm Outlet Sand Cast Iron S&S as per IS: 1729 with C.P jalli all complete.	5	each	26.06	130.30
79	Providing and fixing Emergency eye wash cum shower including all fittings etc. all complete as per IS 10592 and specification.	1	each	6500.00	6500.00
80	Providing and fixing 600 x 450 x6 mm bevelled edge mirror of float glass (of approved quality) complete with 6 mm thick hard board ground fixed to wooden cleats with C.P. Brass screws and washers complete.	2	each	755.54	1511.08
81	Providing and fixing 1200 x 900 x6 mm bevelled edge mirror of float glass (of approved quality) complete with 6 mm thick hard board ground fixed to wooden cleats with C.P. Brass screws and washers complete.	3	each	1511.08	4533.24
82	Providing and fixing 600 x 120 x 5 mm glass shelf with edges rounded off supported on anodised aluminium angle frame with C.P. Brass brackets and guard rail complete fixed with 40 mm long screws, rawl plugs etc. complete.	5	each	522.99	2614.95
83	Providing and fixing 25 mm diameter stainless steel towel rails (600mm X 25mm) all complete.	5	each	1497.25	7486.25
84	Providing and fixing stainless steel / C.P. liquid soap holder cum dispenser. Dispenser shall be round and easily revolving with removable threaded nozzle and mounted on C.P. brackets etc all complete.	5	each	1497.25	7486.25
85	Providing and fixing toilet CP brass paper holder with suitable cover cum cutter fitted with CP screws etc. all complete.	5	each	351.69	1758.45
86	Providing and fixing GI pipes class B medium class conforming to IS:1239 pipes shall be concealed and painted with anticorrosive paint, complete for internal works with GI sockets, unions, elbows, tees, nipples etc and clamps including cutting and making good the walls etc all complete for following sizes:				
(a)	15 mm dia nominal bore.	30	RM	170.61	5118.30
(b)	20 mm dia nominal bore.	20	RM	203.86	4077.20
(c)	25 mm dia nominal bore.	20	RM	225.31	4506.20
(d)	32 mm dia nominal bore.	20	RM	278.65	5573.00

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ST.No.	Description of Item	Quantity	Unit	Unit Rate (Rs.)	Amount (Rs)
87	Providing and fixing GI pipes class B complete for external work with GI sockets, unions, elbows, tees, nipples etc including trenching & refilling, anti-corrosive paint etc all complete for following sizes:				
(a)	15 mm dia nominal bore.	10	RM	146.22	1462.20
(b)	20 mm dia nominal bore.	10	RM	168.32	1683.20
(c)	32 mm dia nominal bore.	15	RM	221.03	3315.45
(d)	40 mm dia nominal bore.	25	RM	267.43	6685.75
88	Making connection of GI distribution branch with GI main of following sizes by providing and fixing tee, including cutting and threading the pipe etc., complete.				
	25 to 40mm nominal bore.	2	each	385.62	771.24
89	Providing and fixing in position tested heavy duty type chromium plated (CP) brass long neck bib cocks including sockets, union, nuts etc all complete				
(a)	15mm nominal bore	5	each	248.49	1242.45
(b)	20mm nominal bore	2	each	267.97	535.94
90	Providing and fixing in position heavy duty brass stop cock of approved quality including all specials etc all complete				
(a)	15mm nominal bore	5	each	248.49	1242.45
(b)	20mm nominal bore	2	each	268.57	537.14
91	Providing and fixing gun metal gate valve with CI wheel of approved quality (screwed end)				
(a)	25mm nominal bore	2	each	365.84	731.68
(b)	40mm nominal bore	2	each	499.15	998.30
92	Providing and fixing ball valve (brass) of approved quality , high or low pressure with plastic floats complete.				
	25mm nominal bore	2	each	290.94	581.88
93	Supply, laying and jointing HDPE pipes including bends, branches and all other necessary fittings, M.S holder bats/clamps, cutting and making good the walls and floors, jointing, testing etc all complete for following.				
(a)	110 mm diameter.	75	RM	699.21	52440.75
(b)	160 mm diameter.	30	RM	1331.30	39939.00
94	Supply, laying and jointing UPVC pipes of class 3 as per IS:4985 including bends, branches and all other necessary fittings, M.S holder bats/clamps, cutting and making good the walls and floors, jointing, testing etc all complete for following.				
(a)	110 mm diameter.	25	RM	423.26	10581.50
(b)	160 mm diameter.	25	RM	717.86	17946.50
(c)	200 mm diameter.	25	RM	904.31	22607.75
95	Providing and fixing square-mouth S.W. Gully trap grade 'A' complete with C.I. Grating brick masonry chamber with bricks of class designation 75 and water tight C.I. Cover with frame of 300 x 300 mm size (inside) the weight of cover to be not less than 4.50 kg and frame to be not less than 2.70 kg as standard design.:				
	100 x 100 mm size P or S type	3	each	1462.79	4388.37
96	Providing and fixing in position pre-cast R.C.C. manhole cover and frame of required shape and approved quality				
	H D - 20 - Circular shape 560 mm internal diameter	5	each	1120.84	5604.20
97	Providing and placing on terrace (at all floor levels) polyethylene water storage tank of approved brand and manufacture with cover and suitable locking arrangement, float valve, stop cock etc. The tank should be ISI marked .	2000	per litre capacity	6.29	12580.00
98	Providing and applying PU based water proofing treatment with one coat of polyurethane or any other equivalent material based primer with an application rate of minimum 6 sq.m per litre and two successive liquid coatings of high solids content urethane pre-polymers or equivalent material based finish coats as per relevant IS/ASTM standards to form an elastomeric membrane with overall dry film thickness 1.5 mm subject to minimum 500 gm/sqm/coat application rate. Item includes surface preparation by applying polymerized mortar, 40g/sqm polyscrim cloth /fabric for edges, joints & vulnerable points etc all complete as per specifications and directions of engineer in charge.	3320	sqm	717.86	2383295.20
99	Providing and laying wearing course consisting of 40mm thick plain cement concrete of grade M15 (1:2:4) with graded aggregate of 12.5mm size cast in panels of maximum size 1.2mx1.2m and reinforced with 0.56 mm dia. galvanised chicken wire mesh and sealing of joints (in grooves of 6mm X 6mm) using silicon /elastomeric compound etc all complete.	3320	sqm	467.07	1550672.40
100	Providing and laying cement concrete chequered flooring tiles of 22 mm thickness and size 250x250 mm / 300x300 mm conforming to IS 13801 with 8 mm thick 1:4 cement mortar over the top most layer of roofing treatment in pathway and entire equipment area with fine joints including sealing of joints (silicon/elastomeric sealant) etc all complete. (Water proofing paid elsewhere)	395	sqm	909.91	359414.45
101	Providing and fixing HDPE down take pipes conforming to IS:4984 as per specification of following diameters.				
(a)	110 mm diameter.	30	RM	576.15	17284.50
(b)	160 mm diameter.	715	RM	1109.42	793235.30
102	Providing and fixing permanently colour coated aluminium false ceiling of approved colour and Luxalon 84 C or approved equivalent with corrosion resistant aluminium alloy panels of minimum thickness 0.5mm including 50mm thick mineral wool insulation (density 48 kg/cum) conforming to IS:8183 bound in polythene bags on top of panels. Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures, A.C. ducts etc all complete.	350	sqm	2620.65	917227.50
103	Providing and Fixing 12mm thick Gypsum board plain/perforated false ceiling tiles(600x600mm) of India Gypsum or equivalent make in plan or elevation with aluminium grid, metal suspension system, anchor fastener adjustable hangers etc. including one coat of primer, two or more coats of acrylic emulsion paint of approved colour to give an even shade with smooth finish all complete.as per architectural design and detail.metal suspension system as per ASTM C-635 shall be hot dipped M.S.galvanized (grade 180 as per is :277) nominal size of T-section shall be 24 x 38 mm or 24 x 25 mm cross runners. 24mm wide exposed flange surface shall be permanently color coated.suspension system shall be as per manufacturer's specification supported over movment platform.The work to be complete as per specifications, drawings and direction of engineer. (Structural steel works for platform for movement is separately payable under relevant items of BOQ)	350	sqm	1248.35	436922.50
104	Providing and installing 50 mm thick under deck insulation with resin bonded mineral wool conforming to IS 8183 backed with 0.05 mm thick aluminium foil and 24 G x 25 mm wire mesh netting including fixing with 100x50x6 slotted mild steel plate welded to MS plate insert embedded at the soffit of the slab at suitable distance and 14G steel wire drawn through slots and fixing to wire netting etc. all complete.	700	sqm	395.72	277004.00
105	Constructing brick masonry manhole with 75 class designation bricks in cement mortar 1:4 (1 cement: 4 coarse sand) RCC top slab with 1:2:4 mix(1 cement:2 coarse sand: 4 graded stone aggregate 20mm nominal size) foundation concrete 1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate 40mm nominal size) inside plastering 12mm thick with cement mortar 1:3 (1 cement: 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 mix(1 cement:2 coarse sand: 4 graded stone aggregate 20mm nominal size) finished with a floating coat of neat cement complete as per standard design.				

BILL OF QTY. CUM PRICE SCHEDULE

PKG-B

**Name of Project
Name of Work**

**: 400KV GIS SUBSTATION AT UDANGUDI
: CIVIL WORKS OF GIS & CRB BUILDING**

ST.No.	Description of Item	Quantity	Unit	Unit Rate (Rs.)	Amount (Rs)
(a)	Inside size 90X80cm and 45cm deep including CI cover with frame (light duty) 455X610mm internal dimensions total weight of cover and frame to be not less than 38kg (weight of cover 23kg and weight of frame 15kg) - With common burnt clay F.P.S. (non modular) bricks of class designation 7.5	3	each	7825.39	23476.17
106	Extra for depth for manholes With common burnt clay F.P.S. (non modular) bricks of class designation 7.5	2	RM	5400.92	10801.84
107	Making soak pit 2.5m diameter 3m deep with 45X45cm dry brick honeycomb shaft with bricks of class designation 75 and SW drain pipe 100mm diameter, 1.8m long complete as per standard design and specification.	1	each	19882.96	19882.96
108	Providing and laying non-pressure NP2 class (light duty) RCC pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine sand) including testing of joints etc., complete.				
(a)	150mm dia. RCC pipe	5	RM	315.32	1576.60
(b)	250mm dia. RCC pipe	5	RM	429.98	2149.90
(c)	300mm dia. RCC pipe	5	RM	459.59	2297.95
(d)	450mm dia. RCC pipe	5	RM	639.06	3195.30
109	Providing and laying non-pressure NP3 class (Medium duty) RCC pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine sand) including testing of joints etc., complete.				
(a)	250mm dia. RCC pipe	5	RM	922.28	4611.40
(b)	300mm dia. RCC pipe	5	RM	1106.73	5533.65
(c)	450mm dia. RCC pipe	5	RM	1660.11	8300.55
110	Providing and placing in position suitable PVC water stops conforming to IS 12200 for construction/expansion joints between two RCC members and fixed to the reinforcement with binding wire before pouring concrete etc. complete. Serrated with central bulb(225mm wide,8-11mm thick)	500	meter	216.54	108270.00
111	Supplying and installation of Dura board HD100 or its equivalent as approved by the Engineer, as filler material in joints including nailing, installation as per manufacturer's recommendation etc. all complete. - 12mm wide joints	110	sqm	523.94	57633.40
112	Providing and applying polysulphide based sealant conforming to IS:12118 in expansion joints in concrete including cleaning of joints, raking out groove, application of primer, scaffolding etc. all complete for following size grooves: 12mm X 25mm	110	RM	394.36	43379.60
113	Providing and fixing sheet covering over expansion joints with iron screws as per design to match the colour/ shade of wall treatment.				
a)	Aluminium fluted strips 3.15mm thick	110	kg	309.77	34074.70
114	Providing and applying two coats of bitumen grade 85/25 as per IS 702 (@ 1.7kg/sqm)with 1% antistripping compound conforming to IS 6241 in foundation, wall, column etc on concrete surfaces exposed to soil / ash including surface preparation etc. all complete.	4000	sqm	111.87	447480.00
115	Supply and placing in position chicken wire mesh at the junction of RCC/Structural steel and brickworks including cutting, bending, fixing etc. complete.	1550	sqm	123.99	192184.50
116	Providing and fixing white vitreous china laboratory sink with C.I. brackets, C.P. brass chain with rubber plug, 40 mm C.P brass waste and 40mm C.P. brass trap with necessary C.P. brass unions complete, including painting of fittings and brackets, cutting and making good the wall wherever required : size 600 x 400 x 200 mm	5	each	2824.72	14123.60
117	Providing and mixing approved Bipolar Concrete penetrating Corrosion inhibiting admixture phenolic base (krishna conchem or equivalent) in concrete as per detail specification of manufacturer etc. all complete. Payment shall be made per cum of concrete.	400	cum	216.00	86400.00
118	Demolishing R.C.C. work manually/ by mechanical means including stacking of steel bars and disposal of unserviceable material within 50 metres lead as per direction of Engineer - in- charge.	15	cum	1454.55	21818.25
119	Demolishing brick work in cement mortar manually/ by mechanical means including stacking of serviceable material and disposal of unserviceable material within 50 metres lead as per direction of Engineer-in-charge.	15	cum	842.75	12641.25
120	Providing and laying dry stone pitching of 230 mm thickness for slope protection in cement mortar 1:6 including hammer dressing, raking of joints, pointing, preparing the bedding surface and voids filling with stone aggregate etc. all complete.	50	SQM	491.76	24588.00
121	Design, preperation of drawing, submission and approval from concerned authorities and construction of rain water harvesting system including all earthwork, brickwork, misc steel, gravel & boulder filling, drilling bore hole, supplying and installation of MS pipe etc. all complete as required for completion of work. Only concrete and reinforcement shall be paid seperately under respective items.	1	LS	244474.20	244474.20
	TOTAL				94985978

SECTION - 2

STANDARD TECHNICAL SPECIFICATION
(N.A.)

SECTION -3

ENCLOSURES TO THE SPECIFICATION

(a) Customer Specification



Tamil Nadu Generation and Distribution Corporation Ltd.

2 X 660 MW Udangudi Supercritical Thermal Power Project – Stage - 1

TENDER ENQUIRY DOCUMENT FOR EPC CONTRACT

[BID Specification No. SE/C/UP/EE/E/OT No. 01/2015-16]

VOLUME - II

SECTION – 5

**DETAILED TECHNICAL SPECIFICATION -
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS**

FICHTNER Consulting Engineers (India) Private Limited
Chennai, India



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VOLUME – II

SECTION – 5

**DETAILED TECHNICAL SPECIFICATION –
CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS**

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SECTION 5.1

GENERAL

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5.1.1 GENERAL

This specification covers design, preparation of general arrangement, construction fabrication drawings and supply of all labours, materials and construction of all civil, structural and architectural works complete.

On ENGINEERING PROCUREMENT CONSTRUCTION (EPC) basis for all buildings and structures described in the specification as mentioned in Mechanical, Electrical, instrumentation, ventilation etc all complete as per scope of work.

The Civil, Architectural and Structural Steel work to be performed under this contract consists of design, engineering and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, 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 including revisions and amendments thereto as may be required during the execution of work.

The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the Civil Works.

The work shall be carried out according to the design / drawings (Architectural, Civil and Structural) to be developed by the Contractor and approved by the Owner / Owner's Engineer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Contractor keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance.

Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Contractor's offer shall cover the complete requirements of the plant and facilities and providing enough space and access for operation and maintenance as per the best prevailing practices and to the complete satisfaction of the Owner.

All works shall conform to Indian Standards and Codes and all local and state regulations. Where requirements are at variance, the more stringent of them shall govern.

All equipments and materials including cement, reinforcement steel, structural steel etc. shall be arranged / procured by the Contractor.

The Contractor's work shall cover complete requirements as per IS codes, fire safety norms, requirements of various statutory bodies, International Standards, best prevailing practices and to the complete satisfaction of the Owner / Owner's Engineer.

The Contractor shall make the layout and levels of all structures from the general grid of the plot and the nearest GSI benchmark or other acceptable benchmark of Govt. dept. as per the directions of the Owner / Owner's Engineer. The Contractor shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Owner / Owner's Engineer for general checking of the correctness of the civil works.

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

The Contractor shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.



In case of any conflict between stipulations in various provisions of the specification, the most stringent stipulation would be applicable for implementation by the Contractor without any extra cost or time to the Owner.

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

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 and other statutory requirements unless stipulated otherwise in detail specification.

The Contractor shall organize his own arrangement to transport his equipment, men and material so as to match the construction schedule.

Contractor shall rectify defects for all civil works for a period of five years from the date of handing over of the entire plant.

5.1.2 SCOPE OF WORKS

The Scope will cover but not limited to Architectural, Civil and Structural works of the following buildings / structure / systems / facilities.

1. Topographic survey
2. Geotechnical Investigation
3. Site Development Work
 - Site clearance works
 - Site grading
 - Fencing and Gates
 - Approach road to the main entry of the plant from State Highway
 - Plant road network including patrol roads, approach roads to all the buildings / structures / services.
 - Plant storm water drainage system for the entire plant, sump, pump houses, drainage channels, drainage pump house, etc.
 - Boundary walls
 - Security Gate Complex
 - Watch Towers
 - Storm Water Diversion Channels
4. Construction Enabling Works
 - Site office
 - Site Store Complex
 - Temporary Workshop and Garage
 - Fabrication Yard
 - Quality Control Laboratory
 - Fuel Storage Area
 - Staff Welfare Facilities



5. Main Power House building consisting of TG bay, Electrical bay, including its substructures with STG, Boiler Feed pumps and all other major / minor equipment foundations, service and maintenance bays.
6. Central Control room building
7. Mill and Bunker building with steel coal bins including sub-structures with foundations and mill foundations, mill reject handling system with mill reject silo.
8. Foundations for Steam generator (Boiler) supporting structures and its auxiliaries along with boiler elevator foundation and interconnection to bunker building and power house building.
9. Foundations for ESP structures and its auxiliaries along with fans, duct supports, etc., including sub-structure.
10. ESP switchgear & Control Room building
11. Boiler Area Paving
12. Transformer yard civil works including transformer foundations, oil soak pits, Burnt oil pit, cable ducts, cable trenches with covers, fire protection walls, roads, drainage, fencing, oil drainage to sump pit and oil recovery, jacking pads, transformer rail tracks (upto maintenance bay of Power House Building) along with foundation, oil test lab and Transformer Oil Filter Plant Building, etc.
13. Switchyard comprising of indoor Gas Insulated Switchgear (GIS) building, Switchyard control building and structures and foundations for outdoor equipments such as towers, gantries, lighting poles, lightning masts, CT, CVT, Lightning arrestors, equipment support etc. cable trenches, fencing, internal roads, drains, etc.
14. Civil, structural and architectural works for Coal handling systems.
15. Civil, structural and architectural works for Ash handling systems
16. Civil, structural and architectural works for Fuel handling Area including Fuel Oil pump house
17. Cooling Water channel, CW fore bay, CW piping etc.
18. CW pump house
19. Chemical House and Chlorination Building
20. CW Inlet and Outlet Conduits
21. Civil, structural and architectural works for Desalination and Water Treatment Plant
22. Pipe and cable racks, pipe pedestals etc.
23. Effluent treatment plant
24. Sewage network and treatment plant.
25. Miscellaneous Plant Buildings
 - Plant Air Compressor Building and Air Washer Room
 - DG House
 - Chemical / Hazardous Store



- Hydrogen Generation Building
- Maintenance Office Cum Stores
- 26. Non-Plant Buildings
 - Service Building
 - Weigh Bridge and Control Room
 - Workshop and Permanent Store
 - Fire Station
 - Administration Building
 - Canteens and Dormitory
 - Dispensary
 - Parking
 - Bank Extension Counter and Post Office
- 27. Other Structures and Facilities
 - Condensate storage tank foundation
 - Pipe Trenches & Duct Banks
 - Service and Potable Water Overhead Tanks
 - Horticulture and Landscaping Works and Green Belt Development
 - Rain Water Harvesting
- 28. Sea water intake system and outfall system including related Bathymetric survey and land / marine geotechnical investigations
- 29. Reinforced concrete chimney
- 30. Natural draught cooling towers.
- 31. Ash pond
- 32. Paving

Any other buildings, structures and works necessary and not specifically mentioned here but required for construction, operation and maintenance of the power plant for system engineering conforming to other sections of this tender document are deemed to be included in the scope of the Contractor.

The work also includes :

- Design and preparation of working drawings (Architectural, Civil and Structural), fabrication drawings, excavation drawings, shuttering drawings, bar bending schedule drawing and construction of all structures.
- Preparation of as built drawings of all structures and facilities to reflect as built status of construction AutoCAD latest version in CD / DVD and hard copies
- Plumbing & sanitary works
- Painting of all Architectural, Civil and Structural works
- Anti weed treatment in Transformer yard and Switchyard.
- Anti termite treatment for all buildings.



- Handing over of complete plant facilities to the satisfaction of Owner.
- All temporary roads and approach roads inside the graded plant area necessary for construction purpose and for conveying main plant equipments with adequate parking area for heavy vehicles and all permanent roads for the power plant to be constructed including formation over the graded site. The road gradient shall not be steeper than 1 in 33 at any location with necessary culverts.
- Fixing of inserts, bolts and other embedments specifically for equipment foundations, tanks, structures, etc as required.
- Fabrication and installation of full plant model in a suitable scale such that it can be accommodated in the model room of Administration Building.
- All statutory clearances / NOC required for implementation of the project from various departments/agencies like PWD, Highways, local bodies etc, shall be obtained by the Contractor.
- The Contractor shall fill or excavate or blast the areas to the required formation levels as indicated in the plot plan and dispose the excavated materials as directed by the Owner.

General Requirements

All buildings / structures / areas shall be provided the following as applicable.

Plastering, painting, plumbing, sanitation, water supply, electrification, lighting, air conditioning, fire fighting, anti termite treatment, plinth protection, damp proof course, garland drains, septic tanks, rain water harvesting, furniture, doors, windows, rolling shutters, ventilators, approach roads, colour and white washing, sunshades, false ceiling, false flooring, flooring, under deck insulation, water proofing, roof treatment, rain water down take pipes, stair case, lift, cranes and monorails, porch, potable water tanks, fans, etc.

5.1.3 TOPOGRAPHICAL SURVEY

The Owner has carried out a preliminary survey of the area and drawings indicating the survey detail are enclosed. This should be treated as for reference only. It is the responsibility of the Bidder to verify the various features on his own before submission of bid. The Owner does not take any responsibility for correctness of various features / contour shown on the drawing.

It is the responsibility of the successful Bidder to carryout detail topographical survey of the proposed power plant area. 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.

Site survey shall be carried out to establish the ground levels and to determine any existing structures, roads, etc. The site survey shall be carried out before the commencement of the work and –if required – during the progress of the work. The site survey shall be carried out at a grid spacing of 5-10 meters and at every change of level of the existing ground to produce contour drawings of 0.25 meter intervals.

A specialized firm approved by the Owner shall carry out the site survey. Before commencing the works, approval for sub vendor may be obtained from Owner.

Survey Points (Reference Points And Bench Marks)

The contractor shall construct adequate number of reference points and bench marks for marking the setting out lines and levels.



The reference points shall consist of suitable metal plates set in 400 mm x 400mm x 500 mm precast concrete plinth (grid pillars) and inscribed with the exact level.

All levels of the benchmarks shall be related to the agreed datum.

The proposed numbers, locations, co-ordinates, and levels of the reference points and bench marks shall be plotted on drawings and approved by the Owner prior to the commencement of the work.

Survey points in solid walls shall be stainless steel plates or cast iron, fixed firmly and sufficiently deep in the walls.

Safeguard of Survey Points

The survey points shall not be removed from their position without the permission of the Owner. If any of the survey points are damaged or lost due to any work carried out near their location the Contractor shall be responsible for replacing such survey points.

Surveying During The Progress of Work

The Contractor shall assist the Owner's Consultant at any time when checking survey points, setting out, checking construction items and erection parts. The Contractor shall provide and arrange the following:

- Provision and maintenance of survey instruments and accessories
- Provision of skilled personnel
- Supply of all material required for the survey
- Exposing covered survey points
- Shifting of any machinery used for construction out of the sight lines
- Stopping all drilling, blasting, driving, and any other works causing soil vibrations and stopping during instrument observations
- Removing all obstructive accumulation of water
- Taking all necessary safety precautions
- Furnishing any marking material requested by the Owner in connection with control surveys
- Providing additional survey points.

5.1.4 SITE LEVELING

The formed levels of the site are available as a separate Annexure to this specification for information and guidance purpose. Necessary additional filling shall be carried out by the Contractor to raise the level to FGL as indicated elsewhere in this specification.

The site is already graded by Owner up to the levels indicated in the Topographical survey drawing within the respective blocks and balance area is ungraded. Balance leveling inside these blocks and in ungraded areas are to be done by the Contractor

5.1.5 GEOTECHNICAL INVESTIGATION

5.1.5.1 Preliminary Geotechnical Investigation

Owner has carried out preliminary geotechnical Investigation in the proposed power plant area. The preliminary soil investigation report made by Owner is enclosed with the specification. The correct assessment and understanding of the existing sub-soil condition is to be done by the Contractor.

Based on the borehole data, it is observed that the site predominantly consists of silty clay with lime at top from 0 to 3m followed by silty clay with limestone of 1.5m thick. Calcareous sand stone layer exists from 4.5m to 18.5m.



5.1.5.2 Final Geotechnical Investigation

Contractor shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit. The Contractor has to carry out detailed geotechnical investigation at no extra cost to the Owner after the award of contract, through some approved/reputed agency and submit geotechnical investigation report with recommendations for Owner's review and approval. The recommendation given in approved final report becomes binding on the Contractor. Before commencing the works, approval for sub vendor shall be obtained from Owner.

The Contractor is not eligible to increase his cost or demand any extension of time if the final report is in variance from preliminary report furnished by Owner. Owner is not responsible for any variation of result between preliminary soil investigation report furnished to bidders and final soil investigation to be carried out by the bidder.

The Contractor shall carry out geotechnical investigation to obtain sufficient information on the sub-soil conditions for the detailed design of foundations and structures under this Contract.

Detailed geotechnical investigation shall be carried out by the Contractor on award of work. Based on the plot plan developed, the Contractor shall identify proposed borehole locations and obtain the approval of Owner prior to commencing the investigation. The Contractor shall obtain approval for the field and laboratory testing scheme proposed by him from the Owner before commencement of geotechnical investigation works. Bore holes shall be provided and spread judiciously to cover all major building as well as equipment foundations. Generally, a grid of 50 metres c/c both ways is recommended from Chimney to end of Switchyard. The investigation shall cover sufficient numbers of bore holes in each area to get the longitudinal of the soil profile as required. If required, additional investigations shall be carried out during work progress at the Contractor's expense in order to obtain additional information.

5.1.5.2.1 Standards

Unless otherwise specified, the following standards shall apply to the works covered by this chapter.

IS:1498 Classification and identification of soils for general engineering purposes.

IS:1888 Method of load tests on soils.

IS:1892 Code of practice for sub-surface investigation for foundations.

IS:2131 Method of Standard penetration test for soils.

IS:2132 Code of practice for thin-walled tube sampling of soils.

IS:2720 Methods of test for soils (All Parts).

IS:2809 Glossary of terms and symbols relating to soil engineering.

IS:2810 Glossary of terms and symbols relating to soil dynamics.

IS:3043 Code of practice for earthing.

IS:4078 Code of practice for indexing and storage of drill cores

IS:4434 Code of practice for in-situ vane shear test for soils

IS:4968 Method of sub-surface sounding for soils (All Parts)

IS:5249 Method of test for determination of dynamic properties of soils

IS:5529 Code of practice for in-situ permeability tests (All Parts)

IS:9214 Method of determination of modulus of subgrade reaction (K-value) of soils in field



IS:10060 Code of practice for subsurface investigation for power house sites

ASTM D 4428 Cross bore shear wave test

5.1.5.2.2 In-situ Testing

Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 40.0 m or 'N' value greater than 100 is obtained for 4 consecutive intervals.

During boring, the level at which ground water is struck shall be carefully noted. Ground water samples shall be collected for chemical analysis. Boring shall be carried out without the use of water or drilling mud up to the depth of ground water table.

In rock strata, core recovery and Rock Quality Designation (RQD) shall be noted carefully for each run, immediately after cores are taken out of barrel.

The diameter of boreholes shall be minimum 150mm in soil and 76 mm in rock.

5.1.5.2.3 Borings in Soil

Drilling and sampling shall be performed in accordance with IS Standards. Disturbed samples shall be taken in all materials at 1 meter intervals and at changes of strata and shall be contained in airtight containers. Undisturbed samples shall be taken in cohesive material or weak cemented granular material where possible at 1 meter intervals and at changes of strata. Samples shall be sealed so that no changes in water content or soil structure occur. Cores of cemented material shall be packed in core boxes immediately on removal from the core barrel.

5.1.5.2.4 Rock Drilling

During boring operation, once the rock strata is encountered, drilling operation shall be resorted to for determining depth and nature of rock strata.

Rotary core drilling technique with continuous core recovery using double tube core barrel with diamond bit attachment should be adopted for drilling through rock. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each borehole the Contractor shall record the rate of sinking of drill rods, ground water table elevations if any, nature, type and sequence of rock drilled. The recovered rock cores shall be properly indexed & stored as per stipulations of IS:4078. From the recovered cores, the Contractor shall determine nature of fractures and degree of weathering of the rock for each borehole. The Contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each borehole. The Contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stage of core advance and for all the boreholes.

The drilling operation shall be terminated either 3 metres in hard rock or 95% of core recovery whichever is later.

5.1.5.2.5 Field tests

Field tests but not limited to the following shall be conducted as per relevant standards:

- Bore holes and standard penetration tests
- Static plate load tests
- Cyclic plate load test
- Cross hole shear velocity test
- Field permeability tests
- Field density tests



- Vane shear tests
- Static cone and dynamic cone penetration tests
- Earth Resistivity Tests
- Pressure meter tests
- Percolation test
- Block vibration tests
- CBR tests
- Seismic refraction tests

5.1.5.2.6 Standard Penetration Test (S.P.T.)

The standard penetration test shall be performed in all boreholes at 1.5 meter intervals and at change of soil strata. The blow count shall be recorded. If the blow count exceeds 75 or if the penetration is less than 25mm per 50 blows, the test shall be stopped. The standard penetration test shall comply with IS: 2131. Even in highly weathered / disintegrated rock, where core recovery is poor, SPT shall be conducted. The first SPT in any borehole shall be conducted at 1m depth.

5.1.5.2.7 Shallow Trial Pits

Trial pits shall be carried out to a depth of 3 meters minimum below ground level and plan area of 10 square meters to examine the in-situ condition of the upper soil strata. After logging, sampling and testing the trial pits shall be backfilled and compacted.

5.1.5.2.8 Laboratory tests

The laboratory tests shall be conducted on soil, rock & water samples collected during field investigations in sufficient numbers as approved by Owner, but shall not be limited to the following. The laboratory tests shall be carried as per relevant standards.

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for

- Grain Size Analysis
- Hydrometer Analysis
- Atterberg Limits (Liquid limit, plastic limit, plasticity index, shrinkage limit, shrinkage ratio).
- Triaxial Shear Tests (UU, CU and CD)
- Natural Moisture Content
- Specific Gravity, Bulk and Dry Unit Weight, Water Content, Soil classification, relative density.
- Consolidation Tests
- Unconfined Compression Test
- Free Swell Index
- Swell Pressure Test
- Chemical Analysis test on soil and water samples to determine the carbonates, Sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.
- Modified proctor density
- Relative density
- CBR Test
- Permeability test

Laboratory tests on rock samples shall be carried out for

- Hardness
- Specific Gravity
- Unit Weight
- Uni-axial Compressive Strength (in-situ & saturated)
- Water absorption test.



On completion of all field and laboratory work, the Contractor shall submit a Geotechnical investigation report for Owner / Owner's Engineer approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field and laboratory observations/ data/ records, analysis of results and recommendations on type of foundation for different type of structures envisaged for all areas of work. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Generally, the geotechnical investigation report shall include, but not be limited to, the following:

- a) Plot plan showing the locations and reduced levels of all field tests.
- b) Geological information of the area.
- c) A true cross section of all individual boreholes and trial pits with reduced levels and coordinates, showing the classification and thickness of individual stratum, position of ground water table, results of various in-situ tests conducted and samples collected at different depths and the rock stratum, wherever met with.
- d) A set of longitudinal and transverse soil/ rock profiles connecting various boreholes.
- e) Detailed bore log Plots of Standard Penetration Tests with depths, ground water level, classification, SPT blow count.
- f) Results of all laboratory tests summarised (i) for each Borehole along with (ii) a consolidated table giving the layer wise soil and rock properties. All the relevant charts, tables, graphs, figures, supporting calculations, conditions and photographs of representative rock cores and trial pits shall be furnished.
- g) For pressure meter tests, the following shall be furnished
 - Field pressure meter, creep air calibration curves indicating P_o , P_f and P_l . Corrected pressure meter and creep curves indicating P_o , P_f , P_l . along with sample calculation for the corrections.
 - Pressure meter modulus, shear modulus and coefficient of sub grade reaction along with sample calculation.
- h) All field test results.
- i) All laboratory test results.
- j) Earth resistivity of subsoil based on electrical resistance tests including electrode spacing Vs cumulative resistivity curve.
- k) Suitability of the sub soil for construction of roads / embankments and their stable slopes for embankment and shallow and deep excavations, values of earth pressures coefficient for active / passive / at rest conditions and modulus of elasticity as a function of depth for the design of underground structures.
- l) Suitability of locally available soils at site for filling and back filling purposes.
- m) If expansive soil is met with, any special treatment, viz. Soil replacement/lime treatment, etc., required including specifications for materials to be used, construction method, equipments to be deployed, etc. shall be furnished.
- n) Protective measures based on chemical nature of soil and ground water with due regard to potential deleterious effects on concrete, steel and other building materials, etc. Remedial measures for sulphate attack, chloride attack and acidity shall be dealt in detail. Susceptibility of soil to termite action and remedial measures for the same.



- o) Identification of any other potential geotechnical problems & their remedial measures.
- p) Description of measures required for erosion control.
- q) Identification of corrective measures required for the improvement of sub-surface conditions such as removal of poor sub soil / material, in-situ densification. If ground improvement is recommended then its detailed specifications, specification for materials to be used, construction method, equipments to be deployed etc. shall be furnished.
- r) Recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total / differential settlement permissible for structures and equipments, minimum depth and width of foundation. Recommended dynamic properties of soil, modulus of subgrade reaction.
- s) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.
- t) If Pile Foundations are necessary, type of piles recommended with reasons for the same, length, diameter, allowable capacity (lateral, pullout and vertical) of individual and groups of piles, negative skin friction if any and magnitude of estimated negative skin friction, structural design etc.
- u) Type of cement to be used for concrete substructures and in stone / brick masonry foundations with reference to the chemical nature of subsoil and ground water.
- v) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.

Geotechnical investigation work shall be got executed by the Contractor through reputed agency after approval of by the Owner / Owner's Engineer:

The detailed Geotechnical Investigation report, Foundation system, founding level to be adopted including the allowable bearing capacities, measures to be adopted as mentioned in the specification shall be submitted to the Owner / Owner's Engineer for approval.

5.1.6 DATA TO BE FURNISHED BY BIDDER AT THE TIME OF BID

A write-up on survey to be undertaken indicating grid, intervals for taking spot levels, contour intervals, precision of surveying instruments proposed to be used, drawings that will be prepared, details to be covered by survey etc.

General arrangement / architectural drawings for all buildings and structures showing dimension, levels plans, sections, elevations, loadings, materials proposed, types of framings, wall / cladding, floors, roofs types of finishes, construction methodology, design criteria etc.

All deviations from bid document shall be furnished by bidder.

List of equipment to be deployed by the bidder and by other subcontractors to be associated with him-in is to be furnished.

List of software proposed to be used against various areas, for analysis, design, construction etc, their source and along with validation report for the software.

The list of documents indicated elsewhere of this section to be submitted by the Contractor to the Owner for his approval and manner in which the same needs to be submitted. No construction shall commence at site without obtaining approval from the Owner on these documents. Therefore it is necessary that bar charts for building / structure / area wise shall be submitted for design / drawing activity indicating.



- A level-1 part showing the start and completion date of all civil construction activities.
- A level-2 part showing the time required for preparation of design criteria, for approval of design criteria by Owner after checking and clearance given by the Owner, time required for detailed design and drawing preparation and time required for approval of design and drawing by Owner after checking and clearance given by the Owner. This part shall take into account the construction schedule (Level-1 part).

A detail note on quality plan both for design and construction activity proposed to be adopted for obtaining quality works.

List of all sub-contractors that the bidder proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be involved in the job on behalf of the Contractor etc shall be submitted to Owner. Only the sub-contractors approved by Owner shall be engaged by the Contractor on the job.

5.1.7 INSPECTION OF SITE BY BIDDER

Bidder 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 and their rates, local working conditions, weather, 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 Bidder will be construed as evidence that such an examination was made and any later claims / disputes in regards to rates quoted shall not be entertained or considered by the Owner.

5.1.8 CONSTRUCTION TOOLS AND MATERIALS SUPPLIED BY Contractor

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 various 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. No claim shall be entertained for mobilizing additional equipment and / or personnel to complete the work within the stipulated time.

Contractor shall provide all fuels and lubricants required for the operation and maintenance of construction machinery and equipment as well as his transport vehicles at his own cost.

The Contractor shall ensure that the work shall proceed uninterrupted even in the event of power failure. As such, adequate number of diesel operated equipment shall be provided by the Contractor at his own cost as an alternative arrangement, in case electrically operated equipment are proposed to be brought to site.

The Contractor shall ensure continuous supply of coarse and fine aggregate conforming to the specification for the duration of the contract period and extended period if any. Adequate stocks are to be ensured before the on-set of monsoon, because the approaches to the quarries becomes difficult during monsoon.

Adequate stocks of material shall be ensured such that there are no interruption of works due to shortage of material at any point of time during the contract period and extended periods, if any.



All materials supplied by Contractor shall be original, new and of the best quality and shall conform to the given specifications. Approval in writing shall be obtained from the Owner before any alternative or equivalent material is used other than what is specifically mentioned in the drawings.

Contractor shall furnish manufacturer's test certificate for all the manufactured items supplied by him. Representative specimens of the material shall also be submitted to the Owner and shall be tested at a recognized testing laboratory at Contractor's cost in case Owner so desire.

The Owner reserves the right to test any construction material supplied by the Contractor in an established testing laboratory at Contractor's cost.

The Owner reserves the right to instruct the Contractor to remove all materials which do not meet the specification requirements.

5.1.9 WORK EXECUTION AND SUPERVISION

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 also operators of machinery and equipment, for satisfactory progress and timely completion of the works.

Contractor's engineer-in-charge of the work at site shall be capable of interpreting the specification and drawings and make adequate site decisions as and when required. He shall also take instructions from the Owner and be responsible for carrying out the instructions.

Contractor shall be fully responsible for the correctness and accuracy of the tests performed, results obtained / tabulated, interpretation of test results and recommendations made. The work shall be executed in a professional manner, with fully understanding of the importance of work for a project of this magnitude.

In the event of occurrence of any accidents at / near the site of the work or in connection with execution of the work, a report shall be made immediately to the Owner, giving full details of the accident. He shall also report such accidents to all the competent authorities wherever such reports are required by them as mandated by statutory laws.

All temporary electrical installation shall be supervised by a qualified electrical supervisor of the Contractor.

Owner reserves the right to order in writing, from time to time, during the progress of the work, removal and re-execution of any work which in the opinion of the Owner, is not in accordance with the specification.

During inclement weather, rains etc., Contractor shall suspend all works for such time as the Owner may direct and shall protect from damage all works already in progress or completed just then. All such temporary protective measures shall be at Contractor's cost and any damage to works shall be made good by the Contractor at his own expense.

Should the work be suspended by reasons of strikes / riot by Contractor's own employees or any other causes whatsoever save and except the force majeure condition, Contractor shall take all precautions necessary for the protection of works and make good at his own expense any damage arising from any other than these causes. No compensation, whatsoever, will be given by the Owner.

During the course of Contractor's works, other works either by the Owner or by other Contractors or by the Owner or by other Contractors or by both simultaneously will be in progress within the project area. Contractor shall make his best effort to work in harmony with others in the best overall interest of the project and towards its speedy completion.



A quality control laboratory shall be set up with all required testing equipments. The quality control laboratory shall be handed over to the Owner and laboratory shall be under the Owner control. However testing of all materials has to be carried out by the Contractor. The bidders have to re-calibrate the testing equipments brought to site by competent authorities from time to time to maintain the accuracy.

Bidder should furnish the list of equipments that will be provided in the laboratory.

The Contractor shall be responsible for maintaining cleanliness of the site. The site shall be free of unwanted rubbish or filth which is hazardous and detrimental to health and affect safety of the work place.

All material supplied shall conform to the specification. Entry of unwanted materials shall be prohibited.

5.1.10 SUBMISSION OF DOCUMENTS TO THE OWNER AFTER AWARD OF CONTRACT

The Contractor shall commence soil investigation only after obtaining and incorporating the comments given by the Owner on the project-specific specification for soil investigation submitted by Contractor.

After completion of soil investigation, Contractor shall submit a detailed soil investigation report to the Owner, after vetting by reputed third party institutions like IIT or NIT , within three months from award of contract, giving all data from tests conducted, conclusions there from, safe allowable bearing pressures, level of ground water, presence of aggressive chemicals to concrete etc., The Contractor shall incorporate all changes suggested by the Owner at no extra cost to the Owner and with no extension of time.

The Contractor shall begin further works like preparation of design criteria only after obtaining approval of the report.

Detailed design calculations / drawings shall be commenced by Contractor only after approval is obtained from the Owner on the basic design criteria for building / structure / areas to be submitted by the Contractor. No later deviation from the approved design criteria shall be permitted unless specifically approved by the Owner in writing, prior to its adoption.

Civil assignment drawings showing all details such as equipment loads, live loads, erection and maintenance loads, cutouts, crane capacity and wheel loads and wheel spacing, point loads due to piping / pipe hangers, ventilation duct, cable trays etc. shall be submitted for information. Vertical bracing, brick wall location, etc shall be based on approved general arrangement (GA) drawings of the equipment, piping / cable tray / ventilation duct layout drawings and shall be submitted by the Contractor for Owner's approval. Interferences shall be indicated in civil GA drawings, Civil GA drawings submitted without prior approval of relevant GA drawings for equipment piping / cable tray / ventilation duct layout shall not be considered for review and approval.

The Contractor shall freeze all loadings applicable for the main plant building within a maximum period of six months from the award of contract.

Design calculations and drawings and other documents shall be submitted sequentially after obtaining approval in a phased manner as per approved L2 schedule. Contractor shall ensure that design calculations / drawings for several structures are not submitted at one time. For this purpose, design / drawing submission schedule furnished during bidding stage and agreed upon by Owner shall be followed. Owner will review and furnish comments / approval, if any, to the designs and drawings. The Contractor shall resubmit the design documents and drawings within a maximum period of three weeks from the date of receipt of comments by the Contractor. Timely submission of designs / drawings to the Owner for review / approval is the sole responsibility of the Contractor and postal or other delays as reasons for late / non-submission shall not be entertained.



by the Owner.

Should there be a requirement for preparation of separate drawings to show enlarged details to facilitate construction / erection, then such drawings shall also be prepared by the Contractor at no extra cost.

Design drawings shall indicate structural arrangements, member sizes, member forces, splice location, details of base plate, anchor bolts details of moment connection, construction joints, waterstops, loadings etc., so that the drawings indicate clearly all the necessary information brought out in relevant design calculations. Proposed bracing patterns shall be subject to approval by Owner. In framing plan of TG and Mill Building and other misc buildings, end shear of all secondary beams and end shear and end moment of frame beams are to be furnished in a tabular form.

Design drawings showing typical connection details conforming to design assumptions shall be submitted for approval before starting fabrication drawings.

Preparation and review of structural steel fabrication drawings is entirely of the responsibility of the Contractor and will not be approved by the Owner. However, all fabrication drawings shall be submitted by the Contractor for Owners reference and records prior to commencement of fabrication.

Bar bending schedule for all concrete works shall be prepared by the Contractor and submitted to the Owner for his reference.

All architectural features of buildings shall be detailed by the Contractor's qualified architect. Detailed drawings along with schedule of doors / windows etc floor / wall finishes including colour scheme shall be submitted for obtaining approval from the Owner. For all non-plant buildings, 2 or 3 three alternate options along with 3D view shall be submitted for Owner's review.

All construction drawings shall include total quantity of concrete (grade wise), reinforcement (diameter-wise) and structural (section wise).

The designs shall clearly spell out the erection scheme for various structures envisaged by the Contractor and resulting additional loadings, if any, shall be duly accounted for. Before taking up actual erection work, detailed erection scheme proposed to be followed by the Contractor shall be submitted for Owner's approval.

Approval / comments conveyed by the Owner neither relieves the Contractor of his contractual obligations and his total responsibility for correctness of dimensions, materials of construction loadings, quantities, design details assembly fits, performance particulars, safety and stability of the structures including foundation / appurtenances and conformity of supplies with the statutory laws as may be applicable, nor does it limit the Owners right under this contract. No change in the approved designs / drawings shall be permitted without prior written approval of the Owner.

Owner or his representative has every right to go to Contractor's design office to check the quality control being implemented at their design office to ensure that the documents being prepared are of approved quality. The Contractor shall provide all assistance required by Owner for carrying out the audit.

Checking for any interference is the sole responsibility of the Contractor.

Erection scheme for all major equipments shall be submitted to Owner for his approval before taking up detail design works.

Specifications issued to sub-contractors must be submitted for approval.

All design calculations and drawings shall be in English and shall be in SI units.



Designs drawings and other documents submitted by the Contractor shall be thoroughly checked and approved by the authorized Contractor's engineers. Any unchecked / unsigned documents will not be reviewed by the Owner. Also design calculations not accompanied by supporting engineering drawings, incomplete or shabbily done design calculations, design calculations without adequate reference or backup data and documents where previous comments have not been incorporated will not be reviewed by the Owner. No claim from the Contractor for extension of time or extra cost on this account shall be entertained by the Owner under any circumstances.

No check will be specifically carried out by the Owner to verify arithmetical / numerical accuracy of the calculations, input data, compatibility of dimensions among various drawings or between drawings and design calculations. These shall remain entirely the Contractor's responsibility.

Contractor shall submit copies of designs / drawings prepared by him in accordance with the distribution schedule.

All modification 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. In this respect, the decision of the Owner shall be binding on the Contractor. Owner will accord his approval only after the Contractor has incorporated in the design and drawings all modifications required by the Owner.

Soft copies of all design calculation and drawings shall be submitted for records after approval of the Owner.

All structural analysis may be done adopting STAAD pro / SAP. Wherever finite element analysis is needed eg. for TG frame, the same shall be done by using NISA / GT Strudl / ANSYS. For power house, mill building etc, response spectrum analysis on 3D model has to be done (in line with IS:1893-2002). The complete input (soft copy with editable format) and output data (soft copy) is to be submitted for Owner's review and approval. The softwares mentioned above are not exhaustive.

Payment will not be made for defective works and other works completed without approved design and drawings.

Final completion report shall be furnished by the Contractor including narrative report with as built drawing in consultation with Owner. Hard copies of 10 set and soft copies 3 set.

**SECTION 5.3****GENERAL REQUIREMENTS****TABLE OF CONTENTS**

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5.3.1 ARCHITECTURAL CONCEPTS AND DESIGN

Architectural Concepts

- a) Layout of the plant area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames. General layout shall be evolved taking over the basis of landform and local climate and due consideration shall be given to orientation and wind direction. The resulting built mass shall present a definite image width in distinct vocabulary in the form of landmarks, nodes and skyline.
- b) Main Plant building shall be architecturally treated in such a way that it retains a monumental scale, yet presents a pleasing composition of mass and void with suitable and functionally designed projections and recesses. The overall impact of the building shall be one of aesthetically unified architectural composition having a comprehensible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions, the building orientation and the existing structures nearby.
- c) All other buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the main plant, surrounding structures and environment. Local architectural characters and materials may be judiciously imbibed. The building shall be designed initiating an architectural control common to all buildings. The architectural control shall be clearly spelt out in terms of scale, man and form.
- d) Overall colour scheme of the plant and other buildings shall be designed judiciously and in a comprehensive manner taking into account the mass and void of buildings, its facade, equipment, exposed structural elements, piping, trestles, bus ducts and other service elements. Minimum two numbers of colour schemes shall be proposed for approval of the owner.
- e) Overall emphasis shall be on developing an eco-friendly architecture, merging with the nature.

The scheme shall be conceptually finalised in totality including that of equipment so that the proper coordination with other agencies can be taken up at appropriate time.

Architectural Design

- a) Natural light shall be used to the maximum extent, especially in the form of north light/sky light. For adequate light and ventilation, National Building code recommendations shall be followed.
- b) Entrance canopies chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided.
- c) All the buildings shall be architecturally designed to meet the National Building Code (SP: 7) norms and local building bye laws, wherever applicable.
- d) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements may be required to be met with, wherever essential. The Architect shall be of National/International repute having experience in similar kind of works. The Architect shall evolve the design philosophy based on Owner/Engineer guidelines and shall present it in the form of presentation drawings, Prospective views, 3-D Models and detail drawings.
- e) Architectural components shall be designed for the conditions at the site for a minimum design life of 30 years.



5.3.2 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.

5.3.3 PLATFORMS AND WALKWAYS

Platforms shall be provided to all major equipment, which are not directly accessible from the floors, for maintenance. Platforms in front of the entry shall be atleast 900 mm wide. Platforms located close to each other shall be connected with walkways.

- | | | |
|---|---|-------------------------------------|
| Platform and walkways | - | 750 mm minimum width |
| | - | With chequered plates/gratings |
| Minimum width of continuous walkway at crane girder level | - | 750 mm with handrails on both sides |

Approach to EOT crane shall be ensured by cage ladder or staircase.

5.3.4 STAIRS & LADDERS

5.3.4.1 Steel Stairs

Normally for all steel staircases,

- | | | |
|--|---|---|
| Minimum clear width (back to back of stringer) | - | 1200 mm |
| Maximum inclination with horizontal | - | 35.75° |
| Maximum height between successive landings | - | 5 m |
| Minimum size of stair stringers | - | Shall be decided during detailed engineering considering loads, span and width of treads. |
| Minimum width of tread | - | 250 mm |
| Maximum height of riser-Plant Buildings | - | 180 mm |
| Maximum height of riser-Non Plant Buildings | - | 150 mm |

Treads shall be made of chequered plate / grating, with suitable nosing, and spaced equally.

Incase of space restriction,

- | | | |
|--|---|--------|
| Minimum clear width (back to back of stringer) | - | 750 mm |
| Maximum inclination with horizontal | - | 45° |

Steel stairs shall be provided with all stringers, treads, risers, newels, hangers, railings, and kickplates. The construction of the steel stairs shall be carried out in a solid and rigid manner. The treads and intermediate landings shall be formed of galvanised steel grating with angle connections to stringers and with nosing of chequered steel plate. Treads shall have punched and slotted side plates for bolting to stringers.



5.3.4.2 Steel Ladders

Ladders shall be provided to platforms, walkways and equipments which do not require frequent access. Normally ladders shall be vertical or its angle with vertical shall not exceed 5° .

Ladders shall have minimum clear width of 450 mm with 20 mm diameter MS rungs at a maximum spacing of 300 mm. The steel ladders shall be made of side rails of 65 mm width and 12 mm thickness flats and 20 mm diameter rungs welded to the side rails. The side rails shall be bent at the top of the ladder and fixed on the roof / floor of the structure to allow for climbing down.

Ladders shall be provided with safety cage of minimum 750 mm diameter clear when the top of ladder is more than 4.5 m above the lower landing level. However safety cages shall start at 2.5 m above the lower landing level. The cage shall consist of 50mm width and 6 mm thickness steel bar hoops bent to the specified radius and spaced uniformly and horizontally on a maximum of 1000 mm with 5 equally spaced vertical steel bars fixed on the inside face of hoops.

5.3.4.3 RCC Stairs

Normally for all staircases,

Minimum clear width of stairs	-	1500 mm
Minimum width of tread	-	250 mm for plant buildings 300 mm for non-plant buildings
Maximum height of riser	-	180 mm for plant buildings 150 mm for non-plant buildings
Maximum no. of risers in one flight	-	15
Edge protection	-	MS angle nosing with minimum 50x25x3 angle with lugs.

5.3.5 HAND RAILS

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

All walkways, stairs, and platforms shall be provided with handrails, supports, and bracing as well as kickplates of minimum thickness of 8 mm & projecting 100 mm above the platform surface.

Stainless steel handrails and posts shall be provided for the following buildings.

- Service Building
- Administration building
- Canteen
- One stair case from ground floor to operating floor in Power House Building for each unit.

All other handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS: 1161 and shall be galvanized.

Handrail shall be a three-rail system with elevations of each rail from floor level shall be as listed below.

- the top rail at 1250 mm
- the intermediate rail shall be at 850 mm
- the bottom rail shall be at 450 mm



For platforms at elevation more than 30m, top rail shall be at 1500 mm and the intermediate rails at 450 mm and 1000 mm.

Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the protected horizontal opening and shall not exceed 1850 mm in such a case.

All handrails shall be shop fabricated and field welded or bolted to the erected structural steel.

5.3.6 PROTECTION AROUND OPENINGS AND EDGE PROTECTION

Protection Around Openings

For openings of size less than 300mm x 300mm, 200 mm high RCC kerb of 200 mm thickness shall be provided around openings and covered with chequered plate / gratings.

For large openings of size greater than 300mm x 300mm, 200 mm high RCC kerb of 200 mm thickness shall be provided around openings with 150 mm high 8 mm thick toe guards with handrails (removable / fixed).

Edge Protection

Edge protection angle of size 50x50x6 with lugs shall be provided for all concrete edges, where breakage of edge is expected. Eg: All round the cut-outs/openings in floor slab, STG foundation columns, edges of drains supporting grating covers, edges of RCC cable / pipe trenches / manholes supporting covers and supporting edges of pre-cast covers etc.

5.3.7 ANCHOR BOLTS AND INSERT PLATES

Anchor bolts

Anchor bolts shall be designed for working stresses, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Anchor bolts shall generally not be considered to transfer the shear to pedestal. Shear keys / bars shall be generally considered for transfer of shear. Shear and crushing strength of concrete shall also be checked.

Insert plates

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

5.3.8 VERTICAL HEAD ROOM

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

Finished floors to bottom of beams (buildings)	-	3000 mm
Central Control Room building	-	3200 mm (Min)
Cable vaults	-	2300 mm
Doors, Walkways, Platforms, Stairs etc.	-	2100 mm
Walkway above false ceiling	-	1000 mm
False ceiling of office areas	-	2400 mm



Access for forklift trucks	-	2800 mm
Main roads / railway crossings & crane access	-	8000 mm
Roads and truck access, in case of trestles	-	8000 mm
Cable & Pipe Rack	-	8000 mm at rail / road crossing. 3000 mm at all other places

5.3.9 EXPANSION/CONSTRUCTION JOINTS

Expansion and construction joints shall be provided wherever required. Maximum spacing between Expansion joints in Concrete structures shall be 45m.

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. Preformed Duraboard HD 100 or equivalent shall be used as joint filler.

All expansion and construction joints of the water retaining structures and underground structures in RCC shall be made watertight using PVC ribbed waterstops with central bulb. However, kicker type (externally placed) PVC waterstops may be used for the base slabs and in other areas where it is required to facilitate concreting.

5.3.10 BRICK/STONE MASONRY AND PARAPET WALL

All masonry works shall be designed in accordance with IS: 1905, IS: 2212, IS: 4326, IS: 2185 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 and codal provisions. Fly ash bricks may also be used.

All Masonry walls for buildings shall be raised on plinth beams.

All walls shall be non-load bearing walls. All external and internal walls shall be of at least one brick thick except for internal partition walls for office area, pantry, change rooms, first aid rooms and toilets which may be half brick thick. Half brick & one brick thick walls shall be provided with RCC bands (transoms and mullions) wherever necessary to curtail the unsupported length / width / height of the wall.

Salient points to be considered for masonry work:

- Compressive strength of brick for all external walls shall be at least 75 kg/sq.cm and for all internal walls shall be at least 35 kg/sq.cm, for non-load bearing brick work.
- 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 transoms and mullions shall be provided.
- DPC shall be provided at plinth level before starting masonry work.
- Transoms shall be provided at lintel / door height. The spacing of mullions shall not exceed 2000 mm center to center.

Cut lintels shall be avoided.

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



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

All upstands and parapet walls on roof shall be of RCC / brick masonry. Minimum height of parapet walls shall be 750 mm and thickness 230 mm for brick work and 125 mm for RCC, with aesthetics of architectural design as approved by the Owner.

Brick work

Bricks are to be whole, uniform texture, sound, well burnt, free from cracks, square and well shaped, uniform in size, uniform red cherry or copper colour and shall emit a clear ringing sound when struck. Slight distortion or rounded edges are permitted provided no difficulty arises during laying of uniform course. Water absorption after 24 hours immersion shall not exceed 20% by weight. Dimensional tolerance shall not exceed 8%. Representative samples shall be submitted and approved samples shall be retained by the owner for future comparison.

Whole of the brickwork shall be carried out by the Contractor in a uniform manner. All the bricks shall be kept under water till they are completely soaked and shall be used for the works on their becoming skin dry. The Contractor shall set out and build all brickwork to the dimension, thickness and heights shown on the drawings. The Contractor shall build all brickwork in English bond and half brick walls and casing to pipe, chases etc in stretcher bond. Brickbats shall not be used except where required for bond.

The Contractor shall lay bricks in full mortar beds with shoved joints. The joints are not to exceed 10 mm in thickness and are to be full of mortar, close, well finished and neatly struck. The vertical joints in any course shall not be nearer than quarter of a brick length from those in the course below. All joints shall be of same width except for small variations to maintain bond. The brickwork shall be laid plumb and trim to line and level. No portion of brickwork shall be raised more than 1 metre above another at one time. If the mortar in any course has begun to set, the joints shall be raked out before another course is laid. The top course of brickwork in reinforced concrete framed structure shall be wedged against reinforced concrete surface and joint well filled with mortar. The Contractor shall flush up thoroughly with mortar all joints as the work proceeds. Where brickwork is to receive plaster, the joints shall be raked to a depth of 10 mm to provide proper bond. All half brick walls shall be reinforced with 2 nos. 8 dia bars at every fourth course. All masonry units shall be bonded to concrete and steel columns by galvanized metal wall ties (4mm thick, 50mm wide 200mm long) at the rate of one tie at every fourth course.

The brickwork as it progresses shall be thoroughly watered on its faces and top. New work shall be properly bonded with the old work. The surface of unfinished work shall be cleaned and thoroughly wetted before joining new work to it. Any work in which the mortar perishes shall be dismantled and rebuilt by the Contractor.

The Contractor shall carry out work in as clean a manner as possible and shall remove excess material and mortar droppings daily. Where brick walls are to receive plaster, excess materials and mortar droppings shall be removed and the surface shall be brushed clean. During cleaning operations, adjacent work shall be protected. Any damage resulting from improper protection shall be made good by the Contractor at his own cost.

The brick masonry works shall be cured for a period of fourteen (14) days after laying.

Encasing of structural steel shall be done by building masonry work around flanges, webs etc., and filling the gap between steel and masonry. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Owner. The minimum lap in chicken wire mesh shall be 50 mm. Other steel embeddings shall be generally embedded in mortar and masonry unit shall be cut as required.

**5.3.11 DRAINAGE****5.3.11.1 Floor Drainage**

For all buildings and areas, suitable arrangement for draining out water collected from equipment blow downs, leakage, floor washing, fire fighting etc. shall be provided on each floor. Gully traps, inspection pits, junction pits, collecting pits etc. shall be located suitably and designed considering flow volume, easy access, maintenance and safety. Wherever applicable, floor drainage shall be routed to oil water separator.

All drains inside the building shall have 40 mm thick galvanized grating covers. In areas where heavy equipment loads would be coming, heavy duty precast RCC cover slabs shall be provided including provision of required oil traps wherever necessary, viz., TG bay, mill & boiler, transformer yard, switch yard, coal handling area, etc., in place of steel grating. These drains shall lead the water to drain sump.

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.

5.3.11.2 Roof Drainage

Roof drainage system shall be provided for quick and efficient draining of rain water from roof to avoid seepage and damage to roof. The run off gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rainwater down comers and fixtures. System shall be designed to handle design 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 around the building.

The rain water down comer pipes shall be HDPE pipes of minimum 150mm diameter conforming to IS 4984.

Rainwater collected from roofs shall be let into a rainwater harvesting pit. Rainwater collected from major buildings may be let into raw water reservoir.

5.3.11.3 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.

5.3.12 WATER PROOFING OF UNDERGROUND STRUCTURES

All underground structures like water retaining structures, other deep underground structures, etc., shall have plasticizer cum waterproofing cement additives conforming to IS: 9103. In addition, limits on permeability as given in IS: 2545 shall also be met with. 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 after hydro test. Construction joints of underground structures, where water tightness is required, shall be provided with waterstops. Hydro test for water tightness shall be done at full height as directed by the owner.

The concrete surface of structures in contact with soil shall be provided with water proofing treatment using minimum two coats of bituminous painting of grade 85/25 conforming to IS 702 at 1.7 kg/sqm minimum.

5.3.13 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, as directed by the owner.

**5.3.14 DAMP PROOFING**

Damp proof course in a thickness of 50mm and consisting of cement concrete with admixture of approved water proofing compound shall be provided at plinth level for masonry walls in super structure.

The proportion of cement to aggregates shall be 1:1.5:3 using 6 mm down stone chips with a waterproofing admixture. The percentage of waterproof admixture shall be as per manufacturer's specification but not less than 1% by weight of cement. The brick masonry surface shall be levelled, flushed up and prepared as directed to receive the damp-proof course. In masonry walls of buildings it shall normally be placed above the external ground level. It shall be laid for the full width of the wall. The top surface shall be kept rough or ribbed for proper adhesion of mortar for brickwork coming over it. All exposed surfaces of the damp proof course shall be finished fair and smooth. It shall be cured for at least seven days. After the surface has partially set, it shall be cleaned with brushes and finally with a piece of cloth lightly soaked in kerosene oil. Then hot bitumen (residual petroleum bitumen of penetration 80/100 of approved quality) shall be applied over the prepared surface in two coats at the rate of 1.7kg per sq. meter per coat and dry sand spread over it.

5.3.15 PLINTH PROTECTION

Plinth protection in 100 mm thick PCC shall be provided with 1000 mm wide or the distance between the brick wall to the garland drain. It shall be laid over prepared subgrade and base formed with broken brick bats or rubble to a thickness of 150 mm. Grade of concrete shall as specified in section related to Reinforced Concrete Works.

5.3.16 TOILETS AND BATHROOMS

Minimum one number toilet block each (for Gents and Ladies) with required facilities shall be provided for the following buildings.

Power House Building - Operating Floor and Mezzanine floors in each unit.

Tripper floor in Mill Building – Each unit.

Central Control Room Building – Control Room and Switchgear Floors

Admin Building – All floors

Service Building – All floors

All other buildings with operating / maintenance personnel rooms shall have minimum one toilet each.

One toilet shall be provided in the Boiler-ESP-Chimney area (common for both units).

One toilet shall be provided in Crusher House

Attached toilets shall be provided for all senior executive rooms and conference rooms.

For other buildings which are not listed above, toilet facilities if required in accordance with National Building Code shall be provided. Final requirements shall be as directed by the Owner.

The facilities provided in the toilet block shall depend on the number of users and as directed by the owner. Number of users in each building will be indicated by the owner during detailed engineering stage. However, minimum facilities to be provided shall be as stipulated in subsequent clause. IS: 1172 shall be followed for working out the basic requirements for water supply, drainage and sanitation. In addition, IS: 2064 and 2065 shall also be followed.



Entrance to the toilet block shall be provided with teak wood door with door closer.

Each toilet block shall have the following minimum facilities depending on the number of users as indicated by the Owner. Unless specified all the fittings shall be of chromium plated brass (fancy type).

- i WC (Indian type, Orissa pan (580 x 440mm) as per IS : 2556 with all fittings including flushing system of appropriate capacity and type.
- ii WC western type 390 mm high as per IS:2556 (part 2) with toilet paper roll holder and bibcock and all fittings including, flushing system of appropriate capacity
- iii Urinal with all fittings with photovoltaic control flushing system as per IS: 2556 .
- iv Wash basin (oval shape) with photo-voltaic control fittings as per IS : 2556 to be fixed on concrete platform finished and under fixed with 20mm thick polished granite stone.
- v 25mm dia Stainless steel towel rail (600 x 20mm), with all fittings – one set each for WCs and Wash basins
- vi Stainless steel liquid soap holder cum dispenser – one each for all wash basins
- vii Janitor room
- viii Provision for installation of water cooler with recessed floor and stainless steel grating for draining of spillage water, including provision for potable water supply connection.
- ix Electric operated hand dryer with photo voltaic control
- x Wall to wall Bathroom mirror (6 mm thick float glass) with high square edges including all fittings.
- xi Provisions for ventilation shaft and exhaust fans. Number of exhaust fans shall be decided as per ventilation requirements to maintain hygienic conditions.

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.

Boiler area toilet shall have minimum 2 no. WC (Indian type), 4 no. urinals, 4 no. wash basins, 4 no. mirrors, 4 no. soap holder cum dispenser, 2 no. Showers, towel rails (in WC and Shower), janitor room and a provision for installation of water cooler.

Emergency eye wash cum shower shall be provided in DM Plant, Battery Rooms, Chlorination Plant, Chemical storage areas, etc as per IS 1059 wherever necessary as per statutory requirements.

5.3.17 STATUTORY REQUIREMENTS

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, approval of other relevant statutory authorities shall be taken into consideration at the time of design and construction.

Provisions of safety, health and welfare according to Factories act shall be complied with design stage. These shall include provision of railings, fire escape, locker room for workmen, pantry, toilets, rest room etc.



Adequate number of fire escapes shall be provided in a building. Fireproof doors, number of staircases, 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 & IS: 1642 shall be followed in addition to TAC requirements.

5.3.18 FIRE WALLS

All masonry firewalls shall be minimum 345 mm thick and RCC fire wall shall be minimum 200 mm thick.

5.3.19 PLINTH LEVEL

Plinth levels of all buildings and pump houses shall be minimum 500 mm above the formation level or FGL.

Finished paving level of boiler area and transformer yard paving shall be kept 150 mm lower than the FFL of Power House Building.

5.3.20 BURIED PIPE LINES

- a) Pipe lines may be run along the road.
- b) RCC Culverts shall be built across road.
- c) Low lying marshy lands and ditches, if encountered, shall be suitably filled with approved material, compacted to 90% proctor density on which the sand bedding is laid to support the buried pipeline.
- d) The buried pipes shall be provided with thrust blocks and anchor blocks
- e) Over head cross overs shall be necessary at locations where the pipeline encounters underground water lines or cables, etc.

**SECTION 5.5****REINFORCED CONCRETE STRUCTURES AND FOUNDATIONS****TABLE OF CONTENTS**

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5.5.1 GENERAL

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

5.5.2 DESIGN METHODOLOGY

5.5.2.1 General RC Structures

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.

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

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

5.5.2.2 Foundations and Underground Structures

Foundations for structures and equipment shall be proportioned to resist the worst conditions of loading and shall be generally designed as per the provisions of IS:1904. The depth of foundation shall be determined based on loading on foundation, safe bearing capacity at the founding level, constructional and technological requirements. The allowable bearing pressure for design of foundation shall correspond to values confirmed by results of detailed soil investigation taking into account limits of allowable settlement considered for design of structures and equipment. Safe bearing capacity shall be determined from shear failure and settlement criteria and least value shall be considered.

The foundations shall be designed for the following factors of safety:-

- | | | | |
|----|-------------------------|---|-----|
| a) | Shallow foundations | : | 3.0 |
| b) | Deep foundation systems | : | 2.5 |

For this purpose, any foundation depth of more than 4.0 metres shall be treated as a deep foundation.

Foundation system adopted shall ensure that settlement / relative settlement is as per provision of IS: 1904 and other Indian Standards.

Maximum settlement for, (as per Table 1 of IS: 1904)

- | | | | |
|----|-------------------|---|-------|
| a) | Isolated footings | : | 25 mm |
| b) | Rafts | : | 40 mm |

However, the settlement shall be restricted to a lower value, if necessary as per the system requirement.

Settlement criteria for shallow foundations shall be generally as follows, subject to specific equipment requirement & differential settlement.



- i) Total settlement : 38 mm
- ii) Differential settlement : 6 mm

Static, dynamic and integrity tests shall be performed by an independent testing analyst.

All foundations including machine/equipment foundations shall be of RCC construction. All foundations shall be designed in accordance with relevant parts of IS: 2974 and IS: 456 as per working stress / limit state method of design. Raft foundation shall be designed as per IS: 2950

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.

In case of isolated foundations, partial contact between foundation and soil strata shall be considered wherever applicable and footings shall be checked for minimum contact area (90%) and maximum bearing pressure. Foundations shall be checked for safety against sliding and overturning.

No foundation shall rest on filled up soil. Minimum depth of foundation shall be at least 1.5m below virgin soil. CNS (cohesive non swelling) soil shall be used for foundations on shallow depth.

For all underground structures such as basement, sump etc., and water retaining structures special care shall be taken to water proof them. Approved integral water proofing compound shall be added to concrete mix to ensure water tightness. PVC waterstop shall be provided at all construction joints as required. Water retaining structures shall be hydro-tested as per IS:3370 for leakage and in case leakage is noticed pressure grouting or any other approved procedure shall be adopted to rectify it. Sumps with pumping arrangements shall be provided at suitable location in underground structures to collect and pump out any incidental water collection to nearest storm water drainage outlet.

Generally foundation for buildings & equipment shall not be structurally connected to ground floor slab. The top level of the stem for building structural column foundations shall be so provided that no part of the steel column base assembly protrudes over finished floor level. The column base assemblies shall be encased with M-15 grade concrete up to floor level.

Supporting structures and foundations for equipment that may cause vibration shall be designed for the dynamic effect of equipment together with the direct loads. The dynamic loads and other relevant data required for analyzing the dynamic effect shall be taken as per manufacturers' data and recommendations.

Foundations of equipment subjected to dynamic loading shall be isolated from adjoining floors/foundations to prevent propagation of vibration to adjoining structures. Structures and foundations supporting vibrating, equipment shall be proportioned to avoid resonant frequencies. The dynamic analysis shall be done as per the stipulations as recommended by respective IS codes as well as the stipulations recommended by equipment manufacturer.

75mm thick lean concrete 1:4:8 shall be provided below footings, pile caps, base slab etc. as blinding concrete layer.

Pile Foundations

The detailed design, preparation of construction drawings, installation and testing of piles forming foundations to buildings and structures shall conform to the latest IS:2911 – Code of Practice for Design and Construction of Pile Foundations.



The Contractor shall be responsible for all aspects of the pile performance installed including demonstration of the adequacy of his design by testing. During detailed design the Contractor shall submit the proposed firm to undertake piling work with details piling system; method of installation; summary of design basis; number, type and size of construction plant items to be employed for the work including crane, piling equipment; concreting equipment and proposal for installation & testing of trial piles and tests on work piles.

5.5.2.3 Liquid Retaining Structures

Water retaining structures shall be designed as per provisions of IS 3370 and IS 456 by working stress method.

In case of leakage in the above structures injection grouting method shall be applied to repair the structure according to the requirement of IS: 6494.

All water retaining / storage structures shall be designed assuming liquid up to the full height of wall irrespective of provision of any over flow arrangement.

Pressure relief valves with 50% uplift load can be permitted in the following underground structures

- a) Cooling Water Fore bay
- b) Cooling Water Channel

Pressure relief valves shall be of gun metal.

Approved water proofing compound shall be used for addition in concrete to all liquid retaining structures.

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.

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 empty condition ignoring super imposed loads.

5.5.2.4 Machine Foundations

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

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

Dynamic analysis shall be carried out for all major vibratory equipment foundations where manufacturer supplies the complete dynamic loading data along with limitation on design criteria. All block foundations resting on soil shall be designed using the elastic half space theory or Barken's theory. Block foundation resting on piles shall be designed using Novak's or Barken's theory.

The mass ratio for centrifugal machine shall be 3 and for reciprocating machine ratio shall be 5. The CG of the combined mass of foundation and equipment should pass through the CG of the base area with tolerance not more than 5%.



Dynamic analysis shall be carried out to calculate natural frequencies in all the modes including coupled modes and to calculate vibration amplitudes. Frequency and amplitude criteria as laid down by the relevant codes and / or machine manufacturers shall be satisfied.

Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

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

Steam turbine generators, Boilers Feed Pumps and crushers may be supported on vibration isolation system. The vibration isolation system shall consist of helical spring units and viscous dampers supporting the RCC inertia block 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. Requirement of vibration isolation system shall be decided based on the requirement specified by the equipment supplier.

For design of inertia block of fan foundations, mill foundations, same criteria as specified above shall be followed except that the analysis can be based either on a plate model / Three dimensional solid finite element model. Dynamic analysis shall be performed, frequency and amplitudes shall be checked as per code / manufacturer requirements. The permissible amplitude of vibration shall be as specified by the manufacturer guidelines. It shall be ensured that not more than 5% of the dynamic loads are transmitted to the substructure. Necessary provisions of DIN 4024 shall be adhered to while designing the substructure. Substructure shall be designed for static loads.

All such foundations 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.

For inertia blocks above vibration isolation system for dynamic foundations shall use concrete of minimum of grade M30.

The foundation systems for rotating equipment shall be sized and proportioned not to exceed the bearing and settlement criteria and to assure satisfactory performance of the equipment. In addition to a static analysis, a dynamic analysis shall be performed to determine the fundamental frequencies of the foundation system. To preclude resonance, the fundamental frequency of the foundation shall be 25 percent away from the operational frequency of the equipment. The dynamic behavior of the foundation shall meet the requirements of IS: 2974 (Part I to IV).

If minor equipments are to be supported on building structures, floors etc suitable vibration isolation shall be provided.

5.5.2.5 Tank Foundations

Foundations for vertical steel tanks shall be resting on hydraulically compacted clear river sand, in layers of 500 mm thickness topped with 150 thk PCC. PCC layer shall be topped with 50 thk. Anti-corrosive asphalt layer, which in turn is topped with 50 thk. Premix carpet. The entire sand fill along with toppings shall be confined within a RCC ring beam of appropriate design.

5.5.3 STABILITY OF STRUCTURES

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.

All building and 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 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.

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.

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.

5.5.4 MINIMUM THICKNESS OF STRUCTURAL ELEMENTS

The following minimum thickness shall be followed :

- a. Suspended floor slab / roof slab / walkways / canopy slabs etc. - 125 mm
- b. Ground floor slab (non — suspended)
 - Plant buildings - 200 mm
 - Non — Plant buildings - 150 mm
- c. Water Retaining Slab / Walls - 200 mm
- d. Cable / Pipe Trenches / Underground pit / Launder walls and base slab - 125 mm
- e. All footings (including raft foundations) - 300 mm
- f. Tapered footings - 200 mm (Min. at edges)
- g. Parapets / Chajjas - 125 mm
- h. Sunshades - 75 mm at edge
- i. Precast louvers / fins - 50 mm
- j. Precast trench cover slabs / floor slabs/ louvers - 75 mm
- k. Paving - 100 mm
- l. Pile cap - 500 mm



- | | | | |
|----|------------------------------|---|--------|
| m. | Basement walls and base slab | - | 200 mm |
| n. | Silo / bin walls | - | 150 mm |
| o. | Underground reservoir | | |
| | Below ground water table | - | 200 mm |
| | Above ground water table | - | 150 mm |

From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig 1 of IS 456. Minimum fire rating of 2 hours shall be considered where fire hazard is expected.

5.5.5 MINIMUM HEIGHTS FOR PEDESTALS OF STEEL COLUMNS

Pedestals to Steel columns for building structures

Top of RCC pedestals for structural steel columns 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 of some columns shall be changed suitable to accommodate underground services, pits trenches, etc.

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

Top of Pedestals to Steel Columns for Equipment structure and Pipe Racks:

- | | | | |
|----|---|---|--|
| a. | Equipment in open area | - | as required (500 mm min.) above FFL |
| b. | Equipment in covered area | - | as required (150 mm min.) above FFL |
| c. | Structures / equipment supplied by Vendor | - | as per vendor's data subject to vendor's minimum or as specified above |
| d. | Coal Handling Area | - | 500 mm above finished ground level |
| e. | Ash Handling Area | - | 500 mm above finished ground level |
| f. | Pipe and Cable Rack | - | 500 mm above finished ground level |

Anchor bolts shall be provided in pedestals for fixing of structures subject to uplift forces. Such pedestals shall be checked for uplift with 50% soil overburden and 0.9 times dead loads.

5.5.6 MINIMUM HEIGHTS FOR ENCASEMENT OF STEEL COLUMNS

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

- | | | | |
|----|----------------------------|---|---|
| a. | Open area | - | 300 mm above paved level |
| b. | Covered sheds | - | 150 mm above the finish floor level |
| c. | Structural steel buildings | - | 1000 mm above the finish floor level |
| d. | Boiler columns | - | upto a height of 8.0m from paved level. |



5.5.7 CONCRETE MIX

The following minimum grades of concrete as per IS: 456 shall generally be used for the type of structures noted against each grade. 53-grade Ordinary Portland Cement (OPC) conforming to IS: 12269, fly ash based Portland Pozzolona cement as per IS: 1489(Part-I) or 43-grade ordinary Portland Cement as per IS: 8112 shall be used. For aggressive/saline soil approved cement shall be used. Sulphate resistant cement shall conform to IS: 12330.

Mix (1 : 4 : 8)	-	Fill concrete Foundation below brick wall Blinding layer below foundations, pile caps, grade slabs, Trenches and underground structures, etc. (Minimum thickness of the layer shall be 75 mm)
Grade M15		Base plate encasement Encasement of structural steel work Screed concrete
Grade M20	-	Ground floor PCC slabs Grade level paving Pavement around building including plinth protection work
Grade M25	-	All RCC drains
Grade M30	-	All RCC members including Foundations Superstructure Grade beams Pedestals Ground floor slabs Roof slabs Water retaining structures Pile and Pile Cap Cable and pipe trenches including precast covers
Grade M35	-	For Coal Mill Foundations
Grade M35	-	For foundation of STG, BFP, PA Fan, FD Fan, ID Fan etc.,

Intermixing of different grades of concrete in the same structure shall not be allowed in a particular structural element.

Minimum cement content shall be governed by the requirement of IS: 456 for normal concrete structures and IS: 2911 for piles.

However higher grade of concrete shall also be used than the minimum specified above to satisfy the design requirement for TG foundations, BFP foundations, under ground structures, etc.

The Minimum Cement content and water cement ratios shall be as per the concrete mix design report subject to a minimum cement and maximum water cement ratio (as per IS: 456) for Concrete grades as follows:-

M15	:	240 kg/m ³ & 0.6
M20	:	300 kg/m ³ & 0.55
M25	:	300 kg/m ³ & 0.50



M30	:	320 kg/m ³ & 0.45
M35	:	340 kg/m ³ & 0.45
For Piles	:	400 kg/m ³ & 0.45

For water retaining structures the minimum w/c ration shall be 0.45

Unless specified 20mm and downgraded aggregates shall be used for all structural concrete works. However 40mm and downgraded aggregates may also be used under special conditions for foundation. 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).

5.5.8 REINFORCEMENTS

High strength deformed steel shall be used for all RCC structures. The grade of reinforcing steel shall be Fe500 or Fe415.

All reinforcement shall be of CRS (Corrosion Resistant Steel) bars conforming to the requirements of IS 1786 and shall be used for all RC structures unless specified else where.

Reinforcement bars shall be as per the following codes:

High Yield Strength Deformed bars	-	IS: 1786
Mild steel bars	-	IS: 432 Grade 1
Welded wire fabric	-	IS: 1566

Inter mixing of different grade of reinforcing bars in the same structure shall not be done.

Reinforcement detailing shall be as per IS: 5525 and SP 34.

Minimum percentage of reinforcement shall be as per relevant applicable standards.

Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more.

Projecting reinforcement or dowel bars for future connection of the structural works shall be protected by cement paint, if they are to be left exposed for a long time

5.5.9 GROUTING

Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticizer 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.

Ready mix grout with Shrink-comp or Conbextra GP2 or equivalent shall be used for base plate grouting works for all major equipments.



Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M35 for equipment foundations and M40 for dynamic equipment foundations.

Nominal thickness of grouting shall be at least 50 mm for building columns and pedestals of major equipments or as specified by the equipment supplier.

For pipe rack pedestals, secondary posts, stair and ladder base etc. grouting shall not be less than 25 mm thick.

Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.

Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water. Water in anchor bolt holes shall be removed before grouting is started.

Forms around base plates shall be reasonably tight to prevent leakage of the grout. Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release entrapped air link chains can be used to work the grout into place.

Grouting through holes in base plates shall be by pressure grouting.

Forms and shims used to obtain adequate clearance shall not be removed and the anchor bolts shall not be tightened for at least three days after placing the grout. After the removal of forms and shims, area occupied by shims shall be filled and the area between the base and edge of the foundation shall be finished smooth to allow drainage away from the base. Attachment of interconnecting piping of machinery and complete load transfer of machinery shall not be done before the bolts are tightened.

5.5.10 MINIMUM COVER TO FOUNDATION BOLTS

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

- a. Clear distance from the edge of the base plate / base frame 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 the pedestal shall be 75 mm.
- c. Clear distance from the edge of the sleeve or anchor plate to the edge of pedestal shall be 75 mm.

5.5.11 MINIMUM COVER TO REINFORCEMENT

The clear cover to reinforcement shall be for 2 hours fire rating as per table 16A of IS: 456 and also meet the requirement of durability requirements based on exposure conditions as per table 16, which ever is stringent.



The minimum cover to the main reinforcement for all the structures, unless otherwise specified, shall be as follows :

Slabs (roof and floors, canopies, chajjas, waist : 15 mm or dia of bar whichever is more slab in stair etc.)

Beams, Lintels : 25 mm or dia of bar whichever is more

Columns : 40 mm

Pedestals : 50 mm

Dry pits / retaining walls

i. Face in contact with earth : 50 mm

ii. Free face : 40 mm

Water / Liquid retaining structures

i. Face in contact with liquid : 40 mm

ii. Away from liquid but in contact with earth : 50 mm

iii. Base raft, pile caps : 75 mm

Footing

i. Sides and top : 50 mm

ii. Bottom : 50 mm

iii. Piles : 75 mm

5.5.12 MISCELLANEOUS REQUIREMENT

5.5.12.1 Formwork Requirements

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.

No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement.

In watertight construction, methods of fixing formwork, which result in holes through the concrete section when the formwork is removed, shall not be used. All wall ties shall have water baffles and wall kickers shall be cast monolithically with the base slab.

Approval for the size, type and position of any holes, insert or fixing required by Contractor shall be obtained before work proceeds. Unless otherwise specified or approved all holes shall be formed and all inserts cast in at the time of pouring. No part of the concrete works shall be drilled or cut away without approval.

Formwork panels shall be stiff enough to prevent damage to the concrete surface caused by excessive movements of the panel during vibration of the concrete.



Damaged and used formwork shall not be re used without repairing.

All joints in form work and joints between the form works shall be sufficiently tight to prevent loss of liquid from the concrete through these joints.

The part of the ties shall be capable of being removed, so that no part remaining embedded in the concrete shall be nearer the surface of the concrete than the specified thickness of cover to the reinforcement. Holes left after the removal of ties shall be filled with concrete or mortar of approved composition.

Formwork props shall be positioned between permanent supports so that all members are supported at not more than 3 meters centre in both directions.

The props shall be in the form of space frames, composite or single members with sufficient stiffness or bracing so that props shall neither sway nor buckle under loads which they are designed to carry.

The formwork or the false work shall not be removed from a structural component until CONTRACTOR ensure that the concrete has attained sufficient strength.

The concrete is to be regarded as sufficiently hardened when the component has attained such strength that it can resist all loads acting at the time of removal of the formwork.

Particular care shall be taken with components which have to carry virtually the full design load directly upon removal of the false work (e.g. in the case of roofs, or floor slabs which have to support loading from floors above them which have not yet hardened).

Props shall remain in position for as long a period as possible, particularly for structural components, which are subjected to a major proportion of their design loading as soon as the formwork has been removed.

No superimposed load shall be allowed on any part of the concrete work prior to the removal of the forms and props.

Tolerance for formed and concrete dimension shall be as per IS:456.

5.5.12.2 Placing of concrete

Before each concreting CONTRACTOR shall give sufficient notice to the Owner as directed such that an inspection shall be made before the concreting.

The concrete shall be mixed in the mixer of adequate capacity having a power elevated loading hopper. The mixer shall be equipped with an automatic water-measuring tank filled with a device for locking the discharge setting. The Mixing shall continue until there is a uniform distribution of the materials and the mass is uniform in colour and consistency.

Any concrete surplus to immediate requirements shall be thrown away. In no case circumstances may the surplus be used later.

The volume of mixed materials in each batch shall comply with the mixer manufacturer's written recommendations.

Concrete shall be transported as quickly as possible from the mixer to its final position without segregation or loss of any of the ingredients.

All equipment to be used for transporting material shall be kept clean; all containers used for transporting concrete shall be thoroughly washed out whenever mixing ceases.



Concrete shall be placed continuously up to construction joints while it is still sufficiently plastic for adequate compaction.

At all times when reinforced concrete is being placed a competent steel fitter shall be in continuous attendance. CONTRACTOR shall adjust and correct the position of any reinforcement, which may be displaced.

CONTRACTOR shall keep on site a complete record of the works showing the time and date when concrete is placed in each part of the work.

Concrete shall be thoroughly compacted by suitable mechanical vibrators during placing and shall be carefully worked around all reinforcement and embedded fixtures and in to the side and corners of the formwork.

Whenever, concrete is being vibrated at least one spare vibrator of each type in use shall be available in case of breakdown.

Compaction shall start as soon as there is sufficient concrete within the formwork to immerse the vibrator and vibration shall continue during the placing operation so that at no time shall there be a large volume of uncompacted concrete in the form work.

For top surfaces of slab and other surfaces for which formwork is not provided a smooth finish shall be provided with a wooden float after compaction.

The concrete shall not be placed directly against a vertical form face but shall be placed to flow to this surface during the compaction process. Care shall be taken to avoid the form face being splashed with mortar during the placing operation.

Exposed surfaces, immediately after final set, shall be protected from the sun. All concrete shall be well watered after it has been set and shall be kept continuously damp until thoroughly cured. Provision shall be made for adequate water distribution to all parts of the work so that if required this treatment can be continued sufficiently throughout the whole period of construction. In order to keep the concrete continuously damp, all exposed surface shall be covered with continuously damped gunny bags or shall have water compounded on them, for full period of curing.

On exposed concrete surfaces in high sun temperatures and /or strong drying wind conditions CONTRACTOR shall use curing method, which also shields the concrete, and this shall be placed in position not later than half an hour after final tamping.

Base mat and top deck of machine Foundations shall be cast in a single pour in addition to the requirement specified above.

5.5.12.3 Temperature Control of Concrete

The placing temperature of fresh concrete shall not exceed 23 deg.C. For maintaining the temperature of 23 deg. C during concreting of machine foundations, crushed ice shall be used in mixing water.

5.5.12.4 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.



5.5.12.5 Testing of concrete in structures

The types of tests described hereinafter are applicable to the finished parts of the structures.

They may be used in routine inspection and for quality control.

Type of tests:

- a) Cutting cores: The procedure used shall comply with the requirements of IS:516 or an approved equivalent standard.
- b) Gamma radiography: The testing shall be carried out in accordance with the requirement of IS:13311 Part 1 or equivalent.
- c) Ultrasonic test: Such tests may be used to obtain approximate indications of the strength of the concrete in the structures (IS:13311 Part 1).
- d) Electromagnetic cover measuring devices: Such tests may be used to verify the position of the reinforcement and shall be in accordance with the requirements of design (IS:13311 Part 1).
- e) Rebound hammer test: Such tests may be used to obtain approximate indications of the strength of the concrete (Ref. IS:13311, Part 2).
- f) Load tests of structures or parts of structures: If the results of the above mentioned check tests show that the quality of the materials is inadequate or if other defects are revealed, the Owner may require a loading test to be made.

For the purpose of testing floors, roofs and similar structures and their supports, the test load shall be equivalent to the sum of the characteristic dead load and one-and-a quarter times (1.25 times) the characteristic imposed load for a period of 24 hours which the works or part thereof to be tested have been designed.

Wherever certain procedures for testing of parts in structures (e.g. piles) are required by standards or codes of practice, these are to be followed. All tests must be conducted in the presence of the Owner.

If within 24 hours of removal of the imposed load, the structure does not recover at least 75% of the deflection under superimposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80%, the structure shall be deemed to be unacceptable.

If the result of the test is not satisfactory, the Owner shall instruct that the part of the works concerned be taken down or cut and reconstructed to comply with this specification. The contractor shall at his own cost take down or cut out and reconstruct the defective work.

The Owner may require other tests to be carried out. Number of samples, tests and types will be as per Owner requirements.

All the costs for the above mentioned tests shall be borne by the contractor

Ultrasonic pulse velocity test shall be carried out for the top decks and columns 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.

**5.5.12.6 Other Requirements**

Haunches and Fillets at the junction of roof / bottom slab with vertical walls shall be provided with cast in situ cement concrete.

A screed layer not less than 100 mm thick of cast in situ concrete 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.

5.5.13 CORROSION PROTECTION OF CONCRETE STRUCTURES**5.5.13.1 Admixture**

Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA) shall be used. CPCIA shall be free from nitrites, chromates and non-migrating types and having 7-8 years of usage history in Indian conditions conforming to ASTM-G-109 with an efficiency factor of minimum 25 times. Dosage as per manufacturer specifications shall be compatible with the type of cement used.

5.5.13.2 Concrete Surface Treatment

Two coats of tar extended moisture compatible coating with a DFT of 300-350 microns. The system shall have minimum 7 years successful usage history in Indian conditions with the following properties

- Salt spray test ASTM-B-117 : Pass 1000 hours min
- Adhesion ASTM-D-4541 : 3.8 N/mm² min
- Resistance (Impedance) : 10⁸ Ohms

5.5.14 PROTECTION OF CONCRETE STRUCTURES IN CONTACT WITH SEA WATER

All concrete surfaces in direct contact with sea water shall be applied with tar extended two component coating system.

High Performance Moisture Compatible Corrosion Resistant Coating System shall be as per technical specifications of Central Electrochemical Research Institute, Karaikudi (CSRI affiliate institute), Tamilnadu, PIN-630006.

The coating system shall be water compatible, compatible for applying in wet conditions also and shall be tolerant to under-prepared surfaces and existing tar / paint. The system shall also be quick curing so as to be suitable for application during shut downs.

The coating material shall be stored in the manner as per recommendations of the manufacturer until ready for use. The coating material shall be used within the manufacturer's written recommended shelf life.

The coating system shall confirm to the following:

Properties of Paint

Base	High Performance Moisture Compatible Corrosion Resistant Coating System CECRI know-how system
Volume Solids	70 %



Specific Gravity (ASTM-D-1475)	1.25 \pm 0.1
Dry Film Thickness (ASTM-D-1186)	160 \pm 10 μ m per coat
Coverage	4 – 4.5 sq.m per litre
Touch Dry	2 Hours
Recoating	24 Hours

Properties of Coating

Salt Spray (ASTM-B-115)	2000 Hours
Resistance to sea water (carried out upto 6 months)	Passes
Coating Resistance (carried out upto 6 months)	10 ⁹ Ω cm ²
Adhesion (ASTM-D-4541)	4.5 Kn minimum
Flexibility (ASTM-3363)	1/8 " passes
Elongation	33 %
Impact (ASTM-G-14-04)	45 cm passes

Paint material and its application method shall be obtained from any manufacturer who has been granted license by CECRI, Karaikudi for technical know-how for High Performance Moisture Compatible Corrosion Resistant Coating System.

The application method of coating shall be got duly approved by CECRI, Karaikudi.

5.5.15 STRUCTURES IN COAL HANDLING PLANT AREA

The Contractor shall have to consider the following design criteria during design of structures in CHP area in addition to other design parameter mentioned elsewhere in this specification.

1. All underground R.C. basement like structures with provision of water proofing treatment (excluding structures under influence of Railway Load) including Tunnels subjected to subsoil/liquid pressure shall be designed as per IS-456.
2. All structures under the influence of Railway load with provision of water proofing treatment shall be designed strictly in accordance with stipulations contained in Indian Railways Bridge Rules and relevant codes considering stress in concrete governing. However, check for shear strength at certain critical section shall have to be done as per IS-456 as decided by the Owner. Impact factor for Railway loads shall be 0.4 times the wheel loads for movement of the same.
3. The underground walls/raft of basement/tunnel shall be designed adopting sound engineering practice. The minimum thickness of various components shall be as follows irrespective of method of design adopted:
 - a) Walls of depth from 0 — 5 M : 300 mm
 - b) Walls of depth from 5 — 10M : 500 mm



- c) Walls of depth from 10 — 15 M : 700 mm
 - d) Base Slab of u/g basement : 500 mm
 - e) Roof of tunnel : 500 mm
4. Dispersion of loads (arising out either of Railway load, Dozer load surcharge or any other load) through soil and coal shall be considered 7 vertical: 1 horizontal or 1 vertical: 1 horizontal whichever is critical.
5. Factor of safety of foundation/structure during and after construction shall be as under:
- a) Sliding and over turning as per 15-456 and 1S-1094
 - b) Minimum FOS shall be 1.20 considering dead weight of structures as 0.9 times the actual value.
 - c) Uplift of shallow foundations due to tension in building column Minimum FOS shall be 2.0
6. For design purpose the ground water table shall be considered upto finished grade level.
7. For design of R.C. structures. Bulk density and angle of repose for coal shall be considered as 1.2 MT/Cu.M and 31 Deg. Respectively.
8. For deep underground structures, minimum clear cover for outer reinforcement shall be 40 mm unless otherwise stated.
9. All hoppers shall be designed under the following load conditions:
- e) The hopper is full upto it's full capacity with top surface horizontal at grating level.
 - f) The hopper IS partially empty with the highest level of coal at grating level and making an Angle of 37 Deg. With horizontal.

The above conditions are to be analysed for the case where the whole content of coal within the hopper is supported by the hopper only without taking support from paddle feeder platform (in case of Track Hoppers) The hopper shall also be designed for lateral coal pressure, frictional forces during filling and emptying and forces due to impact and falling of arches of coal within the hopper etc.

The Reclaim Hoppers additional loads due to bulldozer or coal pile upto 4.0 M height or a critical combination of the above two loads shall be considered.

10. In addition to dead load, live load, wind/seismic loads, all steel structures specially conveyor galleries and trestles shall be designed for thermal loads for a difference of temperature of 40 Deg.C.
11. The crusher foundation shall be of R.C.C. analysed both for static and dynamic load conditions as per IS-2974. The top deck shall be minimum 1.0 M thick. The amplitude of vibration under normal running condition shall not exceed 100 Micron and under 2 (two) missing hammer condition or severe maintenance condition (whichever is critical) shall be limited to 200 Micron. Three Dimensional (3D) method of analysis shall also be adopted for calculating frequency and amplitudes in addition to plane frame method. The Crusher Foundation may also be supported on suitable heavy duty vibration isolators having viscous dampers supported on building steel frame. The top R.C.C. deck in such case also shall not be less than 1.0 M.



5.5.16 CONSTRUCTION REQUIREMENTS

5.5.16.1 Standards

Unless otherwise specified, the following standards shall apply to the works covered under this chapter.

Cement

IS:269 33 grade ordinary Portland cement.
IS:455 Portland slag cement.
IS:1489(Part-1) Portland pozzolana cement – Fly ash based.
IS:4032 Method of chemical analysis of hydraulic cement.
IS:6452 High alumina cement for structural use.
IS:8041 Rapid hardening hardening portland cement.
IS:8112 43 grade ordinary Portland cement.
IS:12269 53 grade ordinary Portland cement.
IS: 12330 Sulphate resisting Portland cement.

Aggregate

IS:383 Coarse and fine aggregates from natural sources for concrete.
IS:460 Test sieves (All parts).
IS:2386 Methods of test for aggregates for concrete (All parts).
IS:2430 Methods of sampling of aggregates for concrete.

Concrete Plain and Reinforced

IS:456 Code of practice for plain and reinforced concrete.
IS:516 Method of test for strength of concrete.
IS:737 Wrought aluminium and aluminium alloy sheet and strips for general engineering purposes.
IS:1199 Methods of sampling and analysis of concrete.
IS:1607 Methods for test sieving.
IS:1834 Hot applied sealing compounds for joints in concrete.
IS:1838(Part-1) Preformed fillers for expansion joint in concrete pavements and structures (non extruding & resilient type)– Bitumen impregnated fibre.
IS:1893 Criteria for earthquake resistant design of structures.
IS:2645 Integral cement water proofing compounds.
IS:2750 Steel scaffolding.
IS:2974 Code of practice for design and construction of machine foundations (All parts).
IS:3370 Code of practice for concrete structures for the storage of liquids (All parts).
IS:4326 Earthquake resistant design and construction of buildings — code of practice.
IS:6494 Code of practice for water proofing of underground water reservoirs & swimming pools.
IS:9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
IS:9103 Admixtures for concrete.
IS:9893 Precast concrete blocks for lintels and sills.
IS:10262 Recommended guidelines for concrete mix design.
IS:10297 Code of practice for design and construction of floors / roofs using pre-cast reinforced / pre-stressed concrete ribbed or cored slab units.
IS:10566 Methods of tests for preformed fillers for expansion joints in concrete paving and structural construction.
IS:10790 Methods of sampling of steel for prestressed and reinforced concrete (All parts).
IS:12118 Two parts polysulphide based sealants (All parts).



IS:13920 Ductile detailing of reinforced concrete structures subjected to seismic forces – code of practice.
SP:23 Handbook on concrete mixes.
BS:5606 Guide to accuracy in buildings.
ACI:347 Recommended practice for concrete formwork.

Reinforcing Steel

IS:432(Part 1) Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement.
IS:1566 Hard-drawn steel wire fabric for concrete reinforcement.
IS:1568 Wire cloth for general purposes.
IS:1786 High strength deformed steel bars and wires for concrete reinforcement.
IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.
IS:2751 Recommended practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
IS:5525 Recommendations for detailing of reinforcement in reinforced concrete works.
IS:9417 Recommendations for welding cold worked bars for reinforced concrete constructions.
SP:34 Handbook of concrete reinforcement and detailing.

5.5.16.2 Materials

The materials described below shall be specified and used.

Aggregates

Fine aggregates shall be clean natural sand. Coarse aggregates shall be crushed rock. All aggregates shall meet the IS requirements of IS:383.

Admixtures

Plasticizers and retarders shall be used to control setting time and to obtain optimum workability. Interior slabs to be trowel finished shall use less air entrainment. The use of calcium chloride shall not be permitted.

Water

Clean water of potable quality shall be used in all concrete mixes.

5.5.16.3 Storage of Materials

All materials shall be stored and handled in a manner that will prevent contamination and/or deterioration. Storage of materials shall conform to IS-4082 "Recommendation on stacking and storage of construction materials and components at site". Deteriorated and/or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the contractor.

5.5.16.4 Sampling and testing of cement

All deliveries of cement to the concrete supplier shall be accompanied by a certified mill test report and shall include all of the physical and chemical properties as required by relevant IS-12269 for grade 53 cement, IS-8112 for grade 43 and IS-12330 for sulphate resistant cement.

The manufacturer's test certificate will normally be accepted as proof of compliance with the specification, but the Owner may order further tests of a character specified in the appropriate Indian standards. The confirmatory tests are to be conducted by a recognized quality control



organization. The contractor shall bear all expenses required for the preparation, dispatch, and tests of the samples. In case the results of such tests show any sample to be inferior to specifications, the whole consignment from which the sample was taken shall not be used and shall be immediately removed from the site.

5.5.16.5 Delivery and storage of cement

The following information shall be provided for all cement shipments (either whole or part) which are intended for delivery to site: date of manufacture, date of original loading, destinations en-route, date of unloading, intended date of delivery to site.

Cement which has been manufactured for longer than 6 months on the proposed date of delivery to the site shall be inspected, sampled and tested for approval purposes before delivery to the site.

The contractor shall obtain and provide to the Owner the manufacturer's Bulk Average Test Certificate for each consignment of cement to the works. The certificates shall be provided before the consignments are required for use and shall show the chemical composition and physical properties determined in accordance with the relevant standard.

Samples shall be taken from each consignment of cement and tested as directed by the Owner in an approved independent laboratory.

When bulk cement deliveries are proposed, the contractor shall provide all information required by the Owner concerning off-site storage and loading arrangements and shall provide reasonable facilities for the Owner to inspect these arrangements for approval purposes.

Consignments shall be used in the order in which they were delivered.

All bagged cement shall be stored in a weatherproof building having dense impervious bituminous or concrete floors which shall be kept swept clean at all times. The storage arrangements shall be fully completed and approved by the Owner before any cement is delivered to site.

Each consignment of cement shall be separately stored for ease of access, identification, inspection and sampling. Sufficient stocks shall be maintained on site to ensure the proper progress of the works and the stock holdings shall be to the approval of the Owner.

If bagged cement is stored in silos it shall be charged into the silos through at 6.3 mm mesh screen which is welded or bolted to and covers the entire feed area of the silo charging hopper.

Cement stored in silos shall be adequately protected against rain, humidity and dewfall, and all silo charging and discharging points shall be properly sealed. Silo aeration equipment shall if available, incorporate de-humidifiers.

No cement from any consignment shall be used in permanent works without the approval of the Owner.

Cement which contains air-set or hardened lumps, re-powdered air-set material, foreign matter or which has been contaminated or is otherwise unsatisfactory in the opinion of the Owner will be rejected and shall be removed from site without delay.

The contractor shall be responsible for satisfying himself that the performance characteristics of cement are not such as to necessitate excessive cement content or be likely to cause or accentuate any undesirable properties in the fresh or hardened concrete notwithstanding apparent compliance with this specification.



Bulk cement shall be used for structures, bagged cement shall be used for masonry, plaster etc.

5.5.16.6 Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The quality of water shall meet the requirements as per IS 456.

Ph value of water shall not be less than 6.

The concrete supplier shall provide chemical and physical test data for each source of water to be used prior to use.

When water is transported in tank trucks, each unit shall be accompanied by a chemical test report indicating compliance with the above requirements. All water to be analysed by an independent laboratory before any work commences and at intervals as direct by the Owner tests and quality of water shall be in accordance with IS:456 or equivalent.

The contractor shall make his own arrangement for water for construction and other purposes.

5.5.16.7 Aggregates

The aggregates for concrete shall be crushed natural rock subject to Owner's approval. The aggregate to be used in the work shall be supplied from an established pit or quarry. The aggregate source shall have a minimum five (5) years history of satisfactory performance in structural concrete and consistency of supply.

The concrete supplier shall obtain from the aggregate producer, or otherwise provide current test, examination, inspection reports performed and certified by an approved laboratory for submittal to the Owner.

As a minimum, this information shall include the following items:-

- Item 1 A comprehensive description, with current photographs of the pit or quarry, including but not limited to, identification by name and location, type of deposit, age, potential reserves, primary products by size including average gradation based on previous six (6) months production and the range for each sieve size; mining methods, process equipment, quality control organization and laboratory; the primary and alternate means of product transportation; listing of primary and secondary users of the product.
- Item 2 Petrographic examination in accordance with IS:2386 (Part-8) performed by a qualified concrete aggregate petrographer. This report shall be based on material produced and examined within the previous six (6) months and must be representative of the current production.
- Item 3 Coarse aggregate shall be sampled from current production in accordance with IS:2386 (Part 1 to 8). Three [20 mm, 10 mm & 5 mm] nominal maximum size (NMS) aggregates shall be sampled and tested.

Aggregates when subjected to the tests defined in items above, unless otherwise approved by the Owner shall meet the requirements of IS:383 and IS:456.



Testing is to be carried out at the following intervals:

Type	Coarse Agg.	Fine Agg.
Grading	Daily	Daily
Specific Gravity	7 days	7 days
Magn Sulphate soundness	30 days	-
Clay, Silt and dust content	Daily	Daily
Shape (elongation and flakiness)	3.5 days	-
Los Angeles Abrasion	Initial stage only	Initial stage only
Moisture content	2 days	2 days
Drying shrinkage	Initial only	Initial only
Organic impurities	30 days	30 days
10% fines value for concrete	7 days	-

Combined grading also on a daily basis.

Storage and handling of aggregates

Aggregate stockpiles shall be arranged and used in a manner to avoid segregation and to prevent contamination with other materials or with other sizes of like aggregates. Aggregate delivery trucks shall be covered to prevent wind blown contamination. Aggregate stockpiles shall be located relative to prevailing winds to mitigate the accumulation of wind-borne dust.

Adequate storage shall be provided for each aggregate. The aggregate storage area shall be on concrete pavement sloped to drain excessive moisture. The aggregate storage area shall provide bulkheads to separate piles and protect against wind blown contaminants. Provision shall be made to shade and sprinkle the aggregates with potable water.

Rescreening Coarse Aggregate:

Rescreening and washing of coarse aggregates is required, if necessary, to reduce total chloride and/or sulphate contents to a level less than the maximum allowed by the specifications. If rescreening is required, the screening and washing shall be just prior to transferring aggregate to batch plant bins. Aggregates shall be dewatered over a screen to remove excess water before being stored in the batch plant bins.

Fine aggregate

Fine aggregate source shall be manufactured crushed stone or rock sand, excluding fines which are by products/rejects of coarse aggregate production. The crushed stone sand shall be graded from fine to coarse with the coarse sizes predominating to give maximum density.

The amount of fine particles as ascertained by the laboratory sedimentation method shall not exceed 10% for crushed stone nor 4% for natural sand. The amount of material passing a 75 micron sieve (IS test sieve) shall not exceed the following limits:-



Crushed stone sand

- a) concrete subject to abrasion 1% by weight
- b) all other concrete 3% by weight

There shall be no clay or fine silt present.

The amount of hollow shells like to form voids or remain partially unfilled and present in material retained on a IS 2.36 mm sieve, determined by direct visual separation, shall not exceed 3% by weight of the entire sample. Fine aggregate shall not contain appreciable amounts of flaky and/or elongated particles.

The water absorption of fine aggregate, determined in accordance with BS 812 shall not exceed 2.0% by weight.

Fine aggregate subjected to five cycles of the soundness test, specified in IS:2386 (Part-5), shall not show a loss exceeding 10% when sodium sulphate solution is used and 15% when magnesium sulphate solution is used, except where approved otherwise.

Tests are to be executed in accordance with IS:2386. The grading of fine aggregate for concrete work shall comply with the requirements of IS:383. The grading of the aggregates should be such as to produce a concrete of the specified proportions which will work readily into position without segregation and without the use of an excessive water content. The grading should be controlled throughout the work so that it conforms closely to that used for the preliminary tests.

A check on the moisture content of sand should be made at least once a day before concreting. The amount of water to be added to the concrete mix should be adjusted accordingly. Any washing, screening, classifying and other operations on the fine aggregate required to meet this specification shall be done by the Contractor. Washing is required if the content of salt adhering to the aggregate is found to be unacceptably high.

Coarse aggregate

Coarse aggregate shall be crushed rock and shall be free from decomposed stone, clay, earth or other deleterious substances. The specific gravity of the coarse aggregate shall not be less than 2.5 t/m³. Aggregate of crushed natural stone is deemed adequate if the stone reveals a crushing strength of 1000 kg/cm² when tested. Friable, flaky and laminated pieces, mica and shale shall only be present in such quantities as not to affect the strength and durability of the concrete.

The grading of coarse aggregate for concrete shall comply with the requirements of IS:383.

Samples of aggregates shall be submitted to the Owner, together with sieve analysis showing the proportion by weight passing sieves. When aggregates which are satisfactory to the Owner have been selected, the contractor shall secure his entire supply of each material from the same source so as to maintain the same quality and grading throughout the work. Should it become necessary to change the source or characteristics of the material supplied this shall only be done after additional tests.

5.5.16.8 Concrete Additives

Use of concrete additives

Concrete additives approved by the Owner shall be used to improve consistency, workability, quality and strength of the concrete.



Chemical admixtures manufacturer shall provide certified test reports from qualified independent laboratories showing actual test results indicating material that complies in all respects with the applicable specification.

Admixtures used in concrete shall conform to the appropriate specification and requirements as indicated below:-

- a) Air entraining admixtures shall conform to IS:9103.
- b) Water reducing and retarding admixtures shall conform to IS:9103. Accelerating admixtures shall not be used. High range water reducers shall be naphthalene-sulfonated polymer based material. No admixtures containing chlorides shall be used.
- c) Chemical admixture suppliers shall provide certified test reports with each shipment indicating compliance with the appropriate specification. The test reports shall include the chloride content of the admixture, specific gravity and solids content.
- d) Fibres: Polypropylene fibres shall be collated, fibrillated polypropylene fibre of approved manufacture.
- e) Corrosion inhibitors: Reinforced concrete subject to contact with seawater and brine, as a result of submergence, splashing, spray, leakage from piping or plant, or from any other cause, shall have a proprietary concrete corrosion inhibiting compound incorporated into a concrete mix.

The corrosion inhibitor shall be appropriate to the protection of steel reinforcement against corrosion throughout the 25 year design life of the structures. The corrosion inhibitor shall be compatible with the required concrete mix and shall be appropriate to the environmental exposure. Before incorporating corrosion inhibitor into any concrete mix, the contractor shall submit details for review and written consent by the Owner.

Admixtures used in production of concrete shall be the same as used in establishing the required concrete mix and shall be used in accordance with the manufacturer's directions.

Accelerating and retarding additives

Such additives shall only be used in case of necessity and after obtaining the written approval of the Owner.

Plasticisers and air entraining additives

Plasticisers and air entrainers are intended to reduce bleeding of free water at the surface. It shall only be used after the written approval of the Owner and in accordance with the manufacturer's instructions.

5.5.16.9 Concrete Mixes

General description and proportions and mixing

The mix proportions are to be determined by proper mix design based on the requirements for strength, workability and the particular site in which the concrete is to be placed. The mix design shall be carried out by the contractor from approved agency. The design of mixes shall be based on the principles of IS:456- 2000.

Concrete aggregates and cement shall be proportioned and batched by weight. Water and liquid additives shall be proportioned. If the contractor wishes to use cement in bulk, his method of obtaining the correct proportions of cement shall be approved by the Owner before use.

Trial mixes



Before concreting commences, the contractor shall, at his own expense, make trial mixes to determine the mix proportions required to produce the strengths specified for each class of concrete and for each degree of workability required to allow placing, transporting and compacting of the concrete with the equipment he proposes to use in any particular situation. Only materials which the contractor intends to use for concreting (including all admixtures) shall be used in the trial mixes. Test cubes from trial mixes shall be made and tested in accordance with IS:516. As per IS:456 and IS:516, three separate batches of concrete should be made, workability of each batch determined and three test cubes shall be made from each batch for each age (e.g. for 7 and 28 days) at which tests are required. The strength shall conform to target mean strength as per IS:456 – Requirements for design mixes.

The appropriate strength requirements may be considered to be satisfied if none of the strengths of the cubes is below the required characteristic strength and if the average strength of the nine cubes is not less than recommended by IS:456 and IS:516, trial mixes.

Quality and testing

Not more than 5% of the test results may fall below the 28 days specified strength. Making and curing of test specimens shall be in accordance with relevant IS:456, IS:516 and IS:1199. All mixes can only be placed following approval by the Owner. The mean strength shall exceed the characteristic strength by a margin of 1.65 times the standard deviation expected from the batching plant. However, no standard deviation less than 3.5 N/mm² shall be used as a basis for designing a mix.

Trial mixes and field tests

Sufficient laboratory trial mixes shall be effected to show that concrete complies fully with the specified performance criteria. The following tests are to be included:-

- a) Air content < 1%
- b) Slump: Piles 170 + 25 mm, regular work 80 + 20 mm as per IS:1199.
- c) Fresh and hardened concrete densities
- d) Field trial mixes are to be carried out under full-scale site conditions as per IS:4925 (for structural concrete only).
- e) Where directed by the Owner, concrete incorporating reinforcement details shall be cored to assess stratification of mixes. Cores of 150 x 200 mm (dia and length) are to be used.
- f) Each trial mix shall have 9 x (150 x 150 mm) cubes taken to measure 24 hours/7 days and 28 day compressive strengths. These trials shall be run for three consecutive days (for structural concrete only).
- g) At least 3 x sets of field trials shall be tested according to the provisions laid down in laboratory testing.
- h) The average 28 day characteristic strength for trial mixes shall be higher by 10 N/mm² than that for cubes taken in the field. Failure to comply shall result in the mix having to be re-designed.
- i) All test results will have to be complied before approval can be given.

Consistency of concrete

The amount of water used in the concrete shall be adjusted as required to ensure such a consistency that it can be readily transported, placed and compacted without segregation of the materials or bleeding of free water at the surface. Addition of water to compensate for stiffening of the concrete before placing shall not be permitted. Consistency of the concrete shall be checked by slump tests measured in accordance with IS-1199 and shall not exceed the values given in clause 7.1 of IS-456-2000.



Mixing of concrete

Batching plant conforming to IS:4925 shall be used for large jobs and as directed by the owner. Minimum 2 nos. concrete batching plants with capacity 30 m³ of concrete per hour per batching plant shall be installed. The accuracy of the measuring equipment shall be within $\pm 2\%$ of the quantity of Cement, water or total aggregates being measured and within $\pm 5\%$ of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically. Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged. Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Owner. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Owner, it shall be carried out on a water-tight 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.

5.5.16.10 Laboratory

The contractor shall establish and maintain a field laboratory on the site and this laboratory shall be available at all time to the Owner. The laboratory must have qualified technicians to carry out all tests and must be adequately equipped to ensure that all necessary testing work can be carried out in compliance with the standards.

5.5.16.11 Strength of Concrete

Testing of fresh concrete by means of test cubes

All test cubes shall be made and tested for compressive strength in accordance with IS:456, IS:516 and IS:1199. The minimum required strength for different classes of concrete is as indicated elsewhere in the specification.

The grade of concrete required will depend partly on the particular use and the characteristic strength needed to provide the structure with adequate ultimate strength and partly on the exposure conditions and the cover provided to any reinforcement.

A minimum of four test samples (of six test cubes each) shall be taken on each concreting day (from the same mix) and for at least each 40 m³ of concrete mixed. At least one sample shall be taken for each shift.

For columns, beams and cantilevers seven (7) cubes for every 15 m³ of concrete poured shall be taken. The concrete for test samples shall be taken directly from the concrete mixer and shall be handled (vibrated etc) under similar conditions to those prevailing during the construction. The moulds for the test cubes shall be made of steel. Tests shall be carried out in an approved laboratory.

The strength level of each type and each strength concrete will be evaluated separately and the concrete strength will be considered satisfactory if:



Compressive strength:

The concrete shall be deemed to comply with the strength requirements when both the following conditions are met:-

- a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of Table 11 of IS:456.
- b) Any individual test result complies with the appropriate limits in col. 3 of Table 11 of IS:456.

Flexural strength:

When both the following conditions are met, the concrete complies with the specified flexural strength:-

- a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm².
- b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm².

If the results are less than those specified, the Owner must suspend all concreting work and order further tests. Any concrete found not to comply with the specification shall be broken out and replaced to the satisfaction of the Owner.

The contractor shall pay all costs incurred in making, curing, delivering and testing of concrete cubes.

5.5.16.12 Transport of Concrete

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods which will prevent the segregation, loss or contamination of materials. The concrete shall be placed and compacted within 90 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from the site. The concrete shall be transported through transit mixers. Before using concrete pumps, placer pipelines, chutes or spouts it is necessary to have the written approval of the Owner.

The contractor shall obtain permission at least 24 hours in advance of any concrete pour.

5.5.16.13 Concreting Operations

Inspection prior to concreting

All concreting methods shall be subject to the approval of the Owner. Concrete placing shall not be started until the Owner has approved all preparation of forms, reinforcement, joints and all mixing, conveying, spreading, curing, finishing and protection equipment.

Placing of concrete

Concrete shall be placed in the forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, not exceeding 2.5 m height in a single pour in walls, columns and similar members.

The contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.



The temperature of concrete shall not exceed 40°C measured at discharge into the works.

The maximum allowable temperature of any point within any cast element is 60°C. The maximum allowable temperature differential between any two points in the same element is 15°C. Additional temperature control measures during construction (such as the use of insulated formwork) will be required. Contractor to prepare a process control chart and method statement verifying measures to achieve these requirements. Temperature monitoring of concrete work is required where:

- a) the minimum dimension of any casting is 0.8 metres or more, or
- b) where otherwise instructed by the Owner.

Where specified on the drawings, construction, expansion or contraction joints shall be provided and the concrete shall be poured continuously between two adjacent joints. No other joints than shown on the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours time shall be subject to the same treatment as the construction joints.

Concrete shall not be dropped into place from a height exceeding 1.5 metres.

Concrete which has partially hardened shall not be exposed to injurious vibration or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

Compaction and mechanical vibration of concrete

As concrete is being placed it shall be compacted by mechanical vibrators complying with IS:2505, IS:2506, IS:2514 & IS:4656, to obtain a dense material free from honeycombing, free from water and air holes. The contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of the concrete is achieved.

Finish of concrete

The concrete face shall have the finishes indicated on the drawings or in the present specification. The finished surface of the concrete shall be sound, solid and free from honeycombing, protuberances, air holes or exposed aggregate. No plastering, cement wash, mortar or paint shall be applied to cover defective concrete surfaces.

5.5.16.14 Construction, expansion and contraction joints

Construction joints

The number of construction joints should be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings. Alternatively, the location of joints should be subject to agreement between the Owner and the Contractor before any work commences.

Construction joints should be at right angles to the general direction of the member and should take due account of shear and other stresses.



Concrete should not be allowed to run to a feather edge and vertical joints should be formed against a stop board.

The top surface of a layer of concrete should be level and reasonably flat unless design considerations make this undesirable. Joint lines should be so arranged that they coincide with features of the finished work.

If a kicker (i.e. a starter stub) is used it should be at least 70 mm high and carefully constructed. The kicker must be incorporated with the previous concrete.

Where possible, the formwork should be designed to facilitate the preparation of the joint surface, as the optimum time for treatment is usually two to four hours after placing.

The maximum horizontal length of wall to be poured in one operation in any one direction is 7.5 metres. A period of 7 days to be allowed between adjacent pours except where waterstops are provided when this can be reduced with Owner's approval. Alternatively a gap of 600 mm wide shall be left between adjacent pours and filled after 7 days from the date of formation subject to Owner's approval.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast should be free from laitance and should be roughened to the extent that the largest aggregate is exposed but not disturbed. Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against it.

Particular care should be taken in the placing of the new concrete close to the joint. This concrete should be particularly well compacted and if possible a vibrator should be used.

Where the Owner considers that special preparation is necessary, i.e. for an in-situ structural connection, preparation should be carried out preferably when the concrete has set but not hardened, by spraying with a fine spray of water or brushing with a stiff brush, which is sufficient to remove the outer mortar skin and expose the larger aggregate. Where this treatment is impracticable, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking of hardened surfaces should be avoided.

A record shall be kept on site of the time and date of placing the concrete in each section of the work.

Expansion and contraction joints

The expansion joints, contraction joints and other permanent structure joints shall be provided in positions as shown in the drawings. Joints shall be straight and vertical, except where other specified, and concrete surfaces on both sides of the joint shall be flush. Where necessary, waterstops of a type approved by the Owner shall be embedded in the concrete. The waterstop should be made of high quality material which must obtain its resilience through the service life of the structure for the double function of movement and sealing.

The surface of waterstops should be carefully rounded to ensure tightness of the joint even under heavy water pressure. To ensure a good tightness with or without movement of the joints the waterstop should be provided with anchor parts. The cross-section of the waterstops should be determined in accordance with the presumed maximum water pressure and joint movements. The complete works of fixed and welded connections must be carried out strictly in accordance with the manufacturer's instructions.

All joints between structural steel and concrete parts shall be sealed by a suitable permanent flexible compound.

**5.5.16.15 Concreting at night**

When approval is given to carry out concreting operations (under control of the Owner) at night or in places where daylight is excluded, the contractor has to provide adequate lighting at all points of mixing, transportation and placing of concrete.

5.5.16.16 Concreting in high ambient temperature

“IS:7861 (Part 1) – concreting in hot weather” shall apply.

The temperature of the mixed concrete at the time of placement shall not exceed 40°C. The contractor shall take special measures in the mixing, placing and curing of concrete. These measures shall include the shading of aggregates, spraying of aggregates with water, cooling of the mix constituents (introduction of ice to the mixing water) and reduction of transportation time to the minimum. During placing suitable measures shall be provided to prevent premature setting of concrete placed in contact with hot surfaces. All concreting areas, formwork and reinforcement shall be shielded from the direct rays of the sun and sprayed with water when necessary.

5.5.16.17 Protective measures for concrete

Immediately after the compaction of the concrete has been finished, the contractor shall ensure adequate protection from the weather. Excessive drying can lead to crack formation as a result of plastic contraction. The concrete surface shall be covered with a layer of sacking, canvas, straw mats or similar absorbent material, special protection sprays kept constant moist for at least 7 days.

Curing compounds or other methods of preventing evaporation may be used if approved by the Owner. Where formwork cannot be removed within 24 hours after placing the concrete, the formwork shall be kept shaded from the direct rays of the sun and shall be sprayed with water.

Owner's approval to the use of a particular curing compound and to the method of application will only be given after the contractor has completed satisfactory site trials and a sample panel has stood for at least 28 days.

Where large sections of concrete are poured, special precautions to the approval of the Owner shall be taken to reduce and dissipate the heat generated by the setting and hardening of the concrete (e.g. built-in cooling water pipe system).

The minimum amount of reinforcement shall be present to prevent shrinking cracks.

No load of any kind, however light, shall be allowed on concrete which has not properly set and the contractor shall prevent any load to be imposed on the concrete structures until it has been declared by the Owner to be ready to carry loads.

5.5.16.18 Concreting under-water

Underwater concreting shall be done as per IS:456. Underwater concrete must comply with the following characteristics:-

- a) The quantity of cement must be not less than 350 kg/m³ when using aggregate mixes with a maximum particle size of 40 mm.
- b) The water-cement ratio must not exceed 0.6.
- c) Preferred aggregates are those with continuous grading curves lying approximately in the middle of the favourable range.
- d) Slump shall be as per clause 7.1 of IS:456.



Underwater concrete is to be placed continuously without interruption. For water depths upto 1 m the concrete may be placed without tremie. In the case of water depths exceeding 1 m, the concrete is to be placed in such a way that it does not fall freely through the water. The tremies must at all times dip sufficiently far into the freshly placed concrete to ensure that the concrete emerging from the tremie does not come into contact with the water. All work connected with the placing of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. Work shall not proceed until all phases and methods to be used in the placing operations have been approved by the Owner.

5.5.16.19 Waterproof concrete

This concrete must meet the provisions of IS:3370. Waterproof concrete must be sufficiently dense (impermeable).

Waterproofing and protection of underground concrete structures

Water aggressive to concrete should be kept away from the fresh concrete. Concrete which is exposed for a prolonged period to "very severe" chemical attack must be protected against direct access of the aggressive substances. The protection, which is to be laid as protection to all concrete surfaces in contact with the ground, shall consist of an approved waterproofing membrane. The membrane shall adhere to all concrete surfaces, including undersides of structures and other surfaces where concrete is cast in contact with the membrane. Such membranes shall be PVC sheets of minimum 0.35 mm thickness with knobs of Maxlock supplied by Maxcorona Owners Pvt. Ltd., or equivalent. The waterproof membranes shall be installed in strict accordance with manufacturer's instructions.

The membranes shall extend 15 cm above ground level.

When setting forms and reinforcing steel caution shall be exercised to avoid damage to the impervious membrane. The surface of the impervious membrane extending outside the forms shall be protected during subsequent operations. Any puncture or damaged areas shall be cleaned and patched according to manufacturer's instructions.

5.5.16.20 Concrete with high wearing resistance

Concrete which is exposed to severe mechanical action, e.g., due to intensive traffic, sliding of bulk materials, frequent impact blows or movements of heavy objects, or due to fast-flowing water carrying solids, or other causes, should possess high wearing resistance and correspond at least to grade 30.

The aggregate upto 4 mm size should consist predominantly of quartz or materials of at least equal hardness; the coarser particles should consist of stone or artificial materials possessing high abrasion resistance. In the case of particularly severe mechanical action, it will be necessary to use special hard materials. The particles of all types of aggregate should have a moderately rough surface and be of compact shape. The combined aggregate should be as coarsely graded as possible. Furthermore, the concrete should be as stiff as possible, in order that there will be no concentration of cement slurry or water in the top layer. The concrete should be kept moist for at least 7 days after placing.

5.5.16.21 Finishing of formed surfaces

Fins and other surface projections shall be removed from all formed surfaces except exterior surfaces that shall be covered with earth backfill. Exterior surfaces that shall be exposed above grade and all interior surfaces, except those not usually exposed to view, shall be cleaned and rubbed. Rubbing shall produce a smooth, uniform surface free of marks, voids, surface glaze, and discolorations.



Rubbing shall be done by hand with a carborundum stone using only the mortar produced by the rubbing action and the application of water.

Projecting ends of all form ties shall be removed. The resulting recesses shall be cleaned, wetted, and filled with patching mortar. Patches on rubbed surfaces shall match the texture of the adjacent concrete.

Finishing of unformed surfaces

No surface treatment shall be required for buried or permanently submerged concrete. As a minimum, unformed surfaces shall be finished by screeding and floating. Surfaces requiring a trowelled finish shall be finished by screeding, floating, and trowelling. Float finished and screeded surfaces shall be finished to provide a flat profile within a 6 mm deviation as measured from a 3 meter straightedge. Trowel finished surfaces shall be finished to form a flat plane. The surface profile shall not deviate more than 3 mm when measured from a 3 meter straightedge.

Screeding

Screeding shall provide a concrete surface conforming to the designated elevations and contours with all aggregates completely embedded in adjacent mortar. Surface irregularities in screeded surfaces shall be limited to the tolerances specified.

All sumps and tank cover slabs shall be provided with minimum 50 mm thick screed concrete.

Floating

The surfaces shall be screeded and given an initial float finish as soon as the concrete has stiffened sufficiently to work. Coarse aggregate disturbed by the float or causing a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a smooth float finish of uniform texture and color.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

Trowelling

The exposed portions of the tops of equipment bases, tops of interior curbs, and the surfaces of interior slabs not receiving a separate finish shall receive a steel trowel finish. Trowelling shall be performed after the second floating when the surface has hardened sufficiently to prevent excess cement from being drawn to the surface. Trowelling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

Surfaces to be covered with neoprene-hypalon coatings shall be lightly trowelled but not burnished.

Brooming

Brooming shall follow the float finish for exterior surfaces where a nonslip surface is required. Brooming shall be done with an acceptable steel or fiber broom not less than 450 mm wide. Brooming ridges shall be transverse to the normal traffic direction and shall be between 1.5 mm and 3 mm deep. Adjacent strokes of the broom shall overlap slightly. Broomed surfaces shall be free of porous spots, irregularities, depressions, and small pockets or rough spots.



Aggregate Exposure

Surface mortar shall be removed and the aggregate exposed from surfaces that shall be covered with mortar, concrete, or grout at a later time.

Edging

Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having a 6 mm corner radius.

Finishing mortar

Finishing mortar shall be added if there is not sufficient mortar available from the concrete mix. The proportions for this finishing mortar shall be 102 kilograms of concrete sand to one bag of Portland cement, mixed with enough water for proper application. Slump for finishing mortar shall not exceed 50 mm.

5.5.16.22 Formwork

Design and construction

For stability and type of formwork and support framing used, IS:14687 is to be observed. The formwork and the supporting structure are to be so dimensioned as to be able to withstand all vertical and horizontal forces safely. Supporting structures shall be sufficiently rigid to maintain the forms in their correct position and to be true to shape and dimensions so that the final concrete is within the limits of the dimensional tolerances.

The contractor shall submit in sufficient time in advance for the approval of the Owner the calculations, designs and details of the methods adopted and materials proposed for the formwork. Approval in no way absolves the contractor from full responsibility for their correctness and completeness in every way nor shall claim any extra cost or time.

Particular attention must be paid to the formwork supports and braces to avoid any slip when the concrete is poured.

Preparation and inspection of formwork

Before concrete is placed, all formwork shall be inspected to see if it is built according to the approved plans and to see if it has been cleaned and is free from sawdust, shavings, dust, mud, earth or other contamination and properly oiled. Contact surfaces of panels shall be treated with a suitable release agent (e.g. non-staining mineral oil) where applicable. Surfaces which are not oiled shall be wetted thoroughly to prevent warping.

Erection and placing of formwork

All formwork shall be erected and placed in accordance with the construction drawings approved by the Owner. Shuttering shall be true to line and braced and strutted to prevent deformation under weight and pressure of the wet concrete, live-loads, wind and other forces. The deflections shall not exceed 3mm.

The formwork for beams and slabs shall be erected so that the form on the sides of the beams and of the soffits of slabs can be removed without disturbing the beam soffit. If the formwork for columns is erected to the full height of the columns, one side shall be provided with openings for concreting in order to guarantee a proper compaction of the poured concrete.



Formwork for walls and elsewhere shall be arranged for a maximum concreting height of 2.5 m in a single pour. Where necessary panel openings are to be provided in the forms for cleaning, inspection, access of vibrators, etc. Before placing of concrete, bolts, ties and fixings shall be positioned and all devices used for forming openings, holes, pockets, chases, recesses, etc shall be fixed to the formwork carefully.

All formwork will be inspected and approved by the Owner before concrete placing commences but this shall not relieve the contractor of any of his responsibilities under the contract.

Striking of formwork

Formwork shall not be removed until the concrete has sufficient strength to carry its own weight plus any constructional or designed loads likely to be applied with a normal factor of safety. It shall be removed in such a manner that no shock or injury shall result to the concrete. Before removal of the formwork, the concrete shall be examined and removal shall proceed only on the instructions and under the supervision of a competent person. In accordance with IS:456 clause 11.3.1, the striking period for cast in-situ concrete under certain conditions may be taken.

Special care is necessary in the case of components which have to carry nearly the full calculated load as soon as the formwork is struck. Columns, piers and walls are to be struck before the beams and slabs supported by them. Scaffolds, formwork supports and self-supporting floor formwork are to be carefully lowered by releasing the devices. Extreme care shall be taken to avoid chipping of corners during removal of formwork. To keep deflections through creep and shrinkage to a small amount, auxiliary supports should be left in place or immediately repositioned after striking.

5.5.16.23 Binding wire

Binding wire for general use shall be 1.6 mm dia annealed wire.

5.5.16.24 Reinforcement supports

Reinforcement supports shall include all spacers, chairs, ties, slab bolster, clips, chair bars, and other devices for properly assembling, placing, spacing; supporting, and fastening the reinforcement. Spacers shall be cast from concrete of the same quality as that in which they will be embedded. Concrete block spacers shall be cast in metal moulds with an approved means of separating blocks and of ensuring that the blocks are of the proper size. Coated binding wire shall be incorporated into the blocks to enable them to be securely attached to vertical or horizontal bars and the contractor shall demonstrate both that the blocks are of the requisite strength and that the means of attachment to the reinforcement are adequate.

5.5.16.25 Certificates

Each consignment of steel reinforcement shall be accompanied by a test certificate from the manufacturer showing that the steel has been tested and analysed and the date of such tests and analyses and that such tests and analyses comply in all respects with the standards. The following tests shall be carried out on reinforcement:-

- a) Cast analysis
- b) Carbon equivalent value
- c) Tensile strength, yield stress, elongation
- d) Bend test
- e) Bond classification
- f) Chemical analysis



Stock of reinforcing steel

In order to ensure due progress of the works, the contractor shall at all times maintain on the site a stock of reinforcing steel sufficient for the following month's work. No reinforcing steel shall be used upon the works until it has been accepted as satisfactory by the Owner. All bars for reinforcement and steel fabric reinforcement shall be stored on the site under cover on timber or concrete supports suitably spaced and of sufficient height to keep the steel not less than 150 mm clear of the ground.

Rejection

The Owner at his discretion may order random testing of the reinforcement steel and in the event of any failed test reject the entire lot notwithstanding the manufacturer's. The contractor shall remove all rejected reinforcing steel from the site without delay at his own expense.

5.5.16.26 Bar-bending schedules

The contractor shall prepare bar bending schedules based on the detailed reinforcement drawings. These shall be presented to the Owner for approval. Approval of these schedules by the Owner in no way absolves the contractor from full responsibility for their completeness and correctness in every way nor shall any claim for extra cost or time be allowed on the grounds of such errors or discrepancies which may arise between drawings and schedules.



5.5.16.27 Waterstops

Waterstops shall be PVC or equivalent and shall be used. Type and manufacturer shall be submitted to the Owner's approval. The minimum thickness and width of PVC waterstops shall be 6 mm and 225 mm respectively.

All intersection pieces shall be prefabricated by the manufacturer and only welding of butt-joints in running lengths will be allowed to be carried out on the site.

The site welding of butt-joints shall be executed by using the manufacturer's purpose-made electrically heated jig and work shall be done by a competent and trained personnel only. The manufacturer's instructions shall be carefully observed.

The wings of the waterstops shall be formed with corrugations or bulbs to achieve a good bond. Moreover, the waterstops shall conform to the following requirements:-

- a) The tensile strength not less than 10 N/sq.mm when tested.
- b) The ultimate elongation shall not be less than 22% when tested.
- c) The tear resistance shall not be less than 2 N/ sq.mm when tested.
- d) The material shall not crack when tested.
- e) Under accelerated elongation, the tensile strength shall not be less than 8 N/ sq.mm and the ultimate elongation shall not be less than 200%.

The waterstops shall be installed so that they are securely held in position during the placing of concrete which shall be fully and properly compacted around the waterstops to prevent voids or porous areas. Adequate clearance between the reinforcement and all the waterstops shall be kept to permit proper compaction of concrete.

No holes or nailing shall be made through any waterstop for fixing purposes. Jointing by lapping two pieces of waterstops shall not be permitted. The free edges of waterstops shall at all times be protected from direct sunlight.

5.5.16.28 Curing

Concrete shall be protected from loss of moisture for not less than 7 days after the concrete is placed. Trowelled surfaces, except those that receive a separate finish or coating, shall be cured with a membrane curing compound. Float finished surfaces, except those that receive a separate finish, may be cured with either a membrane curing compound or with water. Only water curing shall be used if the surface receives a separate finish.

Water curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. Water curing shall begin within 12 hours in dry weather and within 24 hours in damp weather. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water may be interrupted for surface rubbing. The concrete surface shall not be permitted to dry. After the rubbing has been completed, rubbed surfaces shall be covered with burlap and kept saturated for the remainder of the curing period.

Membrane curing

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface or as soon as possible after finishing without causing damage to the surface. Membrane curing compound shall be spray applied at a coverage of not more than 7.4 square meters per liter. Membrane curing shall not be used on surfaces that shall be covered



at a later date with mortar, concrete, damp—proofing, tile, or any coating. Membrane curing shall not be used on cast-in-place concrete bases for field erected tanks.

5.5.16.29 Floor Sealer

All concrete floors shall be given two coats of clear floor sealer in addition to that applied as membrane curing compound. The first coat shall be applied at the end of the curing period before any traffic is permitted on the floor. The second coat shall be applied after the floor has been cleaned in preparation for the final inspection. Floor sealer shall be applied in strict accordance with the manufacturer's recommendations.

5.5.16.30 Repairing of Damaged or Defective Concrete

Concrete which has completed its final setting shall be inspected by the Owner and any cracks, honeycomb areas, segregations, etc shall be marked. No repairs shall be carried out until direction by the Owner.

Surface defects in formed concrete shall be repaired to the satisfaction of the Construction Manager within 24 hours. Concrete that is porous, honeycombed, or otherwise defective to a depth in excess of 25 mm shall be cut out and removed to sound concrete. Edges shall be square cut to avoid feathering. Cut surfaces shall be coated with epoxy bonding compound before the concrete is placed.

Defective concrete shall be replaced within 48 hours after the forms have been removed. Concrete repair work shall not interfere with the curing of surrounding concrete. Mortar and concrete used in repair work shall be adequately cured and shall be finished to match adjacent surfaces.

5.5.17 PERMISSIBLE DEFLECTIONS

The following deflection criteria shall be considered in sizing of structures as per respective clause of IS-456.

Horizontal deflection : $H/325$

Vertical deflection : $L/325$

The final deflection due to all loads including effects of temperature, creep and shrinkage measured from as cast level of the supports of floors, roofs & all other horizontal members shall not exceed span/250.

The deflection including effects of temperature, creep & shrinkage occurring after erection of partitions and the application of finishes should not normally exceed span/ 350 or 20mm, whichever is less.

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5.7.1 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.

5.7.1.1 General

Piping and fittings shall comply with the following standards:

Unplasticized PVC pipes for gravity sewers and for underground drainage shall comply with IS:4985.

Cast iron pipes and ductile iron pipes shall comply with relevant Indian Standards as mentioned above.

Stoneware pipes shall conform to IS:651.

RCC pipes for underground sewer and culverts shall be of class NP2 or NP3 conforming to IS:458.

Cast Iron rain water pipes shall conform to IS:1230.

Glass reinforced plastics (GRP) shall comply with IS:12709.

Manhole covers and frames shall comply with IS:1726.

Pipe Trenches

Prior to laying of pipes, the respective pipe trenches shall be subject to thorough inspection by the owner with respect to alignment, slope, dimensions and suitability of bottom to meet requirements of proper pipe laying. In general, each pipe trench deeper than 1.5 m shall be secured by means of planks, sheet piling, struts and bracings, whatever is required according to the soil conditions, groundwater, nearby road vibration resulting from traffic. The spacing of bracings shall be such as to allow mechanical excavation of the trench where required. All pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported.

The width of a trench shall be adequate for satisfactory jointing of pipes and thorough tamping of the bedding material under and around the pipes. The bedding surface shall provide a firm but slightly yielding foundation of uniform density throughout the entire length of the pipe or the culvert and shall in general be slightly cambered in a direction parallel to the pipe centre line to compensate for expected settlement and ensure tight joint in the lower half of the pipe.

Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template. Where rock in either edge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness of 200 mm minimum. Where a firm foundation is not encountered at the grade established, due to soft or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected material as approved by the owner, properly compacted to provide adequate support for the pipes.

Deviations from given levels shall not be greater than ± 20 mm.

All pipes shall be checked for defects and damages prior to placing. Material that does not conform to the specification or which is found to be defective or damaged shall be rejected and



removed from the site. If more than 10 % of the pipes are rejected because they do not conform to the specification, the owner retains the right to reject the whole consignment.

During connection of pipe sections, the contact surfaces carrying sealing compounds shall be kept clean. All open ends for later connections shall be closed to avoid entering of soil or other contamination into the bores. The pipes shall be laid with their socket ends facing the direction of the flow (such that flow is from socket end to spigot end). The pipes shall be lowered in the trenches by a method as approved by the owner. The pipes shall then be joined by caulking. After placing, each pipe section shall be thoroughly checked as to alignment, level and slope.

After each section of the pipeline has been laid it shall be tested for water tightness before backfilling the trench. On successful completion of testing, the trench shall be backfilled with the excavated earth in layers of 200 mm and shall be watered and rammed. Any subsidence occurring in the line of trenches after backfilling shall be repaired by the Contractor. Pipe supports shall be so constructed as to guarantee the uniform transmission of loads. For concrete supports, a cement-mortar layer shall be applied before placing the pipes to guarantee a uniform transmission of forces.

Manholes

The grade of concrete for manholes shall be M25 for cast insitu. Manholes may be prefabricated or cast in place. Sections of connecting pipes shall be incorporated into the construction of manholes and placed at the elevation, direction, and grade required. The inner ends of the pipes shall be flush with the inner faces of the walls, unless otherwise specified. Half round channels of size suitable for the inlet and outlet pipe diameters shall be formed on the floor of the pit with PCC

The floor of the pit shall be haunched towards the channel as per requirement. Inside of pits shall be finished with cement-sand plaster (1:4) and finished smooth with cement punning. Care shall be taken to avoid unevenness on the surface and sharp bends in the channel. The invert level after finishing shall be as shown in the drawings.

Concrete Encasement of Pipes

Pipelines running under roads, etc. shall be encased in 250 mm thick concrete of Grade M20 for full length. Before concrete is placed, the pipe and all fittings shall receive a double wrapping of bituminous felt. The thickness of the concrete encasement around the pipeline shall be at least the same as the pipe diameter. The concrete shall be reinforced by reinforcing steel bars in case of lack of space in any direction, side or top.

Testing

The Contractor shall test all drainage and sewerage pipelines, joints and fittings before back filling the trenches. The tests shall be carried out between each two manholes in the presence of the owner.

Pipelines shall be clean and dry and the joints shall not be covered with soil the underground water level shall be at the lowest possible level testing shall be carried out by water subject to the approval of owner.

Testing by Water

Water shall be so filled in all parts of pipes, of whatever diameter to be tested, that all air in the pipes is expelled and the pipes are completely filled with water. The pipes shall be tested for 0.5 bar pressure of water and the time for test shall be 12 hours. If any leak is noticed in the pipeline, the Contractor shall repair such leak to the satisfaction of the owner. If in the opinion of the owner any damage had occurred in the pipelines in the process of pouring the concrete or backfilling, he shall have the right to order re-testing of the doubtful part. If a second testing proves that the



pipeline is not serviceable, then the Contractor shall have to locate the damage, make it good and carry out re-testing until he secures satisfactory results.

The Contractor shall fix plugs in ends of pipes to be tested and shall take necessary precautions to prevent plugs or fixing tools from getting inside the pipes as a result of water flushing.

5.7.1.2 Storm Water Drainage System

The plant storm water drainage system shall take in to account the topography of the plant area, area drainage patterns and intensity of rainfall etc. All storm water drains shall be designed for the maximum hourly rainfall intensity.

All storm water drainage shall preferably be through open storm water drains on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. In case of road along boundary wall, storm water drain may be provided on one side.

Surface drains shall be open drains of RCC rectangular cross section. All drains in the power block area and around buildings shall be covered drains.

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.

Minimum slope for paved areas towards drains - 1 in 100

Maximum drainage travel extent - 10 meters

Uncontaminated area surface drainage shall be connected to nearest open storm water drains through rectangular drains.

Contaminated area surface drainage shall be collected through separate network.

Interconnecting pipes and rectangular drains shall be sized for carrying the design discharge when running full.

Minimum width of RCC rectangular drains - 450 mm

Drainage pipe material - RCC class NP2 conforming to IS: 458 except road and rail crossing areas

- RCC class NP3 for road crossings

- Pipes conforming to railway loading standards for rail crossings

Minimum velocity for self cleansing - 0.6 m/sec

Maximum velocity for pipe drains - 2.4 m/sec

Maximum velocity for open drains - 1.8 m/sec

Minimum slope of drains - 1 in 2000

Minimum earth cover over drain pipes in paved areas - 450 mm



Minimum width of garland drains all round the building - 300 mm

Minimum thickness of side walls and bottom slab - 125 mm or as per design requirements whichever is greater

Diameter of pipes used for drainage / culverts shall be between 300 mm to 600 mm. Beyond 600 mm, box drains / culverts shall be provided.

Run-off co-efficient for paved and unpaved areas shall be 0.9 and 0.6 respectively.

Surface drains shall normally have a bed slope not milder than 1 in 2000 along longitudinal direction and RCC pipes shall have such slopes so as to have effective discharge.

Manholes shall be provided to piped drainage lines at every 50 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 of 1.0 m x 1.0 m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.

The cushion over the pipes for storm water culverts shall be minimum 600 mm. Where less cushion is available, pipe shall be encased in RCC M-15. Suitable RCC or masonry structures shall be provided at drops / falls to prevent scouring or damage to surface.

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 to be let.

The Contractor shall furnish a comprehensive layout of drainage system, taking consideration of different construction phase for the approval of the Owner.

Drainage shall be provided for all roads, pavements, sidewalks, buildings, structures and wet areas including cable/pipe trenches, tunnels, basement of buildings, coal stockyard and pits etc. Where gravity flow is not possible, pumps shall be installed for lifting and/or diverting pressurized water to location of discharge points. Pump sumps and pumps shall be provided at all necessary locations.

Proper drainage of floors, basements, cable / pipe trenches tunnels and pits shall be provided for fire water, operation and leakage water.

The outdoor storm water may be drained through concrete lined open ditches ultimately connecting to nearest drainage channel. All building roof and non-contaminated floor drainage, drainage of cable / pipe trenches, tunnels, pits, basements etc., shall be provided with suitable buried piping system (gravity flow) for discharging ultimately into the common outdoor drainage system.

5.7.1.3 Plant Effluent Drainage (Oily Waste / Process Waste Drainage)

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 junctions of pipes. Catch pits shall have a minimum internal dimension of 600mm x 600mm. They shall be of RCC construction and provided with CI grills.

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.

Industrial oily waste water shall be passed through oil water separator system before connecting to the effluent treatment plant.

The drainage of oily waste water from transformers shall be provided with dual system. The oily water during normal operation shall be passed through oil water separator system and then connected to drainage system. The oily water during emergency operation shall be led through another system of pipes connecting to central blind sump. The blind sump shall have sufficient capacity to store transformer oil and fire fighting water for half hour duration.

Very hot (over 60°C) water shall be first cooled down to less than 60°C in collecting basin by mixing with cold water before connecting to storm drainage system.

The maximum temperature, quality, quantity and location of drain water of individual equipment shall be tabulated and furnished to the Owner's representative.

The guard pond (earthen) shall have adequate capacity as per design requirement with 750 mm free board. Top of earthen dyke shall be 500 mm above finished grade level. The pond shall be of such construction as to prevent pollution of ground water by seepage of any wastewater having side slopes and bottom lined with minimum 250 micron LDPE for minimizing seepage loss. Over the LDPE lining, PCC blocks of minimum 75 mm thickness having interstices filled with cement-sand mortar shall be provided. Filter media shall be suitably designed and provided below liner.

5.7.1.4 Sewage System

Salient points to be considered for sewage system,

- HDPE pipes conforming to IS: 4984 of material grade PE 80 having pressure rating PN6 shall be used for above ground level sewage system.
- For below ground level sewage system heavy duty uPVC pipes shall be used.
- Pipes connecting toilet facilities to manholes shall be minimum 100 mm.
- Pipes connecting various manholes shall be minimum 150 mm.

Sewers shall be designed for peak flow condition (3 times the average flow) and pipes flowing half full.

Minimum self cleansing velocity - 0.75 m/sec

Maximum velocity - 2.4 m/sec

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. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.

Sewage from the buildings shall be let into septic tanks. Overflow from soak pits of septic tanks shall be sent to a central sewage treatment plant through a sewerage network. The treated effluent shall be utilized for the irrigation of the landscaped areas and horticulture.

The sanitary sewer system shall be independent of plant and storm drainage system. The treatment of sanitary sewage shall be through septic tanks and soak pits/leaching fields. The



number of septic tank shall be kept minimum and their location shall be away from plants, buildings and facilities. The size of septic tanks shall be designed based on fixture units and for a minimum storage of 5 years but not less than 2.0 CU.M.

All underground piping below concrete slab shall be HPDE minimum 100mm dia and for outdoors it shall be HDPE pipe of minimum 200mm diameter. In buried piping system manholes shall be placed at every change in direction and at every SOM (max.) interval in straight run. Suitable clean outs shall be provided for buried piping under floor slab

Following minimum drainage slope shall be provided:

- Pipes of diameter less than 200mm : 1 (vertical) : 100 (horizontal)
- Pipes of diameter 200 mm & more : 1 (vertical) : 200 (horizontal)

Septic Tanks

For the treatment of sanitary sewage, a septic tank having a minimum of 3 chambers shall be constructed. Septic tank shall consist of the RCC tank with inlet and outlets therefrom, complete with all necessary earthwork and backfilling. The details of septic tank shall be as per IS:2470. The chambers shall be separated by walls with slits. Each chamber shall have one manhole cover for cleaning with mobile pump. Before the outlet in the last chambers, a screen board shall be provided to prevent the passage of floating matter into the discharge pipe.

Septic tank shall also include ventilating pipe of at least 100 mm dia whose top shall be provided with a suitable mosquito proof wire meshes and cowl.

Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height of 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed. After the Septic Tank has been tested to be watertight and the sewage system is checked, the tank shall be filled with water to its outlet before the sewage is let into the tank. It shall be seeded with well-digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge, small quantity of decaying organic matter such as digested cow dung may be introduced.

The volume of the septic tank shall be adequate for the sanitary sewage owing to the number of persons occupying the building, subject to the Owner approval.

Soak Pit

A soak pit shall be arranged at the location shown on drawings for the disposal of sanitary sewage from the outlet of the septic tank. The soak pit shall be constructed in-situ. It shall consist of a minimum 900 mm dia pit 1.0m in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6). The lower part shall be perforated and filled with brickbats.

Inspection opening of 700 mm x 700 mm shall be provided. The cover of the inspection opening shall be of cast-iron. Inlet pipe shall be taken down to a depth of 900 mm from the top as an anti mosquito measure.

5.7.2 INTER PLANT TRENCHES

All cable and pipe trenches shall be of RCC. 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.



Trenches shall be covered using precast RCC cover, each not weighing more than 65 Kg and shall be provided with a lifting hooks.

As far as possible in the open area trenches shall be avoided for running cables. Cable racks are preferred wherever possible.

5.7.3 ROADS & PARKING AREA

The roads and pavements shall be designed and constructed in accordance with the provision of the relevant IRC Codes and MOST (MORTH) standards.

The construction of rigid pavement including box cutting, edging, sub grade, WBM/dry lean concrete sub base, cement concrete pavement, wearing course, shoulder works, etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work in accordance with relevant codes and standards of latest editions of Indian Road Congress, MOST (MORTH) specifications and Bureau of Indian Standards in respect of design, construction, workmanship, quality and properties of materials, method of testing, tolerance etc.

Some of relevant available codes are listed here under:

1. Specification for road and bridge works of Ministry of Road Transport and Highways(Ministry of shipping & Transport (Roads wing)) Published by the IRC.
2. IRC 58 Guidelines for the design of plain jointed rigid pavements for highways.
3. IRC:SP 11 Hand Book of Quality Control for Construction of Roads and Runways.
4. IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.
5. IS:2212 Code of Practice for Brickwork.
6. IS:783 Code of Practice for Laying of Concrete Pipes.
7. IRC:SP-49 Guidelines for the use of dry lean concrete as the sub base for rigid pavements.
8. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard specification, any other standard practice as may be specified by the Owner shall be followed.

Sub-base shall be of granular material i.e. laterites, moorum, natural sand, gravel, crushed stone (grading-1) or combination thereof laid over well compacted sub grade. Granular base shall be of water bound macadam course (WBM) construction. Thickness of sub-base/base shall be designed as per relevant standards.

A separation membrane shall be used between concrete pavement slab and the sub base. Membrane shall be impermeable plastic sheeting of 125 microns thick laid flat without creases

The minimum thickness, minimum grade of concrete, minimum reinforcement for the RCC roads and Pavements shall be as follows.

- a) 250 mm thick with M30 Grade mix, with double mat reinforcement of 8 tor @ 250 c/c both ways- For all roads except patrol road along the boundary wall.
- b) 150mmmm thick with M30 Grade mix with single mat reinforcement of 8 tor @ 250mm c/c both ways for the patrol road along the boundary wall.



The above specified are minimum and indicative and the contractor shall provide roads as per functional and design requirements.

The joints, dowel bars, tie bars, joint filler, sealing compound, tolerances, curing, etc, shall be as per relevant IRC / MOST(MORTH) standards.

Shoulder provided on either side shall be in murrum construction of 150 mm compacted thickness.

The geometric design of roads shall be done in accordance with IRC-73. Road widths, curves and parking areas shall have adequate space for maneuvering of vehicles. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 30. Normally the roads shall have much flatter gradient. Finished top (crest) of roads shall be 250 mm above the surrounding grade level.

All double lane roads shall have a minimum turning radius of 25 meters and all single lane roads shall have a minimum turning radius of 10 meter. However, for minor roads this shall be reduced suitably as per layout requirements and site conditions. Road width and turning radii shall also to be checked for to take largest vehicles and equipment which can reasonably be expected.

All service and utility lines crossing under roads shall be taken through concrete pipes / ducts and designed for imposed loadings. Number of such crossings shall however be kept to a minimum.

Access within the plant site shall be provided by a system of roadways.

A turning area at blind ends shall be provided.

All roads shall be surfaced with gravel during the construction period. Occasional applications of a dust palliative material shall be used to minimize the dust problem during the dry seasons.

Bollards shall be provided along side all type roadways near equipment which requires protection. Spare duct banks shall be provided under all type roads spaced at 100 meter intervals.

Signs shall be provided for vehicle management and shall meet Indian standards. All signs shall be dual worded in both English and Tamil. Finished top (crest) of roads shall be 250mm above the surrounding grade level. The ruling gradient for roads longitudinal shall not exceed 1 in 20. Main roads and roads around the main plant shall be designed for movement of heaviest equipment of the plant.

California Bearing Ratio (CBR) method shall be followed for the design of roads as per IS:2720 (Part XVI). CBR test shall be carried out in remoulded soil samples under soak condition.

The shoulder shall be laid with slope of 1 in 30. Foot path shall be provided at both sides of the road as per requirement for the main road connecting security main gate to the main plant and administrative building.

RCC pipes of 150 mm diameter shall be provided below each road at every 50 m and 600 mm diameter at every 300 m and also at all turnings for maintenance purpose. RCC pipes shall be of Grade 'NP3'.

All the culverts shall be designed for IRC Class' AA' loading and shall be checked for class' A' loading. The Equipment moving load shall also be properly considered.

Minimum width of RCC culverts shall be 1000 mm.

All buildings and facilities/components shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement and as directed by the Owner. Access roads shall also be provided in areas such as transformer areas, steam generator



area and other equipment area shown in the plot plan, where access is necessary for inspection, operation and maintenance.

No underground service piping except for drainage and sewage system shall run directly below the road (including up to 1.0m from the edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

The pre-cast concrete kerb stones shall be provided at both sides of the road and shall be made of concrete grade M20. The size of the kerb stones shall be 380 mm height, 200 mm width at bottom and 150 mm at top and 600 mm length.

Median of suitable width as per relevant standards shall be provided in the road connecting Security building near the main entrance to the main plant.

Parking Area

Sufficient pavement areas adjacent to buildings and facilities shall be provided for parking facilities as directed by the owner.

Parking area shall have PCC paving of M20, 150 mm thick laid over 150 mm thick compacted rubble soling shall be provided. The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 150 mm with interstices properly filled with grits.

Top level of parking area shall be flushed with crown of the connecting roads with a cross slope. Parking areas shall be provided with rigid pavement and shall be provided with antiskid tiles.

Pipe Culverts

The drainage pipes unless otherwise shown on drawings or instructed by the owner, shall be made of RCC (Hume pipe) and shall be either Class NP2 or NP3. Pipe culverts shall be made of reinforced concrete pipe (Hume Pipe) and shall be of class NP2 as decided by the owner or shown in the drawing. All pipes shall meet the requirements of IS:458 and shall be procured from approved manufacturers with collars as per manufacturers Standard specifications. The Tenderer shall specifically mention the particular manufacturer's product he proposes to use.

For bedding concrete for laying the pipes, the maximum size of aggregate shall be 38 mm. Fine aggregate for concrete shall be as per IS:383.

Laying of Pipes

Laying of Hume pipes and collars shall be done as per IS:783. Pipes shall be laid either in trenches or on supports as per drawing and/or instructions of the owner. All pipe sections and collars shall be inspected carefully for defects before laying in the trenches. Broken or defective pipe shall not be used and shall be properly marked and removed from site as soon as the defects are detected. Pipes shall be laid true to line and grade as specified in the drawings and/or instruction of the owner. The bedding of the pipes shall as per IS:783. The profile of cutting of trenches, free working space to be provided on each side of the pipe, etc. shall be decided at site by the owner as per site condition. Side slope, shoring, bailing out water etc. as required shall be done by the Contractor. Side slips, if there be any, shall be removed by the Contractor. After laying of the pipes are completed, back filling of the trenches shall be done in layers of 150 mm, clods and lumps broken, watered and compacted with iron rammers to the satisfaction of the owner. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the owner. The filling shall be done as per specification.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them.



Under no circumstances the pipes shall be dropped into the trench or on supports from a height. The joints of pipes shall be grouted with 1:2 cement - sand mortar and the procedure of jointing shall be as per IS:783. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipes as consistent with the load expected to be transmitted from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under and around the curve of the pipe to form an even bed. Where the pipe is laid in trench in rock, hard clay, shale or other hard materials, the space below the pipe shall be excavated and replaced with an equalising bed of concrete (1:4:8 mix), sand or compacted earth as approved by the owner. In no place shall the pipe be laid directly on such hard material. If end protection wall is shown in drawing, the wall shall be constructed with first class quality locally available bricks from approved source. All civil works connected with the protection work, like concrete, brick masonry, plastering etc. shall be done as per relevant Indian Standards and in accordance with approved construction drawings. All materials used shall also conform to Indian Standards.

Foot Path

Foot path shall be provided at both sides of the road as per requirement for the main road connecting security main gate to the main plant and administrative building.

The sub-grade and sub-base of the foot path shall comply with the requirement for the sub-grade and sub-base of the roads. After the top layer/WBM course for the road width is laid and compacted, the existing surface at the shoulders of the road must be scarified. Fresh quantity of approved earth, which may be extracted from the surplus earth obtained by box cutting, shall be spread in layers for building up the berms. The layer of earth must be compacted by at least three passes of 8 - 10 tonne rollers. The edges must be well compacted by suitable means to prevent edge slips and the work shall be properly trimmed and dressed. The foot path shall be paved Pre-cast concrete tiles 400 mm x 400 mm x 80 mm or Cast in situ concrete as directed by the owner.

Interlocking Paving Tiles

Interlocking paving tiles shall be 80 mm thick and shall be made of concrete grade M20. Pattern and quality of the interlocking tiles shall be subject to the owner's approval. Laying of interlocking paving tiles shall be carried out as follows:

The sub-grade and sub-base shall be prepared as specified above for the subgrade and sub-base of roads. Layer of carefully screeded sand shall be placed of about 100 mm thickness well graded to line and levels as required. The interlocking tiles shall be laid on the sand screed in a herring bone pattern, with all edges fitted to the required shape. After a sufficient area of tiles has been laid the surface shall be vibrated with adequate vibrator. Then the whole surface shall be covered with fine sand and brushed into the open joints.

Pre-cast Concrete Kerb stones

The pre-cast concrete kerb stones shall be provided at both sides of the road and shall be made of concrete grade M20. The size of the kerb stones shall be 380 mm height, 200 mm width at bottom and 150 mm at top and 600 mm length.

5.7.4 FENCING

Fencing shall be provided in areas as listed in Section related to Description of Buildings, Structures and Facilities

Fencing shall comprise of 2.4 m high PVC coated galvanized chain link fence of minimum 8 gauge (excluding PVC coating) with mesh size 75 mm and galvanised barbed wire on inclined member to a height of 600 mm above the chain link fencing. 3 lines of 12 gauge high tensile spring steel wire



shall be provided for the entire length of fencing. Also 50 x 6 galvanised MS flats shall be provided at every fifth post sandwiching the fencing with post using GI nuts and bolts.

Top of toe wall shall be 200 mm above formation level. Toe wall shall be generally of RCC construction and shall extend 150 mm below the formation level and the fencing mesh shall be embedded inside toe wall by minimum 75 mm.

Fencing post shall be fabricated out of galvanised MS angle section and shall be spaced at a maximum spacing of 2.5 m with struts made up of galvanised MS angle at every fifth fencing post in addition to these at bends. Expansion joint shall be provided at every 60 m. All fence posts shall be 65 x 65 x 6 MS angles spaced at 2.5 m C/C distance. All straining posts i.e., end posts shall be 65 x 65 x 6 MS angles. All corner posts will have two stay posts and every tenth post will have a transverse stay post. Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions

Steel entry gates shall be provided for all fenced areas. Gates shall be formed out of tubular section conforming to IS: 1161. Removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

Gate shall be fabricated out of tubular sections conforming to IS : 1161 and shall be hot dipped galvanised. Outer frame shall be 65 NB (medium) tube and diagonal 50 NB (medium) tube 50 mm sq. welded mesh with 4 mm dia GI wire fabric shall be welded to 25 mm x 6 mm thick GI flat which in turn shall be welded to the outer tubular frame. The gate shall be provided with 20 mm wide x 80 mm dia flat M.S. roller at the bottom. The gate frame shall be fixed to GI tubular post or RCC post.

5.7.5 PAVING & GRADE SLABS

Paving in Switchyard and around NDCT shall be as described in respective sections.

5.7.5.1 RCC Paving

150 mm thick R.C.C paving, laid to a slope of 1 in 100 towards the nearest drain, with minimum 8mm dia reinforcement at 200 mm c/c both ways in top and bottom, shall be provided in the following areas. The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits, followed by a layer of PCC 1:4:8, 50 mm thick.

- a) From 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 / Chimney / Condensate Storage Tanks in the either direction.
- b) 5 m wide corridor outside both gable end widths of TG and De-aerator bays of Power House Building.
- c) Ash silo area extending at least 10 m on all sides from outer periphery of the silos. This paving shall be designed for the loads coming from Ash trucks.
- d) Fuel oil unloading area covering decantation ramp and platforms
- e) Paved area not less than 5000 Sq.m at locations pointed out by owner for lorry parking near Ash silo area.
- f) Paving around Store



Coal Stock Pile area

Coal Stock Pile area shall be paved as described below.

- a) The under bed shall consist of well compacted WBM or Dry Lean Concrete of 100mm thickness designed as per MOST / MORTH standards.
- b) Followed by a layer of PCC 1:4:8, 50 mm thick.
- c) Top layer of 150 mm thick RCC paving, laid to a slope of 1 in 100 towards the peripheral drains, with minimum 8mm dia reinforcement at 200 mm c/c both ways in top and bottom
- d) 300 mm coal dust shall be provided on top of the RCC slab as a cushion. Owner will provide the coal dust.

5.7.5.2 PCC Paving

PCC paving of M20, 100 mm thick laid over 150 mm thick compacted rubble soling shall be provided in the following area. The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 150 mm with interstices properly filled with grits, followed by a layer of PCC 1:4:8, 50 mm thick.

- a) Complete Transformer Yard, covering area between A-row of the turbine building up to the fencing of the Transformer yard.

PCC paving of M15, 100 mm thick shall be provided as paving inside the following areas. The paving shall be laid over well compacted ground and laid to slope towards peripheral drain.

- a) Fuel oil tank farm

5.7.5.3 Stone Aggregate Paving

For auxiliary transformer yards, paving of stone aggregate of 100 mm thick using 20 mm size aggregate shall be provided after compacting the under bed and treating with anti-weed chemicals.

5.7.5.4 Grade Slab with equipment (Indoor / Outdoor)

Minimum 200 mm thick of grade M20 with minimum reinforcement of 8 dia (HYSD) @ 200 c/c both ways top & bottom.

The under bed 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 1:4:8, 50 mm thick.



SECTION 5.8

FINISHES

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5.8.1 GENERAL

The various finishes being used for this project are briefly described below.

5.8.2 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 screed 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.

5.8.2.1 False Flooring System

Removable type false flooring system shall be provided in computer rooms and control rooms if required as per equipment layout. RCC floor slab shall be sunk to a depth as required for the false floor system adopted.

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

Supporting Structure

The supporting structure shall comprise of fabricated jacks. Jacks shall be vertically true and located to conform to the size of the floor panels and shall be fixed to the RCC floor slab. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut. The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

Floor Panel

The false flooring panels shall consist of fire resistant phenol formaldehyde bonded particle board panels, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. The edges of the floor panels shall be covered by 4 mm. thick rigid PVC edging. The underside of the panel shall have 0.05 mm. thick Aluminium foil which shall be fixed to the particle board with resin based adhesive.

Each floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq meter or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

Surface Finish

All removable panels shall have the top surface finished with 2 mm thick Anti static Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

Skirting

Skirting shall be of the same Anstistatic Vinyltiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.



Installation

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without any extra cost to the owner.

The false flooring system shall be checked specially for :

- a) Level
- b) Alignment of joints
- c) Thickness of joints
- d) Surface finish
- e) Colour and texture

5.8.2.2 PVC Floor Finish

Two mm thick PVC as per IS: 3462 laid as per IS: 5318 over concrete under bed of 48 mm.

5.8.2.3 Carborandum Tiles

Polished heavy duty cement concrete tiles (carborandum) of 300x300x22 mm thick manufactured as per IS: 1237 using colouring pigment and hard chips like carborandum, quartz etc shall be laid as per IS: 1443 over concrete under bed to result in over all thickness of 50 mm.

5.8.2.4 Terrazzo Tiles

Tiles shall generally be of size 250x250x20 mm laid over concrete bedding to result in an overall thickness of 50 mm.

5.8.2.5 Granolithic Flooring

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, operating floor of pump house, permanent stores and other plant building areas where heavy duty flooring is required.

Granolithic flooring shall 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.

5.8.2.6 Heavy Duty Ceramic Tiles

Heavy duty anti skid ceramic tiles with matt finish shall be used in toilets, pantry, locker rooms etc. The tiles shall be 300 x 300 x 7 mm of approved shade brand and color. Dado in toilets and pantry, locker rooms etc shall also be of similar finish.

5.8.2.7 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 specifications do not apply to D.M. Plant.

5.8.2.8 Integral Floor Finish

For cable vaults room, floors of wagon tripler shed, crusher house, junction towers, pent house shall be provided with floor finish integral to the concrete base shall be provided as per IS: 2571.

**5.8.2.9 Cast-in-situ Terrazzo**

Cast-in-situ terrazzo flooring 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.

5.8.2.10 Acid / Alkali resistant Tiling / Brick lining

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.

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.

For walls of neutralising pit, the same specification as per clause 2.10.2 shall apply except that thickness of the brickwork shall be 115 mm with suitable pilasters at 2000 mm c/c.

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) 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 all round for outdoor installations.

In general, all concrete surfaces in contact with acid / alkali / corrosive environments shall be given protective treatment.

5.8.2.11 Polished Vitrified Tiles

Polished vitrified tiles shall be of 600mm x 600mm x 7.5mm in size and shall be approved shade, brand and colour and shall be laid with CM 1:3. These are proposed in the following areas:

- Operating floor
- Control room area including control room
- Computer room
- Control equipment room
- SWAS room
- Conference room
- Senior executive rooms.



5.8.3 SKIRTING / DADO

150 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.

Toilets & locker rooms shall be provided with dado of 2250 mm high.

For main Control room and control equipment room minimum 5 mm thick decorative granite tiles shall be provided upto false ceiling level.

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.

Staircase wall shall be given dado of cast in situ terrazo to a height of 2100 mm.

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.

5.8.4 METAL CLADDING

5.8.4.1 Permanent colour coated sandwiched insulated metal cladding system and roofing system

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.

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 180 gm / sq.m.

The permanent colour coated sheet shall meet the general requirements of IS: 14246 and shall conform to class 3 for the durability.

Inner sheet shall fixed directly to side runners and Z spacers made of at least 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.

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.

For roof sheeting the specification remains same as that of side cladding except the thickness and galvanisation. The minimum thickness of roof sheeting shall be 0.8 mm with galvanisation rate of 275 gm/sq.m.

Prefabricated sandwiched polyurethane PUF panel system may also be used for side and roof sheeting.

5.8.4.2 Permanent colour coated (non-insulated) metal cladding system

Troughed zinc-aluminium alloy coated not less than 150 gm/sq.m M.S.sheets having 0.6 mm minimum base metal thickness (or High tensile steel sheet of 0.5 mm minimum base metal



thickness) shall be used for the cladding system. The outer side (exposed face) shall be permanently colour coated with PVF2 paint of minimum DFT 20 microns over primer and the inner side (internal face) shall be coated with same paint of minimum DFT 12 microns over primer. These shall be fixed directly to runners. The sheets shall meet the general requirement of IS: 14246 and shall conform to class 3 for the durability. For roof sheeting the specification remains same as that of side cladding except the thickness and galvanisation. The minimum thickness of roof sheeting shall be 0.8 mm with galvanisation rate of 275 gm/sq.m.

5.8.4.3 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.

5.8.5 PLASTERING

All brickwork shall be provided with plastering on both faces and internal and external painting.

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 working consistency.

External face of all walls shall be provided with 20 mm thick cement mortar plastering with an under layer 12 mm thick in CM 1:5 and top 8 mm thick layer in CM 1:3 (Sand faced) with approved water proofing compound.

For internal walls 18 mm thick plaster in CM 1:4 shall be provided on the uneven side of the wall and 12 mm thick plaster in CM 1:4 on the even side of the wall.

Ceiling plastering of 6 mm thick with CM 1:3 shall be provided for all non-plant buildings.

All plastering work shall conform to IS: 1661.

Internal plastering on walls shall be done to cover surfaces from skirting level to bottom of roof slab in all areas including areas where false ceiling is provided.

The under coat shall be scratched or roughed before it is fully hardened to a mechanical key.

All drips, grooves, mouldings and cornices as shown on drawing or instructed by the owner shall be done with special care to maintain true lines, levels and profiles.

Suitable anti-spalling arrangements shall be adopted when plastering steel wall beams.

After the plastering work is completed, all debris shall be removed and the area left clean.

Neat cement finish:

After achieving a true plastered surface with the help of wooden straight edge, the entire area shall be uniformly treated with paste of neat cement at the rate of 1 kg/sq.m and rubbed smooth with a trowel (Aldeck smooth finish).

Curing:

All plastered surface 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.



Plaster-of-Paris Punning

Inside surfaces of walls shall be provided plaster of paris punning over the plastered surfaces in office areas, entrance lobby, corridor, control equipment room and all other air conditioned rooms.

The thickness of punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation. Before bulk work is taken up, a sample of punning shall be done on roughly 1 sq.m area and approval of Owner taken. The work shall then be completed as per approved sample.

This shall be done in the following areas

- All office blocks.
- Administrative building
- Central control room building
- Service building
- All air conditioned areas.

5.8.6 PAINTING

The following standards shall apply to the painting works.

- IS:5 Colours for ready mixed paints and enamels.
- IS:102 Ready mixed paint, brushing, red lead, non-setting, priming.
- IS:123 Ready mixed paint, brushing, finishing, semigloss, for general purposes.
- IS:1477 Code of practice for painting of ferrous metals in buildings.
- IS:2074 Ready mixed paint, air drying, red oxide-zinc chrome, priming.
- IS:2338 Code of practice for finishing of wood and wood based materials.
- IS:2339 Aluminium paint for general purposes in dual container.
- IS:2395 Code of practice for painting concrete, masonry and plaster surface.
- IS:2932 Enamel, synthetic, exterior, a) undercoating, b) finishing.
- IS:2933 Enamel, exterior, a) undercoating, b) finishing.
- IS:5410 Specification for cement paint, colour as required.
- IS:5411 Specification for plastic emulsion paint.

General requirements shall be as below.

- | | |
|--|--|
| External faces of walls, sunshades, etc. | - Water proof cement based paint as per IS: 5410 |
| Inside surfaces – all areas | - Acrylic washable distemper as per IS: 428 |
| Inside surfaces – Control room, Control equipment rooms, all air conditioned areas | - Acrylic emulsion paint as per IS: 5411 |
| Inside surfaces – plant buildings like D.G. house, Compressor house, pump houses, Ash handling pump house etc. | - Acrylic distemper as per IS:428 |
| Walls in DM Plant | - Chlorinated rubber based paint as per IS: 9862 |



- Walls above Dado in battery rooms - Chlorinated rubber based paint as per IS: 9862
- All plastered ceilings - water bound distemper as per IS: 427
- Oil canal and oil equipment room - Oil resistant paint as per IS : 161
- All wood work - Fire resistant transparent paint as per IS: 162 over french polish as per IS: 348 or flat oil paint as per IS: 137.

Following general instruction for painting shall be followed.

- a) For painting on concrete, masonry and plastered surfaces IS: 2395 parts I & II shall be followed.
- b) For painting on wood work IS: 2338 part I & II shall be followed.
- c) All paints shall be of best brand and make.
- d) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.
- e) All painting on masonry or concrete surfaces shall preferably be applied by rollers.
- f) Thinner shall not be used with textured paint (Sandtex Matt etc) finish.
- g) All fire exits shall be painted in Post office red colour shade which shall not be used anywhere except to indicate emergency or safety measure.

Preparation of Surfaces	
All surfaces to be painted shall be smooth, even and free from dirt or rubbish and shall be dry and protected from dampness. In general, all surfaces shall be free of any material which will adversely affect the adhesion or appearance of paint.	
Plaster surface	All defective plaster shall be cut out and trimmed. All holes in internal plaster faces shall be made good with approved material. All dirt and powdery substrate shall be removed by wiping with slightly damp cloth. Concrete surface All laitance shall be removed by wire brush . All holes, defects shall be filled and repaired by epoxy grouts.
New metal surface	All dust and/or mill scale etc. shall be removed with a wire brush or chipping hammer or grinding if necessary. The surface of the metal work shall then be primed with an approved metal primer before application of the undercoat.
Galvanised surface	Pre-treatment of the galvanised surfaces including etch-cleaning and coating shall be carried out as per requirement. Sweep blasting or emery paper may be used to roughen the galvanised surface to get better anchor pattern.
Wood surface	All iron mongery shall be removed prior to the preparation of surfaces and shall be re-fixed upon completion of painting. All knots and resinous parts in wood surfaces shall be treated by two coats of shellac varnish. All cracks and holes shall be treated by one coat of primer and filled with approved filler.



Structural Steel	Painting on structural steel shall be as described in Section related to Structural Steel.
Painting Systems	
Emulsion paints	Emulsion paints shall be used for internal cement plastering and internal fair faced concrete of walls and ceilings. All emulsion paints shall be washable. One coat of Acrylic primer sealer Two coats of filler based on alkaline resistant polyvinyl-acetate Two coats of polyvinyl-acetate emulsion flat finish
Oil Bound Distemper	Oil bound distemper (IS: 428), of approved make shall be used for internal cement plastering and internal fair faced concrete of walls and ceilings. Two or coats of distemper, as found necessary shall be applied to obtain even shade.
Water proof Cement Paint	It shall be made from best quality white cement and lime resistant colours with accelerators, water proofing agents and fungicides. The paint shall conform to IS: 5410.
Oil paints	Oil paints shall be used for wood surface and internal cement plastering and internal fair faced concrete in confined humid areas such as bathrooms. One coat of Acrylic primer sealer Two coats of filler based on alkaline resistant polyvinyl-acetate Two finish coats based on alkyd resins
Varnishes	Varnishes shall be used for wood surfaces and shall be of one of the following types <ul style="list-style-type: none">polyurethane varnishsynthetic varnish of linseed oil alkyd resin
Other systems of paints	Oil resistant paints shall be epoxy paint resistant to all types of oil.

Application of Paints

Before applying the paint, all prepared surfaces shall be dry and clean. All priming paints shall be applied by brush except for etch primer which may be applied by brush or spray. Paints shall be applied as evenly as possible to provide a smooth coating of uniform thickness. Damaged areas of priming coats or undercoats shall be made good before further coats of paints are applied. The various coats of paint shall be distinguishable from each other by their shade. The Contractor shall inform the owner in good time before starting to apply the next coat so that the owner shall have the opportunity of approving the previous coat. Painting systems shall not be carried out at temperature below 5^o C or above 45^o C. Trial coats shall be prepared at the request of the owner. The Contractor shall, upon completion, remove all paint where it has been spilled, splashed or spattered on surfaces including sanitary fixtures, glass and hardware. It shall be removed without marring the surface finish of the item being cleaned.

5.8.7 ROOF

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.

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

Roof of conveyor galleries, steel buildings and steam generator shall be of permanently colour coated galvnaised 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.

5.8.8 ROOF DRAINAGE AND WATER PROOFING

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. 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 : 5 horizontal.

Roof water proofing shall be made either by Seven course water proofing or using High solid content polyurethane based waterproof coating as per relevant standards.

Chequered cement concrete tiles as per IS: 13801 shall be provided over water proofing treatment in areas where movement of personnel is expected. Minimum width of pathway if provided only locally shall be 1000 mm.

Seven course water proofing

- i) Seven courses as per IS: 1346 using 3 layer of Type 2 Grade 1 glass fibre based felt as per IS: 7193.
- ii) 50 mm thick foam concrete as per IS: 6598 for thermal insulation. In areas such as roof of control room bay of Main Turbine building, Bunker bay roof etc. where handling of equipment is anticipated, the foam concrete may be replaced by 40 mm screed of M20 concrete.
- iii) 15 mm thick cement sand plaster 1:4.

High solid content polyurethane based waterproof coating

Roof water proofing may also be provided using High solid content polyurethane based cold liquid applied waterproof coating of 1.5 mm as per ASTM C-836-89 and shall comprise of urethane pre-polymer extended with flexible material, which cure by reaction with atmospheric moisture to give a continuous impervious jointless film, which is rubbery and elastic. The material shall come in a single pack system to site.

The material shall not be diluted. The coating shall have physical features like high viscosity, min. 80% solids, high resistance to impact, abrasion and cracking, superior tensile strength, min. 300% elongation and forming a perfectly smooth permanently flexible seamless membrane which should have good adhesion to PUF insulation and roof substrates. The cured film should have a very low water absorption rate (0.5% maximum at ambient temperature after 7 days). The material shall not be older than 9 months after the date of manufacturing and packing.



Reinforcing layer of non-woven polyscrim cloth made of 100% polyester with minimum weight of 40 gsm/m². Fixing and laying shall be as per ASTM C-898-89.

Wearing course shall be 40 mm screed of 1:2:4 concrete as above cast in panels of 1.2m x 1.2m and reinforced with 0.56 mm dia galvanised chicken wire mesh and joints sealed using sealing compound. Accessible roof shall be provided with chequered cement concrete tiles as above.

Equipments shall be installed on raised pedestals of minimum 300 mm height from FFL of roof to facilitate maintenance of roof treatment.

Haunched portions shall be treated properly.

The slopes and surface level shall be such as to allow quick draining of water 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 water tightness of the roof shall be tested by ponding the roof with 300mm height of water for 7 days and checking for any signs of leakage.

The Contractor shall furnish a performance guarantee of all the waterproofing treatment for a minimum period of five (5) years.

Number and size of rain water down take pipe shall be decided based on the provisions of IS:1742 and IS:2527. The pipe shall be HDPE, 150mm dia pipe conforming to class-3 of IS:4984. It is recommended that the minimum diameter of the pipe shall 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.

5.8.9 DOORS, WINDOWS & VENTILATORS

5.8.9.1 Standards

Unless otherwise specified herein. The following standards shall apply to the works.

Rolling shutter, grills, steel doors, aluminium doors and windows, ventilators, Louvers, suspended ceilings, roof and wall cladding etc.

IS:1038	Steel doors, windows and ventilators
IS:1361	Steel windows for industrial buildings
IS:1948	Aluminium doors, windows and ventilators
IS:1949	Aluminium windows for industrial buildings.
IS:3614	Specification for fire check doors
IS:4351	Specification for steel door frames
IS:6051	Code for designation of aluminium and its alloys.
IS:2108	Blackheart malleable iron castings
IS:6248	Specification for metal rolling shutters and rolling grills
IS:1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
IS:2835	Flat transparent sheet glass



IS:3548	Code of practice for glazing in buildings Builder's Hardware
IS:204	Tower bolts (All parts)
IS:205	Non-ferrous metal butt hinges
IS:208	Door handles
IS:281	Mild steel sliding door bolts for use with padlocks
IS:363	Hasps and staples
IS:723	Steel countersunk head wire nails
IS:1823	Floor door stoppers
IS:2209	Mortice locks (vertical type)
IS:2681	Non-ferrous metal sliding door bolts for use with padlocks
IS:3564	Hydraulically regulated door closures
IS:3847	Mortice night latches
IS:4992	Specification for door handles for mortice locks (vertical types)
IS:6607	Specification for rebated mortice locks (vertical type)
IS :6315 & IS:7197	Specification for floor spring

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, powder coated aluminium framework with glazing.

All doors of office areas and non-plant buildings shall be of factory made pre-laminated particle board (MDF exterior grade). All other doors (unless otherwise specified) shall be of steel.

For all air conditioned areas, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned areas.

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

Doors in WC and shower shall be PVC doors

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. Both doors and frames shall be factory galvanised, primed and field painted.

All steel doors shall conform to IS 1308 and IS 4351.

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.

Rolling shutters upto 9 m² shall be pull & push manual operating type, from 9 m² to 12 m² shall be push & pull ball bearing type and above 12m² shall be mechanically operated. Rolling shutters shall conform to IS: 6248. Components shall be galvanised, factory primed and field painted.



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 for 2 hours. These doors shall be double cover plated type with mineral wool insulation.

Hollow extruded section of minimum 3 mm wall thickness and minimum 38 mm deep as manufactured by INDAL or equivalent shall be used for all aluminium doors, windows and ventilators.

Aluminium windows in ground floors shall have suitable aluminium grills.

All ground floor windows shall be lockable and provided with security grills of 12 mm square painted MS rods.

5.8.9.2 Flush Steel Doors

Steel doors and pressed frames shall be made of 18g steel sheets. Frames shall conform to IS:4351.

No joints shall be permitted in the steel sheets.

All steel doors shall be double-skinned construction with all necessary reinforcement for hinges, locks and other fixtures. The two skins of 18g minimum thick steel sheets shall be mechanically interlocked and bonded together to form an envelope, which shall be closed at the top and bottom with two steel channels, welded to the steel sheets.

Mineral wool or equivalent material approved by the Owner shall be provided as insulation over the whole interior area of the door and shall be fixed with a plastic binder such that no part of the door may become uninsulated due to shocks, blows or long and repeated use of the door.

All doors shall be fitted with necessary best quality hardware and fixtures conforming to relevant IS specifications and shall be capable of withstanding repeated use.

Three steel butt hinges of 100 mm length shall be provided for each door leaf. Steel frames shall be fixed to the masonry by steel sleeve anchor bolts M12 mm passing through holes of 25 mm diameter in the frame. Steel frames shall be fixed to the steel structure by screws.

The clearance of doors shall be 2.5 mm at jambs and heads.

Steel frames shall be provided with door closer fitted with rubber cushions.

External doors shall have an external weather stop.

All fire exit doors shall be provided with panic latch system with horizontal bar action parallel to the door face moving in the direction of the door travel to provide immediate exit in the event of fire or emergency whilst providing security against unauthorised entry.

Sign plates of anodised aluminium or galvanised steel shall be screwed to the door under the horizontal bar, on which the sign, "PUSH BAR TO OPEN" shall be printed.

The thickness of the normal steel door shall be 45 mm for both single and double doors.

All the above specified details shall be applied for normal steel doors, fire resistant steel doors and fire proof steel doors.

The contractor shall provide the Owner with following documents for the steel doors:

- Detailed shop and construction drawings as well as the door schedules and samples of



hardware. Detailed structural analysis of the proposed supplies.

- Test certificates proving conformity of the physical properties stipulated in this specification and relevant standards

5.8.9.3 Fire Resisting And Fire Proof Doors

Fireproof doors with panic devices shall be provided at all fire exit points as per recommendations of Tariff Advisory Committee (TAC). These shall conform to IS:3614 (Part I and Part II). Fire rating of doors shall be as per TAC requirement. However, minimum requirement shall be for two hours. Type of doors shall be double cover-plated type with mineral wool insulation.

5.8.9.4 Rolling Shutter (Hand Operated, Mechanical Gear Operated and Electrically Operated) and Grills

Rolling shutters shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips to IS:2108. They shall be designed to withstand a wind load of 200 Kg/m² without excessive deflection.

The guides shall be either rolled or pressed deep channel sections 75 mm and 25 mm wide fitted with necessary fitting and fixtures.

The suspension shaft shall be formed from heavy duty tubes conforming to IS:1161 and of sufficient diameter so as to resist deflection due to weight of the rolling shutter. The deflection shall not exceed 5mm / metre width. The shaft shall be provided with CI pulleys and helical springs for counter balancing the weight of the shutter adequately.

The springs shall be approved high tensile flat springs conforming to Grade 2 of IS:4454. These shall be fitted inside the fabricated housing at either ends, which counter-balance the shutter curtain.

The ball bearings shall be double row self-aligning ball bearings fitted inside CI housing fixed on side brackets holding the suspension shaft at either end. The roller assembly shall be designed so as to be capable of producing sufficient torque to ensure easy operation of the rolling shutter in any position. The spring tension shall be adjustable by means of suitable adjustment holes drilled on the rims of the pulley.

The hood cover shall be made of 20 gauge sheets with necessary stiffeners and framework to prevent sag. The bottom lock plate shall be made of 5 mm thick M.S. plate and 95 mm wide, reinforced with angle/T iron of suitable section with 6 mm dia M.S. rivets interlocked with last stride of curtain.

The locking arrangement shall consist of sliding bolts at both ends of the bottom plate fitted to engage with suitable receiving pockets at the bottom of guide channels.

Unless otherwise specified, for overall area of rolling shutters up to 9 sq.m, pull and push type hand-operated shutters shall be used. For area between 9 and 12 sq.m, pull and push type shutters shall be provided with ball bearings. For area larger than 12 sq.m mechanical gear type or electrically operated shutters shall be supplied.

Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.



5.8.9.5 Folding Steel Doors

The folding doors shall be used for the entrance of machine halls, workshops and similar. The unit shall be manufactured as a top hung folding door of edged steel sheets and steel sections. Clear height of the pass-gate shall be not less than 2.00 m.

Door leaves shall be manufactured with double flush skin of steel sheet, min 1.5 mm thick, edged and welded to the case. The case shall be stiffened with steel section frame. Thickness of the leaves shall not be less 60 mm.

The door shall be constructed for one way normal manual usage under subtropical conditions for exterior openings in accordance with the architectural design.

The insulation material inside the door shall be fire resistant.

The fixing of the door frame to the wall or steel structure shall be carried out by means of flat steel anchors, size not less than 250/40/4 mm and steel bolts, dia. 8 mm, either cemented into the wall or screwed to the steel structure.

Three anchors shall be provided per 2.5 m length with a minimum of six (6) anchors per door frame.

Joints between doorframe and construction shall be sealed with permanent elastic compound where the door has to be fixed to steel structure.

The door shall be furnished with heavy sturdy-built hardware of corrosion protected steel consisting of:

- Truck brackets
- Intermediate hinges with nylon washers
- Hangers with nylon wheels, ball bearing, lubricated for life incl. wheel centre pattern
- Flush handles outside
- Fold-aside butt hinges, min. three (3) per 2.5 m length
- Door guides with end and centre pattern
- Floor channel
- Furniture, bolts and screws with all fittings

The door and frame shall be galvanised and coated by epoxy paint over galvanizing.

5.8.9.6 Steel Windows and Ventilators

These shall conform in all respects to IS: 1038, IS:7452 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings or called for in the Schedule of Items.

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

Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.



5.8.9.7 Aluminium Doors, Windows, Glass Walls and Louvers

Aluminium sections for doors, windows and glass walls shall comply with IS:1948 and IS:1949. Aluminium doors, windows and glass walls as well as aluminium frames shall be powder coated in accordance with relevant Indian Standards.

All hardware shall be of concealed construction in the aluminium frame and shall be made of stainless steel. Sections of aluminium profiles shall not be less than 50 mm deep.

All doors shall be provided with door closer, door stops.

Aluminium alloys shall be of uniform quality, free from defects impairing strength and durability with regularity of surfaces and accuracy of right angles. Aluminium windows at high levels shall be fitted with mechanical devices of type approved by the Owner to allow for opening of such windows from the ground level.

Marble sills of 30 mm thickness shall be installed under the windows.

Door and window elements shall be fixed to the structure by means of separate rectangular hollow galvanised steel or aluminium frame.

Joints of door and window frames to the walls shall be covered with aluminium angle on each side and they shall be sealed with permanent elastic material in accordance with the manufacturer's instructions. For air-conditioned rooms, the aluminium windows shall have double glazing.

The Contractor shall provide the following documents for all aluminium profile constructions:

- Detailed shop and construction drawings including the doors and windows schedule
- Detailed structural analysis of the proposed supplies
- Test certificates proving the conformity of the physical properties stipulated in the specifications and the relevant Standards stated herein

5.8.9.8 Timber Doors

All doors shall be of solid core with minimum thickness of 44mm. The core shall consist of fully glued laminated board / block board of reverse straight grain timber strips each of which shall be continuous through the height of the door except for 150 mm rails top and bottom. The core shall be planed true overall to receive plywood facing.

All doors shall have 150 mm 1st class hardwood rails for the full thickness and width of core as well as around all openings to cover the end grains of the lamin boards. The plywood facing on both sides shall be well matched teak or commercial 3 ply veneering with vertical grains or cross bands having minimum thickness of 6 mm as per requirement. Hardwood lipping of the same timber as the face veneer shall be provided at all edges of the door as well as to the opening for glazing.

All doors shall be covered by natural veneer. Door frames shall be minimum 50mm thick and 125 mm wide. They shall be fixed to the RCC / masonry frames around the door by screws / hold fasts (MS strip lugs) and shall be provided with adequate rubber sealing. The minimum number of fixtures shall be five screws or three holdfasts on each side of the frame. Holes for screws shall be drilled with a rotary drill and filled with wooden plugs, rawl plugs or hold fasteners. Clearance of doors shall be 3 mm at jambs and heads. All hardware shall be heavy duty of non-corroding materials (stainless steel / anodized aluminium / oxidised copper / brass). Each door leaf shall be furnished with the following:

- Hinges preferably 140 mm high pivoted with ball bearings
- 1 Heavy door lock with profile cylinder for master-key system



- Stainless door level handles of 125 mm
- Stainless door handle plates or roses
- 1 Door stop sealed with PVC or rubber strips to reduce impact sound

5.8.10 GLAZING

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.

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.

For single glazed aluminium partitions and doors, Float glass or flat transparent sheet glass of minimum 6 mm thickness shall be used.

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

Unless specified otherwise in this specification minimum thickness of plain sheet glass used for windows/ventilators shall be 4 mm.

Float glass or flat transparent sheet glass shall conform to IS: 2835.

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

Wired glass

Wired glass shall be polished on both sides and shall be transparent, complying with IS:5437. It shall be square pattern wired. The wired glass will be used for doors and windows etc. and also used in fire resistant doors of up to 30 minutes resistance.

Putty for glazing to wood shall be linseed oil putty in accordance with relevant IS standards.

Glazing and fixing techniques for glass, handling and care on site shall be generally in accordance with IS:3548. Outer glazing shall be rain-proof. For metal and aluminium frames, structural U-channel gaskets of synthetic rubber (neoprene) shall be use as sealing strips.

5.8.11 FALSE CEILING AND UNDER DECK INSULATION

Main control room shall be provided with Aluminium false ceiling system (of approved make) closed type plain panels of approved colour, roll formed out of corrosion resistant aluminium alloy 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.

All other air conditioned area and other control rooms shall be provided with Gyp board false ceiling system of reputable make.

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.

Contractor shall prepare a layout of false ceiling system incorporating light fixtures, supply air diffusers, return air grills, fire protection sprinklers, fire detection systems, etc, ceiling looks aesthetically pleasing. Work shall be commenced only after approval of the layout by the Owner.

**Aluminium false ceiling system**

The panels shall be 0.8 mm thick, stove enamelled, aluminium sheets. Panels of closed appearance of 75 mm or 150 mm wide and length up to 6 meters could be used as directed by the Owner.

The suspension system shall be of sufficient strength and rigidity to carry the panels. The panels shall be supported by stove enamelled aluminium panel carriers. The rod hangers shall be made of galvanised steel. The joints between the panels and the light fixtures and air supply ducts shall be smooth and regular. Power driven fasteners shall be used for fixing the rod hangers in the reinforced concrete ceiling.

Suspension system shall consist of the grid supporting the ceiling panels, intermediate runner supports for the grid if any and hangers, wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses. All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling boards or sheets in a true and level plane without exceeding a deflection of 1/360th of their span. All joints in ceiling panels shall run straight and cross joint shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All MS sections used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer.

Metal Grid Suspension System

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hangers. Main runners shall be hung by M S flats angles or 12 g or heavier galvanized tie wire hangers at maximum 1.2 centres. Extra hangers shall be provided at light fixtures that are supported from the ceiling system. The spacing of main and cross runners shall be as shown on drawings.

The cross tees shall intersect main runners in pattern shown on drawing and positively looked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical wall surfaces and end tees shall rest on the moulding, unless otherwise shown on drawings.

Installation of Ceiling Panels

Installation of ceiling panels shall be strictly as per manufacturer's instruction. For exposed grid ceiling system, tile hold down clips shall be used at the rate of minimum one per 1.2 meter length of perimeter. These shall however be omitted in access panels which shall be located as per the instruction of the Owner.

For concealed grid ceiling system, tiles shall be fixed to the supporting grid in manner shown on drawing or as specified by the manufacturer. Where V joints in tiles are called for in drawings, these shall begin true lines. Where flush surface is required, the joints shall be filled with approved filler material and finished to give a neat uniform surface. Where shown on drawings and schedule of items, 6 mm thick cement : lime : sand surface of ceiling boards and finished in a true and even surface without undulations suitable for subsequent painting. Special care shall be taken to neatly finish the ceiling at junctions with walls, light fixtures, diffusers etc.

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards, joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

No extra payment will be made for arrangement for lighting fixtures air conditioning diffusers access panels, etc. The rate shall include all cutting and wastage from standard size sheets boards, runners, etc.

**Under deck insulation 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 HVAC requirement. Ceiling of air washer room also shall be provided with under deck insulation.

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.

5.8.12 WATER SUPPLY & SANITATION

All material for plumbing and sanitary installation shall be suitable for their intended purpose and appropriately matched to each other. All material and structural components shall be standardised and shall meet the respective quality and dimensional requirements. The Contractor shall submit samples, description, catalogues and/or drawings showing all technical details, type, manufacturer etc. of the offered materials for Owner's approval.

All plumbing and sanitary works shall be executed by a licensed or authorized plumbing supervisor or a licensed or authorised plumber and shall be in accordance with the requirements of IS:1742 and other relevant codes.

For items such as earthworks, excavation, concrete, brick work, stonework, painting etc., relevant specifications for these shall apply, unless other wise specified. The diameter of pipes and fittings wherever mentioned shall mean the internal diameter or nominal bore, unless otherwise specified. The job shall include the cost of making necessary chases, holes etc, in walls, floors and in other places and also making good on completion of the works. Any damage caused to floors, walls etc. during execution of the sanitary and plumbing works shall be made good by the Contractor to the satisfaction of the Owner.

All sanitary fittings shall be procured from approved vendors and shall conform to the requirements of the relevant IS Codes listed above. The sizes shall be as specified in the drawings and where not specified, the same shall be as per owner's approval.

Glazed earthenware fittings shall be of reputed make, white colour and one piece construction. All metallic fixtures like taps, stop cocks, soap holders etc. shall be of Chromium Plated (CP) brass of approved make. All wall fittings shall be fixed with wooden cleats and CP brass screws and washers.

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.

HDPE / Galvanized M.S. pipe of medium class conforming to IS: 1239 shall be used for internal piping works for potable water supply.

All sanitary appliances and fittings shall be inspected and tested as per the requirements of IS:1742. All defects and deficiencies detected shall be promptly rectified by the Contractor to the satisfaction of Owner.

An eye & face fountain (combined unit with receptacle) conforming to IS: 10592 shall be provided in battery room, DM plant and Chlorination plant.



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.

Laboratory sink shall be of white vitreous china of min size 600x400x200 mm conforming to IS: 2556 (Part-5) in laboratories and in Battery room.

Pipes And Fittings

Cast iron pipes and specials shall be of standard quality conforming to IS:3486.

Stoneware pipes shall conform to IS:651.

RCC pipes for underground sewer shall be P1 class conforming to IS:458.

Water supply lines of GI, PVC, HDPE shall conform to IS:1239, IS:4985 and IS:4984 respectively.

PVC fittings for water supply lines shall conform to IS:10124.

Installation

All execution will be done on the basis of approved drawings / instructions given by the Owner. Fittings shall be located and oriented to allow easy reach such that operation, maintenance, repairs and replacements of pipes, fittings and fixtures are conveniently possible.

Sanitary Appliances

All sanitary appliances shall be fixed in position rigidly on floor and walls as indicated in the drawings or as directed by the Owner. All appliances shall be from the approved manufacturer and of approved colour.

Indian Water Closet (IWC) - Squatting type

Squatting type water closet shall be fitted on trap and shall be jointed with gasket yarn and cement mortar. Rim of the pan shall be levelled properly and set flush with the finished floor. The pan shall be connected to PVC low level push button / lever type cistern of 10 litre capacity. The flushing cistern shall be supported on a pair of CI cantilever brackets firmly embedded in the wall in cement mortar (1:4) or screwed to wall with suitable plugs. The flush pipe from the cistern shall be 32mm dia tested quality chromium plated (CP) pipe and connected to the pan inlet by means of hemp and putty joint.

European Water Closet (EWC) - Pedestal type

Pedestal type water closet shall be rigidly fixed on the finished floor by means of 75mm long brass screws with suitable plugs. The flushing cistern shall be PVC low level push button / lever type cistern of 10 litres capacity. The cistern shall be supported on a pair of cast iron or rolled steel cantilever brackets firmly fixed on wall with brass screws and suitable plugs. The flush pipe from the cistern shall be 40mm dia chromium plated with brass end cap / lining and fitted to the closet by means of rubber adapter. The closet shall be provided with double plastic seat cover conforming to IS:2548 with chromium plated hinges.

Urinals

Standing type urinals with suitable partitions shall be firmly fitted on finished wall by means of 50mm long brass screws and suitable plugs. Height of the lip from the standing point shall be as shown in the drawings. Urinals shall be fitted with automatic flushing cistern of 10/15 litres (2/3 urinals) capacity. Flushing pipes shall be of CP pipes of 25mm dia and connected to the urinal with 15mm dia PVC connector fitted with brass cap and lining at one end. The joint to the inlet of urinal shall be neatly finished with putty.

**Wash basin**

Wash basin shall be fitted in position true to level on a pair of cast iron brackets fixed to the wall with brass screws and plugs. The basin shall be fitted with 15mm dia approved quality CP pillar tap and 32 mm dia waste fittings. The type of waste pipe and their connections shall be as shown in the drawings or as directed by the Owner.

Sink

Stainless steel sink shall be levelled properly and fitted in position on a pair of cast iron cantilever brackets firmly embedded in the wall in cement mortar (1:4). The sink shall be fitted with chromium plated brass waste fittings of standard size. The type of waste pipes and their connections shall be as shown on the drawings or as directed by the Owner.

5.8.13 MISCELLANEOUS REQUIREMENTS

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 as below

Window openings	-	600 mm
Entrance doors / rolling shutters of all plant and non-plant buildings	-	1200 mm wide for upto 3.0 m high openings 1500 mm wide for more than 3.0 m upto 6.0 m high openings
Administrative and Service Buildings door openings	-	750 mm wide

Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.

No cable trenches shall be provided in TG hall, Boiler/ESP area, fuel oil pump house, Ash pump houses etc.

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.

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

Natural lighting & Ventilation

The area of windows shall be a minimum 15 % of the floor area to ensure adequate natural lighting.

Fans shall be provided in general office area as per standard norms.

Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.

Master Key System

An appropriate serviceable and functional master key system for the whole plant shall be installed. The elaboration of the system itself shall be made in close coordination with the Owner and only



after obtaining the Owner's approval in writing shall the order of production be placed.

The following requirements shall be met:

- the general master key shall operate all locks
- the main key shall open all locks of one building
- the single key shall open the lock of a single room.

Necessary attention shall be paid to later extensions of the master key system, which shall be suitable for the entire plant including all final stages. The profile cylinders shall be sea water resistant and shall suit all plant requirements. The material of the cylinders shall be of massive brass, nickelplated with six security pawl studs.

The keys shall be made of material approved by the Owner and shall have an engraved indication of the applicable key system and the building or door number.

Keys shall be supplied in the following numbers:

General master key 10 Main keys 10 nos. per each building.

Single keys 3 nos. per each door

Room Designation Signs


The entrance to each room shall be furnished with a room designation sign on an anodised aluminium plate of 4mm thickness. Four horizontal grooves of 10 mm width at the lower end of the sign plate shall take plastic strips on which the designation will be printed in English language. At the upper portion the room number shall be engraved with a black background. The designation sign plates shall be screwed to the wall with non-corroding screws.

SCHEDULE OF FINISHES

5.8.14 Refer Annex – A




ANNEX - A

	PROJECT 2 X 660 MW Udangudi Supercritical Thermal Power Project Stage - 1	SUBJECT Tender Enquiry Document for EPC Contract	SECTION SHEET NO -
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PLANT and NON PLANT BUILDINGS
INTERIOR FINISH SCHEDULE
THE NOMINAL THICKNESS of FLOOR FINISH WILL BE 50mm UNLESS NOTED OTHERWISE
FIRE PROOF DOORS SHALL BE AS PER TAC REQUIREMENT.

SL. NO.	AREA DESCRIPTION	FLOOR FINISH	WALL PAINT / FINISH		CEILING FINISH	ROOF TREATMENT	DOORS	WINDOWS
			INTERNAL	EXTERNAL				
1	MAIN POWER HOUSE BUILDING							
A	Ground Floor: Maintenance Bay and Unloading Areas	Granolithic with Non-Metallic Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Steel Sliding Type / Rolling Shutters	Sliding / Fixed Type Aluminium Frame Work with 6mm Thick Glass
B	Ground Floor: General Area	Granolithic Flooring	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	
C	Mezzanine Floor (Excluding Chqd. Pl. Area	Granolithic Flooring	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
D	Operating Floor: Operating Area, Lay Down Area	Polished heavy duty cement concrete tiles (carborandum)	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
E	Operating Floor: General Circulation & Movement Areas	Glazed Vitrified Ceramic Tiles	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
F	Operating Floor: Heater Area	Polished heavy duty cement concrete tiles (carborandum)	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
G	Toilet	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper		PVC Frame with PVC Door	
2	CONTROL & SWITCH GEAR BUILDING							
A	Central Control Room	Glazed Vitrified Ceramic Tiles	Aluminium composite panel work.	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Double Doors (with Air Locked Lobby) of Powder Coated Aluminium Frame Work with Glazing (Double Swing / Sliding Type)	Glazed Aluminium Sliding / Fixed Type Windows
B	Conference Room, Senior Executive Room	Glazed Vitrified Ceramic Tiles	Acrylic Emulsion Paint	Water Proof Cement Based Paint	Acrylic Distemper		Pressed Steel Frame with Pre-Laminated Particle Board Shutters	
C	Battery Room	Acid / Alkali Resistant Tiles / Painting	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Water Proof Cement Based Paint	Chlorinated Rubber Based Paint		PVC Frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows
D	Switch Gear Room	Granolithic with Two Coats of Epoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Steel Sliding Type Door	Glazed Aluminium Windows with Wire Glass
E	Office, Electronic Cubicle Room, Computer Room, Common Areas & Corridor	Heavy Duty Ceramic Tiles	Acrylic Emulsion Paint	Water Proof Cement Based Paint	Acrylic Distemper		Powder Coated Aluminium Framework with Glazing	Aluminium Glazed Sliding Windows
F	Cable Room	Granolithic with Non-Metallic Floor Hardener	Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	
G	Laboratory Room	Heavy Duty Ceramic Tiles	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper		Aluminium Glazed Doors	
H	Records Room, Lockers Room	Glazed Vitrified Ceramic Tiles	Acrylic Washable Distemper	-	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	
I	Swas Room	Glazed Vitrified Ceramic Tiles	Acrylic Washable Distemper	-	Acrylic Distemper			
J	Toilet	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper		PVC Frame with PVC Door	
K	Pantry	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	-	Acrylic Distemper		PVC Frame with PVC Door	

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PLANT and NON PLANT BUILDINGS
INTERIOR FINISH SCHEDULE
THE NOMINAL THICKNESS of FLOOR FINISH WILL BE 50mm UNLESS NOTED OTHERWISE
FIRE PROOF DOORS SHALL BE AS PER TAC REQUIREMENT.

			WALL PAINT / FINISH					
SL. NO.	AREA DESCRIPTION	FLOOR FINISH	INTERNAL	EXTERNAL	CEILING FINISH	ROOF TREATMENT	DOORS	WINDOWS
3	PUMP HOUSES							
A	Clarified Water Pump House	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Pressed Steel Door Frame with Double Plate Flush Shutters / Steel Sliding Type / Rolling Shutters	Steel Frame with Steel Glazed Window
B	MCC Switch Gear Room	Granolithic with Two Coats of Epoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
C	Control Room	Glazed Vitrified Ceramic Tiles	Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
D	Cooling Water Pump House	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Pressed Steel Door Frame with Double Plate Flush Shutters / Steel Sliding Type / Rolling Shutters	Steel Frame with Steel Glazed Window
E	Raw Water Pump House	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper			
4	OTHER BUILDINGS							
A	Bunker Building	Granolithic with Non-Metallic Floor Hardener	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Pressed Steel Door Frame with Double Plate Flush Shutters	Steel Frame with Steel Glazed Window
B	Chlorination Building	Acid / Alkali Resistant Tiles	Chlorinated Rubber Based Paint	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346		
C	Switchgear Rooms	Granolithic with Two Coats of Epoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Steel Sliding Type Door	Glazed Aluminium Windows with Wire Glass
D	DM Plant	Granolithic Flooring	Chlorinated Rubber Based Paint	Water Proof Cement Based Paint	Chlorinated Rubber Based Paint	Heavy Duty Water Proofing As Per IS:1346	Aluminium Glazed Doors / Steel Sliding Type / Rolling Shutters	Aluminium Glazed Sliding Windows
5	GAS INSULATED SWITCHGEAR (GIS) BUILDING and SWITCHYARD CONTROL ROOM							
A	Switchgear Rooms	Granolithic with Two Coats of Epoxy Painting.	Acrylic Washable Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Heavy Duty Water Proofing As Per IS:1346	Steel Sliding Type Door	Glazed Aluminium Windows with Wire Glass
B	Battery Room	Acid / Alkali Resistant Tiles	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Granular Finish	Chlorinated Rubber Based Paint	Elastomeric Water Proofing Treatment	PVC frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows
6	SERVICE BUILDING and ADMIN BUILDING							
A	Entrance Lobby, Reception, Portico and Lift Area	20 mm Thick Polished Granite Stone	20 mm Thick Polished Granite Stone for 2100 mm height and Acrylic Emulsion Paint above.	Granular Finish	Acrylic Distemper	Elastomeric Water Proofing Treatment	Powder Coated Aluminium Framework with Glazing	Glazed Aluminium Sliding / Fixed Type Windows
B	Office and Conference Room	Glazed Vitrified Ceramic Tiles	Acrylic Emulsion Paint	Granular Finish	Acrylic Distemper		Pressed Steel Frame with Pre-Laminated Particle Board Shutters	
C	Stores and Laboratories	Heavy Duty Ceramic Tiles	Acrylic Washable Distemper	Granular Finish	Acrylic Distemper		PVC frame with PVC Door	
D	Telephone Exchange Room	Heavy Duty Ceramic Tiles	Acrylic Emulsion Paint	Granular Finish	Acrylic Distemper			
E	Battery Room	Acid / Alkali Resistant Tiles	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Granular Finish	Chlorinated Rubber Based Paint			
F	Toilet / Pantry	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Granular Finish	Acrylic Distemper			
G	Locker Room	Heavy Duty Ceramic Tiles	Acrylic Washable Distemper	Granular Finish	Acrylic Distemper		Pressed Steel Door Frame with Double Plate Flush Shutters	

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PLANT and NON PLANT BUILDINGS

INTERIOR FINISH SCHEDULE

THE NOMINAL THICKNESS of FLOOR FINISH WILL BE 50mm UNLESS NOTED OTHERWISE

FIRE PROOF DOORS SHALL BE AS PER TAC REQUIREMENT.

SL. NO.	AREA DESCRIPTION	FLOOR FINISH	WALL PAINT / FINISH		CEILING FINISH	ROOF TREATMENT	DOORS	WINDOWS
			INTERNAL	EXTERNAL				
7	CANTEEN BUILDING							
A	General Area	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Granular Finish	Acrylic Distemper	Elastomeric Water Proofing Treatment	Main Entrance Door - Aluminium Glazed Swing Type with Two Leaves Opening Outside	Aluminium Glazed Sliding Windows. Fly Proof Mesh To Isolate
B	Kitchen	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Granular Finish	Acrylic Distemper			
8	GENERAL REQUIREMENTS							
A	Office Areas	Heavy Duty Ceramic Tiles	Acrylic Emulsion Paint	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	Aluminium Glazed Doors	Glazed Aluminium Sliding / Fixed Type Windows
B	Toilets	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	Water Proof Cement Based Paint	Acrylic Distemper	Elastomeric Water Proofing Treatment	PVC frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows
C	Pantry	Heavy Duty Ceramic Tiles	Dadoing for 2100 mm High + Acrylic Distemper	-	Acrylic Distemper	Elastomeric Water Proofing Treatment	Aluminium Glazed Doors	Glazed Aluminium Sliding / Fixed Type Windows
D	Battery Room	Acid / Alkali Resistant Tiles	2100mm High, Acid & Alkali Resistant Tiles Dado and Chlorinated Rubber Based Paint Over Dadoing	Granular Finish	Chlorinated Rubber Based Paint	Elastomeric Water Proofing Treatment	PVC frame with PVC Door	Glazed Aluminium Sliding / Fixed Type Windows



SECTION 5.9

CODES & STANDARDS

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5.9.1 GENERAL

The engineering & execution of all Civil, Structural & Architectural works shall be based on the latest edition or revision of the applicable portion of the following Codes and Specifications.

- a) I.S.I Codes of practice
- b) National building standard
- c) Environmental protection agency
- d) Indian Road Congress Standards
- e) Indian Railway Standards
- f) Statutory regulations of Tariff Advisory Committee
- g) Rules & Regulations of local authorities.

In absence of any Indian Codes & Specifications for any portion of work, appropriate American / British Standards may be followed subject to prior approval of the Owner.

All the Indian Standards referred to shall be the latest revision (including all amendments issued thereto at the time of execution.

Reference of only some of the codes and various clauses of design criteria listed / indicated in this document shall not limit or restrict the scope or applicability of other relevant codes. All other codes / standards / relevant to a specific job, in addition to those mentioned in this specification shall be followed wherever applicable.

Where British / American / DIN or other codes and standards are referred to in this document, equivalent Indian Standards may be substituted if available.

In case of any conflict between provisions of IS codes and the design criteria, the provisions that are more stringent shall govern unless specifically directed otherwise.

In case of any conflict between provisions of this specification (Civil) and other volumes of the specifications, the provisions that are more stringent shall govern unless specifically directed otherwise.

In case of any conflict between various provisions / clauses of this specification, the more stringent shall govern.

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 also listed elsewhere in reference sections.

Specifications for materials supplied from India, the Indian Standard Specifications may be followed.

25.9.2 EARTHWORK

- | | |
|----------|---|
| IS: 1498 | Classification and identification of Soils for General Engineering Purposes |
| IS: 3764 | Safety code for excavation work. |
| IS: 7293 | Safety Code for working with construction machinery. |

5.9.3 LOADS

- | | |
|---------|--|
| IS: 875 | Code of Practice for design loads (other than earthquake) for buildings and structures (All parts) |
|---------|--|



IS: 1911	Schedule of Unit Weight of building materials
IS: 6922	Criteria for safety and design of structure subjected to underground blasting.
IS: 1893	Criteria for earthquake resistant design of structure (All parts)
IRC Code	Bridge Rules of Government of India, Ministry of Railways (Railway Board)

5.9.4 FOUNDATIONS

IS: 1080	Code of Practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
IS: 1904	Code of Practice for design and construction of foundations in soils (General requirements)
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 foundation for transmission line towers and poles
IS: 8009	Code of Practice for calculation of settlements 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

5.9.5 REINFORCED CEMENT CONCRETE

IS: 269	Specification for 33 grade Ordinary Portland Cement.
IS: 383	Specification for coarse and fine aggregate from natural sources for concrete
IS: 432	Specification for Mild steel and medium tensile steel bars
IS: 455	Specification for Portland Slag Cement
IS: 456	Code of Practice for plain and reinforced concrete
IS: 458	Specification for pre cast concrete pipes
IS: 1343	Code of Practice for prestressed concrete
IS: 1443	Code of practice for laying and finishing of cement concrete flooring tiles
IS: 1566	Specification for Hard drawn steel wire fabric for concrete reinforcement
IS: 1785	Specification for plain hard drawn steel wire for prestressed concrete
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement



IS: 1834	Specification for Hot applied sealing compounds for joints in concrete
IS: 2502	Code of Practice for bending and fixing of bars for concrete reinforcement
IS: 3370	Code of Practice for concrete structures for 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: 4948	Specification for welded steel wire fabric for general use
IS: 4995	Criteria for design of reinforced concrete bins for storage of granular (All parts) and powdery materials
IS: 5525	Recommendation for detailing of reinforcement in reinforced concrete works
IS: 8112	43 grade Ordinary Portland cement
IS: 11384	Code of Practice for composite construction in structural steel and concrete
IS: 11682	Criteria of design of RCC staging for Overhead water tanks
IS: 12269	Specification for 53 grade Ordinary Portland Cement.
IS: 13620	Specification for Fusion Bonded Epoxy Coated Reinforcing Bars
IS: 13920	Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces
BS: 8007	British Standard Code of practice for design of concrete structures for retaining aqueous liquid

5.9.6 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: 919	Recommendations for limits and fits for engineering
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: 1239	Mild steel tubes, tubular and other wrought steel fittings (all parts)
IS: 1363	Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm) [All parts]
IS: 1364	Precision and semi-precision hexagon bolts, screws, nuts and locknuts (dia. range 6 to 39 mm). [all parts]
IS: 1365	Slotted counter sunk head screws (dia range 1.6 to 20 mm)
IS: 1730	Dimensions for steel plate, sheet and strip for structural and general engineering purpose
IS: 1731	Dimensions for steel flats for structural and general engineering purposes.
IS: 2016	Plain Washers
IS: 2062	Structural steel (fusion welding quality)
IS: 3502	Specification for steel chequered plates
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage
IS: 3613	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels
IS: 4000	High strength bolts in steel structures – Code of Practice
IS: 4759	Hot dip zinc coatings on structural steel and other allied products
IS: 4923	Hollow Steel sections for structural use
IS: 7215	Tolerances for fabrication of steel structures
IS: 7280	Base-wire electrodes for sub-merged arc welding of structural steels
IS: 8500	Structural steel - micro alloyed (medium and high strength qualities)
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

5.9.7 MASONRY

IS: 1077	Common Burnt Clay Building Bricks
IS: 2212	Code of Practice for brickwork
IS: 2185	Concrete Masonry units (All parts - Hollow & Solid concrete blocks)
IS: 3414	Code of Practice for design and installation of joints in Buildings
IS: 4441	Code of Practice for use of Silicate type chemical resistant mortars



IS: 4860 Acid Resistant Bricks

5.9.8 DOORS, WINDOWS & VENTILATORS

IS: 883 Code of practice for design of structural timber in building

IS: 1003 Timber paneled and glazed shutters (all parts)

IS: 1038 Steel doors, windows and ventilators

IS: 1361 Steel windows for industrial buildings

IS: 2835 Transparent sheet glass for glazing and framing purposes

IS: 1948 Aluminium doors windows and ventilators

IS: 1949 Aluminium windows for industrial building

IS: 2191 Wooden flush door shutters (Cellular and hollow core type)

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

IS: 3103 Code of practice for Industrial ventilation

IS: 3548 Code of practice for glazing in buildings

IS: 3614 Fire check doors

IS: 4021 Timber door, windows and ventilator frames

IS: 4351 Steel door frames

IS: 6248 Metal rolling shutters and rolling grills

5.9.9 ROOF AND FLOORING

IS: 809 Rubber flooring materials for general purposes

IS: 1195 Bitumen mastic for flooring

IS: 1237 Cement concrete flooring tiles

IS: 2210 Criteria for Design of R.C. shell structures and folded plates

IS: 3201 Criteria for the design and construction of precast concrete trusses

5.9.10 WATERPROOFING

IS: 1322 Bitumen felts for waterproofing and damp proofing

IS: 1346 Code of practice for waterproofing of roofs with bitumen felts

IS: 3067 Code of practice for general design, details and preparatory work for damp proofing and water proofing of buildings



IS: 2645 Specification for Integral Cement Waterproofing Compounds

5.9.11 WATERSUPPLY, DRAINAGE AND SEWERAGE

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

IS: 1742 Code of practice for building drainage

IS: 2064 Code of practice for selection, installation and maintenance of sanitary appliances

IS: 2065 Code of practice for water supply in buildings

IS: 2527 Code of practice for fixing rainwater gutters and downpipes for drainage

IS: 2556 Specification for vitreous sanitary appliances (vitreous china)

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

IS: 12251 Code of practice for Drainage of Building Basement

5.9.12 MISCELLANEOUS

IS: 1905 Code of Practice for structural use of unreinforced masonry

IS: 1641 Code of practice for fire safety of buildings (general): General principles of fire grading and classification

IS: 1642 Code of practice for fire safety of buildings (general): Details of construction

IS: 2210 Criteria for design of reinforced concrete shell structures and folded plates

IS: 2212 Code of Practice for Brickwork

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: 6313 Code of practice for anti-termite measures in buildings

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 on earthquake engineering (IS 1893-1975 and IS: 4326-1976)

SP-24 Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete (IS: 456 -1978)



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: 15	Code of Practice for construction of concrete roads
IRC: 37	Guidelines for design of flexible pavements
IRC: 73	Geometric design Standards for rural (Non Urban) Highways Bridge rules of Government of India, Ministry of Railways (Railway Board)



SECTION 5.10.4

SWITCHYARD AND GAS INSULATED SWITCHGEAR (GIS) BUILDING AND SWITCHYARD CONTROL ROOM

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**5.10.4.1 GENERAL**

Civil & Structural work associated with Switchyard comprising of indoor Gas Insulated Switchgear (GIS) building, switchyard control building and out door equipment such as towers, gantries, lighting poles, lightning masts, equipment support etc. cable trenches, paving, fencing etc.

5.10.4.2 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS / IEC standards including amendments, if any, except where modified and /or supplemented by this specification. Some of the applicable standards are listed below:

Structural works

- 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
- IS : 1161 - Steel tubes for structural purpose.

Fabrication of structures

- IS:802 : Code of practice for use of structural steel in overhead transmission line towers
- IS:808 : Rolled steel beams, channels and angle sections
- IS:813 : Scheme of symbols for welding
- IS:1161 : Steel tubes for structural purposes.
- IS:1367 : Technical Supply Conditions for Threaded Steel Fasteners
- IS : 209 : Zinc Ingot
- IS:1367 : Technical supply conditions for threaded steel fasteners
- IS:1573 : Electroplated coatings for zinc on iron and steel
- IS:1852 : Rolling and cutting tolerances for hot-rolled steel products.
- IS:2016 : Plain washers
- IS:2062 : Steel for general structural purposes
- IS:2633 : Methods of testing uniformity of coating on zinc coated articles
- IS:3063 : Spring washers for bolts, nuts and screws
- IS:4759 : Hot dip zinc coatings on structural steel and other allied products
- IS:6610 : Heavy washers for steel structures
- IS:6639 : Hexagon bolts for steel structures
- IS:7205 : Safety code for erection of structural steel work



IS:7215 : Tolerances for fabrication of steel structures

IS:12427: Threaded Steel Fasteners – Hexagon head Transmission Tower Bolts

Civil works

IS : 456 - Codes of Practice for plain and reinforced concrete.

IS : 802 - Code of Practice for use of structural steel in overhead
(All Parts) Transmission Line Towers.

IS : 1893 - Criteria for earthquake resistant design.

IS : 1080 - Code of practice for Design and Construction of simple spread
foundation.

IS : 4091 - Code of Practice for Design and Construction of Foundations for
transmission line towers and poles.

IRC:6 - Indian Road Congress – Standard Specification and Code of practice for
Road Bridges.

IRC:37 - Indian Road Congress - Guidelines for the Design of Flexible Pavements

Gate & fencing

IS:1161 Steel tubes for structural purposes.

IS:2721 Galvanized steel chain link fabric.

Levels

Top of pedestals for foundation of structures : 300 mm above FGL

Top of cable trench : 150 mm above FGL

Top of paving : 100 mm above FGL

5.10.4.3 LOADING

5.10.4.3.1 General

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 concading 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
- (j) Loads due to conductor tension due to broken wire conditions and shield wire, producing worse effect.

**5.10.4.3.2 Dead Loads**

Dead loads consist of the weights of the complete structure and equipment, conductors, insulators strings, bus bars etc. The unit weight of structural steel shall be considered as 78.5 kN/cum for computation of loads. Unit weight given in IS:875 (part-I) shall be made use for other materials.

5.10.4.3.3 Imposed Loads

Imposed loads in different areas shall include live loads, dust loads, minor equipment loads, cable tray loads, erection loads, operation/ maintenance loads etc. The loads considered shall not be less than that specified in IS:875 (Part II).

5.10.4.3.4 Seismic Load

Seismic forces shall be as per IS:1893 : 2005. Particular attention is drawn to calculation of the design base shear as per relevant clause of the code while using response spectrum method.

5.10.4.3.5 Equipment Load

Static loads of major equipment shall be based on the manufacturer's data of the specified equipment and shall be considered in design in addition to the live load.

Weight of equipment, ducts, conduits, etc. supported by structure shall include maximum possible loading conditions i.e. flooded conditions and associated impacts, test loading, anchorages and constraint effects.

5.10.4.3.6 Wind Loads

Wind load shall be in accordance with IS : 802 (Part 1/Sec1):1995).

The wind pressure on the Towers, Conductor, Ground wire and Insulator strings shall be in line with Clause 8 and Clause 9 and Sub Clauses thereof IS:802 (Part 1 / Sec 1) : 1995.

The wind shall be assumed to blow in any direction and most unfavorable condition shall be considered for design. Wind shall always be assumed to act perpendicular to the Conductor / Rigid bus for structural analysis purposes.

Diagonal wind / inclined wind shall be considered for isolated self-supporting structures like lighting and lightning masts, poles only. Switchyard structures, which are interconnected either by beams or rigid buses, need not be analysed for inclined wind loading.

5.10.4.3.7 Other Loads

- a) Short Circuit Forces in combination with seismic forces along with other normal forces shall be considered for the structural analysis of tower / structures. Short circuit forces and wind forces shall not be considered simultaneously
- b) Other loads shall be as per IS : 802 (Part 1 / Sec 1) : 1995, broadly classified as,
 - 1. Climatic Loads
 - 2. Failure containment loads
 - 3. Construction and maintenance loads

These loads shall be computed in line with Clause 12 and Sub - Clauses thereof of IS : 802 (Part 1 / Sec 1) : 1995.



- c) Anti-Cascading checks, Tension limits, broken wire condition and Strength Factors related to Quality shall be as per IS - 802 (Part 1 / Sec 1): 1995.

5.10.4.4 DESIGN OF STRUCTURES

Three-dimensional analysis shall be carried out for structures like towers and girders while two-dimensional analysis may be adopted for equipment support structures, using standard software package like STAADPro. Any non-standard software used shall be validated with manual calculations and shall be used only with the approval of Owner.

Switchyard structures shall be designed for the worst combination of dead loads, live loads, wind load conditions as per IS: 802, seismic loads, loads due to deviation of conductor, loads due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including snap in case of bundled conductors, etc.

The factor of safety for the design of members shall be considered as 2.0 for normal condition and broken wire condition, 1.5 for combined short circuit and broken wire condition.

Short circuit forces and wind forces shall not be considered simultaneously.

The terminal/line take off gantries shall be checked for ± 30 deg. deviation of conductor in both horizontal and vertical planes.

Permissible stresses, slenderness ratios of members, minimum thickness of steel members, net sectional area of tension members and bolting and framing shall be as per IS : 802 (Part 1 / Sec 2) : 1992.

Wind & Seismic forces shall not be considered simultaneously in any load combination.

The design of structure shall be based on the condition where stringing is done only on one side i.e. all the three conductors broken on the other side. A factor of safety of 2.0 under normal and broken wire condition and 1.5 under combined short circuit and broken wire conditions shall be adopted for design.

Vertical load of half the span of conductors/ string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with the tools shall be considered as 150 kgs for the design of structures.

Terminal/line take off gantries shall be designed for a minimum conductor tension. The distance between terminal gantry and dead end tower shall be taken as 200 meters. The design of these terminal gantries shall also be checked considering ± 30 degree deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

The girders shall be connected with lattice columns by bolted joints.

All pipe support used for supporting equipment shall be designed for the worst combination of dead loads, erection loads, wind loads/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bar as per IS:806. The material specification shall be as per IS:1161 read in conjunction with IS:806.

If luminaries are proposed to be fixed on gantries/towers, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.



Foundation bolts shall be designed for maximum tension occurring when 0.9 times minimum Dead Loads are combined with lateral loads.

Lighting mast shall be of required height shall be provided. Lighting masts shall be provided with a structural steel ladder. The ladder shall be provided with protection rings. Two platforms shall be provided for mounting of lighting fixture. The platforms shall also have protection railing. The details for mounting lighting fixtures would be as per the approved drawings of lighting fixtures

Supporting structures for equipment may either comprise of pipe supports or lattice structural steel supports as per requirement. The pipe supports shall be designed as per IS: 806 and IS: 1161. The lattice steel supports shall be designed as per IS: 802.

Minimum thickness of galvanized lower member shall be as follows:

Members	Minimum thickness (mm)
Leg members, ground wire peak members/ main members	5
Other members	4
Redundant members	4

Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

The minimum bolt diameter shall be 16 mm.

5.10.4.5 STRUCTURES

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.

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.

All steel structure for the Switch yard shall be hot double dip galvanized structure with welded / bolted connections at shop and bolted connection at site.

All bolts and nuts shall also be galvanized.

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.

Towers, beams etc shall be trial assembled at shop, keeping in view the actual site condition, prior to dispatch to erection sites o that they can be conveniently pre-assembled before erection or conveniently assembled during erection.

Each tower shall be provided with step bolts not less than 16 mm diameter and 175 mm long spaced not more than 450 mm apart, staggered on faces on one leg extending from about 0.5 meters above ground level to the tower. The step bolt shall conform to IS:10238. Ladders on towers with lighting appliances shall be provided with safety guards.

Galvanizing

All steel structure for the Switchyard shall be hot double dip galvanized structure with welded / bolted connection at shop and bolted connection at site. All bolts and nuts shall also be galvanized.



The amount of zinc coating for galvanising of Switchyard structures shall be 910 gm./sq.m. for structural members and for bolts, nuts and washers. The same for other non-structural items like fence posts, gates, handrails etc. shall also be 910 gm./sq.m.

Galvanizing of the towers shall be as per IS:4759 and 2633 and as given in the following paragraphs.

Before galvanizing, 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 galvanizing process.

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.

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.

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

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

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

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.

5.10.4.6 FOUNDATIONS

Foundations for switchyard structures shall be reinforced cement concrete.

The type of foundation system, i.e. isolated, strip, or raft to be adopted shall be decided based on the structure, loading arrangement, load intensity and soil strata based on the soil investigation report recommendation. Design of foundations at various levels shall be dependent upon the soil bearing capacity at that level.

All foundations shall be designed for the most critical load combination of dead loads, live loads, inertia forces, wind and seismic loads, short circuit forces and secondary effects such as shrinkage, rise and fall in temperature, swelling and shrinking pressure of soil etc. and other relevant loading from service condition arrived based on detailed structural analysis of the Switchyard gantry structures, equipment superstructures etc.

Foundations for rail track for positioning and jacking of Transformer / reactor shall be provided.

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 on per IS:4091. Contact between foundation and the soil strata shall be ensured for all conditions and combinations of loading.

Foundation for all towers equipment support structure, equipment, railroad and poles shall be designed as per the recommendations of IS : 4091. The structural design of the foundation shall be done as per limit state method of design as given in IS:456

The structural design of the foundation shall be done as per limit state method of design as given in IS:456 and considering the following partial safety factors on working load:

- Normal and broken wire condition 1.5
- Broken wire condition with short circuit forces 1.2

The stability of the foundations shall be checked against overturning, bearing on soil, uplifting, sliding etc. For checking the stability the following factor of safety shall be used:

- Normal and broken wire condition 2.2
- Broken wire condition with short circuit forces 1.65

Normally, all the four legs of tower / gantry structures column / equipment supporting structures shall be supported on a common foundation until and unless the leg spacing of structures at foundation level and soil conditions permit isolated foundation under each leg of the structure.

The pedestal provided for the towers shall be designed for combined action of axial forces viz. compression and tension and bending moments due to horizontal shears in both the longitudinal and transverse directions.

The centroidal P axis of the tower leg shall coincide with the axis of the pedestal. The design of the foundation shall take into consideration the additional forces resulting from eccentricity introduced due to any reason.

The bottom raft / pad shall be designed both for bearing pressure as well as dead load of foundation and over weight of earth. The actual soil pressure under the footing shall be considered to calculate the maximum moments and shears at various sections.

The presence of surface / sub soil water shall be considered in the design of all foundations and underground facilities.

5.10.4.7 TRENCHES / PAVING / FENCING

Trenches

Cable trenches with suitable drainage arrangement with pre-cast RCC covers of removable type, sump pits, oil drainage piping, oil pits, cable tray supports, grounding, etc., shall be constructed in switchyard and transformer areas.

Trenches shall all be of RCC construction. Trench wall shall project 150 mm above the paved / graded level to prevent ingress of storm / rain water.

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



Paving

The complete area within the fencing shall be provided with a mild slope towards peripheral RCC drains which in turn shall be connected to the plant drainage system.

Entire switchyard area shall be provided with 100 mm thick paving using M15 grade PCC.

Fencing

Fencing (with main gates and wicket gates) around switch yard area shall with PVC coated GI chain link fencing of minimum 8G (excluding PVC coating) of mesh size 75 mm and of height 2400 mm above toe wall with 600 mm high galvanised anticlimbing device with barbed wire (8 rows) such that total fence height of 3 m above toe wall is achieved.

5.10.4.8 GAS INSULATED SWITCHGEAR (GIS) BUILDING and SWITCHYARD CONTROL ROOM

Gas Insulated Switchgear (GIS) Building

General arrangement of Gas Insulated Switchgear (GIS) building shall be as per GIS vendor requirements.

Switchyard Control Room

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

Provision shall be made for integration with Stage – II of the power plant extension.

General

The following facilities shall be provided.

1. Control room (Air-conditioned)
2. Relay panels room (Air-conditioned)
3. Battery room
4. UPS and Battery Chargers Room (Air-conditioned)
5. Data room (Air-conditioned)
6. Communication room (Air-conditioned)
7. LV Switchgear room
8. Engineering Room (Air-conditioned)
9. Tariff metering room (Air-conditioned)
10. Cable spreader room
11. Maintenance engineers room (15metreX5metre) (Air-conditioned)
12. Store cum tool room in ground floor
13. Mini Conference Room (5 metreX5metre) (Air-conditioned)
14. Toilet (Men & Women)
15. Pantry Room
16. Room for HVAC

The required furnitures such as Chairs, Tables, Almirahs shall be provided.

Cladding shall be of brick wall and the same shall be supported on RCC beams and plinth beam such that unsupported length is not more than about 3 m.



Pleasing architecture shall be provided for the building.

All partition walls in the ground floor shall be of single brick wall.

Wall around cable vault shall extend up to the ceiling. Cable vault shall be provided with two flush type sheet steel doors. Wall around stores, AHU and stair case also should extend up to ceiling.

Roof shall be accessible by stair.

Stores and AHU room shall have flush type of sheet steel door. Door in AHU room shall be made air tight. Stair case shall have fire proof, automatically closing glazed aluminium door in the first floor. On the ground floor also similar doors shall be provided. Main entrance shall be aluminium glazed double leaf swing door of adequate size with fixed sheet glass glazing in powder coated aluminium frame work on either side.

Separate rolling shutter entry shall be planned for panel movement with a hatch and lifting arrangement / beam on the first floor.

Entry to the air-conditioned area shall be through air lock lobby with aluminium glazed automatic sliding door of adequate size.

All partitions shall be of powder coated aluminium framing with 6 mm sheet glass up to false ceiling. The external partition separating A/C area and non A/C area, above the glazed partition shall be provided in brickwork. All internal partitions in the A/C area shall extend up to the false ceiling.

All doors in Aluminium glazed partition shall be single leaf glazed aluminium swing door.

Control room on the switch yard side shall have continuous fixed glazing in aluminium frame work above 900 mm high Brick wall. For other rooms, aluminium glazed sliding windows may be provided.

False ceiling with aluminium ceiling system shall be provided in the A/C areas.

Under deck insulation shall be provided above the false ceiling on the ceiling as well as for walls as per HVAC requirements.

Roof shall be laid to slope of 1 in 100 using screed or by sloping the top of slab. Heavy duty waterproofing shall be provided as per specification.

In the first floor, stair case shall be given brick enclosure. At least two doors shall be given from the control room to move out during emergency.

Suitably sized porch shall be provided at the main entrance of the control room.

**SECTION 5.11****EARTHWORK AND ROCKWORK****TABLE OF CONTENTS**

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EARTHWORK AND ROCKWORK

5.11.1 GENERAL

This section applies to all earth and rock work required for the construction of buildings, any types of structure and burying service lines in the ground. The contractor shall satisfy himself as to the ground conditions on the site including the nature of the strata to be excavated, obstructions, possibilities of flooding and such like and shall allow for all provisions necessary to carry out the work in the most suitable manner when submitting his tender.

Generally, all buildings and structures must be founded on bearing strata which means that all excavation work for foundations shall meet the requirements of structural analysis based on the results obtained from the soil investigation and of the available information and instruction given in writing by the Owner.

Furthermore, this division applies to excavation works in connection with pavement, roadwork and landscaping as far as earth and rockwork is concerned and deals with the handling and disposal of the materials to be re-used or taken to soil dumps on or off site.

Excavation shall be done to the required dimensions and shall be finished according to the specified lines and slopes, in a way acceptable to the Owner. All necessary precautions shall be taken to cause the minimum possible alteration or disturbance to the material lying under and adjacent to the excavation final lines.

5.11.2 STANDARDS

Unless otherwise specified herein, the following standards shall apply to the works covered here under.

IS:1498	Classification and identification of soils for general engineering purpose.
IS:2720	Method of test for soils (All Parts).
IS:3764	Excavation works – Code of safety.
IS:4081	Safety code for blasting and related drilling operations
IS:7293	Safety code for working with construction machinery.
IS:9759	Guideline for de-watering during construction.
IS:10379	Code of practice for field control of moisture and compaction of soils for embankment and subgrade.

5.11.3 FILL MATERIALS

The fill materials used and source are to be examined and approved. Excavated materials can be used if they fulfill the requirements.

Select fill:

Select fill shall have the following properties:

- Well graded (uniformity index not less than 5), non-cohesive and nearly silt free (silt content not greater than 5%; up to 10% tolerated, except below footings of structures), salt free (content less than 3%), soils free of organic matter (limit 2%).
- Decomposing or compressible materials shall not be used.

All materials shall be of such nature and character that it can be compacted to the specified densities in a reasonable length of time. It shall be free of highly plastic clays, of all materials subject to decay, decomposition or dissolution, and of cinders or other materials which will corrode



pipings or other metal.

The intention is to use select fill below plinth, floors, roads, parking areas etc.

Ordinary fill:

Ordinary fill shall have the following properties:

- i) Natural inorganic soils: salt content not greater than 5%, organic matter less than 3%. For other properties see under 'Select fill'.
- ii) The intention is to use ordinary fill for non-built areas.

Special fill:

Special fill material shall be gravel or crushed rock (for other properties see under 'Select fill'). The intention is to use special fill e.g. as sub-base material for tanks and roads.

Rip-rap / Rockfill

Rip-rap must be of a size suitable for the place where it is to be used, as determined by the speed of the current, wave height and depth of water. Rip-rap shall be of deformable and yielding construction, using round stones if the intention is to safeguard the underlying ground against scour. If the rock infill is to be used as a foundation for structural components, the aim should be to secure effective bedding of angular stones under water. The stones must be weather and waterproof.

5.11.4 EXCAVATION

The works shall be excavated either by hand or by use of excavating plant and tools acceptable to the Owner. Excavation by hand may be required close to existing installations and/or underground services, but subject to special instruction of the Owner. The contractor shall carry out all kind of earth and rockwork for the following particular works as defined hereafter (where applicable):-

- i) Clearing and grubbing
- ii) Excavation of top soil
- iii) Open cut excavation
- iv) Backfilling
- v) Safety precaution during earthwork
- vi) Mining or underground excavation (if required)
- vii) Grading
- viii) Replacement of material
- ix) Trench excavation for service lines
- x) Embankments
- xi) Archaeological findings

The excavation for the foundations can be done by machines, if the underground is not disturbed by this procedure. In every case, the last 20 cm above the foundation level are to be excavated by hand.

5.11.4.1 Safety precaution

The contractor shall be responsible for all necessary safety measures. Proper strutting, sheeting and bracing, including re-arrangement of the installations when necessary, stabilization and protection of slopes, methods of excavation to reduce risks of slides etc shall be to the Contractor's debit. The additional moving of soil resulting from such damages will not be paid for.

**5.11.4.2 Over excavation**

If somewhere, and for any reason, excavation are executed beyond the established design level, the contractor shall at his own expenses backfill with lean concrete to Owner's approval, the volume corresponding to over-excavation. Contractor shall not receive payment for over-excavation not ordered.

5.11.4.3 Pitwall Stability

The excavated pit sides, walls or slopes have to be stable and established with respect to safety regulations:

IS:1200 (Part 1) Method of measurement of building and engineering work

IS:3764 Safety code for excavation work

5.11.5 STOCKPILES AND DISPOSAL

Excavated material from the works selected by the Owner for re-use shall be placed immediately in its final position, if possible, or otherwise may be stockpiled or deposited on site as directed by the Owner.

The contractor shall not have the right either to additional payment or to claim because of work involved in stockpiling materials, re-use of for carting to the waste disposal areas. Soil unfit for re-use shall be removed to sites approved by the Purchaser and shall not be permanently deposited elsewhere. The contractor shall trim and form the edges of spoil to profiles and levels as directed by the Owner.

The placing of materials within the waste disposal areas shall be made in layers not exceeding 0.50 m in thickness in order to obtain an appreciable degree of compaction by means of transportation equipment and/or if required by appropriate compaction equipment.

All traffic to or from the waste disposal areas shall run over the surface of such areas in order to achieve compaction.

5.11.6 PREPARATION OF FOUNDATIONS

All rock surfaces on which or against which concrete is to be poured shall be carefully cleaned and roughened to the Owner's satisfaction. The rock surface shall be free of oil, stagnant or running water, mud, loose rock, residue and impurities or any other improper material. Rock faults, depressions and fractures shall be cleaned to a depth equal to their widths and to sound rock at both sides. Immediately before concrete placing, all rock surfaces shall be thoroughly cleaned by means of air and water jets, wire brushes, sand jets or by any other devices necessary to clean the foundation and keep it free of water, but shall be moistened prior to placing concrete.

All earth surfaces against which concrete is to be poured, shall be clean and free of any detrimental impurities, organic matter or unsuitable material. Immediately after excavation, all such surfaces shall be moistened and treated as directed by the Owner and then protected by means of a lean concrete layer. No concrete is to be poured until formation is inspected and approved by the Owner.

5.11.7 BACKFILLING

Foundations and structures shall be backfilled as shown on the drawings with approved material compacted in layers not exceeding 250 mm by suitable equipment until optimum stability has been obtained to the satisfaction of the Owner. Compacting shall be carried out with special care by means of pneumatic or mechanical rollers or other compactors of a type previously approved by the Owner.



Density requirements as per standard Proctor Test shall be in accordance with relevant parts of IS:2720 and all tests shall be made by/on under the supervision of Purchaser at contractor's own expenses, at optimum moisture content:-

- a) Backfilling of foundations and under grade slabs - 98%
- b) Under roadways and parking areas - 95%
- c) Embankment - 95%

The thickness of fill layers, number of passes and type of equipment to be used shall be proposed to the Owner after compaction tests have been made. Surfaces receiving fill layers shall, if smooth, be previously scarified to obtain a good key between the new fill layer and the sub-grade. Backfilling of foundation work with approved materials shall be carried out only after foundations have been inspected by the Owner.

5.11.8 SOIL REPLACEMENT

The material to be used for replacement of soil shall not contain soluble or swelling components such as clays, or organic matters. Sand gravel mixtures of favourable grain size distribution shall be used in exchange.

Prior to the commencement of work, three samples shall be taken from the anticipated borrow area and tested in respect of IS:2720 or Proctor density, optimum moisture content, grain size distribution and content of soluble matters. These three samples shall cover the approximate variation of materials to be expected within the borrow area.

The fill material shall be placed in horizontal layers of not more than 250 mm in compacted thickness. The fill moisture content shall be controlled and adjusted in order to achieve a maximum of compaction. Fresh water shall be used for watering of soils.

The fill material shall be compacted by vibratory roller (min. weight 20T.). The minimum required degree of compaction shall be as defined under "Tests and Properties". One Proctor and three density tests shall be made at every fourth fill layer prior to continuation of filling work. The testing location will be indicated by the Owner. The contractor shall either provide all required laboratory facilities and staff to perform the tests or he shall co-operate with an experienced soil testing laboratory, subject to the approval of the Owner.

The results of the tests shall be made available to the Owner within 24 hours of the tests. Filling work may be continued in case all tests performed show satisfactory results.

5.11.9 PIPE BED PREPARATION

Pipe beds shall be constructed to guarantee the uniform transmission of loads. The bearing section for supported profiles shall cover at least an arc of 90°. Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template supported at the desired grade, to fit the lower part of the pipe exterior.

Where rock in either ledge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness under the pipe of not less than one quarter of outside pipe diameter with a minimum allowable thickness of 200 mm if not otherwise specified.

Where a firm foundation is not possible at the grade established due to soft, spongy or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected materials as approved by the Owner, properly compacted to provide adequate support for the pipe.

**5.11.10 BLASTING**

The contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosives as per Explosives Rules 1940, corrected up-to-date.

Explosives used for blasting shall be stored in clean, dry, well ventilated magazines to be built for the purpose. Fuses and detonators shall be stored in separate magazines. Detonators and explosives shall be transported separately to the blast site. Explosive shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Only the quantity of explosive required for a particular amount of firing to be done shall be brought to the site of work. All surplus explosives left after filling the holes shall be removed at least 400 metres from the firing point.

A wooden tamping rod shall be used to push the cartridge into the shot hole. Metal rod or hammer shall not be permitted on the site of the works. The charges shall be pressed firmly into place and not rammed or pounded. The explosive shall be fired by means of an electric detonator placed inside the cartridge and connected to the firing cable. 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 and to keep the lead wires short circuited until ready to fire.

Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling. The locations and depths of the holes shall be chosen so that the bed rock below the design level is not shattered and voids, fissures and cracks below this level are not formed. The rock pieces so blasted shall be neatly stacked at allotted places. Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations at least 45 minutes before the firing time by sounding a warning siren.

The area shall be encircled by red flags. All the operations shall be carried out by competent and experienced licensed supervisors. The number of shots fired at a time shall not exceed the permissible limits. Cases of the misfired unexploded charges shall be exploded by drilling a fresh hole alongside the misfired hole (but not nearer than 600 mm from it and by exploding a new charge. The workmen shall not return to the site of firing until at least half an hour after firing. When blasting is conducted in the neighborhood of roads, structures, buildings or any place which requires controlled blasting, only shallow shot holes shall be drilled. These holes shall be filled with a light charge of explosive and the blast controlled by placing steel plates with gunny bags filled with sand or earth over the holes and covering them with wire net fixed to the ground, so as to ensure that the blasted materials do not scatter.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc., shall be taken during blasting operations.

Drilling pattern, charge of explosive for blasting and controlled blasting may be obtained by engaging Government authorized explosive consultant.

5.11.11 DUST CONTROL

The contractor shall use all means necessary to control dust on roads, construction areas and borrow pits. Surfaces shall be regularly watered to prevent dust becoming a nuisance for the public and interfering with the proper execution of the works.

5.11.12 DEWATERING DURING CONSTRUCTION

Prior to the decision for the method and technique to be applied, a comprehensive knowledge of the soil and ground water conditions have to be obtained from the results of the soil investigation



and/or information given in writing by the Owner. All costs for ground water control for keeping the construction pits dry shall be included in the relevant excavation items of the lump sum except otherwise indicated.

The method and technique shall be based on the IS:3764.

The scope of supply includes the installation of all equipment, plants, pipes, machinery, etc and its removal after completion including operation & maintenance of the equipment during the construction period.

Where ever necessary, cofferdams, sheet piles, pump sumps, equipment and channels, troughs, inlet gutters, pipes and any other works required for the water control and discharge shall be part of the scope of supply. The dewatering system shall be designed and installed in such a way that alteration and extensions can be made at any time throughout the operating time, if necessary. Reserve units shall be kept ready for service when failure of any of the installed units occurs. The contractor has to consider the possibility of a temporary failure of any pump, diesel engine and/or the electric power service and shall install emergency power units with sufficient capacity to feed the necessary power to the installed unit at the moment of failure. The contractor shall submit to the Owner, the detailed method of the envisaged pumping system for dewatering, the pump capacity and the standby reserve units. The contractor shall adjust the system if required by the Owner.

The contractor must ensure that any dewatering works will not cause any interference to his own work and to those of other contractors working elsewhere on site or at structures under construction. Any damage occurring during the above mentioned period shall then be made good by the contractor at his own expense.

During the foundation works, the excavated areas, foundation levels, and pits are to be kept free of water down to at least 0.50 m below the foundation level.

All equipment, instruments, machineries, tools, pipelines, etc required for execution of the water control shall be in good repair and shall be kept in good working condition throughout the operation period.

5.11.13 FOUNDATIONS

This clause describes all foundation works which are to be performed so as to ensure the bearing of all loads without detriment for and damage to the structures. The contractor has to choose up-to-date methods and equipment to ensure this in accordance with relevant internationally recognized standards.

The soil conditions met during the foundation works especially in the foundation level are to be checked, recorded and compared with previous known or investigated results. If essential differences occur, which could be detrimental to the structures, the contractor has to inform the Owner and to propose further measures. Foundation works in such areas are to be continued only after approval of such measures by the Owner.

If there is any doubt about the soil quality or if discrepancies appear with regard to the previous decisions or investigations stated by the Owner, then additional measures are to be taken after consulting the Owner (e.g. additional excavation and lean concrete fill).

Immediately prior to concreting any footing, the contractor has to verify the specified soil conditions below the foundation level by a sounding.

For soil improvement works i.e. execution of special foundations (except replacement method) only specialised contractors (or sub-contractors) are acceptable subject to providing proof of experience in successful execution of such works in the form of a detailed description and



references. Together with the description and the references a detailed execution programme including quality control measures relating to the actual site conditions is to be transferred to the Owner for approval.