भारत हेवी इलेक्ट्रिकल्स लिमिटेड
(भारत सरकार का उपक्रम)
BHARAT HEAVY ELECTRICALS LIMITED
(A Govt. of India Undertaking)

TCN - 01

Ref: PSER:SCT:MRK-C1215:TCN-01 Date: 24/06/2011

Sub	Tender change notice (TCN) - 01	
Job	Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.	
Ref	1.0	Tender no PSER:SCT:MRK-C1215:11
	2.0	BHEL's NIT, vide ref no Ref: PSER:SCT:MRK-C1215:11 Dated 09/06/2011
	3.0	Other references (if any).

With reference to above, following points , relevant to tender, may please be noted and complied with while submitting offer.

1.0 Due date of submission of offer is extended from 30/06/2011 to 07/07/2011.
2.0 BHEL clarifications to Bidder's query attached vide Annexure-AA to TCN-01.
3.0 Draft Soil report applicable only for tender purpose is attached herewith.
4.0 7 Nos. of drawings as detailed in the tender are attached herewith.
5.0 Field quality plan for civil works (Erection) and structural steel works (Power House, Mill Bay & Aux. Buildings) (ERECTION) are attached herewith.
6.0 BOQ cum Price schedule format VOL-IIIA, PRICE SCHEDULE, REV-0 has been revised as VOL-IIIA- PRICE SCHEDULE, REV-01 which is enclosed herewith. As such you are requested to consider the revised BOQ/price schedule only and quote your price accordingly. Offer from bidders in superseded price schedule (Vol-III, REV-0) shall not be considered. Bidders are also requested to submit a declaration in techno-commercial offer that they have submitted their price bid in sealed envelope as per REVISED price schedule format (VOL-IIIA , PRICE SCHEDULE , REV-01)
7.0 Revised `No deviation certificate' is attached. Bidder to submit `No deviation certificate' as per attached Format only.
8.0 All other terms & conditions shall remain unchanged.

Thanking you,

Yours faithfully,
for BHARAT HEAVY ELECTRICALS LTD

ENGR (SCT)

Encl

1.0 BHEL's clarifications to bidder's query attached vide Annexure-A to TCN-01
2.0 Draft Soil Report (Tender purpose only).
3.0 7(seven) nos. of drawings (Tender purpose only)
4.0 FQP for civil works (Erection) & Structural Steel Works (erection).
5.0 Revised BOQ cum price schedule format (VOL-IIIA , PRICE SCHEDULE , REV-01)
6.0 Revised `No deviation certificate' format.

पावर सेक्टर पूर्वी क्षेत्र (मुख्यालय)
POWER SECTOR EASTERN REGION, DJ-9/1, SALT LAKE CITY, KOLKATA - 700 091
फैक्स/Fax : (033) 23211960 फोन/Phone : बोर्ड/EPABX : 23211798/ 1691

ANNEXURE - 2

FORMAT FOR NO DEVIATION CERTIFICATE
(To be submitted in the bidder's letter head)

BHARAT HEAVY ELECTRICALS LIMITED,
Power Sector - Eastern Region,
Plot no 9/1, DJ Block, Sector – II, Salt Lake City,
Kolkata – 700 091

Sub	No Deviation Certificate.	
Job	Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura	
Ref	1.0	Tender no PSER:SCT:MRK-C1215:11
	2.0	BHEL's NIT, vide ref no Ref: PSER:SCT:MRK-C1215:11 Dated 09/06/2011
	3.0	BHEL's TCN-01, vide reference no PSER:SCT:MRK-C1215:TCN-01, dated 24-06-2011.

Dear Sirs,

With reference to above, this is to confirm that as per tender conditions, we have visited site before submission of our offer and noted the job content & site conditions etc. We also confirm that we have not changed/ modified the tender documents as appeared in the website/ issued by you and in case of such observance at any stage, it shall be treated as null and void.

We hereby confirm that we have not taken any deviation from tender clauses together with other references as enumerated in the above referred NIT. We hereby confirm our unqualified acceptance to all terms & conditions, unqualified compliance to technical specification, Integrity Pact (If applicable) and acceptance to reverse auctioning process.

In the event of observance of any deviation in any part of our offer at a later date whether implicit or explicit, the deviations shall stand null & void.

We confirm to have submitted offer in accordance with tender instructions and as per aforesaid references.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized
representative of the bidder)

ANNEXURE-AA

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.

S.No.	Reference Clause No of tender Document	Existing Provision	Bidder's Query	BHEL's Clarification
1	Volume IF Clause 15.1.1.1, Pg. no. 7/29	Completion of piling for GT,ST,GTG,STG building - 4 months	Considering the location of the project, minimum one month is required to mobilise the requisite numbers of Rotary Piling Rigs at site.We request to review the MILE STONE for piling work given in the tender document.	Completion of piling for GT,ST,GTG,STG building - 5 months
2	Volume IF Clause 3.00.00 of MODULE-14	SOIL CHARACTERISTICS	We request to provide Soil Investigation Report to appraise the nature of soil and enable to work out most competetive rates.	A Tentetive and Draft Soil Report is attached herewith for consideration in terms of this tender purpose only, without prejudice to any further implication at a later date.
3	Volume IF Clause 5.00.00 of MODULE-C1	SOIL CHARACTERISTICS		STANDS DELETED
4	Volume IF Clause 1, ANNEXURE-II, Pg. 2/20	XVI. Cooling Tower and its auxiliaries.	Your good self would appreciate that construction of Cooling Tower is a special type of work and needs lot of additonal requirements. We request to identify the scope & furnish the quantities under separate items.	It is not possible to indicate separate BOQ for Cooling Tower.
5	Volume IF, SECTION-A, ANNEXURE-II, Pg. 13/20	LIST OF TECHNICAL SPECIFICATIONS		STANDS DELETED
6	Volume IF, SECTION-B, ANNEXURE-II, Pg. 16-17/20	LIST OF DRAWINGS		7 Nos. Drawings (S.No.1 to 7) for tender purpose as indicated in the tender are attached herewith.
7	Volume IF Clause 22.6.1, Pg. 18/29	Allowable wastage – 5 % (five percent) of the theoritical consumption shall be considered.	We request to check & correct the limit of wastage.	Shall be as per Tender Provision.
8	Volume IF Clause 22.4, Pg. 18/29	REINFORCEMENT STEEL & EARTHING MS ROUND WASTAGE	Wastage limit has been given as 5%. Please specify the limit of invisible & visible (Scrap).Please also specify the length of reinforcement to be accepted by BHEL as unused reinforcement.	Shall be as per Tender Provision.
9	Volume IF Clause 30.0, Pg. 21/29	LIQUIDATED DAMAGE- Subject to force majure,penalty a sum equivalent to 0.5 % (half percent) of price for including taxes, duties for delay of each week or part thereof. The liability for delay shall not in any case exceed 5 % (five percent) of total executed contract price of total package.	We request to clarify the clause and consider compensation for LD @ 0.5% of the estimated value of the work remains incomplete for per week delay of the overall work with a maximum ceiling value of 5% of contract value	Shall be as per Tender Provision as detailed in Cl. No. 30.0 of Volume-1F (TCC)
	Volume IB, Clause 2.7.9 Pg. 17	LIQUIDATED DAMAGES/PENALTY- BHEL shall have the right to impose Liquidated Damage/Penalty at the rate of 0.5% of the Contract Value, per week of delay or part thereof subject to maximum up to 10% of the Contract Value.		
10	Volume IB, Clause 2.13.1 , Pg. 22	Normally no advance is payable to the contractor. However, advance payment in exceptional circumstances shall be interest bearing and secured through an equivalent Bank Guarantee and shall be limited to a maximum of 5% of contract value.	We request to consider interest free Mobilization advance @ 10% of the contract value.	Interest bearing recoverable advance is applicable as per relevant Clause (cl no.2.13) of GCC. Cl. No 33.0 of TCC is modified as: INTEREST BEARING RECOVERABLE ADVANCE (IBRA)- Applicable as per GCC.
11	Volume IIIA, 2504 & 2505, Pg. 16/26	Extra over ST. No. 2503 for pile length more than the specified length of 20m below cut off level for the following for 600 mm diameter pile & Rebate on ST.No.2503 for pile length less than the specified length of 20m below cut off level for the following for 600 mm diameter pile.	Pile length given in reffered clause ST 2505 is limited to 12 Mtr & 15 Mtr.However, ST Nos.2504 & 2505 are applicable beyond 20 Mtr length. Please clarify.	Revised BOQ cum Price schedule attached.
12	Volume IIIA, 2606 Pg. 17/26	Supply, transporting, straightening, cutting, bending, placing at any level, binding in position high yield strength steel reinforcements in concrete including cost of reinforcement and binding wire, labour etc complete all as per specifications & drawings (Contractor will provide TMT bar Fe-415/500 quality from SAIL/ TISCO/ IISCO/ SRMB/ SHRICON/ SHYAM STEEL /CONCAST etc). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	The scope of item includes supply of HYSD steel. Kindly clarify whether this item includes supply of HYSD steel by the contractor?	Shall be as per Tender Provision.
13			whether all design drawings required for construction will be issued by BHEL or the contractor is required to submit designs for any structures / foundations	Engineering Construction drawing will be issued by BHEL however Structual fabrication drawings are in Vendor scope.
14	NIT, Annexure-1, Cl. No. 3.0,3.1,3.2 & 3.3 Pg. 7/11	BIDDER SHOULD HAVE EXECUTED/EXECUTING FOLLOWING JOB DURING LAST 7 (SEVEN) YEARS, ENDING ON LAST DUE DATE OF SUBMISSION OF OFFER. RELEVANT SUPPORTING DOCUMENT SHALL BE SUBMITTED. 3.1 CIVIL FOUNDATIONS LIKE GTG (GAS TURBING GENERATOR) OR STG (STEAM TURBINE GENERATOR) FOUNDATION OF RATING 20 MW AND ABOVE 3.2 CONCRETING OF 20000 m3 OF INDUSTRIAL/INFRASTRUCTURAL TYPE CIVIL WORK IN A SINGLE CONTRACT 3.3 BIDDER SHOULD HAVE FABRICATED AND ERECTED IN AN INDUSTRIAL/INFRA-STRUCTURAL TYPE STRUCTURAL WORK OF 2000 MT OF STRUCTURAL STEEL WORK IN A SINGLE CONTRACT	whether the prospective bidder shall qualify the criteria given in para 3.1,3.2 and 3.3 simultaneously or any one of them for being considered eligible for this tender.	Shall be as per Pre-Qualifying Creteria specified in the tender.
15	NIT, Annexure-1, Pg. 7/11		Though Electrical works are quite substantial, no qualification is prescribed for electrical works in the eligibility criteria.	Not required as per Pre-Qualifying Creteria specified in the tender.
16	Standard FIELD QUALITY PLAN FOR CIVIL WORKS AND STRUCTURAL STEEL WORKS are enclosed herewith. All the bidders are requested to consider the same.			

ANNEXURE-AA

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.

S.No.	Reference Clause No of tender Document	Existing Provision	Bidder's Query	BHEL's Clarification
17	On bidder's request, due date of offer submission is hereby extended by 7 days and the revised due date of submission shall be 07/07/2011.			

VOLUME-IIIA, REV-01 **PRICE SCHEDULE**	
JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.	
TENDER NO - PSER:SCT:MRK:C1215:11	
PREAMBLE	
1	This preamble forms part of tender document and schedule of items. The tenderer should read this preamble carefully in filling rates for various items. Clauses under this preamble shall be read in conjunction with various volumes of tender as per NIT together with subsequent changes/ modifications etc thereto as applicable as on date of submission of price offer.
2	The work shall be carried out strictly as per specifications, description of the items in these schedule and / or engineer's instructions.
3	Items of work provided in this schedule but not covered in this specification shall be executed strictly as per instruction of the engineer.
4	Unless specifically mentioned otherwise in the tender document, the tenderer shall quote for the finished items and shall provide for the complete cost towards power, fuel, tools, tackles, equipment, constructional plants, temporary works, labour, dismantling of all temporary piping, structures, valves, pumps, tanks & other misc equipment, strengthening of roads/culverts/bridges etc including arranging all clearances etc required for carrying out different activities & tests, materials, levies, taxes, transport, layout, repairs, rectification, maintenance till handing over, supervisions, colonies, shops, establishments, overheads, profits and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work according to the tender document and this schedule.
5	The quantities of the various items mentioned in this schedule of items are approximate, based on very preliminary information and may vary to any extent or be deleted altogether. The quoted rates of each item will remain firm as long as variation in the total value of work executed under any part of this contract including extra items, if any, but excluding any price escalation remains within 15% (Fifteen percent) of the awarded contract valule as per LOI/WO.
6	The rates quoted shall be inclusive of cleaning of site of any vegetation, dressing and leveling etc including fixing of grid pillars, benchmarks etc required for commencement of site activities. No separate payment will be made towards the same.
7	Rates shall be quoted in figures and in words in clear legible writing. No overwriting is allowed. All scoring and cancellations should be countersigned and in case of illegibility the interpretation of engineer shall be final. All entries shall be in English.
8	The tender shall be deemed to have visited site and made himself aware of all the site conditions, studied the specifications and details of work to the done within the time schedule attached and to have acquainted himself of the conditions prevailing at site.
9	Engineer's decision shall be final and binding on the contractor regarding clarification of items in the schedule with respect to the other sections/volumes of the contract.
10	All works item wise shall be measured upon completion and paid for at the rates quoted and accepted.
11	**ALL THE BIDDERS TO QUOTE MISC ITEM AGAINST ST. NO. 2700. IN CASE BIDDERS FAIL TO INDICATE % (PERCENTAGE) ABOVE, BELOW OR AT PAR, THEN BHEL SHALL ASSUME ALL THE MISC ITEMS TO BE EXECUTED DURING THE COURSE OF CONSTRUCTION AS AT PAR.**

VOLUME-IIIA, REV-01 PRICE SCHEDULE			
JOB: Piling, Civil, structural, architectural work including foundation/super-structure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.			
SUMMARY SHEET			
SL NO.	**DESCRIPTION**	**REFERENCE SCHEDULE**	**AMOUNT (In Rs and In Words)**
A	**MAIN CIVIL AND MISC. CIVIL WORKS**	**SCH-I**	
B	**ELECTRIFICATION WORK AND AREA LIGHTING**	**SCH-II**	
C	**OPERATION & MAINTENANCE OF ELECTRICAL WORK**	**SCH-III**	
GRAND TOTAL (SCH-I + SCH-II + SCH-III)			
NOT	**THE GRAND TOTAL PRICE SHOULD MATCH WITH THE TOTAL PRICES OF SCH-I, SCH-II AND SCH-III**		

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura. (SCH-I)

MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
	LEVELLING & GRADING				
1	Cutting of trees having girth more than 300 mm measured at a height of 1m above ground level including removal of roots, stacking the seviceable material like trunks,branches etc at specified area within the plant boundary and disposal of unseviceable parts/materials withhin a lead upto 1km etc all complete.	EACH	10		
3	Earth work in excavation upto any depth below ground level in all types of soil including moorum, ash which can be excavated by any means for grading including setting out, levelling, dewatering (wherever required), dressing the sides & bottom, levelling to grade, all lifts, ramming/compacting the excavated bottom/graded surface, stacking/disposal of surplus excavated materials within a lead upto 1km, spreading/levelling of disposed materials etc all complete as per specification, drawing and as directed by the engineer-in-charge.	CUM	22772		
9	Earth work in filling upto any depth below ground level for grading to proper grade and level in layers not exceeding 300mm loose thickness with selected approved soil from compulsorily excavated soil available within a lead upto 1km and compacted as specified including re-excavation of stacked earth, all lifts, sorting, spreading, breaking clods, watering, ramming/compaction by manual/mechanical means, dressing, finishing to required lines, grades and slopes, tesing etc all complete as per specification, drawing and as directed by the engineer for the following.				
a	Each layer compacted so as to achieve at least 95% maximum dry density as per IS-2720 (Part-VII)	CUM	25404		
10	Extra over ST No. 1 to 9 for carriage of unserviceable material/earth for every 1 km or part thereof beyond an initial lead of 1km.	CUM	2000		
100	EARTH WORK				
	Earth work In excavation, backfilling and disposal including necessary men/women, materials, equipment, loading, transportation, unloading, dewatering etc as per specification, drawing and as directed by engineer- in-charge for the following.				
101	Earth work in excavation in all types of soil including ash 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	CUM	38338		
b	Depth exceeding 2 m but not exceeding 4 m	CUM	16495		
c	Depth exceeding 4 m but not exceeding 6 m	CUM	1000		
107	Back filling upto any depth below ground level around foundations, plinths, trenches, drains etc to proper grade and level in layers not exceeding 200 mm thickness using/with selected materials from compulsorily 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)	CUM	24495		
109	Extra over ST No. 101 and 107 for carriage of excavated earth/selected materials for every 1 km or part thereof beyond an initial lead of 500m.	CUM	1000		
110	Back filling upto any depth below ground level around foundations, plinths, trenches, drains etc to proper grade and level in layers not exceeding 200 mm thickness using/with approved borrowed soil (borrowed soil to be arranged by the bidder) and compacted as specified including supplying borrowed soil, royalty (if any), 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)	CUM	1000		
112	Supplying and filling CNS (Cohesive non swelling) soil upto the required depth under floors, around foundations, plinths etc. in layers ramming/compaction by manual / mechanical means, dressing, royalty (if any) etc. all complete.	CUM	500		

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura. (SCH-I)

MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
200	CONCRETE WORKS				
	Providing and placing concrete work including cost of labour, materials and equipment for handling, transportation, batching, mixing, placing, vibrating and curing, (excluding cost of centering, shuttering and reinforcement) with mechanised equipments like batching plant, transit mixer, concrete pump etc. complete as per drawing, specifications and as per direction of engineer in charge for the following. CEMENT FOR ALL CONCRETE WORKS SHALL BE ORDINARY PORTLAND CEMENT, 43 GRADE CONFORMING TO IS: 8112. THE ENGINEER INCHARGE MAY PERMIT THE USE OF PORTLAND PUZZOLANA CEMENT CONFIRMING TO IS: 1489 OR PORTLAND SLAG CEMENT CONFORMING TO IS: 455. (CL-7.00.00 OF MODULE C3 OF VOLUME-3, PART E).Cement will be supplied by BHEL free of cost as per TCC.				
201	Concrete of grade M7.5 (1 part cement, 4 part sand, 8 parts of 40 mm graded aggregate by volume) as filling course at any depth below finished floor level, under and around foundations/floors, mass fill etc as per customer specifications in section 09 Module C6 of Part - E, Volume - 3 & clause no. 23.04.00 of Section-II, Part-G, Vol-2.	CUM	1050		
203	Concrete of grade M15 (1 part cement, 2 part sand, 4 parts of 40 mm down graded aggregate by volume) as lean concrete, levelling course, mud mat under and around foundations/floors at any depth below finished floor level etc. as per clause no. 22.02.00 of section-II, Part-G, Vol-2 and drawings, with min. cement content 250kg/m3	CUM	2343		
a	Provind a sliding layer of bitumen paper or craft paper over lean concrete for water retaining structures.	SQ. M	5941		
205	Providing and laying Design Mix cement concrete conforming to IS:456 & IS 10262-2009 for reinforced concrete works with coarse sand and graded hard stone aggregate of size 20mm down in foundations/substructure, grade slab, drains, under floors etc at any level below finished floor level, any shape, position or thickness etc complete including use of plasticizer/ superplasticizer conforming to IS:9103 (latest) to achieve required slump in concrete all complete as per customer specifications in module C3 & C4 of Part - E, Volume - 3 & clause no. 22.31.00 of Section-II, Part-G, Vol-2.and drawing for the following.				
a	M25 Grade (With minimum cement content of 400 kg/m3)	CUM	10109		
206	Providing and laying Design Mix cement concrete conforming to IS:456 & IS 10262-2009 for reinforced concrete works with coarse sand and graded hard stone aggregate of 20mm nominal size in superstructure at any level above finished floor level, any shape, position or thickness including RCC in paving etc complete including use of plasticizer/ superplasticizer conforming to IS:9103 (latest) to achieve required slump in concrete all complete as per customer specifications in module C3 & C4 of Part - E, Volume - 3 & clause no. 22.31.00 of Section-II, Part-G, Vol-2. and drawing for the following.				
a	M20 Grade (with minimum cement content of 300kg / m3)	CUM	2558		
207	Providing and laying Design Mix cement concrete confirming to IS:456 & IS 10262-2009 for reinforced concrete works of in machine foundations for TG, Gas Turbine, ID/FD/PA fans, BFP, Coal mills at all elevations below/above finished floor level including addition of suitable plasticizer conforming to IS 9103(latest) to achieve a slump more than 125mm in concrete as per manufacturer's recommendation with 20 mm nominal size graded aggregate in concrete all complete as per customer specifications in module C3 & C4 of Part - E, Volume - 3 & clause no. 22.31.00 of Section-II, Part-G, Vol-2. and drawing for the following.				
a	M25 Grade (With minimum cement content of 400 kg/m3)	CUM	1070		
209	Extra over St. No. 205 to 208 for controlling of temperature of fresh concrete to less than 25 degree centigrade using ice, including all related arrangements for providing, storing and mixing of ice with water, cooling of aggregates etc. as per customer specification : Module-C8, Part-E, Volume-3.	CUM	550		
210	Extra over ST Nos. 205 to 207 for conducting UPV test for concrete at all levels including all equipments, making necessary arrangements, staging, submission of report etc. all complete as directed by engineer in charge and as per customer specification : clause no. 22.31.00 of Section-II, Part-G, Vol-2.	CUM	550		
211	Providing and encasing of structural steel member with concrete using nominial aggregate size of 12.5mm down. Encased member shall be wrapped with welded wire mesh/chicken wire mesh with proper lap etc. complete as per customer specifications : section 11 of Module-C4 of Part - E, Volume - 3 & drawing for the following.(Payment of welded wire mesh, chicken wire mesh shall be made separately)				
a	M20 grade (With minimum cment content 300 kg/m3)	CUM	400		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
213	Providing and laying Design Mix cement concrete as per IS:456 & IS 10262-2009 for reinforced concrete works using graded aggregate for Concrete in precast works like roof slabs/trench covers, fins, lintels, chajas, beams, columns, wall panels, facias etc.at all levels in all kinds of work including formwork/moulds, curing, rendering the top exposed surface with cement sand mortar (1:3), handling, storing, transpoting, all leads, erection without damage, setting in position with cement sand mortar (1:3), filling the gaps between adjacent preacast units with M30 grade concrete or cement sand mortar (1:3) and including making of holes for bolts for fixing, welding etc.complete with graded aggregate (20/12.5/10 mm) and as per customer specifications : Module-C5 of Part - E, Volume - 3 and clause no.22.08.00 of Sectuion-II, Part G, Vol-2.				
b	M 25 grade (With minimum cement content of 400 kg/m3)	CUM	400		
214	Providing and laying Design Mix cement concrete as per IS:456, IS 3370 & IS 10262-2009 for reinforced concrete works using graded aggregate for Concrete in water retaining/conveying structures including addition of suitable plastisizer cum waterproofing cement additives confirming to IS 9103 latest to achieve a slump more than 125 mm in concrete as per manufacturers recommendation and conforming to limits of permeability as per IS 2545 and as per customer specifications in section-08 of module C4 of Part - E, Volume - 3 & drawing for the following. Completed structures shall pass hydro test as per IS:3370.				
b	M 25 grade(with minnimum cement contenet of 400 kg /m3)	CUM	2284		
215	Dismantling concrete work for all types of structures at all levels including stacking of servicable material to a lead of 500 m and disposal of unservicable material upto a lead of 2 km, cutting of reinforcement, labour, equipment, safety precautions etc all complete as per drawings, specification and instructions of engineer in charge.				
a	Plain cement concrete of all grades	CUM	20		
b	Reinforced cement concrete of all grades	CUM	50		
216	Chipping of concrete in reinforced concrete work, cutting pockets, making openings at all levels and according to shapes, disposal of waste materials upto a lead of 2 km as directed by engineer including equipment, safety precautions, making good the broken surface etc all complete as per specification, drawing, instructions of engineer in charge but excluding cutting of reinforcement .	CUM	20		
217	Extra over and above St No 216 for cutting of reinforcement, all sizes and types including labour, equipment, return of cut reinforcement to store etc all complete as per specification, drawings and instructions of engineer in charge. Measurement shall be on the cross sectional area of reinforcement cut.	SQCM	100		
218	Cutting Reinforced concrete with mechanised tools like Core drilling machine etc. for cutting pockets, holes, cores in slab, beam, column or foundation as per direction of engineer in charge.	CUM	0.25		
300	FORM WORKS				
	Providing, fixing and removing formwork at any elevations for all structures, as per specifications and including all labour, material, scaffoldings and centereing complete including pockets etc. complete as per drawing, specifications and as per direction of engineer in charge for the following.				
301	Fairface form work with good quality water proof ply wood of required thickness and smooth surface below finished ground floor level for foundations, footings, base of columns, walls, columns, pilasters, beams, mass concrete, trenches etc.complete as per customer specifications in section-04 of module C4 of Part - E, Volume - 3 & drawing.	SQM	45487		
302	Fairface form work with good quality water proof ply wood of required thickness and smooth surface above finished ground floor level for columns, beams, suspended floors, roofs, lintels, cantilevers, staircases, landings, balconies, domes, arches, circular overhead tanks etc. for all heights as per customer specifications in section-04 of module C4 of Part - E, Volume - 3 & drawing for the following.	SQM	11508		
303	Fairface Formwork with good quality water proof ply wood of required thickness and smooth surface for TG superstructure (above base raft level) including preparation of scheme, designing, submission and approval of staging drawing with sufficient props, braces and ties at every tier of height of approx. 4m for all heights as per customer specifications in section-04 of module C4 of Part - E, Volume - 3 & drawing .	SQM	550		
304	Providing, fixing and removing formwork in block-outs/pockets and openings (below 0.1 sqm plan area) at all elevations including cutting, formation of all shapes and all other operations required for making the required shape and size all complete as per customer specifications in section-04 of module C4 of Part - E, Volume - 3 & drawing for the following.				
a	Upto 150 mm depth	Each	25		
b	Pockets of depths more than 150mm and upto 300 mm depth	Each	227		
c	Pockets of depths more than 300mm and upto 600 mm depth	Each	24		
d	Pockets of depths more than 600mm and upto 1000 mm depth	Each	10		
e	Pockets of depths more than 1000mm and upto 1500 mm depth	Each	5		

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura. (SCH-I)

MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
400	REINFORCEMENT				
401	Providing, straightening, cutting, bending, placing in position at any level, binding of mild steel reinforcements conforming to grade 1 of IS:432 part 1 in concrete including cost of reinforcement and binding wire, labour, scaffolding, transportation to & from stores etc. all complete as per customer specifications in section-03 of module C4 of Part - E, Volume - 3 & drawing and as directed by the Engineer. Contractor to supply all materials.	MT	1		
403	Transporting from store, straightening, cutting, bending, placing in position at any level, binding in position of steel reinforcements of TMT steel of grade Fe-500D or 500EQR confirming to IS:1786 including cost of binding wire, labour, scaffolding, transportation to & from stores etc complete all as per specifications n section-03 of module C4 of Part - E, Volume - 3 , drawings and as directed by Engineer. Reinforcement material will be supplied by BHEL free of cost as per TCC.	MT	2684		
406	Providing, straightening cutting, bending, placing in position at any level, binding of mild steel reinforcements in brickwork including cost of reinforcement and binding wire, labour, scaffolding etc. complete all aas per customer specifications in section-03 of module C4 of Part - E, Volume - 3 & drawing and as directed by the Engineer. Contractor to supply all materials.	MT	14		
500	WATER PROOOFING WORKS				
	Water proofing works including all labour, material, equipment, transportation, handling, curing, sampling, testing etc at any level as per specification, drawings and as directed by engineer - in - charge.				
501.a	Providing and laying underbed grading plaster with cement mortar 1:4 (1 cement : 4 sand) up to thickness of 25 mm including preparation of surface, batching, mixing, leveling etc. all complete as per customer specifications : Cl no. 23.05.04 of Section-II, Part-G, Vol-2 & Module-C6, Part-E, Volume-3 and as directed by Engineer-in-charge. Cement will be supplied by BHEL free of cost as per TCC.	SQM	2080		
501.b	Providing and laying underbed grading plaster with screed concrete 1:2:4 for thickness greater than 25mm including preparation of surface, batching, mixing, leveling etc. all complete as per customer specifications : Cl no. 23.05.04 of Section-II, Part-G, Vol-2 & Section-07 of Module-C6, Part-E, Volume-3 and as directed by Engineer-in-charge. Cement will be supplied by BHEL free of cost as per TCC.	SQM	2750		
516	Providing and placing good quality water proofing material preferably Master Crete M-81 or equivalent. The application of the same should be done in three layers, first one is used as a prime coat of Master rete-81 or equivalent with cement in 1:2 ratio and 1mm thickness. The second layer is of 3mm thickness and comprises of Polymer modified Mortar with Master Crete M-81 or equivalent @15% by weight of cement-sand. The top layer is 1mm thick and comprises of Master Crete M-81 or equivalent with cement in ratio 1:2. Complete as per customer specifications : Section -07 of Module -C6, Part- E, Volume- 3 and as per the direction of the Engineer-in - Charge.	SQM	4830		
601	Supplying & installation of bitumen impregnated fibre board confirming to IS 1838 as joint filler at joints in concrete including nailing, coating of both faces with coal tar pitch/bitumin etc. all complete as per customer specifications : cl.no.3.11.10 of section-II, Part-G, Vol-2.				
a	12 mm wide joints.	SQM	DELETED		
b	20 mm wide joints.	SQM	DELETED		
c	25 mm wide joints	SQM	98		
602	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 as per customer specifications : cl.no.3.11.10 of section-II, Part-G, Vol-2 & section-o7 0f Module-c4, Part-E, Vol-3				
b	20mmX25mm	RM	660		
603	Supplying and filling in position hot applied bitumin sealing compund (Grade A) confirming to IS 1834/IS 5256 including cleaning, mixing, heating, pouring/injecting sealing compound in gaps in joints including application of primer etc. all complete.				
c	20mmX25mm	RM	261		
606	Providing and fixing PVC water stops in joints conforming to IS 12200 & IS 15058 all complete as per customer specifications : cl.no.22.00.00, 22.13.01 of section-II, Part-G, Vol-2 & section-07&08 0f Module-c4, Part-E, Vol-3				
c	150 mm wide and 6 mm thick	RM	240		
d	230 mm wide and 6 mm thick	RM	390		
608	Providing 150x150 fillets at junction of roof and vertical walls/parapet walls with cast-in-situ cement concrete (1:2:4) nominal mix followed by 12mm thick 1:4 cement sand plaster.	RM	850		
700	MS EMBEDMENTS				
	Embedments including all labour, material, equipment, transportation, handling etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
701	Supply, fabricating and fixing of mild steel embedments, inserts, pipe sleeves, angle pieces, rungs of various diameters, plates of dimensions as required etc. including welding, bolting, cutting, drilling, scaffolding, setting etc. all complete. All materials to be supplied by the contractor.	MT	11.5		

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura. (SCH-I)

MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
703	Fixing of embedments, inserts, pipe sleeves, angle pieces, anchor bolts of various diameters, plates of dimensions as required etc. including scaffolding, setting in position, transportation from BHEL site stores to work spot etc. all complete. All materials to be supplied by the contractor.	MT	9.8		
704.0	Supply, Fabrication, transportation, delivery at site and erection, installation and alignment of mild steel foundation bolt assembly conforming to IS:2062 and grade 1 of IS:432 in concrete along with nuts, lock nuts (as per IS:1363, 1364 and IS:3138), washers, anchor plates, stiffner plates, protective tape, pipe sleeves, templates etc. including welding, cutting, grinding, threading, drilling etc. all complete. All materials to be supplied by the contractor.	MT	14.8		
705	Supplying, fabricating, erecting and installing following items in concrete/brickwall for all kind of works, including setting material in concrete, layout, scaffoling, cutting, forming, grinding, drilling, bolting, welding, jointing, testing etc. all complete. All materials to be supplied by the contractor.				
a	MS pipes of all diameters	Quintal	15		
b	PVC pipes / conduits of all diameters	Quintal	2		
d	Expansion fasteners (mechanical galvanised) of HILTI make or equivalent of safe tensile capacity as specified below for brick work with expansion sleeve of A6 polyamide:				
iii	Beyond 500 Kg and upto 1000 kg	Each	100		
iv	Beyond 1000 kg	Each	200		
e	Expansion fasteners (mechanical galvanised) of HILTI make or equivalent of safe tensile capacity as specified below for concrete work with expansion sleeve of stainless steel:				
iii	Beyond 500 Kg and upto 1000 kg	Each	100		
iv	beyond 1000 kg	Each	200		
800	GROUTING				
	Grouting including all labour, material, equipment, roughening surface, cleaning, ramming, curing etc. at any level unless otherwise specified as per specification, drawings and as directed by engineer - in - charge.				
804.0	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 non shrik free flow grout ConbextraGP-1 or equivalent. (Cost of all material and cleaning of the pockets by compressed air shall be in the scope of the contractor).	CUM	20.7		
805	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 pockets by compressed air shall be in the scope of the contractor).	CUM	4		
900	DOORS, WINDOWS, VENTILATORS, LOUVERS				
	Doors, windows, ventilators, louvers, roof ventilators, rolling shutters, partitions including all labour, material, equipments, transportation, handling, preparation of working drawings etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
903	Providing, fitting and fixing solid core flush door shutter as per IS 2202 part II, 35mm thick homogenous particle board bonded with BWR/MDF type phenolformaldihyde synthetic resin, partical board core conforming to IS 3087 type I, 35x12 mm thick teakwood beading all around including preparation of working drawings. godrej or equivalent make mortice lock with handels on both sides,approved ISI mark anodised fittings like door stopper,300mm long tower bolts,16x300mm long aldrops ,125mm long handles on both sides etc. butt hinges, sliding bolt, knobs, (all fittings shall be anoidised aluminium color dyed), finish synthetic paint over primer, screws etc. all complete as per drawing, specification and instruction of engineer in charge. with commercial faces and teak wood edges. (Finish painting paid separately)	SQM	32		
904	Providing and fixing single or double 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 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 as per customer specifications :4.03.00 Section-04 of Module-C6, Part-E, Volume-3.	SQM	72		
906	Providing and fixing anodized extruded aluminium doors (single or double shutter) conforming to IS:1948, IS:1949 fabricated from extruded sections of HINDALCO/JINDAL or equivalent make having minimum 3mm wall thickness as per IS:1285, IS:733 and anodized and electro color coating of required shade as per IS 1868 (minimum anodized coating of grade AC15). fixed with rawl plugs, expansion fasteners,SS screws / fixing clips necessary filling of gaps at Junctions, at top, bottom & sides with required PVC / neoprene felt for bi-metallic protection etc. Glazing shall be clear float glass/transperant sheet of 5.5mm thickness including snap fit type beading, concealed screws, fixtures, Godrej or equivalent make Mortice lock with handle on both sides, etc all complete. Aluminium section shall be smooth, free of stains, straight, mitred & jointed mechanically wherever required. (Glazing shall be paid separately)	SQM	236		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
907	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 office/signal 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.	SQM	20		
908	Providing and fixing steel windows/ventilator with steel sections as per IS:1038, IS:1361 & IS:7452 latest revision.including all fittings, metal beadings, hold fasts, shop and final painting ,glazing etc. all complete. (Glazing shall be paid separately)				
a	openable type	SQM	216		
b	fixed type	SQM	133		
909	Providing and fixing anodised aluminium work of Jindal, Hindalco or other equivalent approved make for door frames, windows, ventillators, partitions, railing etc with extruded standard tubular and other sections including all fittings & fixtures and accessories of approved make conforming to IS733 and IS1285, anodised and electro color dyed (anodized to min 15 microns) to required shade according to IS 1868 (minimum anodic coating of grade AC15), fixed with rawl plugs, expansion fasteners, SS screws or with fixing clips, including necessary filling of gaps at junctions, at top, bottom and sides with required PVC/neoprene felt for bi-mettalic protection etc.including preperation of working drawings, aluminium cleat angle, aluminium snap-on-beading for glazing/panelling, stair case tread nosing, with all fittings and fixtures (like tower bolts, handles, door stopper with rubber shoes, 'L' drops, stays, floor springs, hydraulic door closures etc.), CP brass/stailess steel screws, providing and fixing hinges/pivots, and making provision for fixing of fitting wherever required including cost of PVC/neoprene gasket, all complete as per drawing, specification and instructions of engineer in charge (Glazing and panelling shall be paid seperately).Weight of aluminium section only shall be measured.	Kg	1164		
910	Providing and fixing of aluminium composite panel(ACP) of following thickness with PVDF or polyester coating for interior partition of approved shade ,color etc all complete as per specification.				
a	3mm	SQM	DELETED		
b	4mm	SQM	DELETED		
c	5mm	SQM	250		
911	Providing and fixing of door closers as per IS 3564 ,of approved make & quality all complete of following type :				
a	Over head hydraulic door closures	Each	12		
912	Providing and fixing pressed steel frames fabricated from 16 gauge M.S sheet mortised, reinforced drilled and tapped for hinges and locks bolts strikes, hold fasts adjustable floor anchors, floor tiles/weather bars ,paintings etc all complete as per customer specifications : Section-4 of Module-C6, Part-E, Volume-3.	Kg	252		
913	Providing and fixing in position rolling shutter complete as per customer specifications : Section-4 of Module-C6, Part-E, Volume-3.				
b	Mechanically Operated	SQM	126		
915	Providing, fixing and fitting of glazing of first grade class in steel/aluminium/wooden frames, where ever required, cleaning after fixing including hardware, gaskets, clips, beadings etc. all complete.				
a	4 mm thick tinted polycarbonate glass	SQM	60		
c	5.5 mm thick clear float glass for aluminium partitions	SQM	263		
f	4 mm thick ground glass for windows/ventilators in toilets complete as per customer specifications : section-05 of Module C6, Part-E, Volume-3.	SQM	63		
g	5.5mm thick tinted glass for windows & ventilators complete as per customer specifications : section-05 of Module C6, Part-E, Volume-3.	SQM	450		
h	6 mm thick plain glass for windows and ventilators complete as per customer specifications : section-05 of Module C6, Part-E, Volume-3.	SQM	50		
i	Two nos. 6 mm thick clear toughened float glass hermetically sealed and separated by 12 mm thick air gap for thermal insulation (only single elevation area to be measured) for double glazed wall panels complete as per customer specifications : section-05 of Module C6, Part-E, Volume-3.	SQM	582		
918	Providing and fixing steel louvered window with ISMC 100 frame all round including verticals with 18G pressed steel louvers, painting etc. all complete.	SQM	57		
1000	BRICKWORK				
	Brickwork masonry including all labour, material, equipment, transportation, handling, scaffolding etc. at all levels as per specification, drawings and as directed by engineer - in - charge. Cement will be supplied by BHEL free of cost as per TCC.				
1001	Providing brick work in cement mortar 1:6 (1 part cement 6 parts coarse sand) in walls, chambers, drains etc. in thickness varying from 230mm to 460mm at all depths, places and positions below plinth including raking out joints, curing, scaffolding etc. complete excluding plastering and painting.				

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
d	Using burnt clay bricks of class designation 5.0 of nominal dimension	CUM	600		
1002	Providing brick work in cement mortar 1:6 (1 cement 6 coarse sand) in walls, chambers etc. in thickness 230mm & 345mm at all heights, places and position above plinth including raking out joints, curing, scaffolding etc complete excluding plastering and painting.				
d	Using burnt clay bricks of class designation 5.0 of nominal dimension	CUM	1232		
1003	Providing brick work in cement mortar 1:4 (1 cement 4 coarse sand) in partition walls, chambers etc. in thickness 115mm at all heights, places and position above or below plinth/graded level including providing two nos. 6 mm diameter MS bars at every third layer, raking out joints, curing, scaffolding etc complete excluding plastering and painting as per specification.				
d	Using burnt clay bricks of class designation 5.0 of nominal dimension	SQM	250		
1010	Supply and placing in position mild steel wire fabric of square mesh 25 mm size and wire diameter of 2 mm for encasing of steel sections in concrete including cutting, bending, fixing etc. complete.	SQM	170		
1012	Providing and filling brick bats in soak pits all complete.	CUM	20		
1100	DAMP PROOF COURSE				
	Damp proof course including all labour, material, equipment, transportation, handling, shuttering, centering, curing etc at any level as per specification, drawings and as directed by engineer - in - charge. Cement will be supplied by BHEL free of cost as per TCC .				
1101	Providing Damp Proof Course with 50mm thick 1:1.5:3 cement concrete (10mm and down graded aggregate) with approved admixture of water proofing compound all complete as per manufacturer specifications. Two layers of hot bitumen coating 85/25 grade as per IS:702 @ 1.7Kg./sqm shall be applied on the top of DPC. Cement will be supplied by BHEL free of cost as per TCC.	SQM	624		
1200	CEMENT MORTAR PLASTER				
1202	Providing 18mm thick plaster in two layers of first 12mm and second 6mm thick outside (rough side) the building/boundary wall in cement mortar 1:4 on walls, finished to a smooth finish including providing 3mmx3mm size grooves at junctions of two dissimilar materials all complete complete as per customer specifications : Section-02 of Module-C6, Part-E, Volume-3. Cement will be supplied by BHEL free of cost as per TCC.	SQM	5246		
1203	Providing 12mm thick plaster inside (smooth side) the building wall in cement mortar 1:6 on walls finished to a smooth finish all complete as per customer specifications : Section-02 of Module-C6, Part-E, Volume-3. Cement will be supplied by BHEL free of cost as per TCC.	SQM	6509		
1207	Providing 6mm thick plaster on ceiling in cement mortar 1:4 finished to a smooth all complete as per customer specifications : Section-02 of Module-C6, Part-E, Volume-3 . Cement will be supplied by BHEL free of cost as per TCC.	SQM	3127		
1210	Forming groove of uniform size from 12X12 mm upto 20X15 mm in plastered surface as per approved pattern, using wooden battens nailed to the under layer, including removal of wooden battons, repair of the edges of plaster panel and finishing the groove etc. complete as per specification, drawing and the instructions of engineer in charge. Cement will be supplied by BHEL free of cost as per TCC.	RM	500		
1211	Providing drip coarse on plastered surface at all elevations for all type of work such as chajjas, parapet, projections etc. including scaffolding, finishing etc. complete with all labour, tools and plants as per specification, drawing and instructions of engineer in charge. Cement will be supplied by BHEL free of cost as per TCC.	RM	650		
1300	FINISHES TO CONCRETE / PLASTERED SURFACES				
	Finishes, painting to concrete, plastered surfaces including all labour, material, equipment, surface preparation, scaffolding etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
1303	Providing and applying two or more coats of oil bound destemper as per IS 428 of approved brand, shade and manufacture to give smooth, hard, durable & glossy finish over a coat of primer over prepared plaster surface all complete as per customer specifications : clause no. 23.08.04 of section-II, Part-G, Volume-2 & Section-13 of Module-C6, Part-E, Volume-3.	SQM	4512		
1305	Providing and applying two or more coats of acrylic emulsion paint as per IS 5411 of approved brand, shade and manufacture to give smooth, hard, durable & glossy finish over a coat of primer over prepared plaster surface all complete as per customer specifications : clause no. 23.08.03 of section-II, Part-G, Volume-2 & Section-13 of Module-C6, Part-E, Volume-3.	SQM	1116		
1307	Two or more coats of fire resistant transparent paint as per IS 162 on all woodwork over french polish as per IS 348 or flat oil paint as per IS 137 of approved grade and manufacture to give an even shade as per specifications.	SQM	41		
1310	Providing and applying 2 coats of water proof cement based paint as per IS:5410 of approved make and color on exterior surface at all heights including material, labour, scaffolding, curing etc over a primer coat all complete as per customer specifications : clause no. 23.08.02 of section-II, Part-G, Volume-2 & Section-13 of Module-C6, Part-E, Volume-3.	SQM	7781		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
1312	Providing and applying 2 mm thick plaster of paris punning on walls including preparation of surface, staging, etc. to achieve a smooth even surface all complete as per customer specifications : clause no. 23.07.02 of section-II, Part-G, Volume-2 & Section-02 of Module-C6, Part-E, Volume-3.specification and as directed by Engineer.	SQM	200		
1317	Providing and applying chlorinated rubber based paint over a coat of primer as per IS : 9862 and specifications 23.08.05 of volume-2, part-G , section II and section 13 of module 6, vol. 3 part -E	SQM	615		
1318	Providing and applying water bound distemper to all plastered ceilings over a coat of primer.	SQM	1950		
1319	Providing and applying oil resistant paint over a coat of primer as per IS : 161 in areas where there is oil spillage and oil equiment rooms all complete as per customer specifications : Section-13 of Module-C6, Part-E, Volume-3.	SQM	150		
1400	FLOORING AND SKIRTING				
	Flooring and skirting at any level including base layer, labour, material, equipments, transportation, handling, curing, polishing etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
1401.a	Providing and laying 50 mm thick heavy duty cement concrete in flooring with metallic hardener pigmented topping 12mm thick uniform graded treated iron paricles in flooring. Under layer of 38mm thick cement concrete mix 1:2:4 (1 cement: 2 sand : 4 stone aggregates 12.5mm well graded) and top layer of 12mm thick metallic concrete of mix 1:2 (1 cement hardner mix with approved quality 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) all complete as per customer specifications : clause no. 23.01.05 of section-II, Part-G, Volume-2 & section-03 of Module-C6, Part-E, Volume-3. Cement will be supplied by BHEL free of cost as per TCC.	SQM	4479.55		
1401.b	Providing and laying 50 mm thick heavy duty cement concrete in flooring with non-metallic hardener 12mm thick, Under layer of 38mm thick cement concrete mix 1:2:4 (1 cement: 2 sand : 4 stone aggregates 12.5mm well graded) and top layer of 12mm thick non metallic concrete of mix 1:2 (1 cement 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) all complete as per customer specifications : clause no. 23.01.05 of section-II, Part-G, Volume-2 & section-03 of Module-C6, Part-E, Volume-3. Cement will be supplied by BHEL free of cost as per TCC.	SQM	770		
1402a	Same as 1401a but in skirting	SQM	70.5		
1402b	Same as 1401b but in skirting	SQM	40		
1405.b	Providing cast-in-situ Terrazo finish to staircases 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 25mm all complete as per customer specifications : Cl.no.23.01.09 0f Section-II, Part-G, Volume-2 & section-03 of Module-C6, Part-E, Volume-3. Cement will be supplied by BHEL free of cost as per TCC.	SQM	200		
1416	Providing and laying vitrified ceramic tiles of polished variety of size 605 x 605 mm from reputed / approved manufacturer, complete including underbed of cement mortar 1:3 with neat cement slurry etc. all complete as per customer specifications : clause no. 23.01.10 of section-II, Part-G, Volume-2 & clause 3.06.00 section-03 of Module-C6, Part-E, Volume-3. Cement will be supplied by BHEL free of cost as per TCC.				
b	10mm thick tiles In flooring	SQM	25		
d	10mm thick tiles In skirting and dado upto specific height.	SQM	10		
1419	Providing and laying granite stone slab of minimum 20mm thickness single piece of approved colour with cutting,making corners,moulding and opening etc. over an under bed of 1:3 cement sand mortar all complete as per customer specifications : clause no. 23.01.11 of section-II, Part-G, Volume-2 & section-03 of Module-C6, Part-E, Volume-3. Cement will be supplied by BHEL free of cost as per TCC.	SQM	200		
1421	Providing and laying Heavy Duty dust pressed (grade-5) Ceramic Tiles (Matt Finish) of size 300x300mm(approved size) and 7mm thick of reputed / approved manufacturer (Kajaria,jhonson,Spartek or equivalent) of approved finish, shade and colour in flooring/Dado . The tiles shall be scratch resistance of minimum 5 on Mohr's scale and shall have a bending strength of 350 Kg./sqm,with Under bed shall average 43mm thk of 1 cement : 2 sand : 4 stone aggregates by volume and brought to proper level including cement mortar all complete as per customer specifications : clause no. 23.01.06 of section-II, Part-G, Volume-2. Cement will be supplied by BHEL free of cost as per TCC.	SQM	258.52		
1422	Providing & fixing Acid / Alkali resistant (Chemical resistant) tiles confirming to IS:4457 in flooring/Dado and shall be laid over a bitumen layer followed by bitumastic lining of min 12mm thick, 6mm thick furane resin or epoxy resin mortar bedding and 20mm, thick acid / alkali resistant tiles jointed with acid/alkali resistant cement slurry as per IS:4457 shall be provided complete as per customer specifications : clause no. 23.01.12 of section-II, Part-G, Volume-2 & section-03 of Module-C6, Part-E, Volume-3.The tiles should be abrasion resistant & durable.				

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
a	20mm thick	SQM	284		
1423	Providing & fixing Acid / Alkali resistant (Chemical resistant) tiles confirming to IS:4457 in flooring/Dado jointed with with acid/alkali resistant cement slurry. Bedding , jointing and pointing shall comprise of furane resin / epoxy resin mortar conforming to IS:4832 (Part-II) all complete for following thicknesses. Total thickness of finish shall be 50mm. The tiles should be abrasion resistant & durable as per customer specifications : clause no. 23.01.07 of section-II, Part-G, Volume-2 & section-03 of Module-C6, Part-E, Volume-3.				
a	20mm thick tile	SQM	375		
1427	Providing and fixing glazed ceramic tiles of approved color and design of size 200 x 300 mm / 300x300mm in dado of approved size, projecting 6mm uniformly from adjacent plaster or wall finish. The mix for underbed plaster shall consist of 1part cement and 3 parts sand by weight. fairly moist but firm, tiles shall be pressed over under bed by applying cement slurry including pigments, curing etc all complete for following thicknesses: Cement will be supplied by BHEL free of cost as per TCC.				
a	5mm thick	SQM	440		
1428	Providing and laying 2mm thick antistatic PVC flooring / skirting of approved shade,as per IS:3426 and laying as per IS:5318 over an underbed of 38mm, all complete as per customer specifications : clause no. 23.01.02 of section-II, Part-G, Volume-2 & clause 3.11.00 ,Section-03 of module C6, part-E, Volume-3.	SQM	249		
1432	Providing and fixing removable type false flooring system with minimum height of 1m consisting of fire resistant phenol formaldehyde bonded particle board panels of size 600X600X35 mm, mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space . 2 mm thick flexible anti static PVC topping and PVC srtip edging on sides of each pane, including proprietary floor supporting system all complete as per customer specifications : clause no. 23.01.01 of section-II, Part-G, Volume-2 & Section-17 of module C6, part-E, Volume-3.	SQM	253.5		
1500	ROOFING / SIDE CLADDING				
	Roofing / side cladding work including all labour, material, equipment, transportation, handling, scaffolding, laps, hooks, washers, corner pieces etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
1501	Designing, providing and fixing permanently color coated galvanised MS troughed metal sheet decking plate of approved colour and conforming to class3 of IS 14246 over roof purlins for cast-in-situ roof slab as per relevant IS code and specification. Bare metal thickness of deck plate shall be minimum 1mm with minimum trough depth of 44 mm having minimum yield strength of 250 MPa and shall serve as permanent shuttering to the roof slab minimum 65mm thick measured over crest of metal decking & shall have adequate strength to support weight of green concrete and imposed loads of min 150 kg/sqm during construction between purlins as per manufacturer's recommendations/ calculations/ test certificates for approval including fixing of plates to purlins, side lapping, end lapping etc. all complete for below mentioned spans. The sheet shall be permanently coated with silicon modified polyster paint of minimum 20 micron DFT on exposed surface (facing operating floor) applied over hot dipped galvanising @ 180 gm/sqm including fixing of sheet to purlin with hwlp of 8mm dia electro galvanized 'L' or 'J' hook bolts. These hook bolts shall confirm to IS : 730 and galvanizing shall confirm to IS : 1573. These hook bolts shall be provided at about 300mm c/c along the length of purlins, whose spacing shall be about 1900mm c/c. These bolts shall be located preferebly in valley only. The holes for bolts shall be punched. The bolts shall be provided with Neo-prene metal washers, nuts and lock nuts complete. Stainless steel self tapping screws shall be used inplace of the hooks for fixing of the sheets where ever shown on the drawing. Stich screws between two adjacent sheets and sealing with epoxy sealant. Measurement of profile sheeting shall be of the plan area of roof covered by MS trough metal decking.All complete as per customer specifications : Cl.no.23.05.01 of Section-II, Part-G, Volume-2 & Section-06 of Module C6, Part-E, Volume-3.				
a	Span upto 1000 mm	SQM	6675.2		
b	Span Exceeding 1800mm and upto 2500 mm	SQM	837.9		
1502	Providing and fixing shear connectors of mild steel studs having 16mm dia and minimum 75 mm projected length above purlin passing through metal decking as per relevant IS codes and specification.	QUINTAL	7.5		
1504	Designing, providing and fixing Permanent colour coated sheet aluminium alloy of AA 5050 or any other equivalent corrosion resistant grade. External face of the sheet shall be permanently coated. Permanent coating shall be provided with coil coating-cum-baking-method or any other internationally accepted practice unless other wise specified. Coating shall be durable and last for a minimum of 10 years. The finished coat side of the sheets, polyurethane of similar type high quality organic paint shall be used. Minimum thickness of the coating including under bed shall be 30 microns.Shade and colour shall be as approved by the Engineer-inCharge. All complete , with fasteners and fixings as per customer specifications : Cl.no.23.03.00 of Section-II, Part-G, Volume-2 & clause 6.05.00 ,Section-06 of Module C6, Part-E, Volume-3.	SQM	8126		
1600	FALSE CEILING				

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
	False ceiling including all labour, material, equipment, transportation, handling, suspension system etc at any level as per specification, drawings and as directed by engineer - in - charge.				
1602	Providing, fixing and laying light weight fissured mineral fiber board false ceiling of armstrong make (RH 90) or equivalent of minimum thickness 14 mm , surfaced with random fissured with 3 coats of white paint and back side sanded with one coat of paint,with aluminium suspension grid system of main and cross Tees suspened by 2mm thick prestretched GI wire with soffit cleat and GI rawl plug @ 1200mm c/c. Tees shall be 32mm web height and 24mm wide unless and other wise specified for main runners of approved colour and make as per specification . Additional hangers and height adjustment clips shall be provided for return air grills, light fixtures. A.C. ducts etc. The size of board shall be 600 X 600 mm. Required MS channel shall be measured & paid extra under respective item unit rate.all complete as per customer specifications : Cl.no.23.11.00 of section-II, Part-G, Volume-2 & Section-18 of Module C6, Part-E, Volume-3.	SQM	959		
1700	RAIN WATER DOWN TAKE PIPES				
	Rain water down take pipes including all labour, material, transportation, 2 coats of approved paint over one primary coat, fixtures, accessories etc at any level as per specification, drawings and as directed by engineer - in - charge.				
1703	Providing and fixing CI down take pipes of 150mm dia with water tight lead joint etc. all complete as per customer specifications : Cl.no.23.05.06 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.	RM	2034		
1800	MISCELLANEOUS WORKS				
	Miscellaneous works including all labour, material, equipment etc. at any level unless otherwise specified as per specification, drawings and as directed by engineer - in - charge.				
1803	Anti termite chemical treatment of soil with Chlorpyriphos/Lindane E.C. 20% with 1% concentration conforming to IS:8944 and as per IS 6313 all complete. (Plinth area of building at ground floor only shall be measured for payment)	SQM	2270		
1808	Providing and fixing aluminium strips minimum 18 SWG thk and 300mm wide over expansion joints with minimum lap of 50mm length including brass / aluminium screws, rawl plugs etc. all complete.	Kg	50		
1809	Providing Chemical injection grouting with pressure pump for water retaining concrete structures conforming to IS:6494, including fixing nozzles, cost of approved cement, admixture, curing etc. all complete . Payment shall be made as per the consumption of chemical grout.	Kg	100		
1810	Transporting from site store, laying and fixing rails and guide rails in concrete for transformer, rail track including cutting of rails, joining of rails, anchoring lugs etc all complete . BHEL will issue transformer rail free of cost	MT	3		
1811	Providing and fixing weep holes in Drains consisting of 100 mm dia HDPE pipe sleeves with single side covering for the pipe mouth with galvanised welded wire fabric of 20 mm sq. opening covered with 40 mm downgraded aggregates in 300 X 300 mm sq. and 300 mm deep size all complete.	EACH	400		
1812	Laying of earthing mats/rods including risers, transportation from yard stores, loading, unloading, cutting to length, welding, protective painting of joints etc. all complete. (Excavation & Back filling shall be paid separately under respective item of earth work. Earthing mats/rods shall be supplied by BHEL free of cost as per TCC)	MT	19		
1813	Providing Earthing pit as per drawing with charcoal & salt, GI pipes, GI earth electrodes, GI wire, GI strips, brick chamber with covers including associated earthwork etc. all complete.	EACH	57		
1814	Construction of below ground earthing system test pits as per drawing/ sketches including brickwork, plaster, concreting, reinforcement, formwork, providing & fixing GI strips/pipes, GI wires, covers etc as per drawing & specification including associated earthwork.	EACH	20		
1815	Providing and fixing GI rungs in concrete/brick walls having zinc coating of minimum 900 g/sqm etc. all complete.	Kg	150		
1817	Providing and fixing HDPE pipes in concrete/ brick work of following sizes including cutting, fixing and levelling in position etc. all complete.				
c	150 mm dia	RM	150		
d	200 mm dia	RM	150		
1818	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.	SQM	1000		
1824	Supply & fixing expanded metal steel sheet conforming to IS:412. Size of mesh shall be 10mmX40mm with strands of 2.5mm width and 1mm thickness to the structural steel for facilitating fireproofing works.	SQM	2000		
1825	Supply and laying approved quality Stone aggregate 40mm size in transformer yards.	CUM	75		
1828	Dismantling old existing reinforced/non-reinforced brickwork/blockwork/stone masonary work in mud/lime/ cement mortar at any level including clearing/cleaning, stacking the serviceable materials at plant site and disposal of unserviceable materials within a lead upto1km all complete.	CUM	50		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
1831	Sprinkling of water by water tanker fitted with perforated GI pipe (portable tanker minimum 3000 litre capacity) for roads and miscellaneous area within plant boundary, for dust supression and reduction of suspended material at site for day to day work, as directed by BHEL site engineer (water for this purpose shall be provided by BHEL free of cost and utilisation of machine will be in terms of Tank-hour put in actual use for water sprinkling).	TANK-HR	800		
1835	Providing 450mmx450mm size Khurras having minimum thickness of 30mm with 1:2:4 concrete over PVC sheet of 1mx1mx400 micron and finished with 12mm thick cement sand plaster	NOS	38		
1836	Construction of spetic tank & Soak pit for 25 nos users all complete as per clause no. 8.00.00 of module C7, volume 3 part-E	Nos	1		
1837	Supply of Indian standard MS angles , channels and pipes of various sizes conforming to IS :2062 for use in electrical works	MT	80		
1838	Supply of an Architectural model to a scale of 1:500 , made in wood, showing the overall development of plant area	NOS	1		
1839	Supply of an Architectural model to a scale of 1:200 , made in plastic, showing main plant building with detailed architectural treatment.	NOS	1		
2000	FENCING AND GATES				
	Fencing and gates including all labour, material, equipment etc at any level as per specification, drawings and as directed by engineer - in - charge.				
2004	Supplying and erecting in position 2.4 m high gavanised chain linked fencing conforming to IS 2761 of 10G hot dip galvanised steel wires woven in the form of zigzag mesh giving an opening size of 50 mm square. Concertina of height of 600 mm at top of chain link fencing shall be provided with all accessories. Concertinal shall be from tensile serrated galvanised wire (HTSW) made with wire diameter of 2.5 mm which will be stretched to 6m and attached on two strands of galvanised HTSSW (high tensile spring steel wire) of 2.5mm dia by means of clips at 1m interval. These two HTSSW strands will be attached to the fence posts/ angles with 12 mm security fasteners. Cost to include for GI hook bolts, rings & washers, hot dip galvanised tension wires, 25X6 mm GI flat stretcher bar at end posts etc. all complete. All materials are to be supplied by the contractor.	RM	150		
2008	Supply, fabrication and fixing of mild steel posts for fencing including painting etc all complete. All materials are to be supplied by the contractor.	MT	0.05		
2009	Supply, fabrication and installing in position and testing hot dipped galvanised MS Gates out of channels, joists, angles, flats, plates, pipes, welded steel wire mesh & sheets including stiffners, bracings, fabricated hinges, MS Aldrops with locking arrangement, tempered steel pivot, guide track of MS Tee, bronze aluminium ball bearing arrangements, castor wheels, paintings etc. all complete. All materials are to be supplied by the contractor.	MT	0.5		
2100	WATER SUPPLY				
	Water supply work including men, material, equipment etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
2101	Providing and fixing in position tested heavy duty type chromium plated (CP) brass long neck bib cocks including sockets, union, nuts etc all complete - 15mm nominal bore.	EACH	6		
2102	Providing and fixing in position heavy duty brass stop cock of approved quality including all specials etc all complete - 15mm nominal bore.	EACH	2		
2104	Providing and fixing GI pipes class B medium class conforming to IS:1239 pipes shall be concealed and painted with anticorrsive 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 as per the customer specifications : Cl.no.19.02.00 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.				
a	15 mm nominal bore.	RM	193		
2105	Providing and fixing galvanized mild steel pipe, medium grade, conforming to IS:1239 shall be used. Pipe fittings shall be sued to suit the site requirenments all complete as per customer specifications : Module C7 of Part-E, Volume-3.				
a	15 mm nominal bore.	RM	65		
b	20 mm nominal bore.	RM	20		
c	25 mm nominal bore.	RM	DELETED		
d	50 mm nominal bore.	RM	DELETED		
2106	Providing and fixing 600mmx450mmx6mm min) thk mirror with bevelled edges from reputed mirror manufacturer. Mirror shall be mounted with glass adjustable revolving CP brackets with CP screws etc all complete as per customer specifications : Cl.no.19.05.00 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.	EACH	8		
2108	Providing and fixing 20 mm diameter C.P. brass towel rails (600mm X 20mm) all complete as per customer specifications : Cl.no.19.05.01 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.	EACH	8		
2110	Providing and fixing glass liquid soap holder mounted with C.P. screws etc all complete.	EACH	8		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
2111	Providing and fixing stainless steel / C.P. liquid soap dispenser. Dispenser shall be round and easily revolving with removable threaded nozzle and mounted on C.P. brackets etc all complete.	EACH	7		
2112	Providing and fixing glazed vitreous wall mounted paper holder with suitable cover cum cutter fitted with CP screws etc. all complete as per customer specifications :Cl.no.19.05.01 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.	EACH	6		
2114	Providing & fixing in position P.V.C. water tank of Syntex or approved equivalent including making all necessary inlet & outlet pipes, fixture, ball cocks, valves etc all complete for following capacities. GI pipes shall be paid separately under ST No. 2105.				
a	1000 litres capacity	EACH	2		
b	2000 litres capacity	EACH	5		
2116	Providing and fixing Hand dryer with photo voltaic controlled operation	EACH	2		
2200	SANITARY WORKS				
	Sanitary work including all labour, material, equipment etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
2201	Supply and fixing glazed vitreous china Wash Basin conforming to IS:2556 part 4 of oval shape to be fixed on concrete platform finished with 12mm thick granite stone, 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 as per customer specifications : Cl.no.19.05.00 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.				
a	White	EACH	9		
2202	Providing and fixing approved vitreous china laboratory sink of size 600x400x200 mm conforming to IS:2556 (part-5) with R.S. or C.I. brackets, chromium plated brass chain with rubber plug 40mm, CP brass waste and 40mm CP brass trap with necessaary union complete including painting the fittings, cutting and making good the wall where required etc. all complete.	EACH	2		
2203	Providing and fixing stainless steel kitchen sink of size 610x510x200mm conforming to IS: 13983 including all fittings etc. all complete as per customer specifications : Cl.no.19.05.04 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.	EACH	1		
2204	Providing and fixing colour glazed vitreous china European type water closet conforming to IS:2556 with siphon, open front solid plastic seat and plastic cover, low level manually operated10 litre Vitreous china flushing system conforming to IS:774 with valveless fittings, necessary C.P connections etc all complete as per customer specifications : Cl.no.19.05.01 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.				
a	Floor mounted	EACH	4		
2205	Providing and fixing colour glazed vitreous indian type Orissa pattern (580x440mm) water closet conforming to IS:2556 part 3 with all fittings including foot rests, low level manually operated10 litre cistern of cast Iron / Glass Fibre Reinforced Plastic (GRP) conforming to IS:774 or IS:7231 with valveless fittings, necessary C.P connections etc all complete as per customer specifications : Cl.no.19.05.00 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.	EACH	10		
2206	Providing and fixing white flat back glazed vitreous china bowl type urinals of size 430x260x350 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.white vitreous china partition slabs of size 825x450x100mm conforming to IS: 2566 (part6/Sec.4) shall be used. All complete as per customer specifications:Cl.no.19.05.00 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.	EACH	10		
2207	Providing and fixing sand cast iron/centrifugally (spun) cast iron pipes fittings and accessories conforming to IS: 1729 and 3989 respectively shall be used for all sanitary works above G.Level. Pipes shall be coated with coal tar by hot dipping process for both inner and outer surface. All complete as per customer specifications: Cl.no.19.03.00 of section-II, Part-G, Volume-2 & Module C7 of Part-E, Volume-3.				
a	75mm dia pipes	RM	100		
b	110mm dia pipes	RM	40		
c	160mm dia pipes	RM	30		
2209	Providing, laying light duty non pressure NP2 class RCC pipes for sewer and drain with collars jointed with stiff mixture of cement mortar 1:2 including testing of joints etc complete as per customer specifications : Module C7 of Part-E, Volume-3.				
a	150mm dia	RM	100		
b	250mm dia	RM	50		
2210	providing and laying stoneware pipes used for sewer and drain of drain conforming to grade A of IS : 651				
b	250mm dia	RM	150		

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ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
2212	Providing and fixing circular heavy duty C.I. manhole cover of 600 mm dia with frame etc. all complete.	EACH	25		
2214	Providing and fixing square mouth minimum 65cm S.W Gully trap grade 'A' complete with CI grating, brick masonry chamber and water tight CI cover with 300x300mm (inside). The weight of cover to be not less than 4.53 Kg and frame to be not less than 2.72 Kg etc all complete as per customer specifications:Module C7 of Part-E,Volume-3.				
c	150x150mm P or S Type.	EACH	12		
2215	Providing and fixing C.I. floor traps with C.P jalli all complete.	EACH	12		
2217	Providing and installing approved brand single tap water cooler of 80 L cooling capacity all complete.	EACH	3		
2220	Providing and fixing an eye & face fountain (combined unit with receptacle) conforming to IS:10592. All complete as per customer specifications : Cl.no.19.05.02 of Section-II, Part-G, Volume-2 & Module-C7 of Part-E, Volume-3.	EACH	4		
2300	STRUCTURAL STEEL				
	Structural steel works including all labour, material, equipments, transportation, handling etc. at any level as per specification, drawings and as directed by engineer - in - charge.				
2301	Transport from Site Store, fabrication and erection of structural steel with mild steel rolled section / built up section / combination of both conforming to IS:2062, pipes conforming to IS:1161/ IS:1239, chequered plate conforming to IS: 3052, mild steel rounds, monorails, stays, safety chains, ladders, MS grating etc. in columns, beams, gantry girders, bunkers, silos, hoppers, roof trusses, portals, laced purlins, space frames, hangers, struts, monorails, galleries, stiffeners, wall beams, sheeting runners, brackets, stub columns, bracings, cleats, trestles, base plates, splice plates, chequered plate flooring, decking and seal plates, steel frame grid over false ceiling, walkway platforms, ladders, stairs, stringers, treads, landings, hand-rails etc including 2 coats of redoxide zinc-chromate primer (one coat at shop and one coat after erection), connection design & preparation of fabrication drgs, collection of steel from stores, fabrication, straightening, cutting, bending, rolling, grinding, machining, drilling, welding, electrodes and other consumables, alignment, erection bolts & nuts (weight of erection bolts, nuts and welds not payable), assembly, edge preparation, preheating (min preheat and interpass temperature of 20o C for welding over 20 mm and upto 40 mm & 66o C for welding over 40 mm and upto 63 mm & 110o C for thickness over 63 mm & use of low hydrogen/ radiogenic electrodes), post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, installation of temporary structures, setting column bases, surface preparation by means of manual or mechanical power tools as per IS:1477 part 1, touch-up painting, rectification, dismantling and removal of all temporary structures (weight of temporary structures not payable), return of surplus / waste steel materials to store etc all complete. Including appointment of a seperate agency, approved by BHEL, for review and approval of fabrication drgs, in consultation with BHEL. All complete as per customer Specifications : Cl.no.3.03.00 of section-II, Part-G, volume-2. & Section C-10 of Part-E, Volume-3. BHEL will supply ISMB, PLATES, CHANNEL, ANGLE free of cost as per TCC. Payments terms - a). Fabrication - 65%; b) Erection - 25%; c) Alignment - 10%.	MT	2536		
2302	Extra over ST NO. 2301 for blast cleaning of steel structures to near white metal surface(Sa 2 1/2). All complete as per customer Specifications : Section 13.0 of module C-6 of Part-E, Volume-3.	MT	2536		
2304	Providing and applying two coats of synthetic enamel paint with minimum 50 micron total dry film thickness (DFT) of approved make and shade to achieve an even shade over steel sections already having primer coats and undercoating and keeping overall DFT with primer not less than 110 microns including protection and cleaning, scoffolding etc. lAll complete as per customer Specifications : Section 13.0 of module C-6 of Part-E, Volume-3.	MT	2536		
2307	Supplying, fabrication, erection and alignment of factory made electroforged galvanised grating units with mild steel (having minimum galvanisation of 610 g/sqm) conforming to IS:2062 in flooring, platforms, drain and trench covers, walk-ways, passages, staircases with edge binding strips and anti-skid nosing in treads etc. including fixing clamps, fittings, fixtures, all taxes, duties, packing, grinding, drilling, welding, edge preparation, etc. all complete. All complete as per customer Specifications : Section C-10 of Part-E, Volume-3. All materials are to be supplied by contractor.	MT	35		
2308	Supplying, fabrication, erection and alignment of factory made galvanised welded grating units with mild steel conforming to IS:2062 in flooring, platforms, drain and trench covers, walk-ways, passages, staircases with edge binding strips and anti-skid nosing in treads etc. including 2 coats of redoxide zinc-chromate primer (one coat at shop and one coat after erection), fixing clamps, fittings, fixtures, all taxes, duties, packing, grinding, drilling, welding, edge preparation, etc. all complete. All materials are to be supplied by contractor.	MT	DELETED		

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ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
2309	Extra over above ST NO. 2301/2307 for finishing the grating units with hot dipped galvanisation @ 610 gm/sqm over blast cleaned steel surfaces instead of painting with two coats of red oxide zinc-chromate primer all complete. All complete as per customer Specifications : Section C-10 of Part-E, Volume-3.	MT	36		
2310	Providing and fixing in position of permanent mild steel bolts (class 4.6 as per IS : 1367 and grade `C' as per IS: 1363) and nuts, washers etc. up to and inclusive of 39 mm diameter and upto 300mm long for structural steel work etc. All complete as per customer Specifications : Section C-10 of Part-E, Volume-3. All materials are to be supplied by contractor.	Quintal	13		
2400	ROAD WORKS				
2401	Consolidating subbase before providing stone soling/WBM with road roller including watering, if required to obtain 95% proctor density including making good undulation etc. all complete as per drawing and specifications section -09,module -6, volume-3, part -E	SQ.M.	11000		
2402	Supplying,laying and rolling Stone soling of consolidated thickness 250mm constructed in 2 layers each of 125mm thick including spreading binding material(sand / morrum) watering and rolling with road roller of minimim 10 tons capacity etc. all complete as per drawings and specifications section -09,module -6, volume-3, part -E	SQ.M.	11000		
2403b.	Supplying and laying WBM in 75 mm consolidated thickness with grade-II aggregate in two layers (total thickness 150mm) with dry and wet rolling etc complete as per drgs and specifications section -09,module -6, volume-3, part -E	SQ.M.	11000		
2404	Providing and laying 50 mm compacted thickness of premixed bituminous carpet (hot process) finish over WBM surface including provision of a tack coat and a seal coat,using bitumen conforming to IS : 73 , preparation of surfaces, rolling etc. and spreading sand on top complete as per specs section -09,module -6, volume-3,part -E	SQ.M.	11000		
2405	Supplying,laying and setting precast concrete edging blocks 300 x 150 mm (at base) and a min.length of 450 mm (except at curves) in M 20 grade concrete including cutting of trench and packing exterior face of blocks with stone chips and murrum including pointing the joints with CM 1:4 etc. all complete as per drawings and specifications	R.M.	12000		
2407	Proving and placing Cement concrete KERB stones of grade M15 on both sides of roads. Cement will be supplied by BHEL free of cost as per TCC.	CuM	300		
2500	PILING WORKS				
2501	Mobilisation of five sets of hydraulic rotary piling rigs and accessories capable of pile boring/drilling in all types of strata/installing various size of bored cast in situ RCC piles to project site and demobilisation of the same after completion of piling works etc all complete.	SET	5		
2503	Installation of Bored cast-in-situ RCC vertical pile as per IS 2911 (Part 1 Sec 2) with diameter and length as specified (length to be measured from pile cut-off level to the bottom of pile) using cement concrete grade M25 conforming to IS:456 with 20 mm nominal size stone aggregates with a minimum cement content of 400Kg per cum of concrete including providing all materials (but excluding reinforcement steel for which measurement/payment shall be made separately), boring/drilling in all types of soil, providing bentonite slurry and/or casing for stabilization of pile bore, flushing of pile bore, cleaning, providing plasticizer wherever required, breaking pile head to cut off level and exposing pile reinforcement for embedment in pile cap etc including empty boring from ground level to pile cutoff level etc all complete as per specification, drawing and as directed by the engineer-in-charge for the following. Cement will be supplied by BHEL free of cost as per TCC.				
d	Pile with 600 mm diameter and 19 m length below cut off level	EACH	1950		
2504	Extra over ST. No. 2503 for pile length more than the specified length of 19m below cut off level for the following.				
c	For 600 mm diameter pile	Rm	100		
2505	Rebate on ST.No.2503 for pile length less than the specified length of 19m below cut off level for the following.				
c	For 600 mm diameter pile	Rm	500		
2507	Conducting initial load test upto a maximum test load of 2.5 times the safe load capacity on single pile as specified in accordance with IS 2911 (Part-4) including preparation of pile head for testing, necessary excavation, all arrangements of loading, unloading, test equipments/accessories, jacks, recording of results, labour, submission of test report but excluding the cost of installation of pile (installation of pile shall be paid seperately) etc all complete as per specification, drawing and as directed by engineer in-charge for the following.				
a	For vertical compression test by cyclic load method				
iii	600 mm diameter pile	Each	2		
b	For lateral load test				
iii	600 mm diameter pile	Each	2		
c	For tension/uplift test				
iii	600 mm diameter pile	Each	2		

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura. (SCH-I)

MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
2508	Conducting routine load test on single job pile as specified in accordance with IS 2911 (Part-4) including preparation of pile head for testing, necessary excavation, providing all arrangements of loading, unloading, test equipments/accessories, jacks, recording of results, labour, submission of test report etc but excuding the cost of installation of job pile complete as per specification, drawing and as directed by the engineer-in-charge for the following.				
a	For vertical compression test by maintained load method				
iii	600 mm diameter pile	Each	10		
b	For lateral load test				
iii	600 mm diameter pile	Each	10		
2509	Carrying out pile integrity test on 450mm/500mm/ 600mm/760mm/900mm diameter pile including all arrangements for test, equipments/accessories, materials, labour, submission of test report etc but excluding the cost of installation of job pile all complete as per specification and as directed by the engineer-in-charge.	Each	10		
2600	MISC CIVIL WORKS FOR CEMENT STORE, APPROACHES , SLEEPER ETC.				
2601	Sand filling (river sand) in plinth in layers not exceeding 15cm as directed by BHEL and consolidating same by thorough saturation with water and ramming complete including the cost of supply of sand (payment to be made on measurement of finished qty).	CUM	360		
2602	Brick flat soling of picked jhama bricks including ramming and dressing bed to the proper level and filing the joints with powder earth or local sand including all materials, labour etc for making hard surfacing for fabrication yard /steel stack yard/storing of equipments etc.	SQM	25000		
2603	Plain cement Concrete 1 :4 :8 (1 cement : 4 sand : 8 graded stone aggregate of 20 mm nominal size) as filling course or lean concrete at any level below foundations, drain, septic tank, floors, hume pipes, incl materials, labour etc complete. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from manufacturer of CCI / GRASIM / CENTURY/ LAFARGE / INDIA CEMENT/ BARRACK VALLEY/ MEGHALAYA CEMENT/ ACC/ BIRLA/TPOCHEM/ADHUNICK MSP or equivalent).	CUM	292		
2604	Reinforced / plain cement concrete 1 : 1.5 : 3 (1 cement : 1.5 sand : 3 graded stone aggregate of 20 mm nominal size) for foundation, columns, beams, chajjas, RCC sleepers, RCC shelf, over head tanks slab, super structure slabs etc excluding cost of shuttering and reinforcement if any but including all materials, labour, curing etc complete all the levels. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from manufacturer of CCI / GRASIM / CENTURY/ LAFARGE / INDIA CEMENT/ BARRACK VALLEY/ MEGHALAYA CEMENT/ ACC/ BIRLA/TPOCHEM/ADHUNICK MSP or equivalent).	CUM	497		
2605	Damp Proof Course 40mm thk. 1:1.5:3 concrete (10mm down aggregate) with 2% of approved admixture of water proofing compound. Hot bitumen @ 1.7Kg./sqm shall be applied before & after the DPC as per specification. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from manufacturer of CCI / GRASIM / CENTURY/ LAFARGE / INDIA CEMENT/ BARRACK VALLEY/ MEGHALAYA CEMENT/ ACC/ BIRLA/TPOCHEM/ADHUNICK MSP or equivalent).	SQM	30		
2606	Supply, transporting, straightening, cutting, bending, placing at any level, binding in position high yield strength steel reinforcements in concrete including cost of reinforcement and binding wire, labour etc complete all as per specifications & drawings (Contractor will provide TMT bar Fe-415/500 quality from SAIL/ TISCO/ IISCO/ SRMB/ SHRICON/ SHYAM STEEL /CONCAST etc). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	MT	43		
2607	Hire and labour charges for 25mm thick shuttering for bldg. works for concrete foundations, floor/ roof slabs, beams, lintels, columns, chajja, fins etc including fitting, fixing and striking out carefully after completion of work for below ground and upto 6m height from finished floor level.				
A	Without vertical props.	SQM	571.25		
B	With vertical props up to (+) 6M height.	SQM	50		
2608	Brick work in cement mortar (1:6) in foundation, plinth, pier, abutment, wing wlls, water tank, septic tank, drains, culvert etc including all materials, labours, scaffolding and other incidental etc. complete.(cement - PPC/OPC/PSC to be supplied by contractor with test certificate from manufacturer of CCI / GRASIM / CENTURY/ LAFARGE / INDIA CEMENT/ BARRACK VALLEY/ MEGHALAYA CEMENT/ ACC/ BIRLA or equivalent).				
A	Ordinary bricks / fly ash bricks, Class designation 75 below plinth lvl.	CUM	75.63		
B	Ordinary bricks / fly ash bricks, Class designation 75, above plinth lvl upto 7.0M height.	CUM	223.13		
2609	Half brick work in cement mortar (1 cement :4 sand) in foundation, plinth, septic tank, drains, super structure etc including cost of scaffolding and other incidental work etc. completed. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from manufacturer of CCI / GRASIM / CENTURY/ LAFARGE / INDIA CEMENT/ BARRACK VALLEY/ MEGHALAYA CEMENT/ ACC/ BIRLA or equivalent).				
A	Ordinary bricks / fly ash bricks, Class designation 75, below plinth level.	SQM	1310		
B	Ordinary bricks / fly ash bricks, Class designation 75, above plinth level upto 7 M height.	SQM	100		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
2610	Plaster to existing masonry / concrete wall, floor, slab soffits, fins, sills etc with sand cement mortar including rounding off or chenfering corners as directed and racking out joints or roughening of concrete surface including chipping & application of cement slury where necessary etc complete as per drawing and direction of engineer. (cement - PPC/OPC/PSC to be supplied by contractor with test certificate from direct manufacturer of CCI / TOPCHEM/ CEMENT MANUFACTURING CO(STAR) /BARRACK VALLEY/ MEGHALAY CEMENT/ACC/ BIRLA or equivalent).				
A	With 1:6 cement mortar average 12 mm thick plaster below GL.	SQM	50		
B	With 1:6 cement mortar average 12 mm thick plaster above GL inside plaster.	SQM	562		
C	Outside plaster with 1:6 cement mortar average 15 mm thick above GL at all levels.	SQM	1171		
2611	Supply, fabrication, erection and painting of structural steel work in columns, beams, wind ties, etc with simple rolled structural members connected to one with another with brackets gusset cleats, bolts & nuts or welding etc as per design & direction complete including fabrication, hoisting & erection including all materials, labour etc complete with one coat of primer & two coats of synthetic enamel painting (Contractor willl provide structural steel from JINDAL/ SAIL/ TISCO/ IISCO/ SRMB/ SHRICON/ SHYAM STEEL/ RINL etc with test certificate). Payment terms - a) On receipt of materials at site - 65%; b) On completion of erection & fixing - 35%.	MT	30		
2612	Supply, fabrication, erection and painting of steel work with tubular sections as per IS 1161& 1239 for roof truss, purlin etc including all materials conforming to relevant IS codes, labour etc as per drawing, specification and direction of engineer with one coat of primer and two coats of synthetic enamel painting (Contractor will provide structural steel from JINDAL/BANSAL/TATA/ SHYAM STEEL/RINL etc). Payment terms-a) On receipt of materials at site - 65%; b) On completion of erection & fixing - 35%.	MT	73		
2613	Providing & fixing corrugated galvanised iron sheet (CGI) 0.5mm thick for roofing & side cladding of TATA/SAIL/ZINDAL/BHUSAN or equivalent make including galvanised J or L hook, bolts and nuts 8mm dia with bitumen washer 25mmdiax 3mm thick and 1.6 mm thick limpet washer complete with all labour, tools and plants. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	3515		
2614	Providing and fixing galvanised iron ridge 0.5 mm thick and 230 mm lappings on both sides of TATA /SAIL /ZINDAL /BHUSAN or equivalent make including fixing necessary screws, washers etc complete with all labour and tools and plants.	RM	212		
2615	Providing, transporting, fixing of MS foundation/ anchor bolt (Grade-1 of IS:432 & IS:2062) assembly in concrete along with nuts, lock nuts, 25mm dia, 950mm long including furnishing of labour, materials, welding, etc all complete as per specification, drawing and instruction of engineer (Contractor will supply all material). Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	KG	5042		
2616	Supplying, fitting & fixing fixed/openable steel window conforming to us IS:1036-1975 & IS:7452-1974 with non-friction projecting type of hinges fitted with revetts or nut bolt system as directed, glazing cleats, lugs, 2 nos MS anodised peg stays & fastner for each window of size 900x1200mm, 4mm thick clear glass pane (each glass max size 450x450mm), including fixing in position, fixing lug in cement concrete 1:2:4 with stone chips 12.5mm down cutting holes & mending good damage, 10mm dia MS round guard bar welded horizontally 125 c/c with each window etc complete with 1 coat of primer and 2 coats of synthetic enamel finish in all respect.	SQM	136		
2617	Providing and fixing anodized extruded aluminium doors (single or double shutter) conforming to IS:1948, IS:1949 fabricated from extruded sections of INDAL or equivalent make as per IS:1285, IS:733 and electro color coating of minimum 15 microns thickness. Glazing shall be clear float glass of 4mm thickness including snap fit type beading, concealed screws, heavy duty concealed floor spring, fixtures, Godrej make Mortice lock with handle on both sides etc complete. Aluminium section shall be smooth, free of stains, straight, mitred & jointed mechanically wherever required (Frames shall be measured and paid under separate item).	SQM	10		
2618	Providing and fixing in position anodised aluminium door frame from extruded sections of INDAL or equivalent make, as per IS:1285 and elctro colour coating of minimum 15 micron thickness including holdfast, filling up of gaps at junctions, at top, bottom and sides etc all complete as per specification.	KG	30		
2619	Providing and laying glazed vertified tiles of approved color and design in floor and skirting 100mm of approved size (600x600x9/10mm) of locally best quality, complete as per specification including under bed cement coarse sand mortar 1:3 of thickness 20/18mm and all material, labour etc.	SQM	900		
2620	Priming one coat to timber or steel or plastered surface or other metal surface with ready mix paint of approved quantity including smoothening of surface by sand papering etc complete.	SQM	150		
2621	Painting two coats with best quantity synthetic enamel paint of approved make and brand including smoothening surface by sand pepering etc including using approved putty etc on the surface if necessary.				
A	On steel or other metal or wooden surface with super gloss.	SQM	150		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
B	3 coats white washing with lime including cleaning and smoothening masonry surface thoroughly to give an even shade.	SQM	50		
C	Providing plaster of paris 2 mm thick punning over finished plaster surface and finished with one coat of acrylic emulsion primer followed by two coats of acrylic emulsion paint inside wall to give smooth and even surface as per specification at all levels.	SQM	946		
D	Two coats of water proofing cement paint of Seacem or equivalent make & shade applied on external wall including scraping the surface thoroughly on plastered or concrete surface (manufacturers specification to be followed) at all levels including all materials, labours, scaffelding etc complete as per direction of engineer.	SQM	354		
2622	Supply and providing MS gate sizes, as per sketch/ drawing (two/ one leaves) or 900/2000mm wide x 2400/4500mm height gate made of 1.5 mm MS sheet framed with 50x50x6 / 75x75x6mm angle, diagonals with two posts ISMB 100/200 & all fittings and fixtures like hinges, hatch bolts, locking arrangements etc. complete as per Drawing, specification and finished with one coats of red oxide primer followed by two coats (Berger) synthetic enamel as directed by Site In-charge.	MT	8		
2623	Providing attach toilet with following facilities as directed by BHEL: (a) Inside size of toilet 1.5x1.35m, (b) 5mm thick white colour ceramic floor tile & inside walls tile upto 1.2m height from finish floor, (c) 1 white vitreous wash basin 450x300mm (Hindustan make or equivalent) with CI bracket, 15mm CP brass pillar taps, 32mm PVC waste water pipe, 32mm CP brass waste, 1 CP towel rail 550mm long, 1 best quality 550x400mm mirror etc complete, (d) 1 European type WC pan with seat and lid black colour, low level 10 ltr capacity white PVC flushing cistern, etc (e) all inside pipe lines shall be 15mm/ 20mm PVC & concealed pipes, (f) main external supply water pipe line shall be 25mmdia PVC of 6m length, complete in all respect including testing, (g) one Soil pipe shall be min 75mm dia CI for below floor if any & outside shall be 100mm dia PVC of supreme or equivalent 5m length. Masonry, plastering & PCC will be paid as per respective items (rate in lumsum for each set of toilet).	SET	4		
2624	Providing common toilet with following facilities as directed by BHEL: (a) Inside size of toilet 6.0Mx2.7M, (b) 5mm thick white colour ceramic floor tile and inside walls tile upto 1.35 M height from finish floor, (c) two white vitreous wash basin 550x400 mm (Hindustan make or equivalent) with CI bracket, 15 mm cp brass pillar taps, 32 mm PVC waste water pipe, 32mm CP brass waste, two CP towel rail 550mm long, two best quality 550x400mm mirror etc complete, (d) two WC chamber with European type WC pan with seat and lid black colour, low level 10 lts capacity white PVC flushing cistern, etc, (e) all inside pipe line shall be 15mm /20mm PVC and concealed pipes, (f) main supply external supply water pipe line shall be 25mm dia PVC of 12 M, (g) one bathroom with one 15 CP tap, one CP shower, complete in all respect. (h) three nos. Flat back urinal with automatic high level CI flushing system , 5 litre capacity with CP connector, (i) one Soil/ drain pipe shall be min 75mm dia CI for below floor inside if any and outside shall be 100mm dia PVC of supreme or equivalent 5m length. Masonry, PCC & plastering will be paid as per respective items (rate in lumsum for each set of toilet).	SET	2		
2625	Consolidation of subgrade/ existing surface with 12 T power roller or vibromax including making good the undulations with earth and rerolling the subgrade for road, hard surfacing of equipment store,fabrication yard, assembly yard etc as directed by BHEL.	SQM	34900		
2626	Providing, laying, spreading and compacting l00mm thick (thickness to be measured on finished surface) each layer WBM 63 mm to 0.075 mm jhama brick aggregates to water bound macadam including spreading in uniform thickness, hand packing, rolling with 12T road roller / vibratory roller in stages to proper grade and camber, applying and brooming and binding materials to fill up the interstices of coarse aggregate, watering and compacting to the required thickness for making hard surfacing or road subgrade etc.	CUM	6980		
2627	Filling area for roads and other underground structures with stone (63 mm down graded), in layers not exceeding 200 mm thickness (on finished surface) including breaking of boulders to required sizes, filling the interstices filled with selected sand and compacting to 85 % of original volume of stone stack for all lifts including rolling with 12T road roller / vibratory roller with all complete as per instructions of engineer-in-charge.	CUM	1260		
2628	12 mm thick cement plaster (1:6) with 1.5/2 mm neat cement punning for drain/septic tank etc complete with all materials (excluding cement), labour etc.	SQM	700		
2629	2M high fencing with MS angle post of size 40X40X5 mm 2.4 M long placed every 3M centre to centre embeded in concrete, angle post shall be embeded in plain cement concrete(1:2:4)size 300x300x400mm deep below ground etc complete including excavation, backfilling, concreting. Contractor will supply all materials, structural steel, labour etc complete.				
A	For structural angle post with two coats of bitumen based protective coating etc complete.	KG	2520		
B	Supplying, fitting, fixing galvanised chain link fencing of approved quality 50mmx50mmx8 g, by means of galvanised `C` clips, with fixing of galvinised special clips for fixing along with 2mm thick GI tension wire at top and bot etc. Contractor to supply all materials. Angle post to be paid separately. Payment terms - a) On receipt of materials at site - 70%; b) On completion of erection & fixing - 30%.	SQM	1800		
C	For G I barbed with all fixing etc complete. Contractor to supply all materials.	KG	319		

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MAIN CIVIL AND MISC. CIVIL, STRUCTURAL WORKS , FINAL PAINTING ETC (SCH-I)

ST. NO	DESCRIPTION OF ITEM	UNIT	QTY	RATE (In Rs.)	TOTAL AMOUNT (In Rs. and in Words)
2630	Providing PVC pipe of Supreme or equivalent quality for drinking water system for BHEL office, Field hostel with all fittings and fixtures, labour etc complete for BHEL office.				
A	For external /internal16mm dia.	RM	20		
B	For external /internal 20mm dia.	RM	20		
C	For external /internal 25mm dia.	RM	20		
D	For external /internal 32mm dia.	RM	20		
E	For external /internal 40mm dia.	RM	20		
F	For external /internal 50mm dia.	RM	20		
2631	Providing PVC pipe with fittings and fixtures of Supreme or equivalent make with all materials, labour etc complete for external sewer line/ waste water line connection upto open drain or manhole to manhole/ septic tank/ soak pit for BHEL office, field hostel.				
A	For external 75mm dia.	RM	30		
B	For external 110mm dia.	RM	30		
2632	Providing & fixing of wooden solid flush door with commercial ply finish, fitted with 3 MS hinges, one 8mm dia 150 mm long aluminium tower bolt, 16x300mm long Al sliding door bolt & 100mm aluminium handle, finished with one coat of primer & two coats of synthetic enamel paint etc complete.				
A	25 mm thick.	SQM	19		
B	30 mm thick.	SQM	15		
2633	Providing and fixing of wooden frame work with second class sisoo or equivalent for door frame or partion wall upto ht of 2.7m with wooden batten 65X65mm, 50X25mm, 40X25mm etc. includng fixing on wall/floor with MS cleats/ flats and embeded in concrete, finished with one coat of primer & two coats of synthetic enamel paint on exposed surface and bitumenous coat on masonry contact surface, etc complete with all labour & materials.	CUM	0.932		
2634	Supplying and fixing 4mm thick commercial ply on wooden frame work with both side finished with one coat of primer and two coats of synthetic enamel paint for wall partition as well as roofetc complete.	SQM	15		
2635	Suppy, fitting & fixing/ laying of GI pipe as per IS 1239/IS 3589 with all necessary accessories ie socket, bend, tee, union, cross, elbow, nipple, long screw, reducing socket, reducing tee, short piece etc complete for making connection from deep well/source to water tank for constrcution/ drinking water system including cost of all necessry jointing materials labour etc all complete (payment will be made on center line meaurement of total pipeline including all specials).				
A	25 mm dia nominal bore, medium quality	RM	50		
B	32 mm nominal bore, meduim quality.	RM	50		
C	50 mm nominal bore, meduim quality.	RM	50		
D	75 mm nominal bore, meduim quality.	RM	20		
2636	Providing and fixing security kiosk size approx 1.5Mx1.5M in plan, front height 3M and back side height 2.9M, made of structural angle frame 65x65x6 all verticals and two horizontals with diagonals, 3 vertical sides and roof shall be covered with CGI sheet 0.5 MM thick with one each side opening 300x300MM for viewing, floor shall be made with 40 MM thick wooden planks (second class treated wood) at an height of 400MM above ground level, one wooden planks 2.0mx450mm size to be provided for sitting arrangement inside kiosk, all angles and planks top side shall be painted with one coat of primer and two coats of synthetic enamel paint finish including all labours and materials etc complete.	SET	6		
2637	Providing and laying NP3 class RCC with collars joint with stiff mixture of cement mortar 1:3 with all materials and labour. All excavation, backfilling, concreting if required shall be paid separately as per relevent items.				
A	200mm dia	RM	30		
B	300mm dia	RM	30		
C	400mm dia	RM	30		
	MISC ITEMS				
2700	For items not covered in the above schedule of rates, Quote % above or % below or at par of the Delhi Schedule of Rate 2007 (DSR 2007).				
A	Rate of complete item	%			
B	Rate of supply of material at site only	%			
C	Rate for execution complete excluding supply of materials.	%			
	TOTAL				

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JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.

SECTION I (D) - (ELECTRIFICATION WORK AND AREA LIGHTING) - SCH-II

SL NO.	DESCRIPTION	QTY	UNIT	RATE (In Rs.)	AMOUNT (In Rs and In Words)
D	**ELECTRIFICATION WORK AND AREA LIGHTING**				
EA1	Supply & fixing of iron clad main switches TPN/ DP on angle iron frame duly painted/ on wall, with all required materials, hardwares, etc. as per instruction of BHEL Engineer, of Standard make (Havells/crompton/approved make) -				
EA1a	200 Amps TPN, MSFU(Main switch fuse)	1	NO.		
EA1b	63 A TPN	27	NO.		
EA1c	30/ 32A TPN.	3	NO.		
EA1d	32A DP.	2	NO.		
EA1e	16A DP.	5	NO.		
EA2	Supply & fixing of sheet metal (16SWG) iron clad busbar chamber (W=500mm x D=150mm) on angle iron frame duly painted on wall with 4 Al bars (25mm x 5mm x 600mm) 500V, with adequate nos of holes drilled for connection of incomimg & outgoing ckts, bars are fixed on porcelain insulators. Including supply of required hardwares for connection, fitted with DANGER board, all complete as per instruction of BHEL Engineer.	1	NO.		
EA3	Supply & fixing of metal sheet MCB BOX, as per instruction of BHEL Engineer -				
EA3a	4 Way	10	NO.		
EA3b	6 way	4	NO.		
EA3c	8 way	4	NO.		
EA4	Supply & fixing of Metal Junction Box with connector Lugs, as per instruction of BHEL Engineer -				
EA4a	Size (8"X10"X3") to terminate 10 sqmm cable and 4 sqmm cable	4	NO.		
EA4b	Size (8"X6"X3") to terminate 6 sqmm cable and 2.5 sqmm cable/1sqmm cable	6	NO.		
EA5	Supply & fixing of composite flush/box mounted type 250 volt 6 Pin 15 Amps Plug socket integral fuse, with single phase motor starter with overload protection, on sheet metal box with bakelite cover and earthing attachement including Switch and Fuse of matching PVC box-make ANCHOR or approved make (Pantry/Kitchen/AC), as per instruction of BHEL Engineer.	50	NO.		
EA6	Supply & fixing composite flush type 250 volt 5 Pin 5Amps Plug socket integral fuse with 5 Amps piano key type switch on sheet metal box with bakelite cover and earthing attachement including Switch and Fuse of matching PVC box-make ANCHOR /or approved make (for Computers / printers), as per instruction of BHEL Engineer.	50	NO.		
EA7	Supply and Fixing of Switch Board(10"X14") with flush type 250 volt 6 Pin 15 Amps Plug socket integral fuse with six no.s 15 Amps piano key type switch on sheet metal box with bakelite cover and earthing attachement including Switch and Fuse of matching PVC box-make ANCHOR or approved make, as per instruction of BHEL Engineer.	20	NO.		
EA8	Supply and installation of switchboard of sheetmetal box with bakelite cover, as per instruction of BHEL Engineer -				
EA8a	Size 4"X8"	5	NO.		
EA8b	Size 4"X10"	10	NO.		
EA8c	Size 4"X4"	5	NO.		
EA9	Supply and Installation of SP MCB for lighting / Power purpose-				
EA9a	16 Amps	10	NO.		
EA9b	6 Amps	10	NO.		
EA9c	62A/65A	26	NO.		

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SECTION I (D) - (ELECTRIFICATION WORK AND AREA LIGHTING) - SCH-II

SL NO.	DESCRIPTION	QTY	UNIT	RATE (In Rs.)	AMOUNT (In Rs and In Words)
EA9d	25A/32A	26	NO.		
EA10a	Supply of 3.5 core 95 sqmm PVC, armoured Aluminium cable of 1.1 KV grade as per IS-1554.	700	RM		
EA10b	Laying below ground in excaveted trench average depth 800 mm with 8 nos of brick on top of the cable per meter including filling the space between brick & cable and also the trench with shifted soil levelling and restoring the surface duly rammed & compacted, as per instruction of BHEL Engineer.	700	RM		
EA10c	End termination with double compression gland and lugs.	20	NO.		
EA11a	Supply of 3.5 core 25 sqmm PVC, armoured Aluminium cable of 1.1 KV grade as per IS-1554.	1000	RM		
EA11b	Laying above ground on wall/ surface with clamps etc, chase cutting on wall/ floor, mending good damages, testing & commissioning of 3.5 core 25 sqmm PVC, Aluminium cable of 1.1 KV grade, as per instruction of BHEL Engineer.	1000	RM		
EA11c	End termination with double compression gland and lugs.	20	NO.		
EA12a	Supply of 4 core 16 sqmm PVC, armoured Aluminium cable of 1.1 KV grade as per IS-1554.	700	RM		
EA12b	Laying above ground on wall/ surface with clamps etc, chase cutting on wall/ floor, mending good damages, testing & commissioning of 4 core 16 sqmm PVC, Aluminium cable of 1.1 KV grade, as per instruction of BHEL Engineer.	700	RM		
EA12c	Laying, below ground in excaveted trench average depth 800 mm with 8 nos of brick on top of the cable per meter including filling the space between brick & cable and also the trench with shifted soil levelling and restoring the surface duly rammed & compacted, as per instruction of BHEL Engineer.	700	RM		
EA12d	End termination with double compression gland and lugs.	20	NO		
EA13a	Supply of 4 core 6 sqmm PVC, armoured Aluminium cable of 1.1 KV grade as per IS-1554.	1750	MTRS		
EA13b	Laying above ground on wall/ surface with clamps etc, chase cutting on wall/ floor, mending good damages, testing & commissioning of 4 core 6 sqmm PVC, Aluminium cable of 1.1 KV grade, as per instruction of BHEL Engineer.	1750	MTRS		
EA13c	Laying, below ground in excaveted trench average depth 800 mm with 8 nos of brick on top of the cable per meter including filling the space between brick & cable and also the trench with shifted soil levelling and restoring the surface duly rammed & compacted, as per instruction of BHEL Engineer.	1750	MTRS		
EA13d	End termination with double compression gland and lugs.	20	NO		
EA14	Supply, drawing through PVC conduit/casing, termination, testing & commissioning as wiring for lighting, power & earthing of -				
EA14a	1 core 10 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	500	RM		
EA14b	1 core 6 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	1150	RM		
EA14c	1 core 4 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	1675	RM		
EA14d	1 core 2.5 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	5150	RM		
EA14e	1 core 1.5/1 sqmm PVC insulated, stranded Copper wire of 1.1 KV grade	4100	RM		
EA14f	1 core 1 sqmm PVC insulated, Green stranded Copper wire for earthing of inside building	1000	RM		
EA15	Supply and fixing of PVC conduit with all bends, tees, reducers, rectangular/circular box, clamps, saddles, etc. along with the accessories in surface/ recess in beam/ roof slab/ wall/ false ceilling and making good the same as required, as per instruction of BHEL Engineer.				
EA15a	1" dia rigid	4000	RM		
EA15b	1" dia flexible	100	RM		

VOLUME-IIIA , REV-01
PRICE SCHEDULE

JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.

SECTION I (D) - (ELECTRIFICATION WORK AND AREA LIGHTING) - SCH-II

SL NO.	DESCRIPTION	QTY	UNIT	RATE (In Rs.)	AMOUNT (In Rs and In Words)
EA16	Supply and fixing of PVC casing with all bends, tees, reducers, rectangular/ circular box, clamps, saddles, etc. along with the accessories in surface/ recess in beam/ roof slab/ wall/ false ceilling and making good the same as required, as per instruction of BHEL Engineer.				
EA16a	1.5" dia	500	RM		
EA16b	1" dia	500	RM		
EA16c	0.5" dia	500	RM		
EA17	Supply & fixing of ceiling rose on circular boxes, as per instruction of BHEL Engineer.	50	NO.		
EA17a	Supply of outdoor luminaires type 1x70 W HPSV lamps in cast aluminium body with acrylic cover along with lamps, control gear, etc including all fixing/ supporting accessories complete. Model: BJMSC-70SV of BAJAJ or equivalent of PHILIPS/ CROMPTON.	47	NO.		
EA17b	Fixing on wall with 40 mm dia swan neck GI pipe with suitable clamps etc & commissioning of outdoor luminaires suitable for 1x70 W HPSV lamps in cast aluminium body with acrylic cover along with lamps. Including all fixing/ supporting accessories complete and flexible wire for connection between ceiling rose & fitting.	47	NO.		
EA18a	Supply of Indoor type luminaries 1x150 W medium bay industrial type, model BJMBI-150SV of BAJAJ or equivalent of PHILIPS/ CROMPTON.	45	NO.		
EA18b	Fixing from roof truss with suitable clamp arrangement, flexible wire for connection between ceiling rose & fitting and commissioning of type HPSV luminaries medium bay industrial type, model BJMBI-150SV of BAJAJ or equivalent of PHILIPS/ CROMPTON.	45	NO.		
EA19	Supply & Installation of Dual Tube Light (2x36 Watt) Fixture of standard make (Philips or approved make)	10	NO.		
EA20	Supply and installation of CFL 2x36 W decorative false ceiling type, with box base & mirror type reflectors with fixing/ hanging material/ hardware, of approved make.	243	NO.		
EA21	Supply and installation of CFL 2x36 watts with box base & vitrious enamelled reflectors with fixing/ hanging material/ hardware, of approved make.	20	NO.		
EA22	Supply of 230V 12" exhaust fan with external louvre	6	NO.		
EA23	Supply of local make approved quality Pedestal fan - 16" sweep.	10	NO.		
EA24	Supply and Installation of earth electrode 40 mm dia 3 metre long GI pipe directly driven into earth including earth excavation if required.	10	NO.		
EA25	Supplying & installation of 16 SWG GI wire for earthing including supply & termination with lugs as required.	1000	RM		
EA26	Supplying & installation of 8 SWG GI wire for earthing including supply & termination with lugs as required.	100	RM		
EA27	Supply and installation of 3.5C X2.5sqmm cable	200	RM		
EA28	Installation of LT Kiosk	4	Nos		
EA29	Installation of Lighting Mast	3	Nos		
EA30	Supply and installation of calling bell	53	Nos		
EA31	Supply & installation of 15/ 16 A piano type switch.	142	Nos		
EA32	Supply & installation of 15/ 16 A flush type power socket.	142	Nos		

VOLUME-IIIA , REV-01 PRICE SCHEDULE					
JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.					
SECTION I (D) - (ELECTRIFICATION WORK AND AREA LIGHTING) - SCH-II					
SL NO.	**DESCRIPTION**	**QTY**	**UNIT**	**RATE (In Rs.)**	**AMOUNT (In Rs and In Words)**
EA33	Supply & installation of 5/ 6 A piano type switch.	525	Nos		
EA34	Supply & installation of 5/ 6 A flush type power socket.	445	Nos		
EA35	Supply & installation of Ceiling Fan 48'' sweep	97	Nos		
EA36	Supply and installation of aquaguard with fitting	5	Nos		
EA37	Supply and installation of Liver Pipe	1050	RM		
EA38	Supply and installation of Casin -1'	53	Nos		
EA39	Supply and installation of Tape	53	Nos		
EA40	Supply and installation of Night bulb	116	Nos		
TOTAL					

VOLUME-IIIA, REV - 01 PRICE SCHEDULE					
JOB: Piling, Civil, structural, architectural work including foundation/superstructure of various various plant equipments/ systems/ facilities, non-plant buildings ,misc civil work Associated electrical enabling and maintenance , Final painting etc for 100 MW Gas Based Combined Cycle Power Plant at NEEPCO, Monarchak, Tripura.					
SECTION II - OPERATION & MAINTENANCE OF ELECTRICAL WORK (SUPPLY AND MANPOWER SERVICE) - SCH-III					
SL.NO.	**DESCRIPTION**	**QTY**	**UNIT**	**RATE (In Rs.)**	**TOTAL AMOUNT (In Rs.)**
1	Skilled electrician having experience in 33/ 11KV substation & overhead lines (minimum 5 years experience or ITI with one year experience) along with necessary tools, insulation tapes as required for the work [8 hrs shift per day, with paid weekly off & 10 + 2 (optional) holidays in a calender year].	16	MAN-MONTH		
2	Unskilled helper alongwith hand tools as required for the work [one shift of 8 hrs per day, with paid weekly off & 10 + 2 (optional) holidays in a calender year].	16	MAN-MONTH		
3	Supply of Dual Tube Light (2x36 Watt) Fixture of standard make (Philips or approved make)	4	NOS		
4	Supply of 15/ 16 A piano type switch.	5	NOS		
5	Supply of 15/ 16 A flush type power socket.	5	NOS		
6	Supply & installation of 5/ 6 A piano type switch.	5	NOS		
7	Supply & installation of 5/ 6 A flush type power socket.	5	NOS		
8	Supply and installation of Night bulb	5	NOS		
	TOTAL PRICE FOR O&M (IN RS.) (SECTION-II)				
NOTE	The supply of above items are subject to occurrence of breakeage/damage/non-working etc as the case may be on certification of BHEL Site engineer during O & M period				

TENDER PURPOSE ONLY

FINAL REPORT ON SOIL INVESTIGATION FOR 1X100MW UNIT AT TRIPURA GAS BASED POWER PLANT, MONARCHAK CCP, NEEPCO, TRIPURA.

INTRODUCTION:

Soil Investigation for 1 x 100 MW unit at Tripura Gas Based Power Plant, Monarchak CCP, NEEPCO, Tripura. has been carried out by M/s. C & C Consulting Firm, Kolkata vide LOI No. PSER:SCT:MRK-C1138:10:LOI:2410 dtd. 26.11.2010. The main objective of the investigation is to ascertain the sub-soil condition at the proposed structures to be constructed / erected at site and to make foundation investigation of the proposed structure based on the findings of field and laboratory investigation.

All the test locations at Site were shown by the Engineer of M/s. Bharat Heavy Electrical Limited to M/s. C & C Consulting firm as per the Plot Plan before commencement of the fieldwork. After the field investigations, laboratory tests has been done to ascertain Engineering properties of soil, which are related to the final design of foundation.

This final report has been prepared after detail analysis of subsoil condition existing at the proposed locations of different structures for obtaining the suitable Foundation and thereof the stability of foundation in respect of Bearing Capacity & Settlement.

GEOLOGY OF THE AREA :

The area under the present investigation falls within the Belonia Valley of South-West Tripura. The Belonia valley is a North-South elongated synclinal valley

occurring in the west of Sonamura-Gozalia-Mamumbhanga hill ranges. The valley is covered by thin alluvial deposits of recent age underlain by semi-consolidated soft sandstone or highly compacted sand of Tipam Series of Tertiary age. In the top, generally, an admixture of clay, sand and sandy clay occurs followed by alternative bands of considerably thick layer of unconsolidated soft sandstone or highly compacted sand and comparatively thin layer of clay/shale. The site of operation is very near to Sonamura where the top layer is composed of moderately stiff sandy clay of reddish brown colour followed by consolidated sand horizon. The top layer extends up to a depth of 4-5 mts with various stiffness.

In this connection, it may be noted that the working area is perhaps situated within the of Artesian flow condition of the ground water that prevails in the Subroom-Belonia Valley system. For which the ground water will be available much near to the surface very easily.

FIELD INVESTIGATION:

The field investigation for proposed Geo-technical investigation for the 1 x 100 MW unit at Tripura Gas Based Power Plant, Monarchak CCP, NEEPCO, Consists of sinking 40 nos. of Boreholes, carrying out Standard Penetration Tests, 4 nos. Dynamic Cone Penetration Tests, conducting 5 nos. of Plate Load Tests, 4 nos. of C.B.R tests and 30 nos. of Earth Resistivity Test. In addition to these, the dynamic properties of soil has been evaluated by conducting 2 nos. Seismic Cross Hole tests. Locations of all such tests are given in the Location Plan in the Annexure.

BORING:

Test boring through different layers of soil has been carried out at the locations marked in the drawings and / or at such other locations as directed by the engineer in a manner described below.

The methods of boring as described in IS : 1892 was adopted depending on the site conditions. Auger boring has been adopted above water table, whereas below the water table the bore holes have been advanced by shell and auger. Minimum diameter of bore hole has been kept 150 mm. Stabilisation of Boreholes was achieved by driving flush jointed seamless casing.

All the boreholes were taken down to a depth of 35.00 m below existing ground level as directed by the engineer and the Customer except the bore hole no.19, where the borehole was terminated at 30.0 m below G.L.
In each borehole Ground Water table was observed during boring as well as 24 hrs after the completion of boreholes. The details of Boreholes together with the observation of Ground water table have been furnished in Table I below :

TABLE - I

The Co-ordinates & Ground Water Table of boreholes:

BH. NO.	*Co-ordinates*	*Ground Elevation (m)*	*Depth*	*Ground Water Table (GWT) m*
01	*N = 343.550 E = 185.500*	*20.796 m*	*35.00*	*8.20*
02	*N = 333.450 E = 145.200*	*17.697 m*	*35.00*	*5.10*
03	*N = 322.800 E =205.350*	*21.989 m*	*35.00*	*9.3*
04	*N = 310.950 E = 97.250*	*14.117 m*	*35.00*	*1.5*
05	*N = 311.000 E = 157.250*	*16.691 m*	*35.00*	*4.1*
06	*N =300.000 E =121.250*	*14.769 m*	*35.00*	*2.2*

BH. NO.	Co-ordinates	Ground Elevation (m)	Depth	Ground Water Table (GWT) m
07	N = 520.000 E = 0.000	13.330 m	35.00	0.73
08	N = 375.000 E = 378.000	14.641 m	35.00	2.2
09	N = 375.000 E = 38.000	14.761 m	35.00	0.35
10	N = 375.000 E = 938.000	17.914 m	35.00	5.3
11	N = 360.000 E =3.400	16.590 m	35.00	4.0
12	N = 333.700 E = (-) 5.520	17.220 m	35.00	4.6
13	N = 312.230 E =10.400	16.601 m	35.00	4.0
14	N = 266.000 E =10.000	17.340 m	35.00	4.6
15	N = 260.500 E = (-) 30.900	17.129 m	35.00	4.4
16	N = 205.200 E =(-) 30.900	17.218 m	35.00	4.6
17	N = 233.250 E =(-)15.550	17.378 m	35.00	4.8
18	N = 234.800 E = 4.000	17.162 m	35.00	4.6
19	N = 238.700 E = 41.000	17.231 m	30.00	4.5
20	N = 196.900 E = 43.000	16.172 m	35.00	3.6
21	N=184.00 E = 85.00	15.625 m,	35.00	2.10
22	N =207.500 E = 88.00	13.708 m	35.00	1.00
23	N =225.700 E = 85.00	13.683 m	35.00	1.00
24	N = 250.500 E = 85.00	13.666 m	35.00	1.00
25	N =256.000 E = 68.200	14.808 m	35.00	1.60
26	N-198.000 E – 110.00	13.570 m	35.00	1.00
27	N =180.500 E = 101.300	13.678 m	35.00	1.00
28	N =263.150 E = 125.500	15.023 m	35.00	2.00
29	N =263.300 E = 166.00	17.317 m	35.00	3.50
30	N =246.750 E = 127.150	14.574 m	35.00	1.00

BH. NO.	Co-ordinates	Ground Elevation (m)	Depth	Ground Water Table (GWT) m
31	N =243.250 E = 179.300	18.027 m	35.00	4.50
32	N =224.850 E = 125.00	14.583 m	35.00	2.00
33	N =227.750 E = 154.00	15.762 m	35.00	2.30
34	N =227.250 E = 175.50	17.057 m	35.00	3.00
35	N =262.100 E = 190.80	19.126 m	35.00	3.40
36	N = 520.00 E = (-) 36.00	14.011 m	35.00	0.00
37	N = 300.00 E = 58.00	15.161 m	35.00	1.2
38	N = 450.000 E = (-) 32.000	13.056 m	35.00	0.46
39	N = 450.000 E = 23.000	12.517 m	35.00	0.12
40	N = 425.000 E = (–) 7.000	13.257 m	35.00	0.200

IN SITU TESTS:

Standard Penetration Test (SPT):

Standard Penetration Tests were conducted as per IS: 2131 (1981) within each borehole at suitable interval of depths as shown in the bore log data sheets. The tests were done with the standard split spoon sampler as per IS: 9640 (1980). The 'N' values were obtained by counting the number of blows required to drive the spoon from 15cm to 45cm. 'N' values thus obtained have been plotted depth wise along with the soil Profile give in the Annexure.

SAMPLING:

Samples of undisturbed soil have been obtained mostly from cohesive deposits at or where a change in strata is indicated. Such samples were obtained by drive sampler of I.D 100 mm and length 450 mm having an area ratio of 12 to 15%.

In addition, disturbed samples were taken at suitable intervals of depths and at changes of stratum in order to examine physically the nature of all strata. They

were collected from the Shell or Auger and the barrel of the split spoon sampler after the Standard Penetration Tests. The depth wise locations of all the disturbed and undisturbed samples have been furnished in the bore log data sheet.

IN-SITU PERMEABILITY TEST :

In-situ permeability test was conducted to determine the water percolation capacity of overburden soil. This test was performed inside the bore hole at specified depths or in each layer or as per the directions of the engineer-in-charge. The type of test was either pump-in or pump-out test depending on the subsoil and ground water conditions. Here we have done the Pump in test by Falling head method. The specification for equipments required for the test and the procedure of testing was in accordance with IS : 5529, Part-I.

FALLING HEAD METHOD (IN BORE HOLE)

This method has been adopted for soils of low permeability and which can stand without casing. The test section was sealed at bottom of the borehole and a packer at the top of the test section. Access to the test section through the packer was by means of a pipe which was extending above the ground level. Water was filled into the pipe upto the level marked just below the top of the pipe and water be allowed to drain into the test section. The water level in the pipe was recorded at regular intervals as mentioned in IS:5529, Part – I, Appendix – B. The test was repeated till constant records of water level are achieved.

PERCOLATION TEST (IN TRIAL PIT)

Percolation test have been conducted in trial pit in areas where water / effluent is stored / discharged in ground level tanks. Here the tests have been done at locations of raw water reservoir, CWR, ETP & Clarifloculator area. The loss of

water due to percolation into the soil was estimated by the soil absorption capacity are given below :

PERCOLATION TEST – 1

Site	:	Neepco, Monarchak, (TGBPP), Tripura (West)
Location	:	Gas Cond. Skid
Co-ordinate	:	N = 520.000, E (-) 36.000
R.L	:	14.000
Ground Water	:	0.000 mtr
Date	:	19.02.2011
Time	:	12.30 P.M
Soil Condition	:	Bluish Grey Silty Clay.
Dia of Pit	:	1.00 mtr. x 1.00 mtr. x 1.00 mtr. (depth)

Water Level at time to (ho) = - 1.000 MT at below EGL

Reading is taken for a period of 6 (six) hours and 17 (seventeen) minutes.

At the end (tn) the Water Level is – 0.500 mtr.

So, Percolation Rate is 1.0 MT x 0.5 MTR

= 0.5 M^3 at 6 hour 17 minutes.

PERCOLATION TEST – 2

Site	:	Neepco, Monarchak, (TGBPP), Tripura (West)
Location	:	Raw Water Reservior – 3
Ground RL	:	12.950
Ground Water	:	0.000 MTR
Date	:	20.02.2011
Starting time	:	8.00 AM
Soil Condition	:	Bluish grey Silty clay.
Dia of Pit	:	1.00 MTR x 1.00 MTR x 1.00 MTR (depth)
Co-ordinate	:	N = 425.000, E (-) 7.000

Water Level at time to (ho) = - 1.000 MT at below EGL

Reading is taken for a period of 5 (five) hours and 57 (fifty seven) minutes.

At the end (tn) the Water Level is – 0.500 mtr.

So, Percolation Rate is 1.0 MT x 1.0 MT x 0.5 MTR

= 0.5 M^3 at 5 hours 57 minutes.

PERCOLATION TEST – 3

Site	:	Neepco, Monarchak, (TGBPP), Tripura (West)
Location	:	Raw Water Reservior - 1
Co-ordinate	:	N = 450.000, E (-) 32.000
Ground R.L	:	13.200
Ground Water	:	0.000 mtr
Soil Condition	:	Bluish Grey Silty Clay.
Dia of Pit	:	1.00 mtr. x 1.00 mtr. x 1.00 mtr. (depth)
Date	:	21.02.2011
Time	:	8.00 AM

Water Level at time to (ho) = - 1.000 MT at below EGL

Reading is taken for a period of 6 (six) hours and 10 (ten) minutes.

At the end (tn) the Water Level is – 0.500 mtr.

Percolation Rate is 1.0 MTR x 1.0 MTR x 0.5 MTR

= 0.5 M^3 at 6 hour 10 minutes.

PERCOLATION TEST – 4

Site	:	Neepco, Monarchak, (TGBPP), Tripura (West)
Location	:	Raw Water Reservior - 2
Co-ordinate	:	N = 450.000, E (+) 23.000
Ground R.L	:	13.550
Ground Water	:	0.000 mtr
Soil Condition	:	Bluish Grey Silty Clay.
Dia of Pit	:	1.00 mtr. x 1.00 mtr. x 1.00 mtr. (depth)
Date	:	25.02.2011
Time	:	12.00 PM

Water Level at time to (ho) = - 1.000 MT at below EGL

Reading is taken for a period of 6 (six) hours and 23 (twenty three) minutes.

At the end (tn) the Water Level is – 0.500 mtr.

Percolation Rate is 1.0 MTR x 1.0 MTR x 0.5 MTR

= 0.5 M^3 at 6 hour 23 minutes.

DYNAMIC CONE PENETRATION TEST :

Dynamic cone penetration test have been conducted using bentonite slurry by driving a cone of 65 mm diameter attached to the bottom of a string of drill rods. The tests have been conducted upto the refusal. Refusals have been considered when the blow count exceeds 150 for 300 mm penetration. The specification for the equipment and accessories required for performing the test, test procedure, field observations and reporting of results are conform to IS:4968, Part-II. The driving system was comprised of a 65 kg weight having a free fall of 0.75m. The cones have 65 mm diameter provided with vents for continuous flow of bentonite

slurry through the cone and rods in order to avoid friction between the rods and soil. On completion of the test, the results was recorded & presented as a continuous record of number of blows required for every 150 mm penetration of the cone into the soil in a suitable chart supplemented by a graphical plot.

PLATE LOAD TEST :

Five numbers of Plate Load Tests have been carried out as per IS : 1888 at locations, specified in drawing and / or at such other locations as directed by the Engineer. This test has been carried out at a depth of 2.50 m below the existing ground level using 600 mm x 600 mm square plates as indicated in the drawing / as directed by the Engineer. All the tests have been carried out to assess the bearing capacities of the soils at particular level. The results of the test have also been used for arriving at the modulus of sub grade reaction and deformation modulus of soil.

The size of the pit was kept 5 times the width of plate and side protection during the test and backfilling after the test have been carried out properly.

The dial gauges and pressure gauges used for the tests were calibrated by ***Electronics Test and Development Centre, Guwahati,*** *and the certificate was produced to the Engineer before commencing the direct load tests at the site. There were adequate numbers of standby gauges available at the site for quick replacement of faulty gauges. The load was applied on the plate with a suitable kentledge as a reaction loading using a hydraulic Jack with pressure gauge.*

The test plate was preloaded with a seating load of 700 kg/sq.m retained for period of 1 hour and then released to take out all slacks of the arrangement. Incremental Loading was done and for each increment of load, settlement observations of the plate was done with the help of two dial gauges placed

diametrically opposite on the plate. Increments of the load have been of about one tenth of the ultimate bearing capacity. The increments were continued till the settlement is 25 mm or the Yield load. After the test, unloading was done in the same manner of Loading and the rebounds were observed.

In addition to carrying out plate load tests, undisturbed / disturb soil samples were also collected. From the test results Load vs Settlement Curves have been plotted as shown in the Appendix. From these Load settlement curves, both ultimate and safe bearing capacity as well as the sub-grade Modulus and deformation modulus of soil are found out and given in Table II and Table III below :

TABLE - II

PLT No.	***Ultimate Bearing Capacity (t/m^2)***	***Safe Bearing Capacity (t/m^2)***
1	*30.0*	*12.0*
2	*46.3*	*18.5*
3	*43.5*	*17.4*
4	*23.5*	*9.4*
5	*22.8*	*9.2*

TABLE – III

PLT No.	***R.L of Test***	***Subgrade modules values from load test result (in kg/cm^3)***	***Modulus for different width (in kg/cm^3)***				***Deformation modules (in kg/cm^2)***
			2.0	***4.0***	***6.0***	***8.0***	
1	*12.996*	*6.24*	*1.872*	*0.936*	*0.094*	*0.007*	*333.33*
2	*15.550*	*6.64*	*2.128*	*0.996*	*0.100*	*0.007*	*317.46*
3	*16.674*	*11.2*	*3.158*	*1.680*	*0.168*	*0.013*	*810.81*
4	*13.622*	*4.32*	*0.821*	*0.648*	*0.065*	*0.005*	*280.37*
5	*13.686*	*4.4*	*3.216*	*0.660*	*0.066*	*0.005*	*272.73*

ELECTRICAL RESISTIVITY TEST :

Resistivity tests have been conducted at the location shown in the drawing or as instructed by the Engineer, to study resistivity characteristics of soil at different depths up to 10 m from existing ground level.

Electrical resistivity of subsurface layers have been determined by vertical sounding by Wenners method as per IS: 3043. The spacing between electrodes were kept as 1,2,3,4,5,10,15 & 20 m. Measurements taken for different spacing of Electrodes are shown in the Annexure together resistivity curves with depth and Polar diagrams. Resistivity values thus obtained are given below in Table IV.

TABLE – IV

TEST	CO-ORDINATE	RL (m)	MEAN RESISTIVITY TEST		
			N-S	E-W	MEAN RESISTIVITY
ERT – 1	N 343.572 E 101.368	15.531	135 ohm-m	179 ohm-m	157 ohm-m
ERT - 2	N 343.544 E 185.502	20.805	150 ohm-m	217 ohm-m	184 ohm-m
ERT - 3	N 317.432 E 102.521	15.579	139 ohm-m	211 ohm-m	176 ohm-m
ERT – 4	N 318.030 E 134.405	16.470	114 ohm-m	169 ohm-m	142 ohm-m
ERT – 5	N 318.158 E 159.013	17.338	124 ohm-m	147 ohm-m	136 ohm-m
ERT – 6	N 316.932 E 193.451	20.232	140 ohm-m	211 ohm-m	170 ohm-m
ERT – 7	N 256.882 E 123.665	14.547	135 ohm-m	77 ohm-m	106 ohm-m
ERT – 8	N 257.469 E 152.867	16.004	128 ohm-m	128 ohm-m	128 ohm-m
ERT – 9	N 254.290 E 185.204	18.519	154 ohm-m	188 ohm-m	171 ohm-m
ERT – 10	N 243.853 E 184.184	18.296	185 ohm-m	142 ohm-m	163 ohm-m
ERT – 11	N 244.884 E 167.541	17.303	112 ohm-m	113 ohm-m	113 ohm-m
ERT – 12	N 244.655 E 148.476	15.691	105 ohm-m	106 ohm-m	106 ohm-m
ERT – 13	N 243.761 E 122.569	14.335	109 ohm-m	92 ohm-m	100 ohm-m
ERT – 14	N 225.756 E 140.876	15.696	78 ohm-m	135 ohm-m	106 ohm-m
ERT – 15	N 231.428 E 176.316	17.259	220 ohm-m	150 ohm-m	185 ohm-m
ERT – 16	N 181.088 E 105.814	13.601	148 ohm-m	165 ohm-m	156 ohm-m
ERT – 17	N 197.237 E 118.121	13.540	86 ohm-m	78 ohm-m	82 ohm-m
ERT – 18	N 203.048 E 86.244	13.689	138 ohm-m	171 ohm-m	154 ohm-m

TABLE – IV

TEST	CO-ORDINATE	RL	MEAN RESISTIVITY TEST		
			N-S	E-W	MEAN RESISTIVITY
ERT – 19	N 240.427 E 86.485	13.629	100 ohm-m	108 ohm-m	104 ohm-m
ERT – 20	N 257.147 E 85.513	13.673	93 ohm-m	95 ohm-m	94 ohm-m
ERT – 21	N 202.040 E 43.459	16.272	319 ohm-m	256 ohm-m	287 ohm-m
ERT – 22	N 233.353 E 45.249	17.229	138 ohm-m	132 ohm-m	135 ohm-m
ERT – 23	N 231.963 E 11.425		427 ohm-m	398 ohm-m	413 ohm-m
ERT – 24	N 311.330 E 19.636	13.673	146 ohm-m	188 ohm-m	167 ohm-m
ERT – 25	N 328.701 E -9.391	17.281	393 ohm-m	427 ohm-m	410 ohm-m
ERT – 26	N 356.896 E - 0.015	16.741	123 ohm-m	168 ohm-m	145 ohm-m
ERT – 27	N 393.494 E 87.566	16.788	178ohm-m	134 ohm-m	156 ohm-m
ERT – 28	N 485.893 E 117.183	22.101	223 ohm-m	278 ohm-m	250 ohm-m
ERT – 29	N 533.686 E 119.014		150 ohm-m	216 ohm-m	183 ohm-m
ERT – 30	N 494.158 E 154.799		227 ohm-m	283 ohm-m	255 ohm-m

C.B.R TEST :

Four nos. of field C.B.R tests were conducted at locations shown in the site plan. Tests were carried out following IS 2720 part XXXI. Before testing the surface soil was soaked with water for 24 hours and the density was measured at the test locations. Data obtained for Load and Penetration are shown for the Locations in the Annexure of the Report.

From the data obtained from the test, Load vs Penetration Curves have been drawn as shown in Appendix and the CBR values have been obtained for 2.5 mm and 5.0 mm penetration. Values thus obtained are given below in Table V :

TABLE – V

Location	*C.B.R value in percentage*		*Field at Density*
	For 2.5 mm	*For 5.0 mm*	*t/m^3*
1	*3.5*	*3.2*	*1.82*
2	*4.2*	*3.6*	*1.87*
3	*3.8*	*3.4*	*1.84*
4	*4.0*	*3.6*	*1.85*

SEISMIC CROSSHOLE TEST :

INTRODUCTION *: In order to design the foundation for vibratory equipments it is required to obtain Dynamic Properties of Soil at different location of the site. Such properties have been evaluated by conducting two numbers of Seismic Crosshole Shear Test. All such tests are elaborated in details and the properties of soil under dynamic loading has been presented in this chapter: Seismic*

Crosshole shear test has been done by the Civil Engineering Department of Jadavpur University.

Seismic Cross Hole Test is generally carried out using two or more boreholes to measure wave propagation velocities along horizontal paths. In the present investigation, the cross-hole test configuration consists of three-hole arrangements in which one contains an impulse energy source called the Source Borehole and other two holes are Receiver holes (R-1 and R-2). All the three boreholes are aligned in straight line with a distance of 3.0 m centre to centre. By fixing both the Source and the receivers at the same depth in each borehole, the wave propagation velocity of the materials between the boreholes and the Source at that depth has been measured. In the present investigation initially the test was conducted at a starting depth of 1.5 m below the existing ground level and thereafter at an interval of 1.5 m upto a total depth of 25.5 m below the existing ground level.

INSTRUMENT USED : *The Olson Instruments in respect of Crosshole Seismic system is useable for providing information on dynamic soil and rock properties for earthquake design analysis for structures, liquefaction potential studies, site development, and dynamic machine foundation design. The investigation determines shear and Compressional wave velocity from which depth versus velocity profile may be obtained. Other parameters, such as Poisson's ratios and both Elastic and Shear modulus can be determined from the measured shear and Compressional wave velocities. The cross-hole seismic system consists of four basic components viz. a Data Personal Computer (PC) with high-speed data acquisition card, Win Geo acquisition and analysis software, a P-SV Electromechanical Source and two Triaxial Geophone receivers.*

The system is designed and manufactured to be in accordance with ASTM D 4428/D4428M Standard Test Methods for Crosshole Seismic Testing by OLSON INSTRUMENTS Inc., USA

METHODOLOGY : *Initially three boreholes of 90 mm dia were drilled upto the required depth of 25.5 m each below ground level with equal spacing of 3.0 m centre to centre in one straight line. After drilling, all the boreholes were cased with 71 mm ID and 78 mm OD PVC casing and the space between the holes and the casing were properly backfilled with sand-cement grout. In the Source borehole, the electromechanical source P-SV which creates, both downward an upward polarised shear vertical waves (SV) at a given depth was installed and in the Receiver holes, Triaxial geophones were installed at the same depth of source borehole. The source and the receivers Geophones are separately lowered into the boreholes at the designated depth of test with a dummy inclinometer probe keeping proper orientation of the Receiver Geophones in relation to the Source borehole. The near hole i.e closest to the source is called R-1 for Receiver-1 and the far hole is called R-2 for Receiver-2. After the desired depth is reached, the bladder attached to the electromagnetic source piston and the receiver Geophones are inflated with air pressure so that it properly fits on the side of casing. All the communication cables in the source and receivers are connected to the Amplifier module of the Data PC together with trigger cable. There are seven channels in the Module, three for each receiver (total six) and one for trigger. For data acquisition, the computer is turned on and after file and parameter set up, the Impact button of the trigger channel is pushed for Up direction and data were recorded by the computer for all the six channels of the two receivers. After obtaining data, the step is repeated for Down direction and thus the data for both direction of Triggering will be obtained for a particular depth. After the data acquisition is completed, for a particular depth, the entire process is repeated for the next depth and the data acquisition was made for the entire 25.5 m depth.*

DATA OBTAINED AND DISCUSSIONS: To meet the objectives envisaged, Two numbers of Seismic Crosshole Shear Wave Tests CST – 1 and CST – 2 have been carried out in the Main Plant Area at locations of Stack and B.FP area as shown in the attached location plan. Cross Hole test data obtained from the tests for the aforesaid locations are given in Table VIA & VIB as shown below which indicates the time of arrival for the Seismic waves in respective receivers.

TABLE - VIA

Data Sheet for Cross Hole Test

TEST NO. – CST - 1

Depth below G.L (m)	S – R_1 (mt)	S – R_2 (mt)	Hit Direction	R_1T_P (ms)	R_1T_S (ms)	R_2T_P (ms)	R_2T_S (ms)
1.5	3.0	6.0	UP DOWN	8.57 8.67	24.00 24.39	17.05 17.24	47.24 46.51
3.0	3.0	6.0	UP DOWN	8.62 8.72	23.08 23.81	17.14 17.34	46.88 48.00
4.5	3.0	6.0	UP DOWN	6.94 6.91	13.95 13.89	13.95 13.89	28.04 27.52
6.0	3.0	6.0	UP DOWN	5.36 5.34	12.05 11.90	10.75 10.71	24.39 24.19
7.5	3.0	6.0	UP DOWN	5.03 5.05	11.45 11.54	10.08 10.03	22.72 22.90
9.0	3.0	6.0	UP DOWN	4.49 4.51	10.68 10.79	8.96 8.98	21.20 21.13
10.5	3.0	6.0	UP DOWN	4.52 4.55	10.60 10.64	9.02 9.09	21.35 21.20
12.0	3.0	6.0	UP DOWN	4.63 4.64	10.79 10.71	9.30 9.29	21.43 21.28
13.50	3.0	6.0	UP DOWN	4.84 4.81	11.03 11.11	9.65 9.68	22.39 22.22
15.00	3.0	6.0	UP DOWN	5.96 5.94	14.93 14.71	11.95 11.95	29.56 29.70
16.50	3.0	6.0	UP DOWN	4.44 4.45	10.34 10.27	8.92 8.90	20.83 20.69
18.00	3.0	6.0	UP DOWN	3.85 3.85	9.43 9.38	7.73 7.71	18.75 18.75
19.50	3.0	6.0	UP DOWN	3.85 3.84	9.23 9.20	7.69 7.66	18.63 18.46
21.0	3.0	6.0	UP DOWN	3.73 3.75	9.15 9.09	7.47 7.49	18.18 18.13
22.50	3.0	6.0	UP DOWN	3.74 3.73	9.15 9.23	7.47 7.47	18.35 18.40
24.0	3.0	6.0	UP DOWN	3.68 3.69	9.38 9.49	7.35 7.36	18.86 18.75
25.0	3.0	6.0	UP DOWN	3.70 3.69	9.43 9.38	7.38 7.36	18.63 18.87

R_1T_p : Compression wave travel time for receiver R_1 in Mili sec.
R_2T_p : Compression wave travel time for receiver R_2 in Mili Sec
R_1T_s : Shear wave travel time for receiver R_1 in Mili Sec.
R_2T_s : Shear wave travel time forceiver R_2 in Mili Sec.

TABLE - VIB

Data Sheet for Cross Hole Test

TEST NO. – CST - 2

Depth below G.L (m)	S – R_1 (mt)	S – R_2 (mt)	Hit Direction	R_1T_P (ms)	R_1T_S (ms)	R_2T_P (ms)	R_2T_S (ms)
1.5	3.0	6.0	UP DOWN	9.52 9.62	18.98 18.75	19.17 18.98	38.46 38.71
3.0	3.0	6.0	UP DOWN	9.09 9.04	18.29 18.52	18.29 18.18	36.14 36.59
4.5	3.0	6.0	UP DOWN	6.12 6.17	13.04 13.16	12.29 12.35	25.86 26.09
6.0	3.0	6.0	UP DOWN	5.61 5.64	12.20 12.10	11.32 11.28	24.69 24.49
7.5	3.0	6.0	UP DOWN	5.91 5.94	12.40 12.30	11.76 11.81	24.59 25.00
9.0	3.0	6.0	UP DOWN	5.86 5.79	12.77 12.71	11.65 11.67	25.21 25.31
10.5	3.0	6.0	UP DOWN	5.37 5.40	11.81 12.00	10.79 10.75	23.80 24.00
12.0	3.0	6.0	UP DOWN	5.00 5.03	12.50 12.30	9.97 10.00	24.59 24.39
13.50	3.0	6.0	UP DOWN	5.24 5.22	12.61 12.40	10.51 10.43	25.00 25.00
15.00	3.0	6.0	UP DOWN	5.06 5.04	11.58 11.45	10.14 10.08	23.26 23.17
16.50	3.0	6.0	UP DOWN	4.62 4.64	11.36 11.45	9.26 9.27	23.08 22.72
18.00	3.0	6.0	UP DOWN	3.85 3.84	9.49 9.58	7.74 7.71	19.23 19.11
19.50	3.0	6.0	UP DOWN	3.79 3.80	9.32 9.23	7.59 7.56	18.75 18.58
21.0	3.0	6.0	UP DOWN	3.77 3.76	9.09 9.04	7.53 7.54	18.29 18.18
22.50	3.0	6.0	UP DOWN	3.76 3.77	8.96 9.00	7.52 7.50	17.86 17.96
24.0	3.0	6.0	UP DOWN	3.73 3.74	8.77 8.67	7.48 7.48	17.65 17.44
25.0	3.0	6.0	UP DOWN	3.79 3.78	8.88 8.82	7.58 7.59	17.75 17.54

R_1T_p : Compression wave travel time for receiver R_1 in Mili sec.
R_2T_p : Compression wave travel time for receiver R_2 in Mili Sec
R_1T_s : Shear wave travel time for receiver R_1 in Mili Sec.
R_2T_s : Shear wave travel time forceiver R_2 in Mili Sec

From the arrival time and the distance of the Receivers from the Source, both compression and Shear wave velocities have been computed and presented in the Table VIIA& VIIB as shown below :

TABLE - VIIA

Estimation of Compressional and Shear Wave Velocities

TEST NO. – CST - 1

Depth below G.L (m)	Hit Direction	Compression : Wave Velocity V_P (m/sec)			Shear Wave Velocity V_S (m/sec)			Avg. Velocity (m/sec)	
		$S – R_1$	$S – R_2$	$R_1 – R_2$	$S – R_1$	$S – R_2$	$R_1 – R_2$	V_p	V_s
1.5	UP DOWN	350 346	352 348	354 350	125 123	127 129	129 136	350	130
3.0	UP DOWN	348 344	350 346	352 348	130 126	128 125	126 129	347	128
4.5	UP DOWN	432 434	430 432	428 430	215 216	214 218	213 220	432	216
6.0	UP DOWN	560 532	558 560	557 559	249 252	246 248	243 244	560	245.5
7.5	UP DOWN	597 594	595 598	594 602	262 260	264 262	266 264	596	264
9.0	UP DOWN	668 665	670 668	671 671	281 278	283 284	285 290	667.5	281
10.5	UP DOWN	664 660	665 660	667 661	283 282	281 283	279 284	662.50	282
12.0	UP DOWN	648 646	645 646	642 645	278 280	280 282	282 284	646.50	280
13.50	UP DOWN	620 624	622 620	624 616	272 270	268 270	264 270	622	270
15.00	UP DOWN	503 505	502 502	501 500	201 204	203 202	205 200	503.5	202.50
16.50	UP DOWN	676 674	673 674	667 666	290 292	288 290	286 288	674.50	290
18.00	UP DOWN	780 780	776 778	773 777	318 320	320 320	332 331	778	319
19.50	UP DOWN	780 782	780 783	781 780	325 326	322 325	319 324	781.50	324
21.0	UP DOWN	804 801	803 801	809 802	328 330	330 331	332 332	802.50	329.50
22.50	UP DOWN	802 805	803 803	804 802	328 325	327 326	326 327	803.5	326.50
24.0	UP DOWN	815 812	816 815	817 817	320 316	318 320	316 324	814	318
25.0	UP DOWN	810 812	813 815	815 817	318 320	322 318	326 316	812.50	320

$S – R_1$: Source to receiver Geophone 1
$S – R_2$: Source to receiver Geophone 2
$R_1 – R_2$: Receiver Geophone 1 to 2

TABLE - VIIB

Estimation of Compressional and Shear Wave Velocities

TEST NO. – CST -2

Depth below G.L (m)	Hit Direction	Compression : Wave Velocity V_P (m/sec)			Shear Wave Velocity V_S (m/sec)			Avg. Velocity (m/sec)	
		$S – R_1$	$S – R_2$	$R_1 – R_2$	$S – R_1$	$S – R_2$	$R_1 – R_2$	V_p	V_s
1.5	UP DOWN	315 312	313 316	311 321	158 160	156 155	154 150	314	157.5
3.0	UP DOWN	330 332	328 330	326 328	164 162	166 164	168 166	329	164
4.5	UP DOWN	490 486	488 486	486 485	230 228	232 230	234 232	488	230
6.0	UP DOWN	535 532	530 532	525 532	246 248	243 245	240 242	532	245.5
7.5	UP DOWN	508 505	510 508	513 511	242 244	244 240	246 236	507.5	243
9.0	UP DOWN	512 518	515 514	518 510	235 236	238 238	241 240	515	236.5
10.5	UP DOWN	559 556	556 558	554 561	254 250	252 250	250 250	557.5	252
12.0	UP DOWN	600 597	602 600	638 604	240 244	244 246	248 248	599.5	243
13.50	UP DOWN	573 575	571 575	569 576	238 242	240 240	242 238	574	240
15.00	UP DOWN	593 595	592 595	590 595	259 262	258 259	257 256	593.5	260.5
16.50	UP DOWN	650 647	648 647	647 648	264 262	260 264	256 266	648.5	262
18.00	UP DOWN	780 782	775 778	771 775	316 313	312 314	308 315	778.5	314
19.50	UP DOWN	792 790	790 794	789 798	322 325	320 323	318 321	792	322.5
21.0	UP DOWN	795 798	797 796	798 794	330 332	328 330	326 328	796.5	330
22.50	UP DOWN	798 796	798 800	798 804	335 333	336 334	337 335	798	334.5
24.0	UP DOWN	805 803	802 802	800 802	342 346	340 344	338 342	803.5	343
25.0	UP DOWN	790 794	792 790	796 787	338 340	338 342	338 344	792	340

$S – R_1$: Source to receiver Geophone 1
$S – R_2$: Source to receiver Geophone 2
$R_1 – R_2$: Receiver Geophone 1 to 2

Based on the values of Shear wave velocities at two locations the classification of the has been done according to uniform Building Code (1997).

The classification of subsurface formation Building Code (1997) is furnished below for ready reference.

Type of Formation	***Average Shear Wave Velocities (Vs) (m/sec)***	***Classification***
Hard Rock	*>1500*	*SA*
Rock	*760-1500*	*SB*
Very Dense Soil and Soft Rock	*360-760*	*SC*
Stiff Soil	*180-360*	*SD*
Very Soft Soil	*<180*	*SE*

In order to find out the dynamic properties, such as, shear modulus (G), elastic modulus (E) and Poisson's ratio (μ) the following formulations have been used.

Poisson's ratio $\mu = [0.5(V_P/V_S)^2 - 1] / [(V_P/V_S)^2 - 1]$

Modulus of elasticity $E = 2G(1 + \mu)$

Modulus of rigidity $G = V_s^2 \rho$

Where,

ρ = *Mass density of soil in ton* sec^2/m^4

V_p = *Velocity of compression wave in m/s.*

V_s = *Velocity of shear waves in m/s.*

Based on the above the values of Shear Modulus, Elastic Modulus & Poissons ratio have been estimated as shown in Table VIII.

Table :VIII

SHEAR MODULUS, ELASTIC MODULUS AND POISSON'S RATIO FROM CROSSHOLE TEST

Location	*Layer Classification*	*Depth*	*Average (V_p/V_s)*	*Average Shear Wave Velocities (m/sec)*	*Shear Modulus (t/m^2)*	*Elastic Modulus (t/m^2)*	*Poisson's Ratio*
CST - 1	*SE*	*(0 – 4.5)*	*2.70*	*129*	*3053.4*	*8675.39*	*0.42*
	SD	*(4.5 – 18.0)*	*2.30*	*259*	*12992.2*	*35858.47*	*0.38*
	SD to SC	*(18.0 – 25.50)*	*2.47*	*322*	*21138.43*	*59187.60*	*0.40*
CST - 2	*SE*	*(0 – 4.5)*	*1.99*	*161*	*4756.14*	*12676.50*	*0.33*
	SD	*(4.5 – 18.0)*	*2.26*	*245*	*11710.14*	*32300.2*	*0.38*
	SD to SC	*(18.0 – 25.50)*	*2.39*	*330*	*22291.62*	*62190.3*	*0.39*

**Vp = Compression Wave Velocity, Vs = Shear Wave Velocity*

C_z = Coefficient of Elastic uniform compression

$C\tau$ = Coefficient of Elastic uniform Shear

$C\phi$ = Coefficient of Elastic non uniform compression

$C\psi$ = Coefficient of Elastic non uniform Shear

In order to obtain the Elastic Constants of Soil under dynamic loading the values of Elastic modulus 'E' obtained from cross hole test results were utilised as per IS 5249 – 1981 in which the values are as follows :

$$\boldsymbol{C_z} = \frac{E}{1-\mu^2} \; X \; \frac{1.13}{\sqrt{A}}$$

$$C\tau = \frac{\boldsymbol{C_z}}{1.75} \qquad C\phi = 3.46\, C\tau \text{ and } C\psi = 0.75\, \boldsymbol{C_z}$$

Where C_z = *Coefficient of Elastic uniform compression*

$C\tau$ = *Coefficient of Elastic uniform Shear*

$C\phi$ = *Coefficient of Elastic non uniform compression*

$C\psi$ = *Coefficient of Elastic non uniform Shear*

μ = *Possions ratio of Soil*

A = Contact Area of foundation with soil (Taken as 10 m^2*)*

Recommended Values of Dynamic Properties of Soil :

As stated earlier, Values of Elastic Modulus, Shear Modulus have been obtained from wave Propagation test Following Seismic Cross Hole Test. Design values of this Modulus should be corrected for corresponding Strain pertaining to M/C Foundation. For the M/C Foundation the Strain Level is usually, in the range of 10^{-4} *and for wave propagation test like cross hole test the strain level is* 10^{-5}*. Hence the Shear Modulus 'G' and in turn the Elastic modulus 'E' were corrected from the test results using strain correction as*

$$\frac{G}{G\ test} = \frac{1}{\frac{1+\gamma\ test}{\gamma}}$$

Where G = Design value of Shear Modulus for M/C foundation

G test = Shear Modulus from Cross Hole

γ *test = Strain level of Cross Hole*

γ *= Strain level of M/C foundation*

For contact area more than 10 m^2 *no area correction is required. Based on the above, the design parameters of Modulus of Elasticity, Shear Modulus and the dynamic elastic constants are presented for both the location in Table IX as given below :*

TABLE IX:

DESIGN VALUE OF DYNAMIC PROPERTIES OF SOIL

Location	*Depth (m)*	*Average Shear Wave Velocities (m/sec)*	*Average (V_p/V_s)*	*Shear Modulus (kg/cm^2)*	*Elastic Modulus (kg/cm^2)*	*Poisson's Ratio*	*C_z (kg/cm^3)*	*$C\tau$ (kg/cm^3)*	*$C\phi$ (kg/cm^3)*	*$C\psi$ (kg/cm^3)*
CST - 1	*(0 – 4.5)*	*2.70*	*129*	*277.58*	*788.33*	*0.42*	*3.46*	*1.97*	*6.81*	*2.59*
	(4.5 – 18.0)	*2.30*	*259*	*1182.13*	*3262.70*	*0.38*	*13.85*	*7.91*	*27.36*	*10.38*
	(18.0 – 25.50)	*2.47*	*322*	*1921.67*	*5388.30*	*0.40*	*23.23*	*13.27*	*45.91*	*17.42*
CST - 2	*(0 – 4.5)*	*1.99*	*161*	*432.37*	*1152.40*	*0.33*	*4.68*	*2.67*	*9.23*	*3.51*
	(4.5 – 18.0)	*2.26*	*245*	*1064.55*	*2936.40*	*0.37*	*12.40*	*7.08*	*24.49*	*9.30*
	(18.0 – 25.50)	*2.39*	*330*	*2026.51*	*5653.7*	*0.39*	*24.22*	*13.84*	*47.88*	*18.16*

**Vp = Compression Wave Velocity, Vs = Shear Wave Velocity*

SUBSOIL PROFILE AND PROPERTIES :

INTRODUCTION : In the entire area of the project 40 numbers of Boreholes have been sunk upto a maximum depth of 35.0 m below existing ground level. The existing ground is highly undulated with R.L various between +13.0 m to + 20.0 m. In general the subsoil condition as revealed from the Boreholes indicate similar stratification with the presence of top deposit of Sandy clay followed by deep deposits of Sandy soil of different relative density. Cohesive deposit of hard clay / clay shale is found to be sandwiched between two successive sandy deposits. The sequence of stratification in general is common in the entire area with variation in the thickness of strata. However at some locations, the top deposit is found to consist of thin layer of soft silty clay instead of the Sandy clay layer.

With the above in view, the subsoil profile has been presented area wise and for each area an average soil profile has been generated to design the foundation for different utilities of the Power Plant.

I. MAIN PLANT AREA :

In the Main Power Plant area, the Subsoil Conditions as revealed from 17 nos. of Boreholes (BH No. 19 to 35) are shown in the borelog data sheet as well as in the soil profile drawn with these boreholes Alluvium of alternate layer of clay, sand & silt which continues upto a great depth of 35.0 m below G.L and no Rock formation has been found upto the explored depth of 35.0 m. The elevation of existing Ground level in this area vary between RL + 13.57 m and RL + 19.10 m with a topmost stratum of moderately stiff sandy clay of average. Thickness 5.0 m. Thereafter there is a thick sandy stratum which continues up to an average depth of 14.0 m which is underlain by a thin very hard clay / clay stone and followed by a deep deposit of sand upto the explored depth of 35.0 m.
In general the subsoil profile at Main Power Plant area is as shown below :

STRATUM	*DESCRIPTION*	*RANGE OF THICKNESS (M)*	*RANGE OF 'N' VALUE*
I	*Brownish grey sandy clay*	*3 to 6.5*	*6 to 14*
II	*Medium to Dense yellowish silty fine sand with clay binders*	*7.5 to 13.0*	*22 to 54*
III	*Hard Bluish grey / grey silty clay with kankars / clay stone.*	*1.0 to 4.5*	*24 to 65*
IV	*Dense to very Dense yellowish fine to medium sand.*	*More than 15.0 m*	*48 to 99*

Variation in the type of soil at the top deposit of stratum I has been noticed wherein at locations of BH No. 24 & 26, the top deposit consists of very soft Dark grey Silty clay of average thickness of 4.0 m. The ground water tables were noticed at an average R.L of + 13.00 m.

Based on the general soil profile, the average design soil profile at the main plant are has been obtained as given below :

STRATUM	*AVG. R.L of Bottom of Stratum (m)*	*AVG. Thickness of Stratum (m)*	*Remarks*
I	*+ 11.3*	*5.0*	*Avg. R.L of Ground +16.3 m*
II	*+ 2.40*	*8.9*	
III	*- 0.05*	*2.45*	
IV	*- 18.70*	*18.65*	

Engineering Properties of different strata as obtained from Laboratory as well as field test data are summarised below :

Stratum	*Bulk Density t/m^3*	*N.M.C %*	*LL %*	*PL %*	*Cohesion*	*Avg. of Ultimate friction*	*Volume Compressibility mv(cm^2/kg)*
					C t/m^2	*ϕ*	
I	*1.84 to 1.87*	*28 to 31*	*38 to 40*	*15 to 20*	*3.2 to 4.8 (UCS) 2.5 to 3.8 (UU)*	*$\bar{10}$ to 15^0*	*.032 to .035*
II	*1.90 to 1.95*	*17.5 to 29*	*-*	*NP*	*0.0*	*30 to 34^0*	*-*
III	*1.91 to 2.0*	*26 to29*	*58 to 60*	*22 to 24*	*8.5 to 11.0 (UCS) 9.0 to 12.0 (UU)*	*- 0^0*	*.022 To .032*
IV	*2.0 to 2.02*	*14 to 16*	*-*	*NP*	*0*	*34 to 36^0*	*-*

II. COOLING TOWER AND DM PLANT:

In the Cooling Tower Area & DM Plant, the Subsoil Conditions as revealed from 08 nos. of Boreholes (BH No. 11 to 18) indicates an Alluvium of alternate layer of clay, sand & silt which continues upto a great depth of 35.0 m below G.L and no Rock formation has been found upto the explored depth of 35.0 m. The elevation of existing Ground level vary between R.L + 17.4 m and + 16.60 m with a topmost stratum of moderately stiff sandy clay of average thickness 5.0 m. Thereafter there is a thick sandy stratum which continues up to an average depth of 13.0 m which is underlain by a thin very hard clay / clay stone and followed by a deep deposit of sand upto the explored depth of 35.0 m.

In general the subsoil profile at Cooling Tower & DM Plant Area is as shown below :

STRATUM	*DESCRIPTION*	*RANGE OF THICKNESS (M)*	*RANGE OF 'N' VALUE*
I	*Brownish grey sandy clay*	*5.0*	*6 to 16*
II	*Medium to Dense yellowish silty fine sand with clay binders*	*07 to 09*	*14 to 28*
III	*Hard Bluish grey / grey silty clay with kankars / clay stone.*	*1.00 to 3.50*	*15 to 25*
IV	*Dense to very Dense yellowish fine to medium sand.*	*More than 15.0 m*	*30 to 99*

The average design soil profile in this area has obtained as given below :

STRATUM	*AVG. R.L of Bottom of Stratum (m)*	*AVG. Thickness of Stratum (m)*	*Remarks*
I	*+ 12.0*	*5.0*	*Avg. Gr. R.L of this area is +17.0 m*
II	*+ 4.0*	*8.0*	
III	*+ 1.7*	*2.30*	
IV	*- 18.0*	*19.7*	

Engineering Properties of different strata as obtained from Laboratory as well as field test data are summarised below :

Stratum	*Bulk Density t/m^3*	*N.M.C %*	*LL %*	*PL %*	*Cohesion*	*Avg. of Ultimate friction*	*Volume Compressibility $mv(cm^2/kg)$*
					C t/m^2	*ϕ*	
I	*1.85 to 1.87*	*26 to 28*	*36 to 41*	*14 to 22*	*3.1 to 4.8 (UCS) 2.4 to 3.8 (UU)*	*$\_$ 09^0 to 14^0*	*0.032 to 0.034*
II	*1.90 to 1.96*	*16 to 27*	*-*	*NP*	*0.0*	*31.35^0 to 34^0*	*-*
III	*1.93 to 1.95*	*21 to 30*	*55 to 57*	*21 to 25*	*8.3 to 10.90 (UCS) 8.9 to 11.6 (UU)*	*- 0^0*	*0.021 To 0.032*
IV	*2.0 to 2.02*	*14 to 16*	*-*	*NP*	*0*	*34 to 36^0*	*-*

III. SWITCH YARD AREA :

In the Switch Yard Area, the Subsoil Conditions as revealed from 06 nos. of Boreholes (BH No.01to 06) including BH 37 which is adjacent to the Switch Yard Area, indicates an Alluvium of alternate layer of clay, sand & silt which continues upto a great depth of 35.0 m below G.L and no Rock formation has been found upto the explored depth of 35.0 m. The elevation of existing Ground level vary between (+) 14.0 m to (+) 22.00 m with a topmost stratum of moderately stiff sandy clay of average, thickness 5.0 m. Thereafter there is a thick sandy stratum which continues up to an average R.L of (+) 3.0 m which is underlain by a thin very hard clay / clay stone and followed by a deep deposit of sand upto the explored depth of 35.0 m.

In general the subsoil profile at Switch Yard Area is as shown below :

STRATUM	*DESCRIPTION*	*RANGE OF THICKNESS (M)*	*RANGE OF 'N' VALUE*
I	*Brownish grey sandy clay*	*4 to 5.0*	*7 to 15*
II	*Medium to Dense yellowish silty fine sand with clay binders*	*8 to 11*	*12 to 40*
III	*Hard Bluish grey / grey silty clay with kankars / clay stone.*	*3.0 to 6.00*	*14 to 51*
IV	*Dense to very Dense yellowish fine to medium sand.*	*More than 15.0 m*	*23 to 99*

The average design soil profile for this area has been obtained as given below :

STRATUM	*BOTTOM R.L (m)*	*THICKNESS (m)*	*REMARKS*
I	*+ 12.5*	*4.80*	*The avg. R.L of Ground level is + 17.3 m*
II	*+ 3.0*	*9.50*	
III	*- 0.90*	*3.90*	
IV	*- 17.70*	*16.80*	

The ground water table at the time of investigation was found to be at RL + 12.50 m.

Engineering Properties of different strata as obtained from Laboratory as well as field test data are summarised below :

Stratum	*Bulk Density* t/m^3	*N.M.C %*	*LL %*	*PL %*	*Cohesion*	*Avg. of Ultimate friction*	*Volume Compressibility* $mv(cn^2/kg)$
					C t/m^2	ϕ	
I	*1.83 to 1.86*	*25 to 28*	*36 to 40*	*15 to 22*	*3.3 to 4.7 (UCS) 2.5 to 3.6 (UU)*	11^0 *to* 15^0	*0.031 to 0.033*
II	*1.88 to 1.96*	*17 to 29*	*-*	*NP*	*0.0*	31.38^0 *to* 37^0	*-*
III	*1.95 to 1.98*	*22 to25*	*55 to 59*	*21 to 24*	*10.9 to 11.20 (UCS) 11.9 to 12.3 (UU)*	0^0	*0.022 To 0.024*
IV	*2.0 to 2.02*	*14 to 16*	*-*	*NP*	*0*	36^0	*-*

IV : CLARIFLOCCULATOR CLEAR WATER AND FIRE WATER AREA ::

In this area there are four nos. of Boreholes (BH 7 to 10). In general the existing ground level varies between +13.3 and +17.9 m with avg. Ground Level of + 15.2 m. As the finished ground level will be at RL + 16.5 it indicates that there will be an maximum fill of 1.3 m. The subsoil profile as revealed from the boreholes indicate the presence of top stratum of Sandy clay of thickness of 4.0 m which is subsequently followed by deep deposits of sand of different relative density with a thin clay layer in between the sandy stratum. In general the soil profile is generalized as given below :

STRATUM	*DESCRIPTION*	*THICKNESS (M)*	*RANGE OF 'N' VALUE*
I	*Medium Brownish grey sandy clay.*	*3.5m to 5.0 m*	*8 to 14*
II	*Medium Grey Silty fine sand with clay binders*	*3.5 m to 9.5 m*	*15 to 26*
III	*Hard Bluish grey silty clay with kankars.*	*4.0 m to 9.0 m*	*13 to 38*
IV	*Very Dense Yellowish fine to medium sand*	*More than 15.0 m (upto the explored depth of 35.0 m)*	*52 to 92*

The design average subsoil profile for this area has been arrived as given below :

STRATUM	*R.L OF BOTTOM OF LAYER (m)*	*THICKNESS (m)*	*REMARKS*
I	*+ 11.0*	*4.00*	*The avg. Ground level is at RL + 15.0 m*
II	*+ 3.40*	*7.6*	
III	*- 2.60*	*6.0*	
IV	*- 20.0*	*17.4*	

Engineering Properties of different strata as obtained from Laboratory as well as field test data are summarised below :

Stratum	*Bulk Density t/m^3*	*N.M.C %*	*LL %*	*PL %*	*Cohesion*	*Avg. of Ultimate friction*	*Volume Compressibility $mv(cn^2/kg)$*
					C t/m^2	*ϕ*	
I	*1.85 to 1.94*	*22 to 26*	*35 to 39*	*17 to 21*	*3.5 to 4.5 (UCS) 3.80 to 4.8 (UU)*	*$\_$ 11^0 to 15^0*	*0.031 to 0.033*
II	*1.88 to 1.94*	*18 to 22*	*-*	*NP*	*0.0*	*31^0 to 32^0*	*-*
III	*1.95 to 2.0*	*22 to 24*	*55 to 59*	*21 to 23*	*10.9 to 12 (UCS) 11.9 to 12.3 (UU)*	*- 0^0*	*0.02 To 0.022*
IV	*2.0 to 2.02*	*14 to 16*	*-*	*NP*	*0*	*34 to 36^0*	*-*

V : RAW WATER & CLEAR WATER RESERVOIRS :

In this area there are four nos. of Boreholes (BH 36 & 38 to 40). In general the existing ground level varies between +12.5 and +14 m with avg. Ground Level of + 13.2 m. As the finished ground level will be at RL + 16.5 it indicates that there will be an maximum fill of 3 m. The subsoil profile as revealed from the boreholes indicate the presence of top stratum of very soft clay of Avg. thickness of 4.5 m which is subsequently followed by deep deposits of sand of different relative density with a thin clay layer in between the sandy stratum. In general the soil profile is generalized as given below :

STRATUM	*DESCRIPTION*	*THICKNESS (M)*	*RANGE OF 'N' VALUE*
I	*Soft dark grey Silty clay.*	*4.5m*	*2 to 3*
II	*Medium Grey Silty fine sand with clay binders*	*7.5 m to 9.5 m*	*10 to 25*
III	*Hard Bluish grey silty clay with kankars.*	*2.0 m to 4.0 m*	*13 to 38*
IV	*Very Dense Yellowish fine to medium sand*	*More than 16.0 m (upto the explored depth of 35.0 m)*	*52 to 98*

The design average subsoil profile for this area has been arrived as given below :

STRATUM	*R.L OF BOTTOM OF LAYER (m)*	*THICKNESS (m)*	*REMARKS*
I	*+ 8.75*	*4.5*	*The avg. Ground level is at RL + 13.2 m*
II	*+ 0.54*	*8.2*	
III	*- 3.16*	*3.7*	
IV	*- 22.0*	*19.0*	

Engineering Properties of different strata as obtained from Laboratory as well as field test data are summarised below :

Stratum	*Bulk Density t/m^3*	*N.M.C %*	*LL %*	*PL %*	*Cohesion*	*Avg. of Ultimate friction*	*Volume Compressibility $mv(cn^2/kg)$*
					C t/m^2	*ϕ*	
I	*1.70 to 1.75*	*34 to 36*	*52 to 59*	*24 to 26*	*1.5 to 1.8 (UCS) 1.6 to 1.8 (UU)*	*$\_$ 0^0*	*0.055 to 0.060*
II	*1.88 to 1.92*	*18 to 22*	*-*	*NP*	*0.0*	*31^0 to 32^0*	*-*
III	*1.88 to 1.92*	*24 to 26*	*52 to 60*	*22 to 24*	*8.5 to 9.5 (UCS) 8.9 to 9.8 (UU)*	*- 0^0*	*0.028 To 0.030*
IV	*2.0 to 2.02*	*14 to 16*	*-*	*NP*	*0*	*34 to 36^0*	*-*

3. FOUNDATION CONSIDERATION & BEARING CAPACITY

INTRODUCTION :

The Proposed 100 M.W Cyclic Power Plant at Monarchak, Tripura will house different Plant structure with equipment foundation. In addition to these there will be some appurtant Structures in the area. Among all these structure foundation for the Main Plant, Cooling Tower, Switch Yard are etc. will cater moderate to high load. On the other hand for the other appurtant structures, the loading will be light to moderate. Now for any type of foundation, the design criterion from the subsoil condition would be the suitable factor of safety against shear failure and the serviceable limit of settlements of the foundations for Plant and equipments. In case of foundations under vibratory loads, the design should be based on the dynamic properties of subsoil.

Based on the above, both shallow and deep foundations have been discussed area wise. In case of shallow foundation Bearing Capacity has been found out at different types of footings as specified in the contract.

Bearing Capacity of Shallow Foundation

In all most in all the areas excepting at Raw Water, Clearwater & Reservoir area the subsoil consists of a top deposit of sandy clay of average thickness 4.0 to 5.0 m which is followed by sandy stratum. For depth of foundation upto 3.0 m below NGL, will be guided by the properties of the top stratum whereas foundation below 3.0 m will be guided by the sandy deposit immediately below the top stratum. The Bearing capacity values at different depth in top stratum has been found out following IS 6403 – 1981. on the other hand those in the next sandy stratum has been obtained using Teng's formulation. The net allowable Bearing

capacity has been obtained with a factor of safety of 2.5 against shear failure and permissible settlement of 25 mm & 40 mm respective. All detailed calculations have been given in the Appendix.

BEARING CAPACITY OF SHALLOW FOUNDATION AT POWER BLOCK AREA

SQUARE FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
1.0X1.0	**14.3**	**23**
2.0X2.0	**8.6**	**12.80**
3.0X3.0	**5.7**	**9.2**
4.0X4.0	**4.2**	**6.7**
5.0X5.0	**3.7**	**5.2**
AT 3.0M DEPTH		
1.0X1.0	**13.9**	**22.20**
2.0X2.0	**9.3**	**12.8**
3.0X3.0	**6.6**	**10.50**
4.0X4.0	**4.9**	**7.9**
5.0X5.0	**4.4**	**7**
AT 4.0M DEPTH		
1.0X1.0	**16.00**	**25.50**
2.0X2.0	**9.7**	**15.6**
3.0X3.0	**8.7**	**13.9**
4.0X4.0	**8.0**	**12.9**
5.0X5.0	**6.6**	**10.5**

AT 5.0M DEPTH

1.0X1.0	**22.2**	**35.50**
2.0X2.0	**13.0**	**20.80**
3.0X3.0	**11.5**	**18.40**
4.0X4.0	**10.60**	**16.00**
5.0X5.0	**8.4**	**13.5**

BEARING CAPACITY OF SHALLOW FOUNDATION AT POWER BLOCK AREA

RECTANGULAR FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**9.50**	**15.30**
4.0X2.0	**5.05**	**8.10**
6.0X3.0	**3.7**	**5.9**
8.0X4.0	**3.2**	**5.1**
10.0X5.0	**2.8**	**4.5**

RECTANGULAR FOOTING
AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**0**	**15.7**
4.0X2.0	**5.8**	**9.3**
6.0X3.0	**4.4**	**7.1**
8.0X4.0	**4**	**6.3**
10.0X5.0	**3.6**	**5.7**

RECTANGULAR FOOTING
AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	11.43	18.03
4.0X2.0	6.04	11.33
6.0X3.0	5.8	9.40
8.0X4.0	5.71	9.21
10.0X5.0	4.71	7.5

RECTANGULAR FOOTING
AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	15.70	25.10
4.0X2.0	9.19	14.71
6.0X3.0	8.13	13.01
8.0X4.0	7.42	11.31
10.0X5.0	5.94	9.55

BEARING CAPACITY OF SHALLOW FOUNDATION AT POWER BLOCK AREA

STRIP
FOOTING
AT 2.0M
DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	7.17	11.47
2	6.3	10.08
3.0	5.5	8.8
4	5.21	8.34

STRIP FOOTING AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	7.86	17.5
2	8.34	13.53
3.0	8	11.3
4	7.57	10.70

STRIP FOOTING AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	10.22	22.75
2	10.68	17.29
3.0	10.11	14.29
4	9.57	13.53

STRIP FOOTING AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	11.11	24.73
2	11.43	18.52
3.0	10.74	15.16
4	10.17	14.35

BEARING CAPACITY OF SHALLOW FOUNDATION AT COOLING TOWER & DM PLANT

SQUARE FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0X1.0	11.42	13.54
2.0X2.0	8.59	12.83
3.0X3.0	6.85	10.95
4.0X4.0	5.73	9.17
5.0X5.0	3.72	5.26

AT 3.0M DEPTH

1.0X1.0	7.52	7.52
2.0X2.0	6.98	6.98
3.0X3.0	5.96	6.66
4.0X4.0	5.10	6.45
5.0X5.0	4.51	7.3

AT 4.0M DEPTH

1.0X1.0	14.49	23.18
2.0X2.0	12.15	19.44
3.0X3.0	10.86	17.38
4.0X4.0	10.06	16.09
5.0X5.0	6.87	10.11

AT 5.0M DEPTH

1.0X1.0	**22.05**	**35.28**
2.0X2.0	**18.22**	**29.16**
3.0X3.0	**16.13**	**28.81**
4.0X4.0	**14.82**	**23.71**
5.0X5.0	**8.45**	**13.62**

BEARING CAPACITY OF SHALLOW FOUNDATION AT COOLING TOWER & DM PLANT

RECTANGULAR FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**6.52**	**10.44**
4.0X2.0	**5.59**	**8.95**
6.0X3.0	**4.79**	**7.66**
8.0X4.0	**4.46**	**7.14**
10.0X5.0	**2.92**	**4.65**

RECTANGULAR FOOTING
AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**5.01**	**6.36**
4.0X2.0	**4.39**	**6.1**
6.0X3.0	**4.00**	**5**
8.0X4.0	**3.69**	**4.5**
10.0X5.0	**3.70**	**5.78**

RECTANGULAR FOOTING
AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	6.34	18.90
4.0X2.0	6.11	15.79
6.0X3.0	5.94	12.83
8.0X4.0	5.76	11.71
10.0X5.0	4.81	7.64

RECTANGULAR FOOTING
AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	6.90	20.55
4.0X2.0	6.59	1.91
6.0X3.0	6.36	13.74
8.0X4.0	6.15	12.47
10.0X5.0	5.99	9.58

BEARING CAPACITY OF SHALLOW FOUNDATION AT COOLING TOWER & DM PLANT

STRIP FOOTING AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.00	5.37	8.59
2	4.52	7.23
3.00	3.93	6.29
4.0	3.59	5.74

STRIP FOOTING AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.00	4.99	5.79
2	4.14	4.4
3.00	3.5	3.5
4.0	2.9	2.9

STRIP FOOTING AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.00	5.79	17.41
2	5.57	14.54
3.00	5.42	11.82
4.0	5.25	10.79

STRIP FOOTING AT 5.0M DEPTH

ALLOWABLE BEARING CAPACITY(t/m^2)

	25mm Settlement	40mm Settlement
1.00	6.29	18.92
2.00	6.01	1.76
3.00	5.80	12.66
4.00	5.61	11.49

BEARING CAPACITY OF SHALLOW FOUNDATION AT SWITCH YARD AREA

SQUARE FOOTING AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0X1.0	11.42	13.54
2.0X2.0	8.59	12.83
3.0X3.0	6.85	10.95
4.0X4.0	5.73	9.17
5.0X5.0	3.78	5.30

AT 3.0M DEPTH

1.0X1.0	9.80	13.1
2.0X2.0	7.36	11.78
3.0X3.0	5.96	9.54
4.0X4.0	5.10	8.16
5.0X5.0	4.4	7.86

AT 4.0M DEPTH

1.0X1.0	**12.56**	**20.09**
2.0X2.0	**10.53**	**16.85**
3.0X3.0	**9.42**	**15.07**
4.0X4.0	**8.72**	**13.95**
5.0X5.0	**6.69**	**10.63**

AT 5.0M DEPTH

1.0X1.0	**13.65**	**21.84**
2.0X2.0	**11.28**	**18.06**
3.0X3.0	**9.99**	**15.98**
4.0X4.0	**9.18**	**14.68**
5.0X5.0	**8.54**	**13.55**

BEARING CAPACITY OF SHALLOW FOUNDATION AT SWITCH YARD AREA

RECTANGULAR FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**6.52**	**10.44**
4.0X2.0	**5.59**	**8.95**
6.0X3.0	**4.79**	**7.66**
8.0X4.0	**4.46**	**7.14**
10.0X5.0	**2.91**	**4.59**

RECTANGULAR FOOTING
AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	5.01	8.03
4.0X2.0	4.39	7.04
6.0X3.0	4.00	6.40
8.0X4.0	3.69	5.91
10.0X5.0	3.61	5.73

RECTANGULAR FOOTING
AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	8.25	17.61
4.0X2.0	6.92	14.77
6.0X3.0	6.19	13.20
8.0X4.0	5.73	12.22
10.0X5.0	4.76	7.62

RECTANGULAR FOOTING
AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	12.56	26.81
4.0X2.0	10.38	22.16
6.0X3.0	9.19	21.89
8.0X4.0	8.44	18.01
10.0X5.0	6.10	9.74

BEARING CAPACITY OF SHALLOW FOUNDATION AT SWITCH YARD AREA

STRIP FOOTING AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	5.37	8.59
2.0	4.52	7.23
3.0	3.93	6.29
4.0	5.24	8.39

STRIP FOOTING AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	4.99	7.99
2.0	4.14	6.62
3.0	3.65	5.84
4.0	7.62	10.81

STRIP FOOTING AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	7.53	16.22
2.0	6.31	13.60
3.0	5.64	12.16
4.0	9.65	13.61

STRIP FOOTING AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
1.0	**11.46**	**24.69**
2.0	**9.47**	**20.41**
3.0	**8.38**	**20.16**
4.0	**10.21**	**14.49**

BEARING CAPACITY OF SHALLOW FOUNDATION AT RAW WATER & CLEAR WATER RESERVOIRS AREA

SQUARE FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0X1.0	12.2	19.8
2.0X2.0	6.6	10.75
3.0X3.0	3.7	8.2
4.0X4.0	3.2	5.7
5.0X5.0	2.7	4.2

AT 3.0M DEPTH

1.0X1.0	11.7	19.20
2.0X2.0	7.8	12.8
3.0X3.0	5.6	9.47
4.0X4.0	3.9	6.9
5.0X5.0	3.45	6.1

AT 4.0M DEPTH

1.0X1.0	14.00	20.50
2.0X2.0	7.7	13.4
3.0X3.0	7.5	11.9
4.0X4.0	6.0	10.9
5.0X5.0	4.6	9.5

AT 5.0M DEPTH

1.0X1.0	**20.2**	**30.50**
2.0X2.0	**12.0**	**17.80**
3.0X3.0	**10.5**	**16.40**
4.0X4.0	**9.60**	**14.00**
5.0X5.0	**6.4**	**11.5**

BEARING CAPACITY OF SHALLOW FOUNDATION AT RAW WATER & CLEAR WATER RESERVOIRS AREA

RECTANGULAR FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**8.40**	**14.30**
4.0X2.0	**4.05**	**7.10**
6.0X3.0	**2.7**	**4.9**
8.0X4.0	**2.2**	**4.1**
10.0X5.0	**2.0**	**3.5**

RECTANGULAR FOOTING
AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**0**	**13.7**
4.0X2.0	**4.8**	**8.3**
6.0X3.0	**3.4**	**6.1**
8.0X4.0	**3**	**5.3**
10.0X5.0	**2.6**	**4.7**

RECTANGULAR FOOTING
AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	9.40	16.00
4.0X2.0	4.04	8.33
6.0X3.0	4.8	7.40
8.0X4.0	4.60	8.10
10.0X5.0	3.80	6.5

RECTANGULAR FOOTING
AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	13.60	22.00
4.0X2.0	8.10	12.65
6.0X3.0	6.10	11.00
8.0X4.0	5.40	9.34
10.0X5.0	4.55	7.35

BEARING CAPACITY OF SHALLOW FOUNDATION AT RAW WATER & CLEAR WATER RESERVOIRS AREA

STRIP
FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	6.15	9.40
2	4.3	8.08
3.0	4.5	7.8
4	3.20	6.30

STRIP FOOTING AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	5.86	15.5
2	6.30	11.45
3.0	6	9.20
4	5.50	8.65

STRIP FOOTING AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	8.20	20.55
2	8.60	15.22
3.0	8.10	12.20
4	7.50	11.45

STRIP FOOTING AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	9.10	22.70
2	8.40	16.50
3.0	8.70	13.10
4	8.15	12.30

BEARING CAPACITY OF SHALLOW FOUNDATION AT FIRE WATER, CLEAR WATER RESERVOIRS (1 TO 3) AND EFFLUENT TREATMENT PLANT AREA

SQUARE FOOTING

AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
1.0X1.0	**13.98**	**21**
2.0X2.0	**8.47**	**11.90**
3.0X3.0	**5.50**	**8.98**
4.0X4.0	**3.98**	**5.97**
5.0X5.0	**3.51**	**4.98**

AT 3.0M DEPTH

1.0X1.0	**12.85**	**21.10**
2.0X2.0	**8.3**	**11.90**
3.0X3.0	**5.96**	**9.50**
4.0X4.0	**3.9**	**6.9**
5.0X5.0	**4.3**	**6**

AT 4.0M DEPTH

1.0X1.0	**15.00**	**25.00**
2.0X2.0	**8.97**	**14.75**
3.0X3.0	**7.86**	**12.98**
4.0X4.0	**7.0**	**11.87**
5.0X5.0	**5.68**	**9.55**

AT 5.0M DEPTH

1.0X1.0	**21.2**	**34.50**
2.0X2.0	**12.0**	**19.80**
3.0X3.0	**10.5**	**17.30**
4.0X4.0	**9.90**	**15.85**
5.0X5.0	**7.85**	**12.94**

BEARING CAPACITY OF SHALLOW FOUNDATION AT FIRE WATER, CLEAR WATER RESERVOIRS (1 TO 3) AND EFFLUENT TREATMENT PLANT AREA

RECTANGULAR FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**8.86**	**14.38**
4.0X2.0	**4.75**	**7.98**
6.0X3.0	**2.99**	**4.9**
8.0X4.0	**3.11**	**4.98**
10.0X5.0	**2.64**	**3.48**

RECTANGULAR FOOTING
AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	**40mm Settlement**
2.0X1.0	**0**	**14.81**
4.0X2.0	**4.98**	**8.25**
6.0X3.0	**3.95**	**6.89**
8.0X4.0	**3.5**	**5.26**
10.0X5.0	**3.5**	**5.51**

RECTANGULAR FOOTING
AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	10.42	17.01
4.0X2.0	5.94	10.30
6.0X3.0	5.75	8.45
8.0X4.0	5.65	8.20
10.0X5.0	3.98	6.5

RECTANGULAR FOOTING
AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
2.0X1.0	14.98	24.17
4.0X2.0	9.10	13.70
6.0X3.0	7.10	12.00
8.0X4.0	7.40	10.30
10.0X5.0	5.90	9.45

BEARING CAPACITY OF SHALLOW FOUNDATION AT FIRE WATER, CLEAR WATER RESERVOIRS (1 TO 3) AND EFFLUENT TREATMENT PLANT AREA

STRIP
FOOTING
AT 2.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	7.10	10.78
2	5.98	9.98
3.0	5.0	8.60
4	5.10	8.24

STRIP FOOTING AT 3.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	7.80	16.75
2	8.25	12.50
3.0	7	10.31
4	6.50	9.98

STRIP FOOTING AT 4.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	9.25	21.74
2	9.98	16.99
3.0	9.15	13.99
4	9.47	13.00

STRIP FOOTING AT 5.0M DEPTH

	ALLOWABLE BEARING CAPACITY(t/m^2)	
	25mm Settlement	40mm Settlement
1.0	10.87	24.00
2	10.38	19.55
3.0	9.75	15.00
4	9.97	13.75

DEEP FOUNDATION FOR MEDIUM TO HIGHLY LOADED STRUCTURE:

A. POWER BLOCK AREA :

Shallow foundation in this area will be suitable for lightly loaded structure. However for moderate to highly loaded structure R.C.C Pile foundation is recommended. From the subsoil condition in the Power Block area it may be seen that dense sandy stratum is available from an average R.L of -3.0 m Hence the R.C.C Bored Pile would get adequate bearing at R.L – 5.0m.

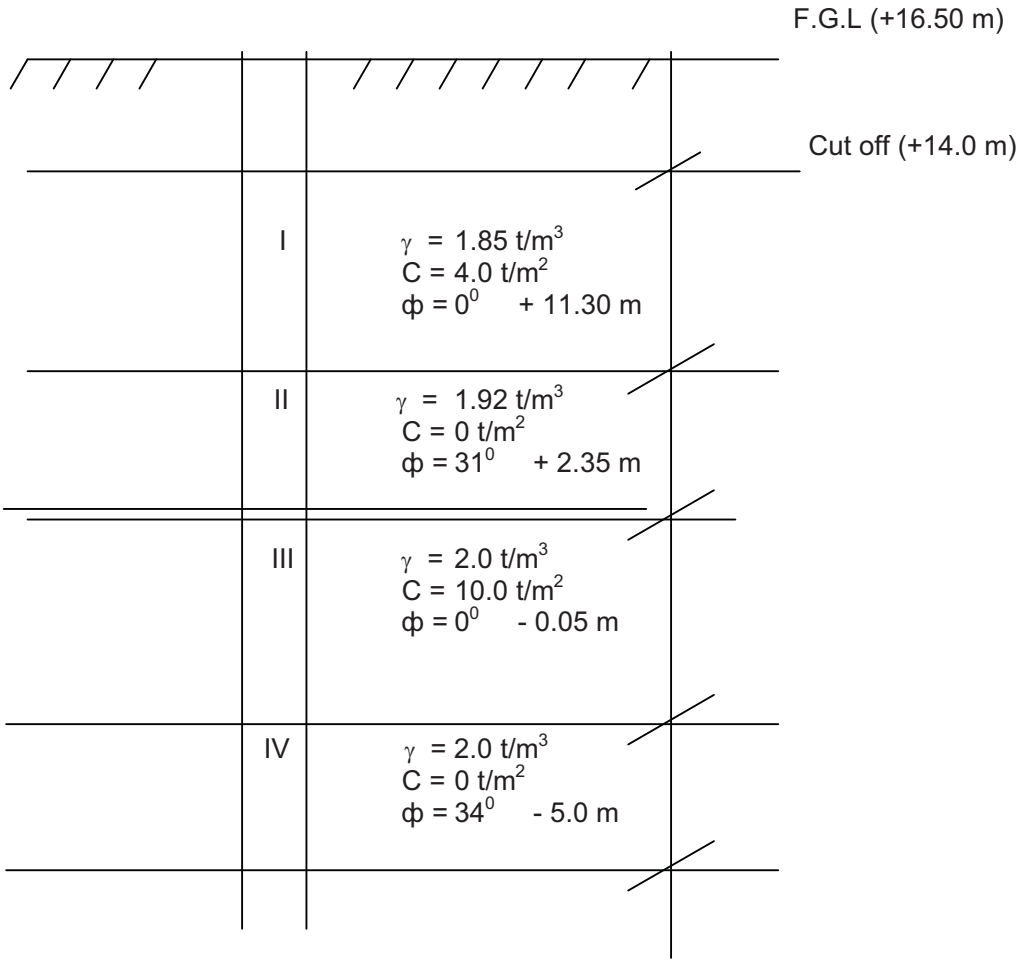
a) Vertical Capacity of Pile

R.L of F.G.L = +16.50

R.L of Pile Tip = - 5.0 m

R.L of cut-off level = +14.0 m

Cut off length = 2.50 m



Considering looseing effect due to boring (Ref : Davis & Poulous 1981).

Design $\phi = 34^0 - 3^0 = 31^0$

For $\phi' = 31^0$, $N_q = 32$,

Now end bearing $= 1/2.5 \times (\pi/4\ d^2 \times N_q \times p_d')$

p'_d *has been estimated for critical depth* $= 20 \times d$

For 450 mm dia $p_d' = 0.85 \times 2.7 + 6.3 \times 0.92 = 8.10\ t/m^2$

For 500 mm dia $p_d' = 0.85 \times 2.7 + 7.3 \times 0.92 = 9.02\ t/m^2$

For 600 mm dia $p'_d = 9.02 \times 1.6 + 0.92 + 0.4 \times 1 = 10.9\ t/m^2$

For 450 mm dia pile end bearing = 17.0 ton

For 500 mm dia pile end bearing = 23.0 ton

For 600 mm dia pile end bearing = 39.0 ton

Skin friction for 450 mm dia pile $= \pi d / 2.5\ [\Sigma l \times \alpha \times c + K p_d' \tan \delta \times l]$

$= \pi d/2.5\ [2.7 \times 4 \times 0.6 + 5.2 \times 1 \times \tan 28^0 \times 8.9$

$+ 2.4 \times 10 \times 0.3 + 4.95 \times 1.5 \times 8.10 \times \tan 31^0]$

$= 42$ *ton*

Similarly Skin Friction for 500 & 600 mm dia piles have been estimated as 49 ton & 67 ton respectively.

Hence total capacity = End Bearing + Skin friction

For different shaft diameter, the vertical capacity of pile with pile tip at RL -5.0m for cutoff level at +14.0 m would be as tabulated below :

Dia of Pile (mm)	***End Bearing (ton)***	***Skin Friction (ton)***	***Total (ton)***
450	*17.0*	*42.0*	*59.0*
500	*23.0*	*49.0*	*72.0*
600	*39.0*	*67.0*	*106.0*

b) Uplift Capacity of Pile

The allowable uplift capacity of Pile has been obtained by Considering the skin friction in which the value of skin friction in sandy layer has been reduced by 33% as in sand during uplift as full mobilisation of friction does not occur in sand. (Ref. Foundation Engg. by P.C. Verghese)

Now for 450 mm dia pile, uplift Capacity

$Q_a = \pi$ x 0.45/2.5 [2.7 x 4 x 0.6 + 0.67 x 1 x 5.2 x tan 28^0 x 8.9

+ 2.4 x 0.3 x 10 + 0.67 x 1.5 x 4.95 x 8.10 x tan 31^0]

= 31.0 ton

Similarly the uplift capacity for 500 mm and 600 mm dia piles have been estimated as tabulated below :

Dia of Pile (mm)	*Uplift Capacity ton*
450	***31.0***
500	***43.0***
600	***58.0***

c) Lateral Capacity of Pile

The lateral capacity of pile has been estimated following IS: 2911 Part I Sec 4

Data Considered :

E of pile for M_{25} grade concrete

$= 5000 \sqrt{f_{ek}}$ N/mm^2

$= 250000$ N/mm^2

$= 2.5 \times 10^5$ kg/cm^2

Now as the upper stratum is thin, the behaviour of Pile under lateral load will be guided by the sandy stratum immediately below the upper layer. The coefficient of sub grade modulus from code $k_1 = 0.5$ kg / cm^3.

Now stiffness factor $T = (E\,I/K)^{1/5}$

$E = 2.50 \times 10^5\ kg/cm^2$

$(I)_{500} = \pi \times (50)^4/64 = 3.07 \times 10^5\ cm^4$

$(I)_{600} = \pi \times (60)^4/64 = 6.36 \times 10^5\ cm^4$

$(I)_{450} = \pi \times (45)^4/64 = 2.02 \times 10^5\ cm^4$

For 600 mm dia, $T = (6.36 \times 10^5 \times 2.50 \times 10^5 / 0.5)^{0.2}$

$= 200\ cm$

For 500 mm dia, $T = (2.50 \times 10^5 \times 3.07 \times 10^5 / 0.5)^{0.2}$

$= 173\ cm$

For 450 mm dia, $T = (2.50 \times 10^5 \times 2.02 \times 10^5 / 0.5)^{0.2}$

$= 159\ cm$

∴Depth of fixity, $(L_f)_{600} = 2.2 \times 200 = 440\ cm$

$(L_f)_{500} = 2.2 \times 173 = 381\ cm$

$(L_f)_{450} = 2.2 \times 159 = 350\ cm$

For 5 mm Lateral deflection,

$(Q)_{600} = 12 \times 2.50 \times 10^5 \times 6.36 \times 10^5 \times 0.5 / (440)^3 = 11199\ kg = 11.20\ ton$

$(Q)_{450} = 12 \times 2.50 \times 10^5 \times 2.02 \times 10^5 \times 0.5 / (350)^3 = 7067\ kg = 7.10\ ton$

$(Q)_{500} = 12 \times 2.50 \times 10^5 \times 3.07 \times 10^5 \times 0.5 / (381)^3 = 8326\ kg = 8.3\ ton$

So the capacity of pile of different diameters may be taken as suggested below:

Dia of pile (mm)	***Pile Tip RL (cm)***	***R.L of cut off (m)***	***Vertical capacity (ton)***	***Uplift capacity (ton)***	***Lateral capacity (ton)***
450	***- 5.0***	***+14.0***	***59***	***31.0***	***7.10***
500	***- 5.0***	***+ 14.0***	***72***	***43.0***	***8.30***
600	***- 5.0***	***+ 14.0***	***106***	***58.0***	***11.20***

B . COOLING TOWER & DM PLANT AREA :

Shallow foundation in this area will be suitable for lightly loaded structure. However for moderate to highly loaded structure R.C.C Pile foundation is recommended. From the subsoil condition in the Cooling Tower & DM Plant it may be seen that dense sandy stratum is available from an average R.L of -5.0 m Hence the R.C.C Bored Pile would get adequate bearing at R.L – 5.0 m.

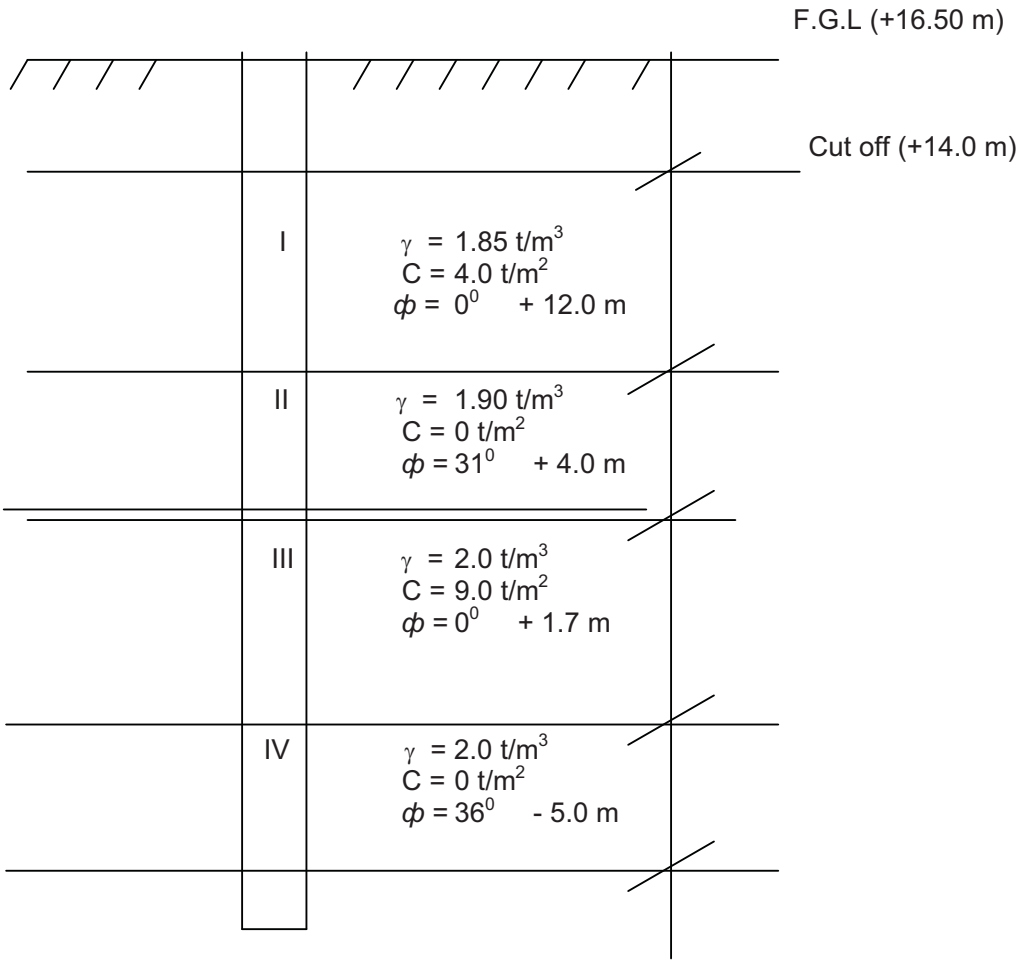
a) Vertical Capacity of Pile

R.L of F.G.L = +16.50

R.L of Pile Tip = - 5.0 m

R.L pf cut-off level = +14.0 m

Cut of length = 2.50 m



Considering loosening effect due to boring (Ref: Davis & Poulous 1981),

design $\phi' = 36^0 - 3^0 = 33^0$

For $\phi' = 33^0$, $N_q = 35$,

Now end bearing $= 1/2.5 \times (\pi/4\ d^2 \times N_q \times p_d')$

p'_d *has been estimated for critical depth* $= 20 \times d$

For 450 mm dia $p_d' = 0.85 \times 2.0 + 7 \times 0.90 = 8.0\ t/m^2$

For 500 mm dia $p_d' = 0.85 \times 2 + 8 \times 0.90 = 8.9\ t/m^2$

For 600 mm dia $p'_d = 0.85 \times 2 + 8 \times 0.9 + 2 \times 1 = 11.1\ t/m^2$

For 450 mm dia pile end bearing = 16.0 ton

For 500 mm dia pile end bearing = 25.0 ton

For 600 mm dia pile end bearing = 44.0 ton

Skin friction for 450 mm dia pile $= \pi d / 2.5\ [\Sigma l \times \alpha \times c + K p_d' \tan \delta \times l]$

$= \pi d/2.5\ [2 \times 4 \times 0.6 + 1 \times 4.4 \times \tan 28^0 \times 8$

$+ 2.3 \times 9 \times 0.3 + 6.7 \times 1.5 \times 7.1 \times \tan 33^0]$

$= 43.0$ *ton*

Similarly Skin Friction for 500 & 600 mm dia piles have been estimated as 52 ton & 72 ton respectively.

Hence total capacity = End Bearing + Skin friction

For different shaft diameter, the capacity of pile with pile tip at RL -5.0m for cutoff level at +14.0 m would be as tabulated below :

Dia of Pile (mm)	***End Bearing (ton)***	***Skin Friction (ton)***	***Total (ton)***
450	*16*	*43*	*59.0*
500	*25*	*52*	*77*
600	*44*	*72*	*116*

b) Uplift Capacity of Pile

The allowable uplift capacity

$\pi d / 2.5 [\Sigma l \times \alpha \times c + 2/3 \text{ of } K \times p_d' \tan \delta \times l]$

Now for 450 mm dia pile, uplift Capacity

$Q_a = \pi \times 0.45/2.5 [2 \times 4 \times 0.6 + 0.67 \times 1 \times 4.4 \times \tan 28^0 \times 8$

$+ 2.3 \times 0.3 \times 9 + 0.67 \times 1.5 \times 6.7 \times 7.1 \times \tan 33^0]$

$= 31.0$ *ton*

Similarly the uplift capacity for 500 mm and 600 mm dia piles have been estimated as tabulated below :

Dia of Pile (mm)	*Uplift Capacity ton*
450	***31.0***
500	***36.0***
600	***52.0***

c) Lateral Capacity of Pile

The lateral capacity of pile has been estimated following IS: 2911 Part I Sec 4

Data Considered :

E of pile for M_{25} *grade concrete*

$= 5000 \sqrt{f_{ck}}$ *N/mm*^{2}

$= 250000$ *N/mm*^{2}

$= 2.5 \times 10^5$ *kg/cm*^{2}

Now as the upper stratum is thin, the behaviour of Pile under lateral load will be guided by the sandy stratum immediately below the upper layer. The coefficient of sub grade modulus from code $k_1 = 0.5$ *kg / cm*^{3}.

Now stiffness factor $T = (E I/K)^{1/5}$

$E = 2.50 \times 10^5$ *kg/cm*^{2}

$(I)_{500} = \pi \times (50)^4/64 = 3.07 \times 10^5\ cm^4$

$(I)_{600} = \pi \times (60)^4/64 = 6.36 \times 10^5\ cm^4$

$(I)_{450} = \pi \times (45)^4/64 = 2.02 \times 10^5\ cm^4$

For 600 mm dia, $T = (6.36 \times 10^5 \times 2.50 \times 10^5 / 0.5)^{0.2}$

$= 200$ cm

For 500 mm dia, $T = (2.50 \times 10^5 \times 3.07 \times 10^5 / 0.5)^{0.2}$

$= 173$ cm

For 450 mm dia, $T = (2.50 \times 10^5 \times 2.02 \times 10^5 / 0.5)^{0.2}$

$= 159$ cm

$\therefore$ Depth of fixity, $(L_f)_{600} = 2.2 \times 200 = 440$ cm

$(L_f)_{500} = 2.2 \times 173 = 381$ cm

$(L_f)_{450} = 2.2 \times 159 = 350$ cm

For 5 mm Lateral deflection,

$(Q)_{600} = 12 \times 2.50 \times 10^5 \times 6.36 \times 10^5 \times 0.5 / (440)^3 = 11199\ kg = 11.20\ ton$

$(Q)_{450} = 12 \times 2.50 \times 10^5 \times 2.02 \times 10^5 \times 0.5 / (350)^3 = 7067\ kg = 7.10\ ton$

$(Q)_{500} = 12 \times 2.50 \times 10^5 \times 3.07 \times 10^5 \times 0.5 / (381)^3 = 8326\ kg = 8.3\ ton$

So the capacity of pile of different diameters may be taken as suggested below:

Dia of pile (mm)	***Pile Tip RL (cm)***	***R.L of cut off (m)***	***Vertical capacity (ton)***	***Uplift capacity (ton)***	***Lateral capacity (ton)***
450	***- 5.0***	***+14.0***	***59***	***31.0***	***8.45***
500	***- 5.0***	***+ 14.0***	***77***	***36.0***	***10.0***
600	***- 5.0***	***+ 14.0***	***116***	***52.0***	***13.50***

C. SWITCH YARD AREA :

Shallow foundation in this area will be suitable for lightly loaded structure. However for moderate to highly loaded structure R.C.C Pile foundation is recommended. From the subsoil condition in the Switch Yard area it may be seen that dense sandy stratum is available from an average R.L of -5.0 m Hence the R.C.C Bored Pile would get adequate bearing at R.L – 5.0 m.

b) Vertical Capacity of Pile

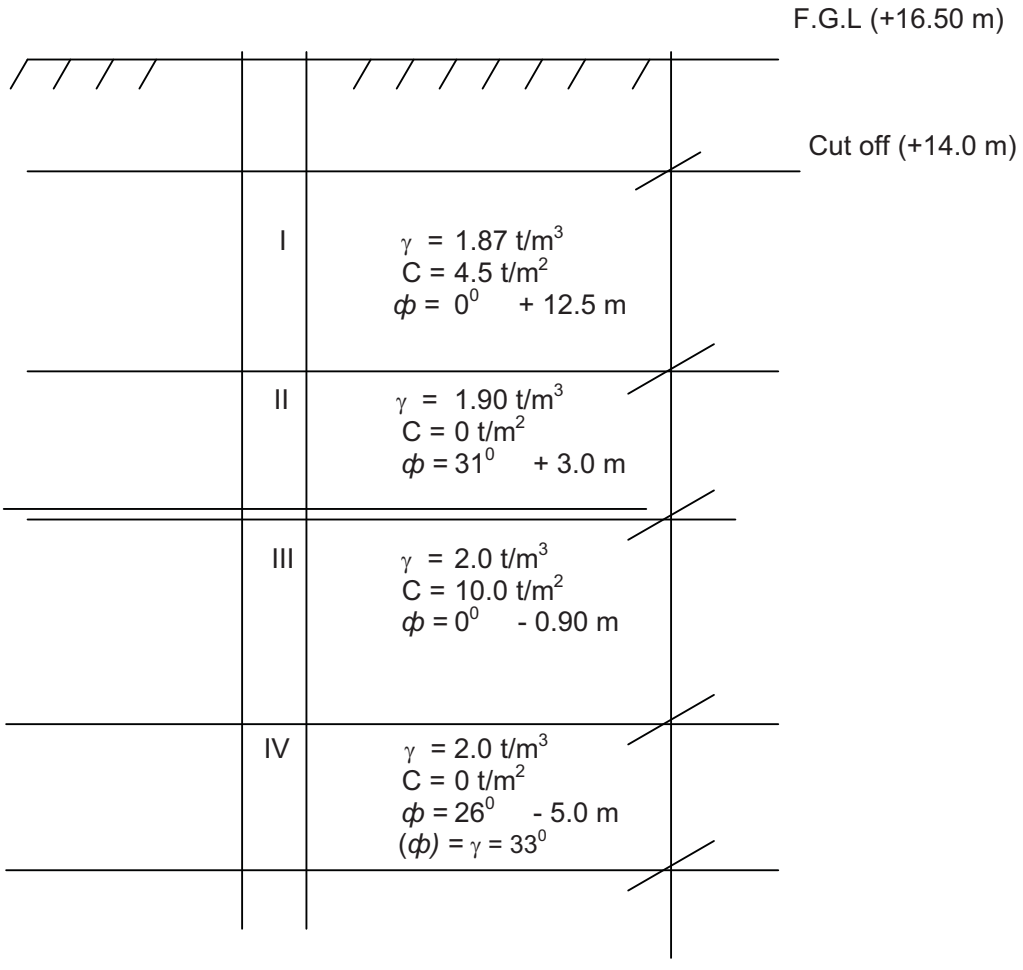
R.L of F.G.L = +16.50

R.L of Pile Tip = - 5.0 m

R.L pf cut-off level = +14.0 m

Cut of length = 2.50 m

Properties of stratum IV : $\gamma = 2.0\ t/m^3$



Considering loosening effect due to boring (Ref: Davis & Poulous 1981),

design $\phi' = 36^0 - 3^0 = 33^0$

For $\phi' = 33^0$, $N_q = 35$,

Now end bearing = 1/2.5 x (π/4 d^2 x N_q x p_d')

p'_d has been estimated for critical depth = 20 x d

For 450 mm dia p_d' = 0.87 x 1.5 + 7.5 x 0.90 = 8.06 t/m^2

For 500 mm dia p_d' = 0.86 + 1 x 0.90 = 8.96 t/m^2

For 600 mm dia p'_d = 8.96 + 1 x 0.9 + 1 x 1 = 10.9 t/m^2

For 450 mm dia pile end bearing = 18.0 ton

For 500 mm dia pile end bearing = 25.0 ton

For 600 mm dia pile end bearing = 43.0 ton

Skin friction for 450 mm dia pile = π d / 2.5 [Σ l x α x c + K p_d' tan δ x l]

= πd/2.5 [1.5 x 0.5 x 4.5 +1 x 4.7 x 9.5 x tan 28^0 + 3.9 x 10 x 0.3 + 1.5 x 8.06 x tan 33^0 x 4.1]

= 40.0 ton

Similarly Skin Friction for 500 & 600 mm dia piles have been estimated as 49 ton & 66 ton respectively.

Hence total capacity = End Bearing + Skin friction

For different shaft diameter, the capacity of pile with pile tip at RL -5.0m for cutoff level at +14.0 m would be as tabulated below :

Dia of Pile (mm)	***End Bearing (ton)***	***Skin Friction (ton)***	***Total (ton)***
450	*18*	*40*	*58*
500	*25*	*49*	*74*
600	*43*	*66*	*109*

b) Uplift Capacity of Pile

The allowable uplift capacity

$\pi d / 2.5 [\Sigma l \times \alpha \times c + 2/3 \text{ of } K \times p_d' \tan \delta \times l]$

Now for 450 mm dia pile, uplift Capacity

$Q_a = \pi \times 0.45/2.5 [1.5 \times 0.5 \times 4.5 + 0.67 \times 1 \times 4.7 \times \tan 28^0 \times 9.5$

$+ 3.9 \times 0.3 \times 10 + 0.67 \times 1.5 \times 4.1 \times 8.06 \times \tan 33^0]$

$= 30.0$ *ton*

Note : In sandy stratum, the uplift resistance is not fully mobilised for which the friction has been taken as 67%. Refer Foundation Engg by P.C. Vergeesh.

Similarly the uplift capacity for 500 mm and 600 mm dia piles have been estimated as tabulated below :

Dia of Pile (mm)	*Uplift Capacity ton*
450	***30.0***
500	***36.0***
600	***48.0***

c) Lateral Capacity of Pile

The lateral capacity of pile has been estimated following IS: 2911 Part I Sec 4

Data Considered :

E of pile for M_{25} grade concrete

$= 5000 \sqrt{f_{ek}}$ *N/mm*^{2}

$= 250000$ *N/mm*^{2}

$= 2.5 \times 10^5$ *kg/cm*^{2}

Now as the upper stratum is thin, the behaviour of Pile under lateral load will be guided by the sandy stratum immediately below the upper layer. The coefficient of sub grade modulus from code $k_1 = 0.5$ kg / cm^3.

Now stiffness factor $T = (E\,I/K)^{1/5}$

$E = 2.50 \times 10^5$ kg/cm^2

$(I)_{500} = \pi \times (50)^4/64 = 3.07 \times 10^5$ cm^4

$(I)_{600} = \pi \times (60)^4/64 = 6.36 \times 10^5$ cm^4

$(I)_{450} = \pi \times (45)^4/64 = 2.02 \times 10^5$ cm^4

For 600 mm dia, $T = (6.36 \times 10^5 \times 2.50 \times 10^5 / 0.5)^{0.2}$

$= 200$ cm

For 500 mm dia, $T = (2.50 \times 10^5 \times 3.07 \times 10^5 / 0.5)^{0.2}$

$= 173$ cm

For 450 mm dia, $T = (2.50 \times 10^5 \times 2.02 \times 10^5 / 0.5)^{0.2}$

$= 159$ cm

∴Depth of fixity, $(L_f)_{600} = 2.2 \times 200 = 440$ cm

$(L_f)_{500} = 2.2 \times 173 = 381$ cm

$(L_f)_{450} = 2.2 \times 159 = 350$ cm

For 5 mm Lateral deflection,

$(Q)_{600} = 12 \times 2.50 \times 10^5 \times 6.36 \times 10^5 \times 0.5 / (440)^3 = 11199$ kg $= 11.20$ ton

$(Q)_{450} = 12 \times 2.50 \times 10^5 \times 2.02 \times 10^5 \times 0.5 / (350)^3 = 7067$ kg $= 7.10$ ton

$(Q)_{500} = 12 \times 2.50 \times 10^5 \times 3.07 \times 10^5 \times 0.5 / (381)^3 = 8326$ kg $= 8.3$ ton

So the capacity of pile of different diameters may be taken as suggested below:

Dia of pile (mm)	***Pile Tip RL (cm)***	***R.L of cut off (m)***	***Vertical capacity (ton)***	***Uplift capacity (ton)***	***Lateral capacity (ton)***
450	***- 5.0***	***+14.0***	***58***	***30.0***	***8.45***
500	***- 5.0***	***+ 14.0***	***74***	***36.0***	***10.0***
600	***- 5.0***	***+ 14.0***	***109***	***48.0***	***13.50***

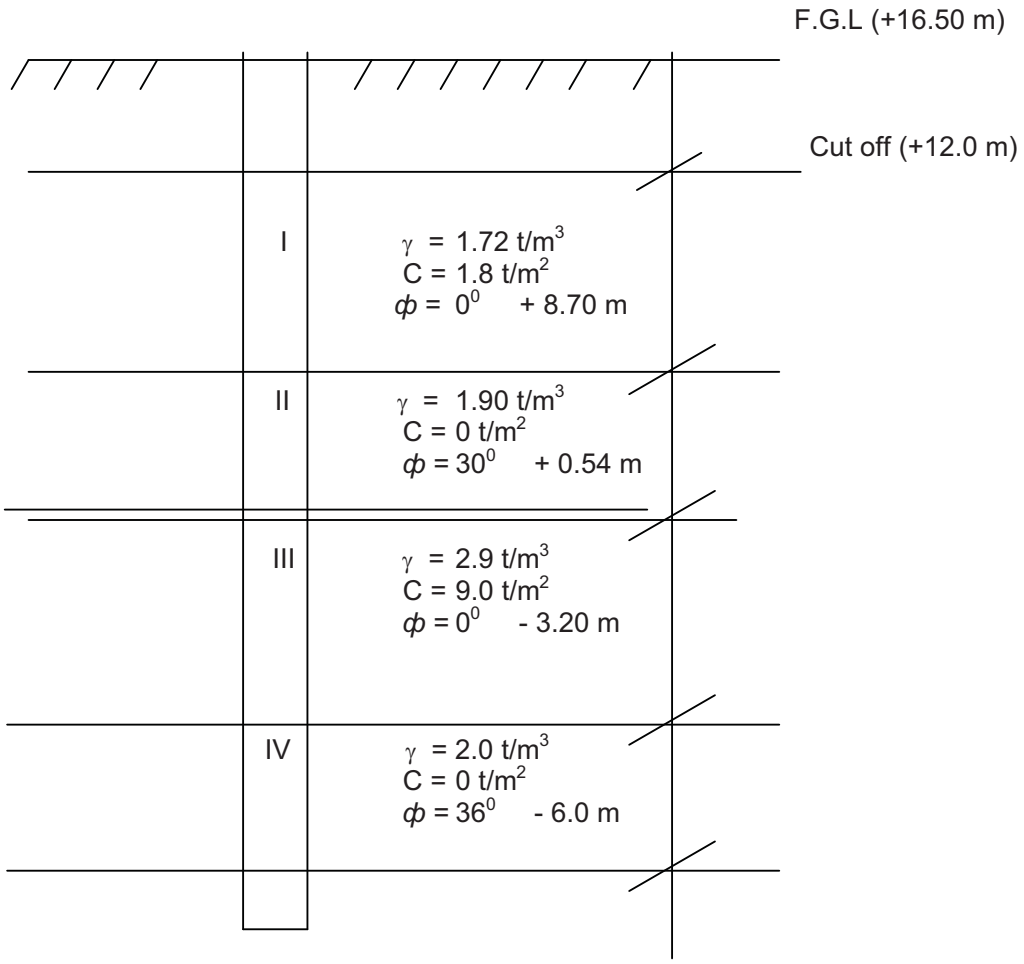
D. ***RAW WATER & CLEAR WATER RESERVOIRS*** *: (BH No. 36,38 to 40)*

In this area the avg. ground level is + 13.20 m where the finished ground level is +16.50 m. So there will be a filling of about 3.0 m. Now the top deposit in the area consists of soft clay of average thickness 4.5 m. So there will be negative skin friction due to this soft clay layer. In estimation of Pile Capacity, the positive skin friction of the layer has been neglected to consider the negative friction. As the depth of Reservoir is not know to estimate the Pile capacity the cut-off level has been assumed at + 12.0 m and the tip of Pile at – 6.0 m.

Vertical Capacity of Pile :

R.L of Tip of Pile = - 6.0 m
R.L of F.G.L + 16.50 m
R.L of Cut off = + 12.0 m

Considering the average soil profile the vertical capacity has been estimated from End Bearing and skin friction. To account for negative friction due to soft clay layer at top, the positive friction due to this layer has been ignored.



For 450 mm dia Pile, $p_d^{'}$ = 7.5 t/m²

End bearing = 1/2.5 x (π/4 x 0.45)² x 7.5 x 35) = 17.0 ton

Skin friction = π x 0.45 / 2.5 [l x 5 x tan 28⁰ x 8.2 + 0.3 x 9 x3.7

+ 1.5 x 7.5 x tan 33⁰ x 2.8]

= 30.0 ton

Hence the total capacity of 450 mm dia Pile at – 6.0 m works out as 47.0 ton. The uplift capacity of 450 mm pile has been obtained by considering the ultimate skin friction in sand as 2/3 rd of the skin friction mobilized in sandy stratum. Accordingly the uplift capacity for 450 mm dia pile has been worked out as 22.0

ton. Similarly both the vertical and uplift capacities of 500 and 600 mm piles at RL -6.0 m have been estimated as given below :

Dia of Pile (mm)	*R.L Tip of Pile (m)*	*RL of Cut-off (m)*	*Vertical Capacity (ton)*	*Uplift Capacity (ton)*
450	*-6.0*	*+ 12.0*	*47*	*22*
500	*- 6.0*	*+ 12.0*	*56*	*24*
600	*- 6.0*	*+ 12.0*	*95*	*36*

For higher capacity of Pile, the depth of embedment of Pile in dense sandy stratum may be increased. It has been found that for each 1.0 m of embedment depth of pile in dense sandy stratum, the capacity of Pile increases about 8.0 t.

Lateral Capacity of Pile

The lateral capacity of pile has been estimated following IS: 2911 Part I Sec 4

Data Considered :

E of pile for M_{25} grade concrete

$= 5000 \sqrt{f_{ek}}\ N/mm^2$

$= 250000\ N/mm^2$

$=2.5 \times 10^5\ kg/cm^2$

Now as the upper stratum below the cut-off level is soft clay of Pile under lateral load will be guided by this stratum immediately below the upper layer. The coefficient of sub grade modulus from code K for soft clay has been taken as 8.00 kg/c^2..

Now stiffness factor $R= (E\ I/K)^{1/4}$

$E = 2.50 \times 10^5\ kg/cm^2$

$(I)_{500} = \pi \times (50)^4/64 = 3.07 \times 10^5\ cm^4$

$(I)_{600} = \pi \times (60)^4/64 = 6.36 \times 10^5\ cm^4$

$(I)_{450} = \pi \times (45)^4/64 = 2.02 \times 10^5\ cm^4$

For 600 mm dia, $R = (6.36 \times 10^5 \times 2.50 \times 10^5 / 8.0)^{0.25}$

$= 395cm$

For 500 mm dia, $R = (2.50 \times 10^5 \times 3.07 \times 10^5 / 8.0)^{0.25}$

$= 313$ cm

For 450 mm dia, $R = (2.50 \times 10^5 \times 2.02 \times 10^5 / 8.0)^{0.25}$

$= 282$ cm

∴Depth of fixity, $(L_f)_{600} = 2.2 \times 375 = 825$ cm

$(L_f)_{500} = 2.2 \times 313 = 688$ cm

$(L_f)_{450} = 2.2 \times 282 = 620$ cm

For 5 mm Lateral deflection,

$(Q)_{600} = 12 \times 2.5 \times 10^5 \times 6.36 \times 10^5 \times 0.5 / (825)^3 = 1699$ kg $= 1.70$ ton

$(Q)_{450} = 12 \times 2.50 \times 10^5 \times 2.02 \times 10^5 \times 0.5 / (620)^3 = 1271$ kg $= 1.27$ ton

$(Q)_{500} = 12 \times 2.50 \times 10^5 \times 3.07 \times 10^5 \times 0.5 / (688)^3 = 1414$ kg $= 1.41$ ton

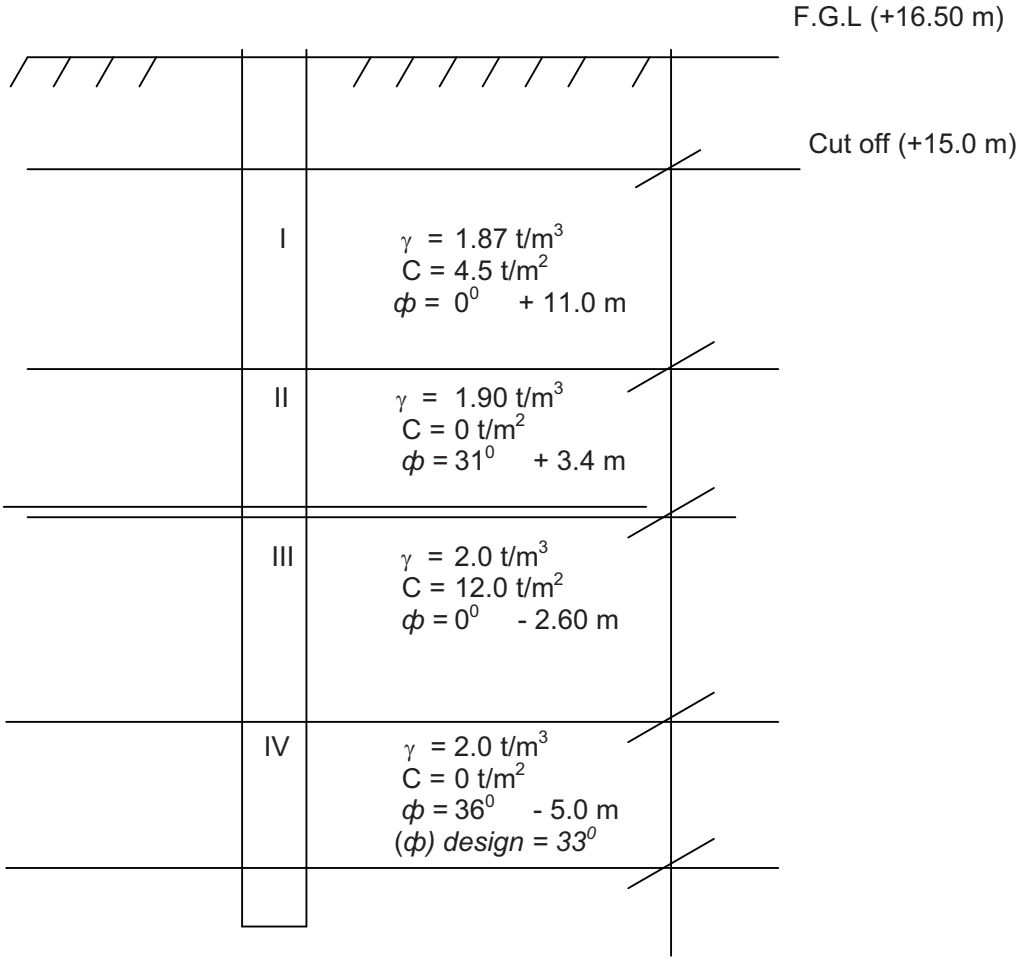
So the capacity of pile of different diameters may be taken as suggested below:

Dia of pile (mm)	***Pile Tip RL (cm)***	***R.L of cut off (m)***	***Vertical capacity (ton)***	***Uplift capacity (ton)***	***Lateral capacity (ton)***
450	***- 6.0***	***+12.0***	***47***	***22.0***	***1.27***
500	***- 6.0***	***+ 12.0***	***56***	***24.0***	***1.41***
600	***- 6.0***	***+ 12.0***	***95***	***36.0***	***1.70***

E. FIRE WATER, CLEAR WATER RESERVOIRS (1 TO 3) AND EFFLUENT TREATMENT PLANT :

Foundation for the above structures in this area would require the consideration of the subsoil as well as the uplift as the ground water table is higher. The existing average Ground level is at R.L + 15.2 m and the furnished Ground level would be +16.5 m indicating an average filling of 1.3 m. Now from the subsoil

profile it is found that the top deposit of Sandy clay which occurs upto an avg. R.L of + 11.0 m is moderately stiff. Deep foundation with R.C.C Pile is suggested at R.L – 5.0 m with cut off level at + 12.0 m. Negative skin friction in this area has been neglected as the deposit continues sandy clay of low plasticity.



Vertical Capacity

R.L of Pile tip – 5.0 m

RL F.G.L = + 16.5 m

R.L of Cut off level = +12.0 m

End bearing = 1/2.5 x (π/4 d^2 x p_d' x N_q)

(p_d') 450 dia = 9.0 t/m^2 (L/D = 20)

(p_d') 500 dia = 10.0 t/m^2 (L/D = 20)

(p_d') 600 dia = 9.0 t/m^2 (L/D = 20)

Now for ϕ design = 33^0, N_q = 35

$\therefore$ End Bearing for 450 mm dia = 1/ 2.5 x π/4 x $(0.45)^2$ x 9 x 35

= 20 ton

Similarly for 500 and 600 mm dia End Bearing have been obtained as 27 and 47 ton respectively.

Skin friction has also been found out as

$Q_f = \pi x\, d / 2.5\, [l x\, \gamma\, x\, c + k x\, p_d' \tan \delta x\, l]$

In case of uplift capacity, the mobilized skin friction in sand has been taken as 2/3 rd of the ultimate friction due to uplift load, and thus the uplift capacity has been obtained.

Hence for different shaft dia the vertical, and uplift capacity would be as follows

Dia of pile (mm)	***Pile Tip RL (cm)***	***R.L of cut off (m)***	***Vertical capacity (ton)***	***Uplift capacity (ton)***
450	***- 5.0***	***+12.0***	***57***	***29.0***
500	***- 5.0***	***+ 12.0***	***70***	***34.0***
600	***- 5.0***	***+ 12.0***	***106***	***45.0***

c) Lateral Capacity of Pile

The lateral capacity of pile has been estimated following IS: 2911 Part I Sec 4

Data Considered :

E of pile for M_{25} grade concrete

= 5000 $\sqrt{f_{ek}}$ N/mm^2

$= 250000\ N/mm^2$

$= 2.5 \times 10^5\ kg/cm^2$

Now as the upper stratum is thin, the behaviour of Pile under lateral load will be guided by the sandy stratum immediately below the upper layer. The coefficient of sub grade modulus from code $k_1 = 0.5\ kg / cm^3$.

Now stiffness factor $T = (E\ I/K)^{1/5}$

$E = 2.50 \times 10^5\ kg/cm^2$

$(I)_{500} = \pi \times (50)^4/64 = 3.07 \times 10^5\ cm^4$

$(I)_{600} = \pi \times (60)^4/64 = 6.36 \times 10^5\ cm^4$

$(I)_{450} = \pi \times (45)^4/64 = 2.02 \times 10^5\ cm^4$

For 600 mm dia, $T = (6.36 \times 10^5 \times 2.50 \times 10^5 / 0.5\ )^{0.2}$

$= 200\ cm$

For 500 mm dia, $T = (2.50 \times 10^5 \times 3.07 \times 10^5 / 0.5\ )^{0.2}$

$= 173\ cm$

For 450 mm dia, $T = (2.50 \times 10^5 \times 2.02 \times 10^5 / 0.5)^{0.2}$

$= 159\ cm$

∴Depth of fixity, $(L_f)_{600} = 2.2 \times 200 = 440\ cm$

$(L_f)_{500} = 2.2 \times 173 = 381\ cm$

$(L_f)_{450} = 2.2 \times 159 = 350\ cm$

For 5 mm Lateral deflection,

$(Q)_{600} = 12 \times 2.50 \times 10^5 \times 6.36 \times 10^5 \times 0.5 / (440)^3 = 11199\ kg = 11.20\ ton$

$(Q)_{450} = 12 \times 2.50 \times 10^5 \times 2.02 \times 10^5 \times 0.5 / (350)^3 = 7067\ kg = 7.10\ ton$

$(Q)_{500} = 12 \times 2.50 \times 10^5 \times 3.07 \times 10^5 \times 0.5 / (381)^3 = 8326\ kg = 8.3\ ton$

So the capacity of pile of different diameters may be taken as suggested below:

Dia of pile (mm)	***Pile Tip RL (cm)***	***R.L of cut off (m)***	***Vertical capacity (ton)***	***Uplift capacity (ton)***	***Lateral capacity (ton)***
450	***- 5.0***	***+14.0***	***57***	***29.0***	***7.10***
500	***- 5.0***	***+ 14.0***	***70***	***34.0***	***8.30***
600	***- 5.0***	***+ 14.0***	***106***	***45.0***	***11.20***

The centre to centre distance between the piles in a group should be kept as 3 times the dia of Pile.

All the above capacities are for Bored pile. If Driven piles are used the capacities may be increased by 15%. In order to avoid group failure, the centre to centre distance between the piles in a group should be kept minimum as 3 times the diameter of Pile. It is also suggested to keep provision for both initial and Routine Load test on piles as per relevant IS code of Practise. For Bored piles installation of Pile should be followed with DMC/RMC method using good qualities of Bentonite and the grade of concrete is suggested as M_{25}.

No harmful chemical constituents in soil or water has been observed from chemical analysis of soil & water, ordinary Portland Cement or Portland Slag cement may be used with minimum cement content of 330 kg/m^3.

EXCAVATION AND FILLING AT SITE :

Excavation for shallow foundation in the top deposit of sandy clay may be done by providing a slope 2 : 1 in which the slopes will be stable. In addition for filling the site, the available materials at the site may be used after removing all the foreign materials line tree roots, shrub or any decomposed materials. The fill

materials should be compacted in layers not exceeding a thickness of 300 mm and the compacted density should be at least 95% of the proctor density.

CONSTRUCTION OF ROAD :

Flexible Pavement is suggested in the Area. For design of the thickness of Pavement, C.B.R values of Subgrade may be considered as 4% with subgrade materials of sandy clay available at site.

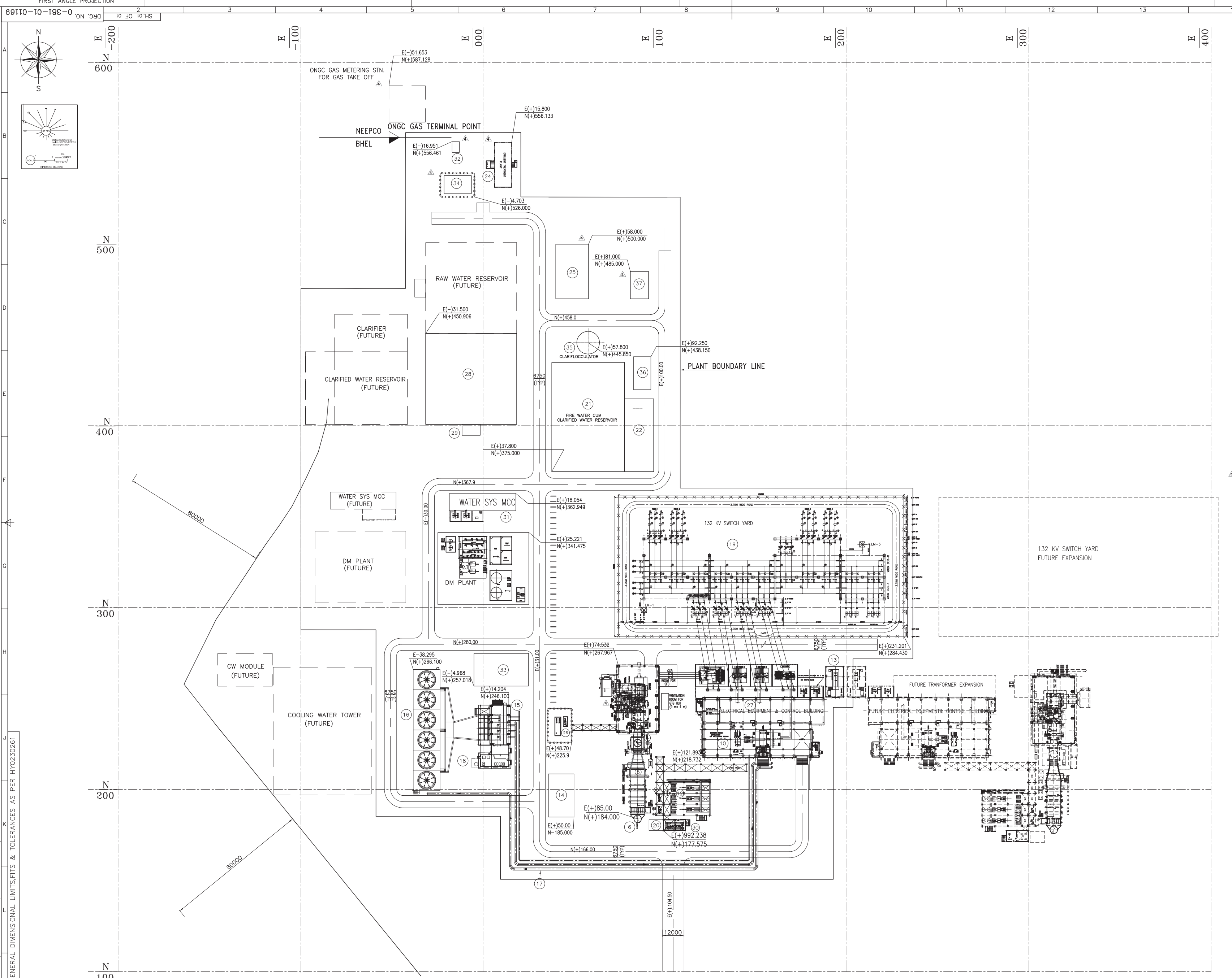
For & behalf of ***C & C CONSULTING FIRM***

(PROF. PHALGUNI BHATTACHARYA)
Consulting Geo-technical Engineer

FIRST ANGLE PROJECTION

(ALL DIMENSIONS ARE IN mm)

DRG. NO. 0-381-01-01169 SH.01 OF 01



LIST OF EQUIPMENT

SL.NO.	DESCRIPTION	SIZE (TENTATIVE)
1	GTG HALL	37.46m x 23.16m
2	GAS TURBINE GENERATOR	12.50m x 7.30m
3	INLET AIR FILTER	9.26m x 5.355m
4	BY-PASS STACK	ø3.90m
5	HRSG	1 no.
6	HRSG STACK	ø4m
7	GT GENERATOR TRANSFORMER-3ø ,1 no	12.0m X 18.0m
8	ST GENERATOR TRANSFORMER-1 no.	12.0m x 14.0m
9	STATION TRANSFORMERS-2 no.	12.0m x 12.0m
10	STG HALL	58.0m x 18.0
11	PIPE RACK	--
12	BFP & DEAERATOR STRUCTURE	21.750m x 18.0M
13	D.G.BUILDING	16.5 m x 9.5m
14	AIR COMPRESSOR& N2 SHED	20.0m x 10.0m
15	CW. & ACW.PUMP HOUSE, SG ROOM	21.0 x 9.50
16	COOLING TOWER	66.42m x14.72m
17	UNDERGROUND CW.PIPING	--
18	CW.CHLORINATION SHED	15.5m x6.0m
19	132 KV SWITCHYARD	156.725m x 76.5m
20	CEMS ANALYSER ROOM	8m x 6m
21	FIRE WATER CUM CLARIFIED WATER RESERVOIR	60m x 40.0m
22	CLARIFIED & FIRE WATER PUMP HOUSE	40m x 16m
23	DM PLANT AREA	50m x 39.5m
24	EFFLUENT TREATMENT PLANT SHED	25m x 9.6m
25	GAS BOOSTER COMPRESSOR	30m x 18m
26	GAS FINE FILTER SKID	13.09mx18.75m
27	ELECTRICAL EQUIPMENT & CONTROL BUILDING	65m x 13.0m
28	RAW WATER RESERVOIR	50m x 50m
29	RAW WATER PUMP HOUSE	10m x 6m
30	SWAS ROOM	12.0m x 6.0m
31	WATER SYSTEMS MCC ROOM	36.5m x 10.0m
32	GAS CHROMATOGRAPH ROOM	4.0m x 6.0m
33	COOLING WATER MODULE	30m x 18m
34	GAS COND. SKID	15m x 10m
35	CLARIFICULATOR	ø12.5m
36	PRE-TREATMENT PLANT AREA	18.15m x 9.45m
37	SLUDGE TREATMENT PLANT	15m x 10m

LEGEND

PIPE SLEEPERS :
PIPE RACK :

GTG / STG HALL OTHER BUILDING
(FFL) 100.00
(HPP) 99.70
(LPP) 99.60
(FGL) 99.50

LEGEND:
FFL: FINISHED FLOOR LEVEL
HPP: HIGHEST PAVED POINT AND CRANE MOVEMENT AREA LEVEL
LPP: LOWEST PAVED POINT
FGL: FINISHED GROUND LEVEL

NOTES:
1. FGL EL 99.50 CORRESPONDS TO SITE RL 16.50m AS PER M/s NEEPCO's MAIL DTD 26.11.10

REF.DRAWINGS
1. PLOT PLAN (M/s NEEPCO DRG No.) : NEEPCO/TGBPP/02 REV 00

नॉर्थ ईस्टर्न इलेक्ट्रिक पावर कॉरपोरेशन लिमिटेड
भारत सरकार का उपक्रम
NORTH EASTERN ELECTRIC POWER CORPORATION LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)

त्रिपुरा गैस आधारित सी सी विद्युत परियोजना
त्रिपुरा
TRIPURA GAS BASED CC POWER PROJECT
(TRIPURA)

CONSULTANT: DESEIN PRIVATE LTD., NEW DELHI

BHARAT HEAVY ELECTRICALS LTD. HYDERABAD

	NAME	SIGN.	DATE	NO.OF VAR.
DRN.	CH.MANOJ		04.09.10	N.A
CHD.	V.V.S.S		04.09.10	
APPD.	B.I.B		04.09.10	

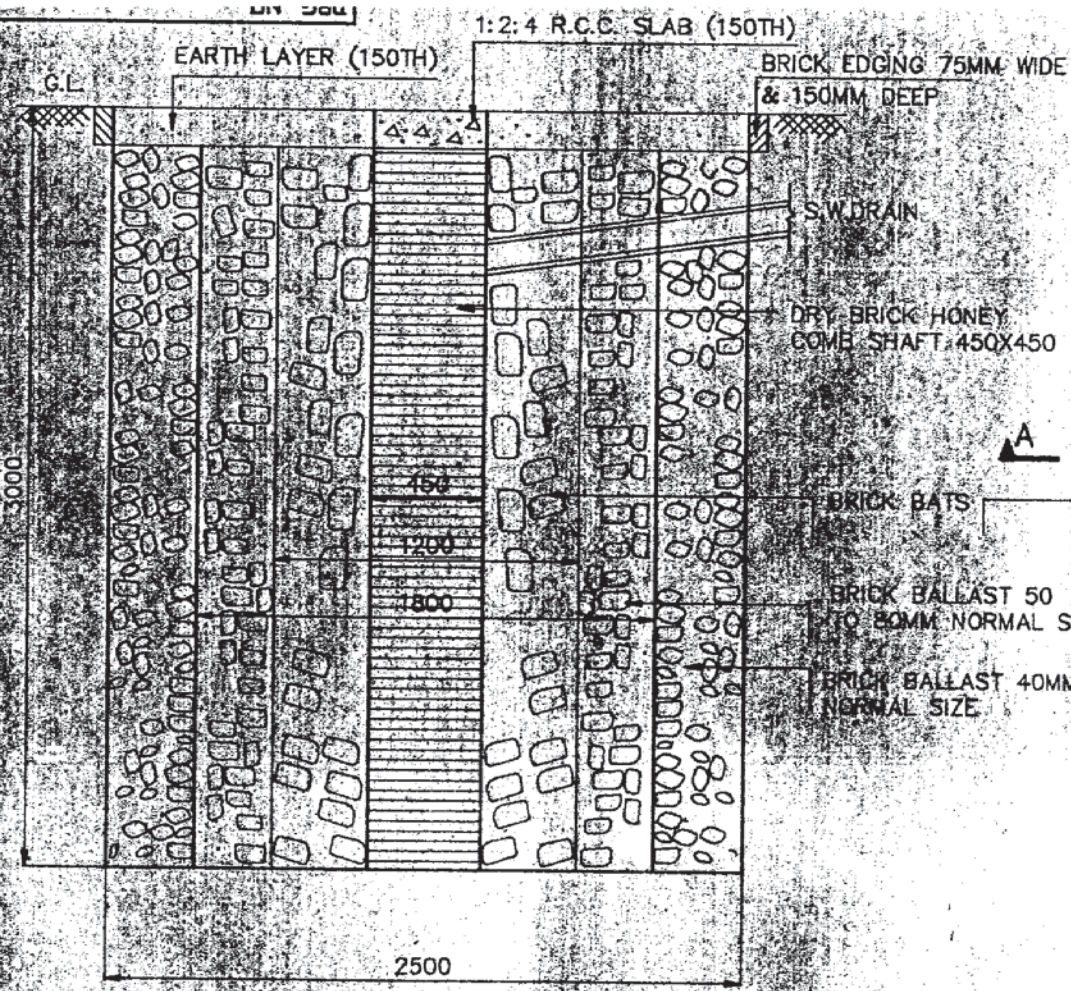
REV.	DATE	ALTERED	CHD/APPD	ZONE / DESCRIPTION
04	03.06.11	CHM	VVSS	REVISED BASED ON CUSTOMER COMMENTS DTD 03/06/2011. AND MARKED AS 4
03	09.12.10	RAASI	CHM/VVSS	REVISED BASED ON CUSTOMER COMMENTS DTD 07/12/2010. PRE TREATMENT PLANT SHOWN. ACCESS ROAD EXTENDED TO GAS COND. SKID.
02	03.12.10	RAASI	CHM/VVSS	REVISED BASED ON CUSTOMER COMMENTS DTD 22/11/2010. ALL BUILDINGS/EQUIPMENTS RELOCATED AS PER NEEPCO COMMENTS AND ALL COORDINATES MARKED.
01	29.10.10	J.C.S	CHM/VVSS	REVISED BASED ON DISCUSSINONS WITH CUSTOMER ON 13 & 14 SEPT. 2010 AT BHEL, HYDERABAD AND BASED ON COMMENTS RECEIVED VIDE LETTER DTD 17.09.2010.

DEPT. PE&SD CODE. 450 | UNTOL. DIMS. GR. C/M/F | SCALE 1:700 | WEIGHT (KG) N.A | REF. TO ASSY. DRG. -N.A.- | ITEM NO. -N.A.- | NO.OF ITEMS -N.A.-

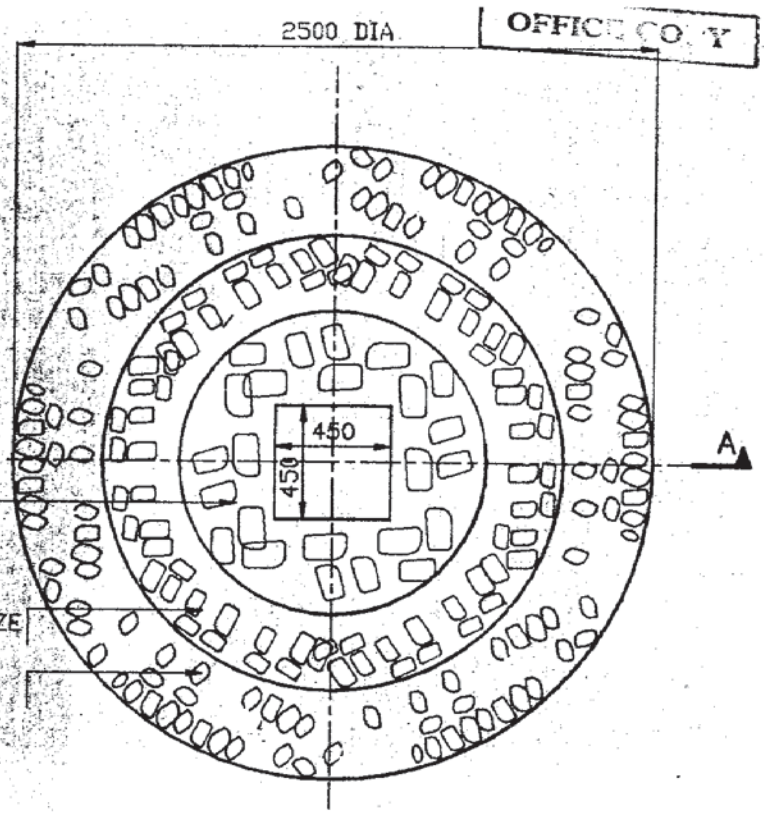
TITLE: PLOT PLAN

CARD CODE N.A. | DRAWING NO. 0-381-01-01169 | REV. 04 | SHT. No 01 | NO. OF SHT. 01

GENERAL DIMENSIONAL LIMITS,FITS & TOLERANCES AS PER HY0230261



SECTION A–A



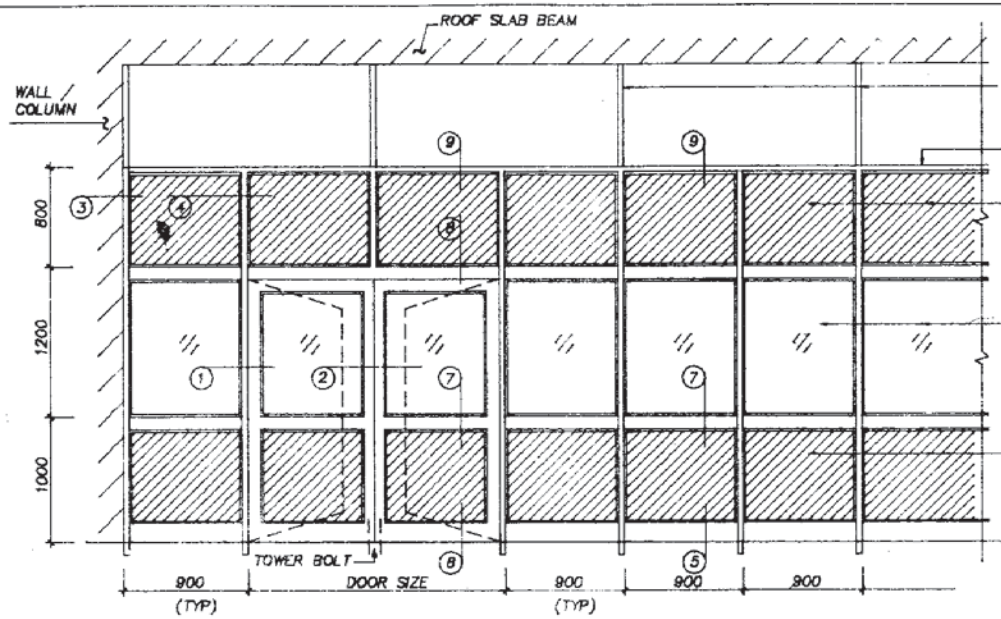
PLAN

O/C

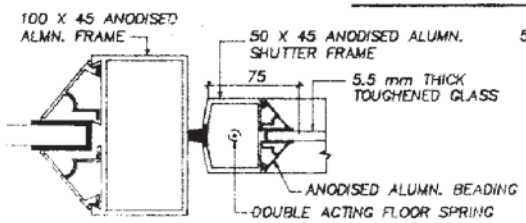
TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: STANDARD							
BHARAT HEAVY ELECTRICALS LTD. HYDERABAD			DRN.	NAME L.W.C	SIGN.	DATE	NO. OF VAR
			CHD.	M.R.RAM		23/10/93	
			APPD.	P. SAHA		23/10/93	
REV.	DATE	ALTERED/ CHECKED	DEPT. PED	SCALE 1:20	WEIGHT (KG)	REF. TO ASSY DRG.	ITEM NO. / NO. OF ITEMS
			CODE 459				
TITLE: SOAK PIT DETAILS			CARD CODE	DRAWING NO. 3-38144-00003			REV. 00
				SHEET NO. 1	NO. OF SHEETS 1		

(83)

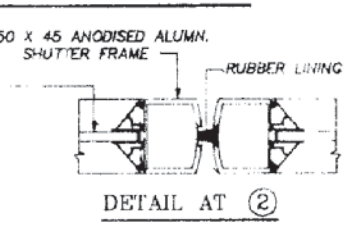
OFFICE COPY



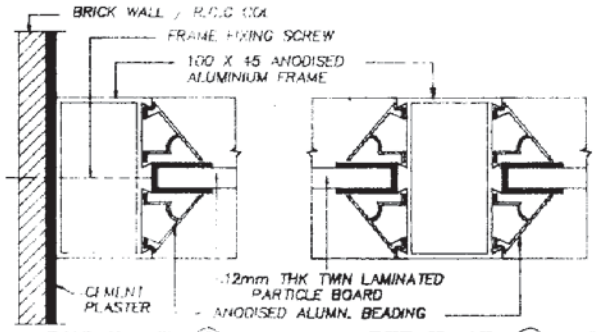
TYPICAL ELEVATION OF PARTITION



DETAIL AT (1)

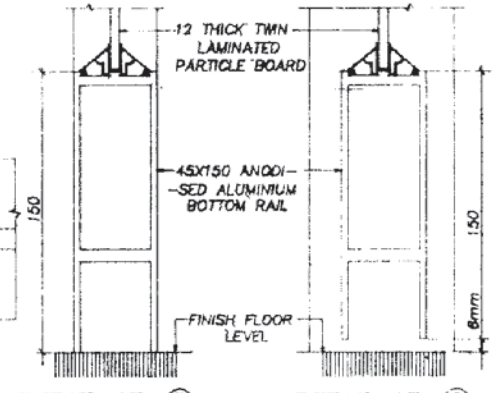


DETAIL AT (2)



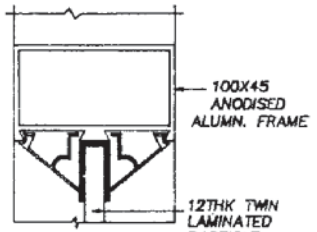
DETAIL AT (3)

DETAIL AT (4)

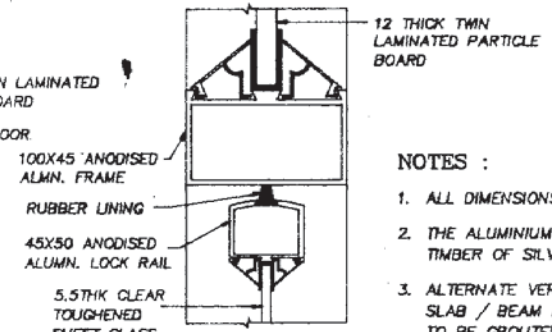


DETAIL AT (5)

DETAIL AT (6)



DETAIL AT (9)



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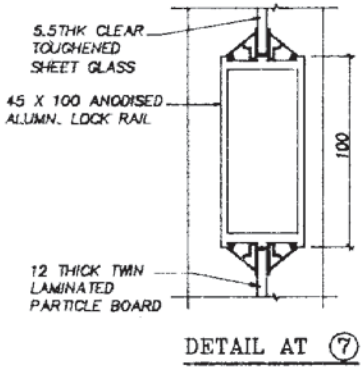


DETAIL AT (7)

NOTES :

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. THE ALUMINIUM HOLLOW SECTIONS SHOULD BE FILLED WITH TIMBER OF SILVER OAK.
3. ALTERNATE VERTICALS ARE TO BE TAKEN UP TO THE ROO SLAB / BEAM AND FIXED WITH CLEATS. ALL VERTICALS AR TO BE GROUTED 25mm INTO THE FLOOR FINISH , AT THE BOTTOM. HOWEVER , FOR MEASUREMENT , ONLY AREA OF PARTITION ABOVE FLOOR FINISH & BELOW FALSE CEILING WILL BE CONSIDERED.
4. THE MAXIMUM SPACING OF VERTICALS SHALL BE 900 MM.
5. TWIN LAMINATED PHENOL BONDED PARTICLE BOARD SHALL BE OF 'NOVAPAN' MAKE OR APPROVED EQUIVALENT.
6. TWIN LAMINATED PHENOL BONDED PARTICLE BOARD SHALL BE OF APPROVED SHADE.
7. FOR LAYOUT OF PARTION REF. DRG. NO. 1-38142-00532.
8. ALL ALUMINIUM HOLLOW SECTIONS ARE TO BE 3 MM THK.
9. DOORS SHALL BE PROVIDED WITH DOUBLE ACTING HEAVY DUTY FLOOR SPRINGS, APPROVED TYPE OF HANDLES, DOOR STOPS, 450 LONG TOWER BOLTS AT THE TOP AND 300 LONG TOWER BOLT AT THE BOTTOM FOR EACH SHUTT A MORTICE LOCK, GODREJ MAKE OR APPROVED EQUIVALEN SHALL BE PROVIDED FOR EACH DOOR

ARCHITECTURAL	NO	DATE	REVISION	DRN	CHD	APP
	0	22-4-96	ISSUED AS STANDARD	M.R.J		

BHEL PROJECT ENGINEERING BHEL HYDERABAD

DETAILS OF ALUMINIUM PARTITIONS

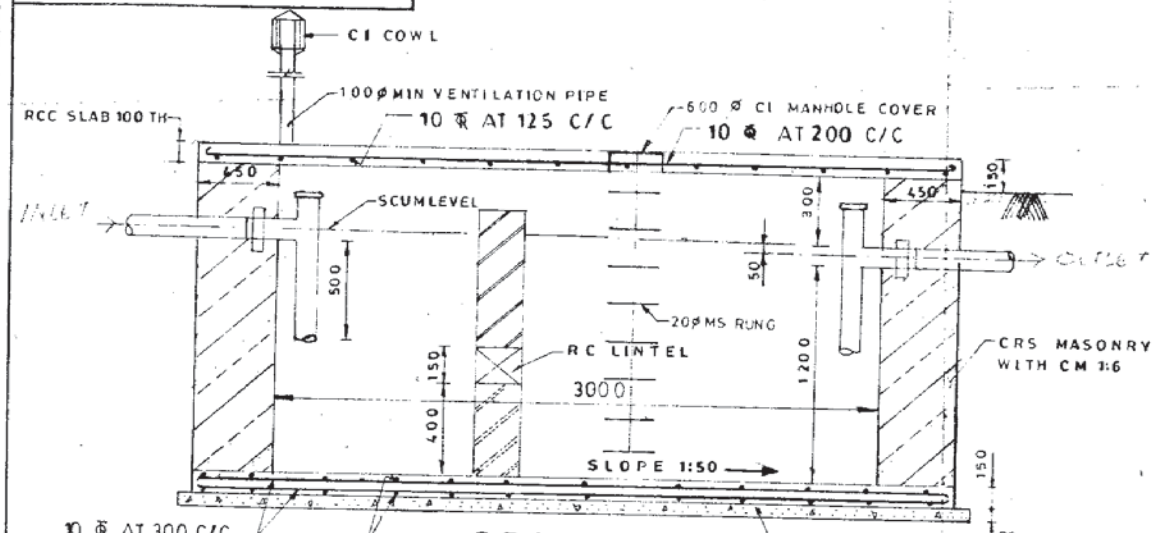
DRG. NO 3-38144-00008

RE 0

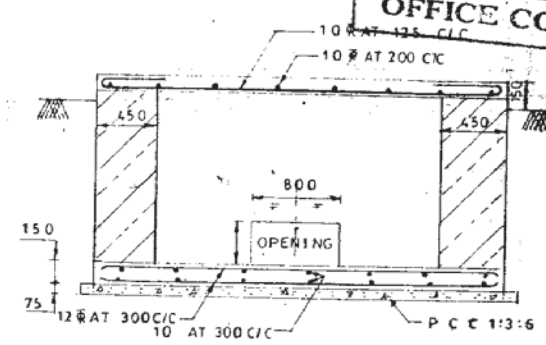
DRG. NO. 3-38144-00009

(ALL DIMENSIONS ARE IN mm)

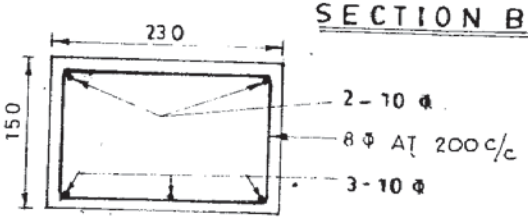
OFFICE COPY



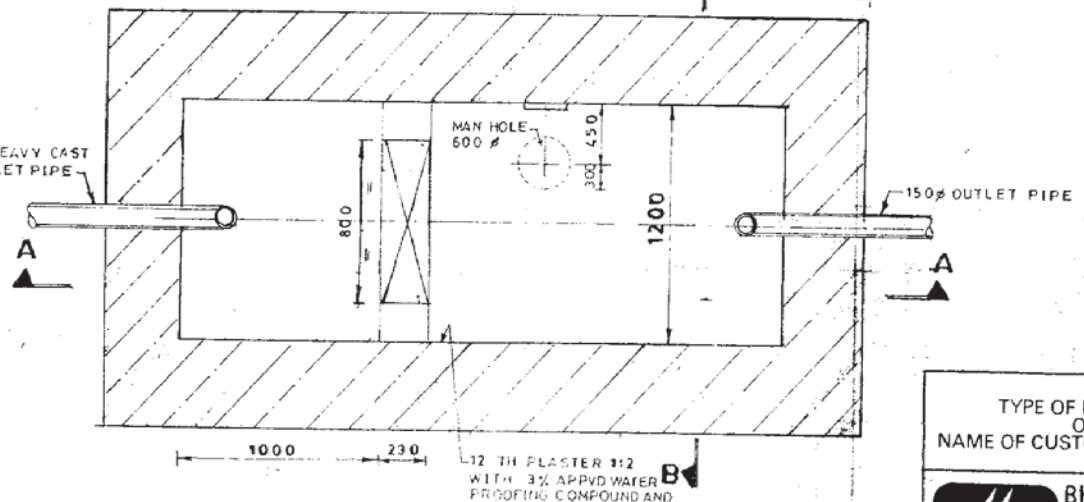
SECTION A-A



SECTION B-B



LINTELBEAM DETAIL



PLAN

NOTES

1 ALL DIMENSIONS ARE IN MM **UOS.**

STD.	DRAWING NO.	IT NO.	MATL. CODE	A/C	UNIT WT.	GS	ZONE
		VAR.	MATL. SPCN.	UNIT	QTY.		

28 → CARD TYPE-1

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: **STANDARD**

BHARAT HEAVY ELECTRICALS LTD.
HYDERABAD

	NAME	SIGN.	DATE
DRN.	G.S.S.		26/6/92
CHD.	S. SARKAR.		9/7/92
APPD.	K.T. SAILESH		9/7/92

NO OF VAR.

REV.	DATE	ALTERED / CHECKED	ZONE

DEPT. PED
CODE 450
GRADE OF TOL. DIM. C/M/F
SCALE N.T.S
WEIGHT (Kg)
REF. TO ASSY. DRG.
ITEM NO.
NO. OF ITEMS

TITLE: **SEPTIC TANK (25 USERS)**

CARD CODE

DRAWING NO. **3-38144-00009** REV. **00**

SHEET 1 NO. OF SHEETS

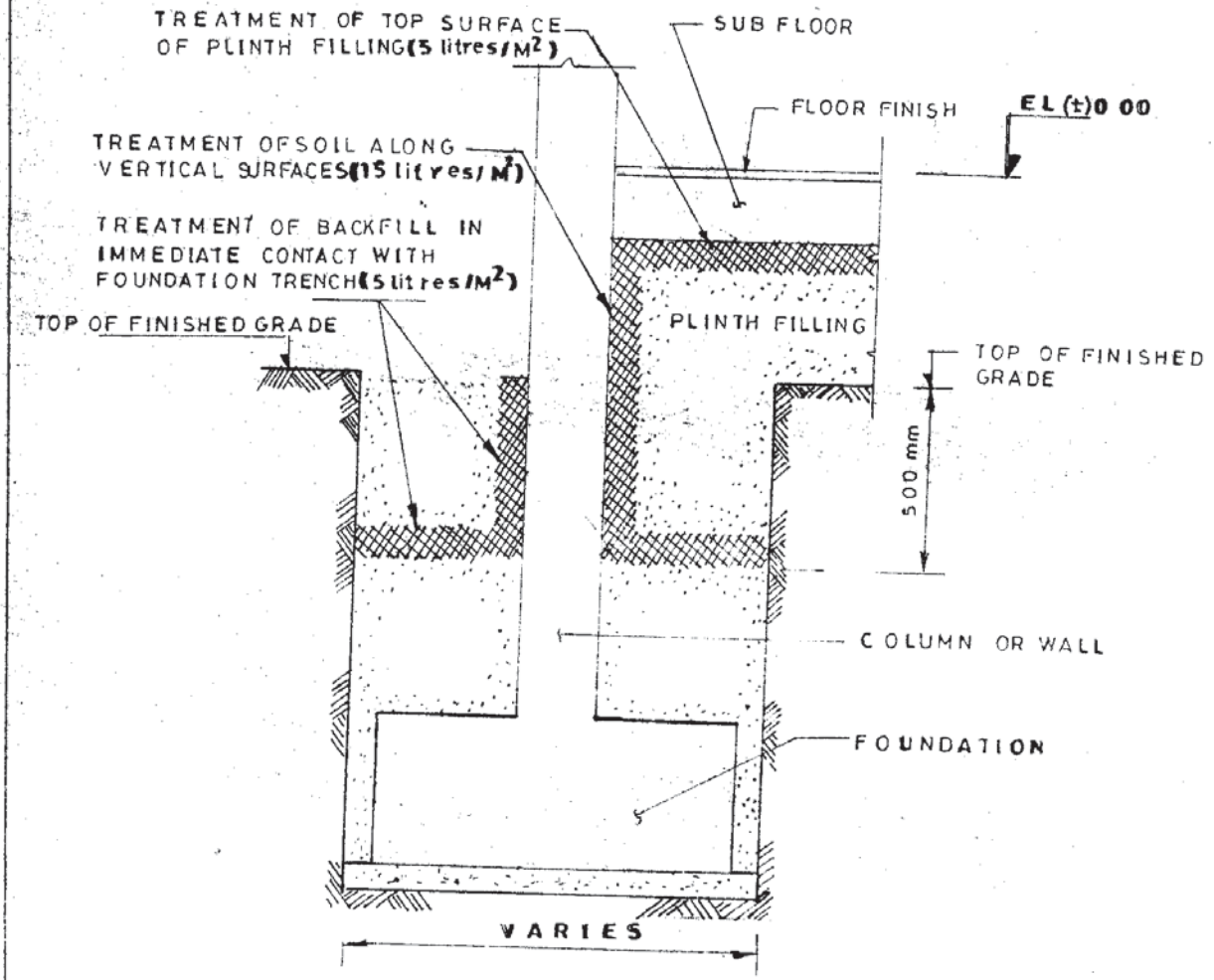
SIZE A2

INVENTORY NO | SIGN & DATE | REF. DRG NO

ID 151, REV NO 2

OFFICE COPY

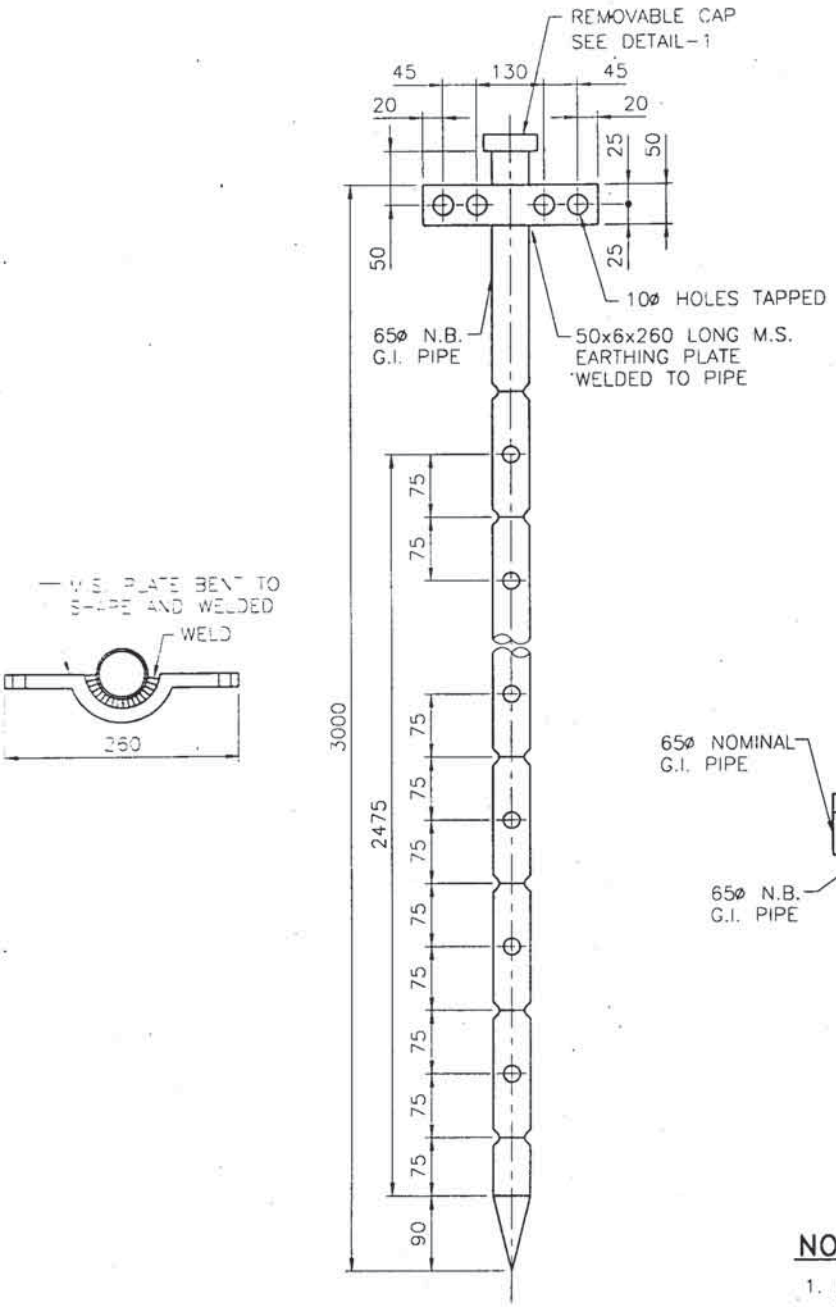
ARCHITECTURAL	NO	DATE	REVISIONS	DRN	CHD	APPD
	0	05/02/93	ISSUED AS STANDARD			

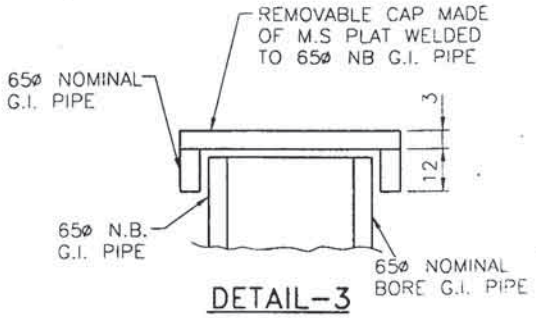


A TYPICAL SECTION

PROJECT ENGINEERING BHEL HYDERABAD	ANTI-TERMITE TREATMENT	DRAWING NO: 4-38144-00004	REV 0

1.2 PIPE ELECTRODE





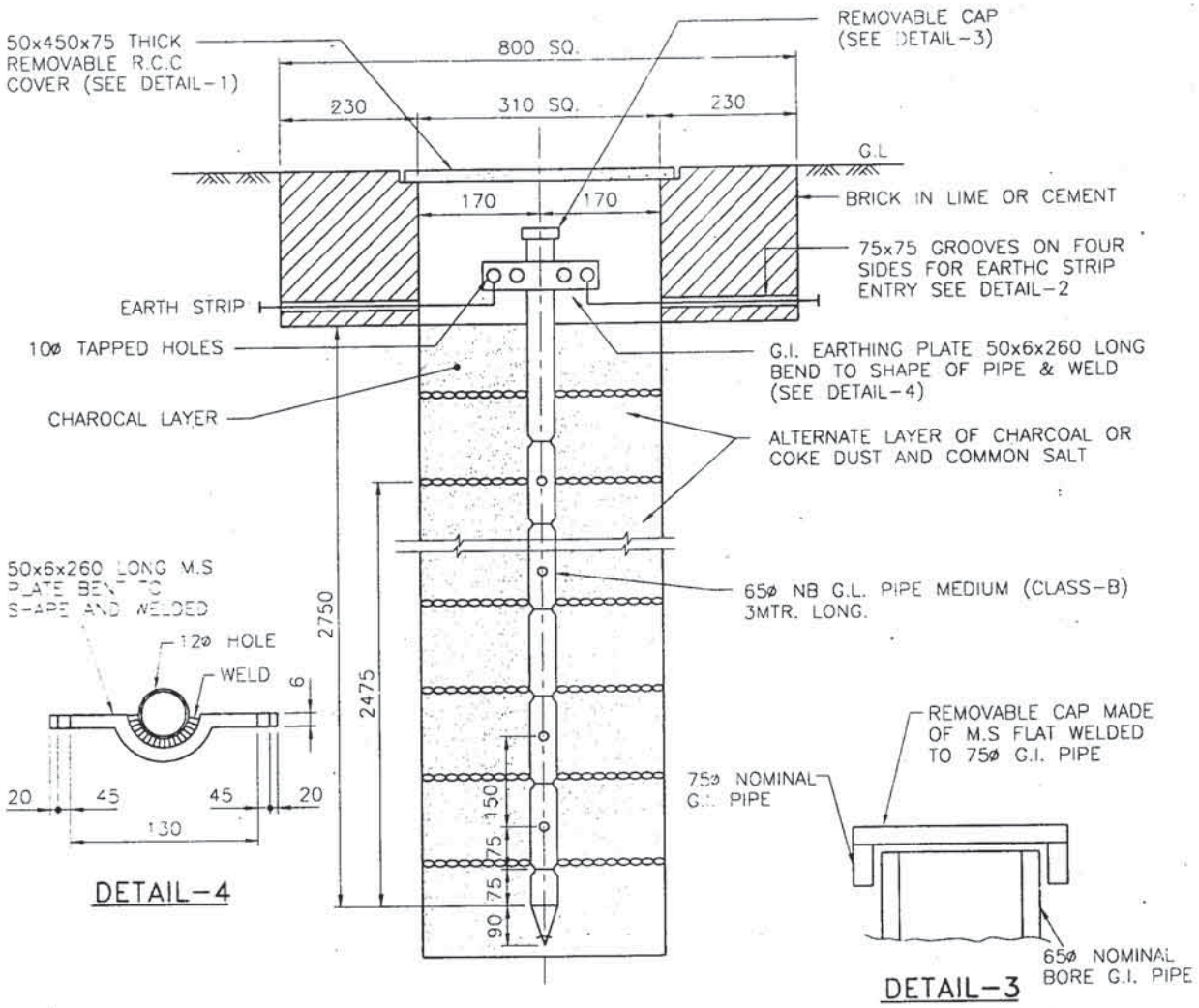
DETAIL-3

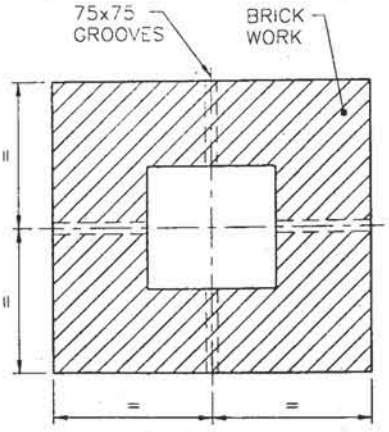
NOTE:-

1. PIPE ASSEMBLY SHALL BE HOT DIP GALVANISED AFTER FABRICATION
3. AS PER IS:3043 (LATEST REVISION)

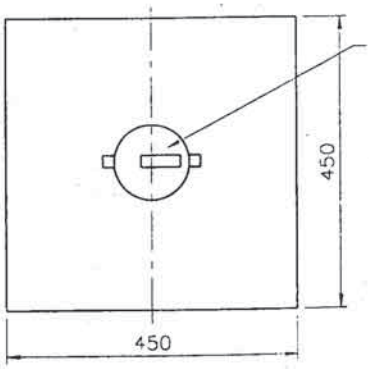
Ref. Doc

1.1 EARTH ELECTRODE IN TEST PIT





DETAIL-2



DETAIL-1

NOTE:-

1. PIPE ASSEMBLY SHALL BE HOT DIP GALVANISED AFTER FABRICATION
2. CONDUCTOR SIZES & MATERIAL ARE AS PER ANNEXURE-A OF THIS SPECIFICATION.
3. AS PER IS:3043 (LATEST REVISION)

FIELD QUALITY PLAN

FOR

CIVIL WORKS

(ERECTION)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR EASTERN REGION

DOC.NO.:QPE:STD:500:CL:01
REV.NO. :R03

FIELD QUALITY PLAN

FOR

CIVIL WORKS

(ERECTION)

PREPARED BY	DGM/QLY, PSER	APPROVED BY	HEAD / QLY, PSER
FQP NO.		**QPE:STD:500:CL:01**	
ORIGINAL DATE OF ISSUE		14.11.2007	
REVISION NO. & DATE		R03 / 21.02.2011	
COPY NO.			
ISSUED TO			
DATE OF ISSUE			
CONTROLLED / INFORMATION COPY			
ISSUED BY (SIGNATURE & DESIGNATION)			

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR EASTERN REGION

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S.NO.	DESCRIPTION	NO. OF SHEETS
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2.0	AUTHORISATION FOR DIFFERENT CATEGORIES OF CHECK	1
3.0	STATEMENT OF CHECKS FOR CONSTRUCTION	27

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ii) Bricks
iii) Levelling and grading
iv) Filling & Compaction
v) Earth Work
vi) Piling
vii) Cement
viii) Fine Aggregate (Sand)
ix) Course Aggregate
x) Reinforcing Steel
xi) Water
xii) Form Work (Shuttering)
xiii) Plant & Machinery
xiv) Embedded Parts
xv) Concreting
xvi) Testing
xvii) Water Retaining Structure
xviii) Water Supply
xix) Drainage and Sanitation
xx) Flooring and Finishing Works
xxi) Weathering Course
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xxiii) Suspended Ceiling
xxiv) Bought out Items
xxv) Roof Decking

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S.NO.	DESCRIPTION	NO. OF SHEETS
3.0	STATEMENT OF CHECKS FOR CONSTRUCTION	27
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6.0	PROTOCOL	1
7.0	FEEDBACK ON FIELD QUALITY PLAN	1

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (ERECTION)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03 SHEET 1 / 1 SHEETS

STATUS OF REVISIONS

SL. NO.	REFERENCE OF SHEETS REVISED	REVISION NO. & DATE	REMARKS
1	All	01/15.02.2010	Numbering System of SFQP revised as per work instruction.
2	All	02/ 09.09.2010	Levelling and grading, Filling and compaction & Piling sub-systems included.
3	All	03/ 19.02.2011	Roads and drains, Water proofing and painting included.

AUTHORISATION FOR DIFFERENT CATEGORIES OF CHECKS

Classification of Check		Checking Authority	Accepting Authority
Symbol	Description		
A	Critical	BHEL & Customer	Customer
B	Major	BHEL	HOS
C	Minor	BHEL	BHEL

Legend : Customer : Customer or any other agency authorised by customer.

HOS : Head of Section

BHEL : Concerned Task Performer of BHEL .

NOTE :

1. Quantum of check shall be 100% for all characteristics unless otherwise mentioned in reference documents.
2. Customer shall witness A category checks. He is also authorised to carry out Surveillance in any of the B & C category of checks at his discretion.
3. In case of non-conformity, accepting authority shall ensure dispositioning before accepting and the dispositioning shall be reflected in log sheets / protocols. Dispositioning of non-conformities to be authorised by Head/TSX with intimation to Head/Quality.
4. Instruments with valid calibration to be used for measurements.

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (ERECTION)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03 SHEET 1 / 27 SHEETS

STATEMENT OF CHECKS

Capacity / Type :	
System :	Civil
Sub-system :	----------
Area :	Construction

NOTES :

1. As an evidence of having carried out the work satisfactorily, a general purpose logsheet, L-00 shall be maintained for checks where no protocols are available.
2. Drawing / Contract requirements shall apply over and above the checks given.
3. Abbreviations used in the column 'Type of check' are:

   R : Record verification

   M: Measurement

   V : Visual

   P : Physical

   T : Test

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : TEST EQUIPMENT**	**AREA : CONSTRUCTION**	SHEET 2 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
1.0	**TEST LABORATORY ESTABLISHMENT :** a)Ensure that test laboratory is established at site sufficiently before commencement of civil work. (List of equipment as per Annexure-I)	V		B	Annexure-I	100%	-	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : BRICKS**	**AREA : CONSTRUCTION**	SHEET 3 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
2.0	**BRICKS :**							
2.1	Approval of bricks as per TS/IS.	V		**A**	IS1077/ IS-12894	One for every 10000 nos. or part thereof or change of source	Protocol	
2.2	Ensure that the following tests are conducted : - Compressive strength & water absorption	M	Compressive Strength Testing machine, weigh balance	**A**	DO	DO	L06, L07	
2.3	Check for soundness	P	Weigh balance, Oven	C		DO		

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : levelling and grading**	**AREA : CONSTRUCTION**	SHEET 4 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
3.0	**LEVELLING & GRADING:**							
3.1	Prework levels and identification of disposal points.	P		B		100%	Protocol	
4.0	**FILLING AND COMPACTION:**							
4.1	Approval of Fill material as per TS/IS.	P		A		100%		
	a)Proctor density & Optimum Moisture content	T		A			Protocol	
	b) Relative Density Index	T		A			Protocol	
4.2	Ensure that the compacted soil is tested for "DRY DENSITY" for each filling. Acceptance criteria for dry density is >90%	T	Core Cutter	B	IS 2720/Tech specn	Once in every 10000M2 on each compacted layer	Register .	
4.3	Ensure additional two samples are tested where the sample does not satisfy the specified condition after further compaction of the layer Note: Two samples for each layer should satisfy the specified condition	T	Core Cutter	B	IS 2720/Tech specn	On each compacted layer on above	Register	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03

SYSTEM : CIVIL WORKS	**SUB-SYSTEM : EARTH WORKS**	**AREA : CONSTRUCTION**	SHEET 5 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
5.0	**EARTH WORK** (Excavation, Filling, Compaction) **:**							
5.1	Approval of Filling material as per TS/IS.							
5.2	Degree of Compaction of fill.							
	a) Dry Density by Core Cutter Method / Sand Displacement Method	M	As per IS 2720	A	IS 2720	Annexure-II	Protocol	
	b) Moisture Content of Fill before Compaction	M	As per IS 2720	A	IS 2720	Annexure-II	Protocol	
	c) Dry Density by Proctor Needle Penetration (Random)	M	As per IS 2720	A	IS 2720	Annexure-II	Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)						FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03	
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : PILING**		**AREA : CONSTRUCTION**				SHEET 6 / 27 SHEETS	
S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
6.0	**PILING WORKS :**							
6.1	**Checks during Boring Operation**							
6.1.1	Approval of Drill Mud (Bentonite) as per TS/IS	V		A	Review of MTC	One from each Tank/day		
6.1.2	Centring of pile on positioning of pile location	P	Total Station	A	As per IS 2911 (Part 1/Sec 2) - 1979	100%	Pour Card	
6.1.3	Verticality of pile bore	V	Inclonometre of Hydraulic Piling Rig	A	-do-	100%	Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01
		REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : PILING**	**AREA : CONSTRUCTION**	SHEET 7 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
6.1.4	Specific Gravity of bentonite slurry during boring/ drilling operation.	P	Sp. Gravity meter	A	Less than 1.2	100%	Protocol	
6.1.5	Marsh Cone Viscosity	P	Marsh Cone	A	30 sec – 90 sec.	100%	Protocol	
6.1.6	Specific Gravity of bore water just before concreting operation.	P	Sp. Gravity meter	A	Less than 1.12	100%	-do-	
6.1.7	Termination level of pile before concreting.	P	Chain Link	A	As per drawing	100%	-do-	
6.1.8	Pile reinforcement checking	P/V	BBS	A	-do-	100%	Pour Card	
6.1.9	Concrete workability by slump cone method	P	Slump Cone	A	IS 456-2000/ Design Mix recommendation	100%	-do-	
6.1.10	Concrete cube sampling	P	Cube Moulds (150mm x 150mm x 150mm)	A	As per IS 516	As per IS 456-2000	-do-	
6.2	**Checks involved after pouring of concrete**							
6.2.1	Compressive strength of cube samples.							
	At- 7 days	P	Compressive testing Machine	A	As Per IS 456- 2000	As per IS 456-2000	Site Lab test report / Cub Strength registers	
	At- 28 days	P	-do-	A	-do-	-do-	-do-	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : PILING**	**AREA : CONSTRUCTION**	SHEET 8 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
6.2.2	Check for pile termination level, continuity of concrete throughout the length of pile through foundation pile diagnostic system by Pile Integrity Test	P	NDT Kit	A	ASTM 14945		Test Certificate by 3rd party	
6.2.3	Pile Load Test							
A.	Test pile							
a.	Vertical Load test (Maintained load method)	P & V	Hydraulic Jack system	A	IS 2911 (Part 4)	As per contract	Protocol/ Test report	
b.	Lateral Load test	P & V	-do-	A	-do-	-do-	-do-	
c.	Pull Out test	P & V	-do-	A	-do-	-do-	-do-	
B.	Job Pile / Working Pile							
a.	Vertical load test (Routine test)	P & V	-do-	A	-do-	-do-	-do-	
b.	Lateral load test	P & V	-do-	A	-do-	-do-	-do-	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : CEMENT**	**AREA : CONSTRUCTION**	SHEET 9 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
7.0	**CEMENT :**							
7.1	Ensure the following tests are conducted for conformity with requirement for strength and quality						Test Certificate	
	a) Consistency of cement	M	Vicat Needle	A	Annexure-III	Annexure-III	L-01	
	b) Initial and final setting time	M	Vicat Needle	A	IS269, IS455, IS4031,		L-02	
	c) Compressive strength - 3days & 7 days	M	Compressive Testing Machine, Cube Mould, Vibrator, Curing chambers, Standard Sand	A	IS1489-1		Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : FINE AGGREGATE**	**AREA : CONSTRUCTION**	SHEET 10 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
8.0	**FINE AGGREGATE (SAND) :**	A						Refer cl. 8.0 of Annexure-II
8.1	Approval of material source as per TS/IS.							

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : COARSE AGGREGATE**	**AREA : CONSTRUCTION**	SHEET 11 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
9.0	**COARSE AGGREGATE :** (Stone metal / Gravel)							Refer cl.9.0 of Annexure-II
9.1	Approval of Coarse Aggregate material (source as per TS)			A				

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : STEEL** / **AREA : CONSTRUCTION**	SHEET 12 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
10.0	**REINFORCING STEEL**							
10.1	Verify the following :							
	a) Surface characteristics like free from cracks, Surface flaws, Imperfect edge, Lamination & Rough jogged.	V		B		Random		
	b) Dimension	M	Screw Gauge	B		Random	Protocol	
	c) Proper identification for Corrosion Resistant Steel (CRS)	V		B		Random		
10.2	Check for placement of reinforcement bar The bar bending schedule with necessary hooks, laps, covers, spacers, binding & chairs shall be 100%. Check for all before start of concreting**.**	M	Measurement Tape	B	Drawing	100%	Pour Card	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : WATER** / **AREA : CONSTRUCTION**	SHEET 13 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
11.0	**WATER**							
11.1	Ensure that water from all source is potable as per the standard before use	Testing		B	Annexure-III, Test certificate	Once a month per source/once in 6 months if from borewell/ once a month in rainy season		
11.2	Conduct test for neutralisation of water	M	Indicator	B	Annexure-III, IS 3025 & IS456	Once a month per source/ -do-	Site logbook	
11.3	Check and ascertain limits of solids	M	Lab Test	B	Annexure-III, IS 3025 & IS456	Once a month per source/-do-	Site logbook	
11.4	Conduct test for PH value	M	PH Meter	B	Annexure-III, IS456	Once a month per source/-do-	Site logbook	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03

SYSTEM : CIVIL WORKS	**SUB-SYSTEM : FORM WORK**	**AREA : CONSTRUCTION**	SHEET 14 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
12.0	**FORM WORK** (SHUTTERING) **:**							
12.1	Approval for Type of Shuttering			A				
12.2	Check for the following :							
	a) Cleanliness, Damage and warpage	V		C		100%	Pour Card	
	b) Ensure internal dimension of box forms and distances between internal surfaces of shuttering of walls.	M	Measuring Tape	B	Drawing	100%	-do-	
	c) Staging	R /V /P		B	Drawing/ Design	100%	-do-	
	d) Ensure the following :							
	(i) Soundness of material	M/ V	Hammer	C	Drawing	100%	-do-	
	(ii) Proper joining bracing	V		C	Drawing	100%	-do-	
	(iii) Proper support	V		C	Drawing	100%	-do-	
	(iv) Verticality of side shuttering before and after reinforcement	M	Plumb bob	C	Drawing	100%	Pour Card	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : PLANT & MACHINERY**	**AREA : CONSTRUCTION**	SHEET 15 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
13.0	**PLANT & MACHINERY :**	V / P		C		100%	Pour Card	
13.1	As per requirement: a) Concrete Mixer b) Vibrators of adequate capacity c) Weigh batches & batching plant d) Lighting e) Air compressor f) Pumps g) Jack hammer h) Transit mixer i) Generator j) Winches k) Cranes l) Excavator, Power roller, plate compactor							

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : EMBEDDED PARTS**	**AREA : CONSTRUCTION**	SHEET 16 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
14.0	**EMBEDDED PARTS :**							
14.1	Ensure the following : a) Position and level of embedded parts	M	Dumpy level, Measuring Tape	B	Drawings	100%	Pour Card	
	b) All necessary steps like welding of lug to reinforcement are done to keep the embedded parts undisturbed during the process of concreting	V		B	Drawings		Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : CONCRETING** / **AREA : CONSTRUCTION**	SHEET 17 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
15.0	**CONCRETING :**							
15.1	Ensure Preliminary tests are conducted for determining design mix for required strength.	Test		A	Annexure III Test certificate IS456, IS1199	Annexure-III	L-05	
15.2	Ensure compliance of Sl. No. 10.0, 12.0, 13.0, 14.0 before concreting	P		B			Pour Card	
15.3	Ensure the following : Workability of the concrete checked at frequent intervals by Slump Cone test or Completion Factor Test.	M	Slump Cone	B	IS456, IS2386 Part III IS1199 Annexure-IV	Annexure III	L-05	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01
		REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : CONCRETING**	**AREA : CONSTRUCTION**	SHEET 18 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
15.4	a) The temperature of concrete does not exceed 25° C for major equipment foundation, use ice proportionally to maintain temperature	M	Thermometer	B	IS 456	100%	Protocol	
	b) Stripping time of formwork is strictly regulated as follows in normal circumstances (where temperature is above 20° C) and where ordinary cement is used. i) Wall columns & vertical sides of beams : 24 to 48 hours ii) Slab (props left under) : 3 days iii) Beams soffits (props left under) : 7 days iv) Removal of props to slabs span less than 4.5m : 7 days v) Removal of props to slabs spanning over 4.5m : 14 days vi) Removal of props to beams and arches Spanning upto 6 m : 14 days	M/P	Thermometer	B	IS 456	100%	Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)					FQP. NO.: QPE:STD:500:CL:01		
						REV. NO. : R03		
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : CONCRETING**		**AREA : CONSTRUCTION**			SHEET 19 / 27 SHEETS		
S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
	c) Removal of props to beams and arches spanning over 6m : 21 days Note : Where rapid hardening cement is used the stripping time in respect of items ii and vi of above be regulated at 3/7 of the corresponding periods stated for ordinary cement with the approval of customer.							
15.5	Ensure the following : Curing of concrete is carried out for a minimum of 7 days from the date of placing of concrete. Curing is started not later than 10 to 12 hours after termination of concreting in normal weather and in hot and windy weather within 2 to 3 hours.	P		B		100%	Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01
		REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : TESTING** / **AREA : CONSTRUCTION**	SHEET 20 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
16.0	**TESTING :**							
16.1	Ensure that adequate number of test specimen (Cubes) are taken from mixed concrete and kept properly identified for purpose of testing as per specifications/standards (min. 3 nos. for 7 days and 3 nos. for 28 days)	Lab Test		A	IS456, IS2911		--	
16.2	Ensure that concrete cubes are tested and recorded at specified period of curing as per standards	Lab Test	Compressive Test Machine	A	Annexure-V IS516, IS2911	Annexure-III	L-05	
16.3	Ensure that test results of concrete cubes are examined to verify the specified grade of concrete as required			A	Test results IS516, IS2911	100%	--	
16.4	Load Test on Structures (If required by Customer's engineer)	Load Test		A	IS456		Protocol	
16.5	Rebound Hammer Test (If required by Customer's engineers) or any other non-destructive tests	P		A	IS13311-II		Protocol	
16.6	UPV test on TG and other identified machine foundations	Test		A			Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : MISCELLANEOUS** / **AREA : CONSTRUCTION**	SHEET 21 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
17.0	**WATER RETAINING STRUCTURE :**							
17.1	Ensure inspection of finished structure and identify if pressure grouting is required.	V		A	Drawing	100%	Protocol	
17.2	Ensure construction joints are as per drawings and specification	V		C	Drawing	100%	Protocol	
17.3	Checks on Copper &PVC Water stops, joint filler	V		B				
18.0	**WATER SUPPLY :**							
18.1	Check properly alignment level and grades of each laid length	M	Measuring Tape, Levelling instrument	C	Drawing	100%	Protocol	
18.2	Ensure that the water supply lines are tested.	M	Pressure Gauge	B	Drawing	100%	Protocol	
19.0	**DRAINAGE AND SANITATION :**							
19.1	Check for alignment and slope	M	Levelling instrument	B	Drawing	100%	Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01
		REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : MISCELLANEOUS** / **AREA : CONSTRUCTION**	SHEET 22 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
20.0	**FLOORING AND FINISHING WORKS :**							
20.1	Check for levels and slope	M	Dumpy Level	B	Drawing	100%	Protocol	
21.0	**WEATHERING COURSE :**							
21.1	Check for slope	M	Dumpy Level	B	Drawing	100%	Protocol	
22.0	**PLASTERING** :							
22.1	Ensure that the plastering of brick walls shall be of min. 19 mm thick for outside and 13 mm for inside or as per TS/BOQ.	V / M	Steel Tape	B	Drawing	Random Test	Protocol	
22.2	Ensure that the curing of plastering surfaces are carried out for 7 days (min.)	V		C		100%		
23.0	**SUSPENDED CEILING :**							
23.1	Ensure density of resin bonded mineral wool	M		B		Sample Test	Protocol	
24.0	**BOUGHT OUT ITEMS :**							
24.1	Check the bought out items are as per Technical specification / IS codes before use. Approval of all bought out items.	Verifi-cation		A	Annexure-VI	100%	Protocol	
25.0	**ROOF DECKING :** a) Sheets approved of samples by engineer in-charge. - Review of T/C Dimension Check including thickness, depth of valley centre to centre distance of valley	M	Measuring Tape	B	Drawing	Sample Test	Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : MISCELLANEOUS** / **AREA : CONSTRUCTION**	SHEET 23 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
	b) Fixing of Decking Seats	V		C	IS 3618	Sample Test		
	Appearance, Water Tightness, Check side end laps, Check conformity of Fixing as per approved design, Review of T/C for fasteners and Z spacers	V		C		Sample Test		
26.0	**RECORDS :** Prepare logsheets / Protocols as per drawing and record the following :	V		B		100%	Protocol	
	a) Orientation with co-ordinates b) Elevation / levels c) Slope d) Pitch / Diagonals e) Spacing / Diagonals	V / M	Steel Tape, Dumpy Level, Theodolite	A	Drawing	100%	Protocol	

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01
		REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : RECORDS** / **AREA : CONSTRUCTION**	SHEET 24 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
27.0	**WALL CLADDING WORK :**							
	a) **Inner sheets**			B	Drawing / Specification	100%	Protocol	
	i) Approval of sample by Engineer In-charge							
	ii) Review of TC for physical & chemical properties.	R						
	iii) Dimensional conformities including thickness, Rib depth, cover width.	M	Measuring Tape					
	b) **Outer skin sheets**			B	Drawing / Specification	100%	Protocol	
	i) Approval of sample by Engineer In-charge	V						
	ii) Review of TC for physical & chemical properties	R						
	iii) Dimensional conformities including thickness, Rib depth, cover width.	M	Measuring Tape					

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : RECORDS**	**AREA : CONSTRUCTION**	SHEET 25 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
	c) **Thermal Insulation**							
	Thickness, Thermal conductivity at 50°C, Density and review of TC for all test as per IS 8183	M / V		B		100%	Protocol	
	i) Check positioning and location of laps.	M	Measuring Tape	B		100%	Protocol	
	ii) Check alignment of sheets and fixing (Plumb & level)	M	Water level / Plumb					
	iii) Check End lap and Side lap fixing of other item	V						
	iv) Check location and spacing of fixing.	V/ M	Measuring Tape					

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01
		REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : Roads** / **AREA : CONSTRUCTION**	SHEET 26 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
28.0	**ROADS :**							
(i)	Alignment as per layout	V		B				
(ii)	Subgrade							
	(a) Filling in layers 250 mm with Vibro Roller or excavation as per profile	P	Proctor Density	A	IS 1200/Technical Specification	Every 1000 sqm and each layer	Protocol	
	(b) Compaction > 95%							
	(c) Level as per Drg.							
(iii)	Granular Sub Base							
	(a) Aprroval of Fill material	R	Level M/c,	A	As per TS	Once or change of source	Document	
	(b) Thickness of Fill in each layer after dry rolling as per CBR Value	P	Sieves, Impact M/c	B		Every 1000 sqm and each layer	Protocol	
	(c) Level & Camber Check before and after rolling	P		B				
	(d) Sieve Analysis	P		B				
(iv)	WBM							
	(a) Aprroval of Fill material	R	Level M/c,	A	As per TS	Once or change of source	Document	
	(b) Thickness of Fill in each layer after dry rolling	P	Sieves, Impact	B		Every 1000 sqm and each layer	Protocol	
	(c) Level & Camber Check before and after rolling	P	M	B				
	(d) Sieve Analysis	P		B				
(v)	Tack Coat (Qty. Of Bitumen/Sqm to be ascertained)	P	Meaurement	A	As per TS	Every 1000 sqm and each layer	Protocol	
(vi)	Bituminous Macadam							
	(a) Mix Design as per Specification	R	Lab Test	A	As per TS	Once or change of source	Protocol	
	(b) Approval of Material	R	Lab Test	A		Every 1000 sqm and each layer		
	(c) Temperature of Mix before Laying	P	Temp. Gauge	B				
	(d) Thickness of Fill	P	Measurement	B				
	(e) Level & CamberCheck before and after rolling	P	Level M/c	B				
	(f) Random Bitumen qty. Check	P	Chemical Test	B				

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01
		REV. NO. : R03
SYSTEM : CIVIL WORKS	**SUB-SYSTEM : ROADS** / **AREA : CONSTRUCTION**	SHEET 27 / 27 SHEETS

S.NO.	CHARACTERSTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
(vii)	Premix Carpet							
	(a) Mix Design as per Specification	R	Lab Test	A	As Per TS	Once or change of source	Protocol	
	(b) Thickness of Fill	P	Measurement	B				
	(c) Level & Camber Check before and after rolling	P	Level M/c	B				
	(d) Random Bitumen qty. check	P	Chemical test	B		Every 1000 sqm and each layer		
29.0	**WATER PROOFING :**							
(i)	Approval of Material	R	Test Certificate	A	As per TS	Once	Document	
(ii)	Laying as per Manufacturer Recommendation	P		B	As per Manufacturer	Every 1000 sqm or per roof	Protocol	
(iii)	Other masonry works as per FQP							
30.0	**DRAIN :**							
(i)	Alignment & Invert Levelas per Drg.	P	TS/Level M/c	B	Drgs.	100%		
(ii)	Concrete as per FQP	P						

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ANNEXURE - I

RECOMMENDED LABORATORY EQUIPMENTS/MEASURING DEVICES/INSTRUMENTS FOR CIVIL WORKS AT TURNKEY PROJECTS

FQP. NO.: QPE:STD:500:CL:01

REV. NO. : R03

SL NO.	BROAD CLASS	NOMENCLATURE DESCRIPTION	UTILITY	TEST PROCEDURE	CODE REF.	TO BE AVAILABLE AT SITE
1	Routine Test Lab. Equipment	1.1 Vicat Apparatus	Cement Consistence	Penetration of Std. Needle	IS 5513	Yes
		1.2 Lechatelier's test Apparatus	Cement shrinkage	Size variation after curing of sample	IS 5514	Yes
		1.3 Mould (cement) (70.7x70.7x70.7mm)	Cement cubes	Cubes made of 1:3 cement: Sand	IS 10086	Yes
		1.4 Cement Mortar Mould Vibrator	Cube Compaction	Vibration for fixed duration	IS 10078	Yes
		1.5 Concrete cube mould (150x150x150)mm	Concrete cubes	--	IS 10086	Yes
		1.6 Compressive strength Testing machine	Concrete cube test	Crushing strength of cube	IS 2505	Yes
		1.7 Concrete slump cone	Workability check	Drop in cone height of concrete	IS 7320	Yes
		1.8 Coarse aggregate sieves	Sieve analysis	Sieving	IS 383	Yes
		1.9 Fine aggregate sieves	Sieve analysis	Sieving	IS 383	Yes
		1.10 Sieve shaker	Mechanical sieving	--		Yes
		1.11 Aggregate impact test machine	Impact value of aggregate	--	IS 9377	Yes
		1.12 Compaction factor Apparatus	Workability of concrete	Lab test	--	--

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ANNEXURE – 1

RECOMMENDED LABORATORY EQUIPMENTS/MEASURING DEVICES/INSTRUMENTS FOR CIVIL WORKS AT TURNKEY PROJECTS

FQP. NO.: QPE:STD:500:CL:01

REV. NO. : R03

SL NO.	BROAD CLASS	NOMENCLATURE DESCRIPTION	UTILITY	TEST PROCEDURE	CODE REF.	TO BE AVAILABLE AT SITE
		1.13 Abrasion and Attrition Testing Machines.		--	--	Yes
		1.14 Proctor Density Testing Equipment with Mould		--	--	Yes
		1.15 Thermometer/Poker		--	--	Yes
		1.16 Measuring Cylinders		--	--	Yes
2.0	Dimensional & Allied Measuring Equipment	2.1 Theodolite, levelling Instruments & Levelling Staff, Total Station	Levelling and centre line marking & verticality measurement	Measurements & recording	--	Yes
		2.2 Measuring tape	Dimension	--	--	Yes
		2.3 Slide Callipers	Dimension	--	--	Yes
		2.4 Screw Gauges	Dimension	--	--	Yes
3.0	Process Control Accessories	3.1 Oven	Material drying for moisture control	Material to be kept for specific duration		Yes
		3.2 Physical balance with weight	Weighing	--	--	Yes
		3.3 Platform weighing machine (1000 KGs capacity)	-do-	--	--	Yes

CHECKLIST FOR CIVIL WORKS

1.0 TEST LABORATORY ESTABLISHMENT

- Preliminary Survey & Layout

2.0 BRICKS

- Ensure that the bricks are free from cracks, warpage and of uniform colour.
- Ensure clear ringing sound is heard on being struck.
- Check for the dimension, Check for bond / closers thickness of joints in masonry, Line, level and plumb,
- Racking out joints, keys in brick work, if any.
- Check for efflorescence & curing.

3.0 LEVELLING & GRADING

- Ensure that the vegetation in the plant area is completely removed.
- Ensure that excavation is carried out for levelling & grading including dressing to the specified levels & grades.
- Ensure that surplus earth unsuitable for filling are dumped and leveled as specified.

4.0 FILLING AND COMPACTION

- Check that all the "blocks" are filled with approved filled material as per priority.
- Ensure that the area to be filled is free from water slush, vegetables, roots etc.
- Ensure that compaction is carried out for the original ground with required passes of rolling.
- Carry out the leveling of the filled area
- Ensure that the filled material is spread in horizontal layers not exceeding 300mm.
- Ensure that each block is finished with formation level, as specified.
- Check that watering is done before starting compaction
- Ensure that the compaction is carried out by rolling to the required extent

5.0 EARTH WORK

Ensure that the material is as per standard :

a) Proctor Density & Optimum moisture content (Standard Proctor Test)

b) Relative Density Index

6.0 PILING WORKS

The following tests are to be performed:

- Specific Gravity
- Differential Free Swell
- Liquid Limit
- pH value
- Sand Content
- Marsh Cone Viscosity

7.0 CEMENT

Ensure that material is stored properly to avoid deterioration due to moisture and contamination by various impurities

- Covered storage is provided
- Material is stored on raised platform
- Not more than 10 bags are stacked on one heap with proper access for inspection
- Cement shall be stacked consignment wise, type & grade wise for clear identification

8.0 FINE AGGREGATE (SAND)

Ensure that the following tests are conducted for each source of supply and check the material is as per standards (for mix design)

- Silt & Clay content
- Sieve analysis (Particle size and shape)
- Bulking of sand
- Specific gravity, density, voids & absorption
- Moisture content
- Deleterious materials
- Petrographic examination
- Soundness
- Reaction with Alkali : Mortar making properties.
    - Conduct tests and ensure that the material is as per standards before use at site

- Silt & Clay content
- Sieve analysis
- Bulking of sand

9.0 COARSE AGGREGATE (Stone Metal/Gravel)

Conduct the following tests and ensure that the material is as per standards (for Mix design)

- Sieve Analysis (Particle Size and Shape)
- Moisture content
- Specific gravity
- Crushing Strength
- Bulk density
- Absorption value, Abrasion value & Impact Value
- Voids
- Soundness
- Reaction with Alkali
- Petrographic examination
- Deleterious materials
- Temperature Cycle test
- Flakiness

10.0 REINFORCING STEEL

- Conduct following chemical and mechanical tests wherever required and ensure that the material is as per standards :
  - Chemical analysis including chromium and other corrosion resistant element
  - Tensile strength, Proof stress, Elongation
  - Bend Test
- Ensure fabrication is done as per details given in drawings and bar bending schedules
- Ensure that the joints and crossing bars are tied properly with right gauge wire.
- Ensure lapping of bars, wherever necessary

11.0 FORM WORK

- Ensure the form work is as per contract specifications and drawings. Also before form work of main castings like TG raft, Fans, Mills etc. ensure availability of Mechanical GA Drgs.
- Ensure horizontality before and after placement of reinforcement.
- Form work material are as per the specification and approved.
- Check that there is no loss of liquid through joints.

12.0 EMBEDDED PARTS

- Check for Position, depth and size of bolt holes
- Ensure suitable pipe sleeves have been provided for bolt holes before concreting
- Ensure length, diameter and verticality of embedded bolts
- Ensure that sufficient length of bolts protruding above finished floor level to accommodate equipment (Base frame)
- Ensure that the threads of foundation bolts are adequately projected.

13.0 CONCRETING

Ensure the following :

- Preliminary tests are conducted for determining design mix for required strength
- Cement water and aggregate content as per mix design (W-C ratio and cement content)
- Ensure the continuous concreting and the quantity of constituents measured by weigh batching
- Ensure that all measuring equipment are maintained in a clean serviceable condition and their accuracy checked periodically.
- The reinforcement rods are clean and free from rust, paint, oil and other coatings.
- The reinforcement are placed correctly in position with adequate separators before pouring concrete.
- Area to be concreted is clean and free from debris and any extraneous matter of water logging
- Water stopper or seals are introduced wherever required
- Old concrete surfaces are chopped, cleaned with wire brush, wetted and coat of cement slurry applied before layingnew concrete

- Adequate cover is provided between reinforcement and shuttering
- Ensure chipping of pile head as per pile cap requirement
- Concrete is transported/ placed and compacted before expiry of initial setting time of cement and not disturbed subsequently
- Concrete is placed in even layers in quick succession, each of which is compacted before placing next layer and no cold joints are formed.

14.0 WATER RETAINING STRUCTURE

Ensure proper jointing of RCC pipes and curing of joints for minimum of 10 days

15.0 DRAINAGE AND SANITATION

- Ensure proper jointing of each length
- Ensure that water fill test is conducted to identify water leakage in joints for RCC non-pressure pipes.
- Ensure that all pipe i.e. fittings and fixtures are as per relevant code and as per drawing.

16.0 FLOORING & FINISHING WORKS

- Ensure that the floors are chipped prior to commencement of actual finishing work.
- Ensure that the cement concrete floors are cured minimum for 7 days
- Ensure that the tiled finished floors are polished as per the requirement of customer

17.0 WEATHERING COURSE

Check for joint finishing

18.0 BITUMEN TOP

Check for proper laying of Bitumen top

19.0 PLASTERING

Ensure that the plastering of concrete ceiling is as specified.

20.0 SUSPENDED CEILING

Ensure that the false ceiling is done as per drawing / specification

Ensure that as per requirement resin mineral wool is packed in black polythene and laid on top of Ceiling panels.

21.0 WALL CLADDING WORK

- Inner sheets
  - Check for galvanizing weight of zinc coating
  - Type of permanently colour coating and appearance
- Outer Skin Sheets
  - Check for Fluor Polymer Paint Coating Thickness

FREQUENCY OF SAMPLING AND TESTING

SL No.	Nature of Test / Characteristics		Method of Test	No. of samples & Frequency of Test	Remarks
I	**EARTH WORK**				
	Suitability of Fill Materials				
	(a)	Grain size Analysis	1S:2720 (Part IV)	One in every 2000 Cu.m. for each type and each source of fill material subject to a minimum of two samples	Test for soil and sand
	(b)	Liquid limit and Plastic Limit	IS:2720 (Part V)		Test for soil
	(c)	Shrinkage Limit	IS:2720(Part VI)	One in every 5000 cu.m. for each type and each source of fill materials	The frequency of Test shall be increased depending on type of soil.
	(d)	Free swell Index	IS:2720 (Part XL)		
	(e)	Chemical Analysis	IS:2720 (Part 5)		
	(i)	Organic matter	Part XXII	One in every 5000 cu.m. for each type and each source of fill materials	Test for soil and sand
	(ii)	Calcium Carbonate	Part XXIII		
	(iii)	PH	Part XXVI		
	(iv)	Total soluble sulphate	Part XXVII		
II.	**Standard Proctor Test**		IS:2720 (Part VII)	One in every 2000 cu.m. for each type, each layer and each source of fill materials	Test for soil for determining optimum moisture content, Dry Density etc.
III	**Moisture content of Fill before compaction**		IS: 2720 (Part-II)		Test for soil

FREQUENCY OF SAMPLING AND TESTING

SL No.	Nature of Test / Characteristics	Method of Test	No. of samples & Frequency of Test	Remarks
IV	**Degree of compaction of fill**			
	a) Dry density by core cutter method OR Dry density implace by sand displacement methods	IS:2720 (Part XXIX) IS:2720 (Part XXVIII)	i. For foundation filling one for every ten foundations for each compacted layer for location of important and heavily loaded foundations. ii. For each filling, one for every 1000 sq.m. area for each compacted layer.	Test for soil
	b) Relative density Index	IS:2720 (Part XIV)	-do- (I) & (ii)	Test for sand
	c) Dry Density by proctor needle-penetration.	Standard Practice	Random checks to be carried out for each compacted layer in addition to tests mentioned under IV (a) above.	Test for soil.
	d) Permeability Test .	Standard Practice	Random checks	.Test for soil

FREQUENCY OF SAMPLING AND TESTING

SL No.	Nature of Test / Characteristics	Method of Test	No. of samples & Frequency of Test	Remarks
I	**Coarse Aggregates**			
	e) Particle size and shape	1S:2386 (Part I)	One per 100 cu.m. or part thereof or change of source whichever is earlier	Result to be as per the requirement of design mix, subject to variations within the limits specified in relevant Indian Standards.
	f) Moisture content	IS:2386 (Part 3)	Once for each stack of 100 cu.m. or part thereof except during monsoon when this has to be done every day before starting of the work.	Accordingly water content of the concrete shall be adjusted.
	g) Specific gravity, density, voids, absorption.	IS:2386 (Part 3)	Once in 12 weeks or change of source, whichever is earlier.	These tests shall be carried out while establishing design mix and results to be intimated.
	h) Mechanical properties, crushing value, abrasion value and impact value.	IS:2386 (Part 4)	Same as `c' above	Acceptance norms shall be as per IS:383.
	i) Soundness	IS:2386 (Part 5)	Same as `c' above	Acceptance norms shall be as per per IS:383.
	j) Reaction with alkali	IS:2386(Part 7)	Same as `c' above	These tests shall be carried out while establishing design mix and result to be intimated. Acceptance shall be as per IS:2386 (Part 7)
	k) Flakiness and petrographic examinations	IS:2386	This is to-be done once in 12 weeks and should be repeated in case the source is changed.	These tests shall be carried out while establishing design mix and result to be intimated.
	h) Deleterious materials	IS:2386(Part 2)	Same as `c' above	Results should be within the limits as specified in relevant Indian Standard.

SL No.	Nature of Test / Characteristics	Method of Test	No. of samples & Frequency of Test	Remarks
II	**FINE AGGREGATES / SAND**			
	a) Particle size and shape.	IS:2386 (Part I)	One per 100 cu.m. or part thereof or change of source, whichever is earlier.	Should be as per the requirement of design mix, subject to variation within the limit as specified in relevant IS Codes.
	b) Specific gravity density voids, absorption and bulking.	IS:2386 (Part 3)	Once in 12 weeks or change of source whichever is earlier.	These tests will be carried out while establishing design mix and results To be intimated.
	c) Bulkage, moisture content (Routine test)	IS:2386 (Part 3)	To be done everyday before start of work.	Volume of sand and weight of water shall be adjusted as per bulkage and moisture content.
	d) Silt, clay deleterious materials, organic impurities.	IS:2386 (Part 2)	Once per source and to be repeated, if source is changed.	Acceptance norms shall be as per IS:383.
	e) Soundness and Petrographic examination.	IS:2386(Part 5&8)	Same as `b' above	Acceptance norms shall be as per IS:383.
	f) Mortar making properties.	IS:2386 (Part 6)	Same as `b' above	Acceptance norms shall be as per IS:383.
	g) Reaction with alkali.	IS:2386(Part 7)	Same as `b' above	Acceptance norms stall be as per IS:383 and IS:2386 (Part 7)

SL No.	Nature of Test / Characteristics	Method of Test	No. of samples & Frequency of Test	Remarks
III	**CEMENT**			
	a. Setting time	IS:4031	One sample from each batch received from stores.	Acceptance norms shall be as per relevant Indian Standard.
	b. Compressive Strength c. Fineness	IS:4031	One sample from each batch received from stores.	Acceptance norms shall be as per relevant Indian Standard.
IV.	**WATER**			
	Harmful substances, pH value, initial setting time, compressive strength.	IS-3025, IS:4031 & IS:516	Once a month for each source	Acceptance norms shall be as per Cl.4.3 of IS:456 1978.
V.	**CONCRETE**			
	a) Workability (Slump and compaction factor).	IS: 1199	One sample every two hours from every mixing plant.	Acceptance norms shall be as per Cl.6.1 of IS:456 1978.
	b) Crushing Strength	IS:516	i) As per Cl. 14.2.2 of IS:456-1978 for initial period.	Acceptance criteria shall be as per Cl.15 of IS:456-1978.
			ii) 0ne sample of six cubes per 150 cu.m. or part thereof for mass concrete for subsequent period.	A minimum of 3 (Part-7) specimens shall be tested for 28 days strength.
	c) Water cement ratio.	IS:1199	At random at the time of batching.	According to mix design.
	d) Cement Content	IS:1199	At random at the time of batching.	According to mix design.
	e) Water-tightness test (for water retaining Structures).	IS:370	Each tank or reservoir.	Acceptance criteria as per specification & relevant IS codes.
	f) Finished:- dimensions	Physical measurement	All structures	Acceptance as per Specifications.

SL No.	Nature of Test / Characteristics	Method of Test	No. of samples & Frequency of Test	Remarks
VI.	**FORM WORK**			
	a) Staging (Durability, strength & soundness of staging, joints. adequacy of its foundation and specific level).	Visual / Measurement	Each member	Any staging intended for use shall be approved by the Engineer for its durability and strength.
				After erection of staging, nominated representatives of Engineer shall check the soundness of the staging as a whole, its joints, adequacy of its foundation and the specific levels.
	b) Shuttering			
	i) Materials	Visual	Random	Form work materials shall be strictly as per specifications and approval of the Engineer. Materials for form work shall be unwrapped, thoroughly clean and without broken or damaged edges either due to repetitive use or otherwise oiling of form work before concreting shall be resorted to.
	ii) Joints	Visual	Random	Joints shall be leak proof to avoid loss of liquid.
	iii) Dimensions and plumb	Physical. measurement	Each member and before every lift.	Tolerances as per Specifications.

SL. No.	Nature of Test / Characteristics	Method of Test	No. of samples & Frequency of Test	Remarks
VII.	**REINFORCEMENT**			
	a) Placement	Visual/ Measurement	each	The bar bending schedule with the necessary hooks, laps, covers, spacers and chairs shall be 100% checked for all concreting works before start of the work.
	b) Cutting tolerance	Physical measurement	Random	Tolerance shall be as per specification.
	c) Freedom from defects. d) Tensile strength	Visual Lab test	Random	Any of the bars selected for use shall be free from cracks, surface flaws, laminations and rough, jagged and imperfect edges.
VIII	**EMBEDDED PARTS**			
	a) Type of embedment	Visual/ Measurement	Each part	Type/Details as per drawings. Tolerance as per specification.
	b) Location	Physical/ Measurement	-do-	Detail as per drawings. Tolerance as per specification.

METHOD FOR DETERMINATION OF SLUMP OF CONCRETE

Slump test As per IS 1199

Objective : To determine the consistency of fresh concrete and to check the uniformity of concrete from batch to batch.

Test Procedure

1. Internal surface and mould should be cleaned thoroughly to make it free from moisture and any set concrete.

2. Place the mould on levelled metal plate.

3. The internal surface of the mould (cone) shall be thoroughly cleaned and free from superfluous moisture and any set concrete.

4. The mould shall be placed on a smooth, horizontal rigid and non-absorbent surface (such as carefully levelled metal plate)

5. Cone shall be filled in four layers, each approximately one Quarter of the height of the mould.

6. Each layer shall be tamped with 25 strokes of the rounded end of the tapping rod in such a manner that the strokes are uniformly distributed over the cross section of the mould and for the second and subsequent layers the rod to be penetrated into the underlying layers.

7. After the top layer has been rodded the concrete shall be struck off level with a trowel or tapping rod.

8. Leaked out mortar between the mould and the base plate is cleaned away.

9. The mould should be removed from the concrete immediately by raising it slowly and carefully in a vertical direction.

10. The slump shall be measured immediately. (The slump can be measured by keeping the tamping rod on the inverted mould and thus measuring the difference between the height of the mould and that of the highest point of the specimen being tested).

NOTE:-

i) The test is to be carried out at a place free from vibration or shock and within two minutes of sampling.

ii) Slump specimen which collapsed or sheared off laterally should be rejected and another test should be carried out.

iii) Actual slump to be recorded in logsheet L-05

METHOD FOR DETERMINING THE COMPRESSIVE STRENGTH OF CONCRETE CUBES

(IS 516)

a) Age Test :

The age shall be calculated from the time of the addition of the water to the dry ingredients.

The testing shall be carried out at the age of 7 days and 28 days.

b) Number of Specimens :

Three specimen from different batches.

c) Procedure :

Specimens stored in water shall be tested immediately on removal from the water, in testing machine. The load shall be applied without shock and increased continuously at the rate of approx. 140 kg/ cm^2/min, Until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded.

d) Calculation :

Compressive Strength (kg / cm^2) = Max. Load Applied / Cross-sectional area

BOUGHT OUT ITEMS

Check the following bought out items for their specifications / IS codes before use

i. Teak wood
ii. Grout Materials
iii. Steel doors & Press steel door frames (IS 4351)
iv. Steel glazed windows
v. Glass for glazing of doors & windows & partition work
vi. Aluminium partition, doors, windows (IS:1548)
vii. Rolling shutters
viii. Water proofing cement paint
ix. Alkali / Acid resistant resin based epoxy paint
x. Fire resistant paint
xi. Anti-corrosive bituminastic paint
xii. Acid resistance bricks
xiii. Asbestos Mill board
xiv. Asbestos rope
xv. Mineral wool
xvi. Vineertax
xvii. Marine Terrazo flooring / Cement Concrete flooring (granolithic & ironite)
xviii. Glazed / Ceramic / tiles flooring, wall cladding
xix. Flexivinyle lining / PVC tiles
xx. Heavy duty water proofing treatment on roof
xxi. Under desk insulation & aluminium false ceiling materials
xxii. Galvanised pipeline for water supply including fittings, C I pipes, RCC non-pressure pipes
xxiii. Coarse aggregate
xxiv. Fine aggregate
xxv. Reinforcement
xxvi. Cement

Note :-

1) Customer may witness the tests at manufacturers' premises or at laboratory as and when felt necessary.

PSER	FIELD QUALITY PLAN FOR **CIVIL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:01 REV. NO. : R03 SHEET 1 / 1 SHEETS

DOCUMENTS REFERRED IN FIELD QUALITY PLAN

Sl. No.	Reference Document	Issuing Authority
1	Drawings	PEM
2.	IS 269, 370, 383, 432, 455, 456, 515, 516, 1077, 1199, 1489-1, 1566, 1786, 2386 part 1 to 7, 2502, 2720, 2911, 3025, 3616, 4031, 4351, 5513, 5514, 7320, 8183, 9377, 10078, 10086, 13311 - II	Bureau of Indian Standards (BIS)

PSER

RECORD OF QUALITY CHECKS

SHEET NO. OF FQP	CHECK NO.	RESULTS ACHIEVED OK / NOT OK	DRAWING / DOCUMENT REFERENCE	FORMAT OF RECORD	INSPECTED BY SIGN. & DATE	CLEARED BY SIGN. & DATE	REMARKS

Note : Any protocol made is to be numbered & mentioned in “Format of Record” column.

		SYSTEM	SUB-SYSTEM	AREA	FQP. NO.: QPE:STD:500:CL:01
PROJECT					REV. NO. : R03
UNIT NO.					LOG SHEETNO. L-00
RATING					PAGE 1 OF 1

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

CONSISTENCY OF CEMENT PASTE

This method is for determining the quantity of water required for preparing a cement paste of standard consistency. This can be performed by vicat apparatus.

Date of Testing

Reading recorded by analyst

Weight of sample mould	_____gms	500 gms for 80 mm diameter vicat
Quantity of water	_____ ml	
Time of gauging	_____ min.	3 to 5 min.
Penetration of plunger of 10 mm diameter	_____ mm	5 to 7 from bottom of the mould

Formula : $\frac{\text{Water added X 100}}{\text{Weight of cement}}$

Consistency : %

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV. NO. : R03
UNIT NO.		CLEARED BY			LOGSHEETNO. L-01
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

INITIAL & FINAL SETTING TIMES OF CEMENT
(VICAT APPARATUS)

Date of testing

Weight of sample mould	_____gms	500 gms for 80 mm diameter vicat
Quantity of water	_____ ml	85% of standard consistency

i) Initial Setting Time :

Penetration of vicat needle of 1 mm^2 — 5 + 0.5 mm from the bottom of the mould

Initial Setting — min/sec — Total time from water addition to proper penetration of the needle.

ii) Final Setting Time :

Final setting Time — min. / sec. — Total time from water addition to failure of making outer impression of the surface of the cement specimen.

iii) Specification :

Initial (mins.) Min 30 min.

Final (mins.) Max 600 min.

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV. NO. : R03
UNIT NO.		CLEARED BY			LOGSHEETNO. L-02
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

GRADING OF THE SAND
(FINE AGGREGATE)

Date of testing

Weight of sample _____gms Type of Aggregate : _____

Sl. No.	Retained on IS Sieve No.	Weight Retained	Percentage Weight Retained	Cumulative % Weight Retained	Percentage Passing
1.	10 mm				
2.	4.74 mm				
3.	2.36 mm				
4.	1.18 mm				
5.	600 microns				
6.	300 microns				
7.	150 microns				
8.	75 microns				

GRADING ZONES OF FINE AGGREGATE (IS 383)

IS Sieve Designation	Percentage Passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90 - 100	90 - 100	90 - 100	95 - 100
2.36 mm	60 - 95	75 - 100	85 - 100	95 - 100
1.18 mm	30 - 70	55 - 90	75 - 100	90 - 100
600 microns	15 - 34	35 - 59	60 - 79	80 - 100
300 microns	5 - 20	8 - 30	12 - 40	15 - 50
150 microns	0 - 10	0 - 10	0 - 10	0 - 15

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV. NO. : R03
UNIT NO.		CLEARED BY			LOGSHEETNO. L-03
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

SIEVE ANALYSIS

GRADING OF COARSE AGGREGATE

Date of testing

Weight of sample _____gms Type of Aggregate : _____

Sl. No.	Retained on IS Sieve No.	Weight Retained	Percentage Weight Retained	Cumulative % Weight Retained	Percentage Passing
1.	40 mm				
2.	20 mm				
3.	16 mm				
4.	12.5 mm				
5.	10 mm				
6.	4.75 mm				
7.	2.36 mm				

GRADING ZONES OF FINE AGGREGATE (IS 383)

IS Sieve Designation	Percentage Passing for Graded Aggregate of Nominal size			
	40 mm	20 mm	16 mm	12.5 mm
40 mm	95 - 100	100	-	-
20 mm	30 - 70	95 - 100	100	100
16 mm	-	-	90 - 100	-
12.5 mm	-	-	-	90 - 100
10 mm	10 - 35	25 - 55	30 - 70	40 - 85
4.75 mm	0 - 5	0 - 10	0 - 10	0 - 10
2.36 mm	-	-	-	-

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV. NO. : R03
UNIT NO.		CLEARED BY			LOGSHEETNO. L-04
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.							
	DATE OF INSPECTION							
	DRAWING / DOCUMENT REF.							

COMPRESSIVE STRENGTH OF CEMENT CONCRETE

Name of Agency : Location / Structure : Grade of Concrete Mix Proportion :

Sl. No.	Date of Casting	Cube Identification Mark	Slump (mm)	Concrete Quantity from which sampling done	Date of Testing	Age of Cube	Weight of Cube	Compression Strength / mm^2		Remarks
								Individual	Average	

			NAME	SIGNATURE / DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV. NO. : R03
UNIT NO.		CLEARED BY			LOG SHEET NO. L-05
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.						
	DATE OF INSPECTION						
	DRAWING / DOCUMENT REF.						

COMPRESSION STRENGTH OF BRICKS

AREA/LOCATION :

Sl No	Sample No.	Brick Mark	Dimensions L Cm x B Cm x D Cm	Area of Cross Section Loaded	Load In Kg	Compression Strength Kg/Cm2	Remarks

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV. NO. : R03
UNIT NO.		CLEARED BY			LOGSHEETNO. L-06
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

COMPUTING WATER ABSORPTION TEST OF BRICK

Sample No.	Brick Mark	Dimension (L x B x D) (CmxCmxCm)	Weight of Dry Brick (W) In Kg	Duration of Soaking Water			Weight of Soaked Brick (Wi) In Kg	Weight of Water Absorbed (Wi – W) In Kg	%age of individual absorption (Wi–W) x100 W	Remarks
				From	To	Period				

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV. NO. : R03
UNIT NO.		CLEARED BY			LOGSHEETNO. L-07
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO./TAG NO.		
	DATE OF INSPECTION		
	DRAWING / DOCUMENT REF.		

PROTOCOL

			NAME	SIGNATURE & DATE	FQP. NO.: QPE:STD:500:CL:01
PROJECT		INSPECTED BY			REV.NO.: 03
UNIT NO.		CLEARED BY			PROTOCOL
RATING		CUSTOMER			PAGE:

PSER

FEEDBACK ON FIELD QUALITY PLAN

In the Field Quality Plan, following Checks / Log sheets may be added / rewritten / deleted (cannot be carried out / not required) due to reasons as mentioned below :

Sheet No. of FQP	Check No. / Log Sheet No.	Proposed Change / Reasons / Remarks

PROJECT		From :	To 2. Head (Quality) PS-ER Kolkata-91	FQP. NO.: QPE:STD:500:CL:01
UNIT NO.				REV NO. : 03
RATING				SHEET 1 / 1 SHEET

FIELD QUALITY PLAN

FOR

STRUCTURAL STEEL WORKS

(Power House, Mill Bay & Aux. Buildings)

(ERECTION)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR EASTERN REGION

DOC. NO.: QPE:STD:500:CL:03
REV. NO. : R02

FIELD QUALITY PLAN

FOR

STRUCTURAL STEEL WORKS

(Power House, Mill Bay & Aux. Buildings)

(ERECTION)

PREPARED BY	DGM/QLY, PSER	APPROVED BY	HEAD / QLY, PSER
FQPNO.		**QPE:STD:500:CL:03**	
ORIGINAL DATE OF ISSUE		01.11.2007	
REVISION NO. & DATE		R02 / 22.10.2010	
COPY NO.			
ISSUED TO			
DATE OF ISSUE			
CONTROLLED / INFORMATION COPY			
ISSUED BY (SIGNATURE & DESIGNATION)			

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR EASTERN REGION

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (ERECTION)	FQP. NO.: QPE:STD:500:CL:03 REV. NO. : R02 SHEET 1 / 1 SHEETS

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	iv) Fit up	
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	vi) Welding	
	vii) Non destructive Testing	
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PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (ERECTION)	FQP. NO.: QPE:STD:500:CL:03
		REV. NO. : R02
		SHEET 1 / 1 SHEETS

STATUS OF REVISIONS

SL. NO.	REFERENCE OF SHEETS REVISED	REVISION NO. & DATE	REMARKS
1	All	01/15.02.2010	Numbering System of SFQP revised as per work instruction.
2	All	02/22.10.2010	RT has been replaced by UT.

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (ERECTION)	FQP. NO.: QPE:STD:500:CL:03
		REV. NO. : R02
		SHEET 1 / 1 SHEETS

AUTHORISATION FOR DIFFERENT CATEGORIES OF CHECK

Classification of checks		Checking authority	Accepting authority
Symbol	Description		
A	Critical	BHEL & Customer	Customer
B	Major	BHEL	HOS
C	Minor	BHEL	BHEL

Legend : Customer : Customer or any other agency authorised by customer.

BHEL : Concerned engineers of BHEL – Task Performer.

HOS : HEAD OF SECTION for BHEL.

Note :

1. Quantum of check shall be 100% for all characteristics unless otherwise mentioned in reference documents.
2. Customer shall witness A category checks. He is also authorised to carry out Surveillance in any of the B & C category of checks at his discretion.
3. In case of non-conformity, before accepting , BHEL shall ensure dispositioning and the same shall be reflected in Logsheets/protocols. Dispositioning of non-conformities to be authorised by Head/TSX with intimation to Head/Quality
4. Before starting of the work at site, necessary testing laboratory with calibrated instruments shall be set up by BHEL at site.
5. Instruments with valid calibration to be used for measurements

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (ERECTION)	FQP. NO.: QPE:STD:500:CL:03
		REV. NO. : R02
		SHEET 1 / 14 SHEETS

STATEMENT OF CHECKS

Capacity / Type :

System : Civil Works

Sub-system : Structural Steel Works

Area : Erection

NOTES :

1. For checks where logsheets are not called for, suitable records should be maintained in the form of logsheets / protocols.
2. As an evidence of having carried out the work satisfactorily, a general purpose logsheet, L-00 shall be maintained for all the checks.
3. Drawing / Contract requirements shall apply over and above the checks given.
4. Abbreviations used in the column 'Type of check' are:

   R : Record verification

   M: Measurement

   V : Visual

   P : Physical

   T : Test

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:03 REV. NO. : R02
SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM : ----**	**AREA : ERECTION**	SHEET 2 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
1.0	**RAW MATERIALS**							
1.1	Ensure that the raw materials (including Stainless steel) is as per the specification	T/R		B	Test / Test certificates, Drawing, IS2062, 8500, 808, 3502 and other relevant codes	100%	TC	In absence of correla-tion,tests to be done.
1.2	Ensure that the raw material is free from defects like cracks, seams, laps, lamination and pitting	V		B		100%	L00/ Protocol	
	NOTE: 1. UT on all plates >25mm thickness In the absence of correlation with TCs test shall be carried out on the materials as per specification.	R/T		A	ASTM-A435	100%	TC	
2.0	MARKING AND CUTTING							
2.1	Ensure that the marking are done as per the requirement	V		B	Drawing & Annexure-II	100%	L00	
2.2	Check that the marking are done by punching at convenient intervals	V		B	Annexure-II	100%	L00	
2.3	Ensure that the raw materials are cut by using suitable method	V		B	Annexure-II	100%	L00	
2.4	Ensure that the cut edges are properly cleared/dressed before taking up fabrication	V		B	Drawing	100%	L00	

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:03 REV. NO. : R02
SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM :----**	**AREA : ERECTION** SHEET 3 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
2.5	Check that the raw materials after cutting are identified with part number.	V		B	Drawing	100%	L00	
3.0	**FORMING** (If applicable)							
3.1	Ensure that forming is done using proper tooling & free from damages.	V		C	Drawing	100%	L00	
4.0	**FIT UP:**							
4.1	Ensure proper fit up before welding	M	Measuring Tape	B	Drawing	100%	Protocol	
4.2	Check that the gap is minimum for all fillet welds (max. gap 2 mm)	M	Measuring Tape	B	Drawing	100%	Protocol	
4.3	Ensure that the butt weld joints are properly aligned and the offset is not to exceed 10% of the thickness of the thinner part of the joint. Maximum permitted value is 3.2 mm.	M	Measuring Tape Feeler gauge	B	Drawing	100%	Protocol	
4.4	Ensure match markings are punched for all trial assembled components.	M	Measuring Tape	B	Drawing	100%	Protocol	

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:03 REV. NO. : R02
SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM : ----**	**AREA : ERECTION** SHEET 4 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
5.0	**MINIMUM PREHEATING & INTER PASS TEMPERATURE:**							
5.1	Ensure pre heating is carried out wherever applicable. (using appropriate method)	V	Thermal chalk	B	Annexure-II	100%	Protocol	
5.2	Ensure that the preheating temperature is uniform prior to start of welding as well as during the welding.	V	Thermal chalk	B	Annexure-II	100%	Site Log	
6.0	**WELDING:**							
6.1	Ensure that the qualified welders and qualified welding procedures are used for all welding.	T/R		A	Welding Manual, WPS, IS817 & ASME SEC. IX	100%	Site Log	
6.2	Ensure that the welding consumables are as per WPS.	R		A	Welding Manual, WPS, IS817 & ASME SEC. IX	100%	Site Log	
6.3	Ensure proper edge preparation wherever required.	V	Bevel protractor	B	Drawing	100%	Site Log	
6.4	Ensure proper sequence of welding.	V		B	WPS	100%		
6.5	Check that the temporary attachment welded are removed and ground & painted	V		B		100%		

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SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM :----**	**AREA : ERECTION** SHEET 5 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
6.6	Check and ensure that the overlap/excess weld metal is removed by grinding and painted.	V		B		100%	L00	
6.7	Check the measurement of parts after welding for the correctness of dimension & matching.	M	Measuring Tape	B	Drawing	100%	Protocol	
7.0	**NON DESTRUCTIVE TESTING:**							
7.1	Carry out UT/LPI as applicable	T	Testing equipment	A	Drawing , Annexure-I & NDE Manual	As per Annexure-I	protocol	
8.0	**CLEANING AND PAINTING:**							
8.1	Ensure that the surface are cleaned and painted as specified	V		B	Specification	100%	L00	
8.2	Ensure that the following markings are done							
	a)Assemblies designation	V		C	Drawing	100%	L00	
	b)Part Number	V		C	Drawing	100%	L00	
	c)Any other important identifications	V		C	Drawing	100%	L00	
8.3	Ensure Dry Film Thickness of paint is as per specification **Note : All tolerances during fabrication should be as per Annexure-II**	M	Elcometer	B	Specification	100%	Protocol	

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SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM :----**	**AREA : ERECTION** SHEET 6 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
9.0	**FOUNDATION CHECKS:**							
9.1	Ensure availability of permanent Bench Mark.	V		B		100%		
9.2	Check the foundations are cast as per requirement and with proper positioning of foundation bolts/ inserts as per drg.	M	Measuring Tape	B	Drawing	100%	L-01	
9.3	Check the orientation of the foundation.	V		C	Drawing	100%		
9.4	Check the top level of foundation pedestals with respect to permanent benchmark.	M	Dumpy Level	B	Drawing & Annexure-I	100%	L-02	
9.5	Check the centre to centre distance of column foundation pedestals with respect to the reference axis.	M	Measuring Tape/ Theodolite	B	Drawing & Annexure-I	100%	L-03	
9.6	Check the diagonals between column foundation pedestals.	M	Measuring Tape	B	Drawing & Annexure-I	100%	L-04	
9.7	Check the pitch distance of foundation bolts on both axis and diagonals.	M	Measuring Tape	B	Drawing & Annexure-I	100%	L-05	
10.0	**COLUMN PRE-ASSEMBLY CHECKS:**							
10.1	Ensure cleaning of Base plate and HSFG bolt area	V		C		100%	L00	

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SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM :----**	**AREA : ERECTION** SHEET 7 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
10.2	Check individual column pieces for identification. Match mark column No. length, camber, sweep & condition of the column joints.	M	Measuring Tape	A	Drawing & Annexure-I	100%	L-06	
10.3	Ensure columns are pre-assembled as per match marks and centre line already punched on the column pieces and respective splice plates wherever applicable. **Note:** 1. Interchanging of column pieces and turning of column by 180 degree is not permitted. 2. Splice plates are to be positioned as per shop match marks and placing them upside down turning by 180 degree shall be totally avoided. 3. For Pre-assembly of columns use only correct size black bolts.	V		B	Drawing & Annexure-I	100%	L-06	
10.4	Check camber, sweep, match mark and total length after trial assembly of columns. Note: thickness of packer plates shall be decided (STATEMENT OF CHECKS) based on total length of columns and the top level of corresponding foundation.	M	Measuring Tape	B	Drawing & Annexure-I	100%	L-07	

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SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM :----**	**AREA : ERECTION** SHEET 8 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
11.0	**ROOF TRUSS PREASSEMBLY CHECKS BETWEEN ROWS**							
11.1	Ensure roof trusses are pre-assembled as per match mark and C.G line punched on top and bottom angles.	V		B	Drawing & Annexure-I	100%	L00	
11.2	Check the following							
	a) Camber	M	Measuring Tape	B	Drawing & Annexure-I	100%	L-08	
	b) Sweep	M	Measuring Tape	B	Drawing & Annexure-I	100%	L-08	
	c) Alignment of CG line punch mark and the match mark given on the top & bottom angles, permitted deviation in C.G line matching is ±5 mm)	M	Measuring Tape	B	Drawing & Annexure-I	100%	L00	
	d) Horizontal level of assembled roof truss with water level with respect to centre line punch mark on end gusset plate face permitted deviation is ± 5mm	M	Measuring Tape	B	Drawing & Annexure-I	100%	L00	
	e) Total length of assembled roof truss between faces of end gusset plates at top & bottom (Permitted deviation is ± 5 mm.	M	Measuring Tape	B	Drawing & Annexure-I	100%	L00	
	f) End plates are aligned and in one plane on both the ends.	M	Measuring Tape	B	Drawing & Annexure-I	100%	L00	

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SYSTEM : STRUCTURAL STEEL WORKS.	**SUB-SYSTEM : ----** **AREA : ERECTION**	SHEET 9 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
11.3	Ensure the following during welding of roof truss.							
	a) Proper fit up	M / V	Measuring Tape	B	Drawing	100%	L00	
	b) Qualified welders are engaged and qualified procedures are employed.(In absence of valid docs WPS & welder to be qualified)	T / R		B	Drawing, Welding Manual & Annexure-I	100%	L00	
	c) Recommended welding consumables and methods are employed.	R		A	Tech Spec, Drawing & Annexure-I	100%	L00	
	d) LPI on finished welds 100% for butt welds and 10% for fillet welds.	T		B	Drawing & Annexure-I	100%	L00	
	Butt Welds : 1. Ultrasonic Test : Spot Ultrasonic Test shall be carried out on 100 % joints in Tension zone and 10% joints in Compression zone for bunker girders and crane girders. Minimum 300 mm length shall be spot ultrasonically tested after grinding the surface. 2. Ultrasonic Test : All other Butt welds shall be subject to Ultrasonic Test as per Drawing/welding schedule/NDE Manual.							Class of check `A' Acceptance standard as per NDE Manual.

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SYSTEM : STRUCTURAL STEEL WORKS	**SUB-SYSTEM : ----**	**AREA : ERECTION** SHEET 10 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
12.1	Ensure foundation bolts are free from damages and foundation bolt pocket is free from debris and foreign materials.	V		B		100%	L00	
12.2	Ensure cleaning of packer plates and that they are free from undulations and burrs.	P		B		100%	L00	
12.3	Ensure thickness of packer plates does not exceed specified value.	M	Measuring Tape	B	Drawing & Annexure-I	100%	L00	
12.4	Ensure maximum contact between the top surface of packer plate and bottom surface of the column base plate and also packer to foundation top.	V		B	Drawing	100%	L00	
12.5	Ensure proper orientation of column.	V		B	Drawing	100%	L00	
12.6	Ensure that centre line of base plate coincides with foundations pedestal axis (both in X and Y axis)	V		B		100%	L00	
12.7	Ensure first pieces of all columns are erected and aligned.	M	Measuring Tape & Plumb bob	A		100%	L00	
12.8	Ensure the stub welded on the columns for connecting girder are in the same elevation. Note :variation in level leads to mismatching of bolt holes.	M	Measuring Tape	B	Drawing	100%	L00	

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:03 REV. NO. : R02
SYSTEM : STRUCTURAL STEEL WORKS	**SUB-SYSTEM : ----**	**AREA : ERECTION**	SHEET 11 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
12.9	Ensure the erection of horizontal beams/girders and vertical bracing (use correct size HSFG/HT bolts and follow the tightening procedure). **Note**: Site to decide about the horizontal beams/vertical bracings not to be erected for the movement of Cranes or any erection equipment. The left out members shall be erected at the appropriate time	M		A	Drawing & Annexure-I	100%	L00	
12.10	Check verticality of first piece columns after erection of the respective connecting adjacent columns.	M	Plump bob / Theodolite	A	Drawing & Annexure-I	100%	L00	
12.11	Ensure proper tightening of foundation bolts with lock nuts.	V		B	Drawing	100%	L00	
12.12	Ensure locking of all packer plates by tack welding.	V		C		100%	L00	
12.13	Ensure grouting up to the base plate bottom after ensuring verticality of columns and cure (Cube test to be carried out)	M / V	Compressive Testing m/c	B		100%	L-09	
12.14	Ensure erection of second pieces of all columns.	V		C	Drawing & Annexure-I	100%	L00	
12.15	Ensure erection of interconnecting members.	V		C	Drawing	100%	L00	
12.16	Ensure tightness of bolts (HSFG/HT bolts as the case may be)	M	Torque Wrench	B	Annexure-I	100%	L00	

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:03 REV. NO. : R02
SYSTEM : STRUCTURAL STEEL WORKS	**SUB-SYSTEM : ----**	**AREA : ERECTION**	SHEET 12 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
12.17	Check verticality of 1st and 2nd pieces after the erection of Connecting pieces. **Note:** The same method shall be followed for further pieces erection	M	Plump bob	A	Drawing & Annexure-I	100%	L-09	
12.18	Check the verticality of total erected column	M	Plump bob/ Theodolite	A	Drawing & Annexure-I	100%	L-10	
12.19	Check and ensure the following during Crane girder erection wherever applicable							
	a) Bracket top level on the column are aligned with water level (Tolerance 5mm Max)	M	Water Level	A	Drawing & Annexure-I	100%	L00	
	b) Check top flange level of crane girder are aligned with water level (Tolerance 5 mm Max.)	M	Water Level	A	Drawing & Annexure-I	100%	L-11	
	c) Check web axis of crane girder in a row and aligned (tolerance on web axis shift in a row 3m Max.)	M	Water Level	A	Drawing	100%	L00	
	d) Centre to Centre distance girders Tolerance ± 5mm	M	Measuring Tape	A	Drawing	100%	L-12	

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (STATEMENT OF CHECKS)	FQP. NO.: QPE:STD:500:CL:03 REV. NO. : R02
SYSTEM : STRUCTURAL STEEL WORKS	**SUB-SYSTEM : ----**	**AREA : ERECTION** SHEET 13 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
12.20	Ensure the following during the erection of roof trusses							
	a) Proper handling to avoid damage & distortion to assembled trusses.	V		C		100%	L00	
	b) Alignment of bolt holes between columns and truss gussets.	V		C	Drawing	100%	L00	
	c) Slope of truss as per drawing.	M	Spirit Level / Water Level	B	Drawing	100%	L00	
	d) tightness of bolts.	M	Torque Wrench	B	Annexure-I	100%	L00	
	e) truss to truss connecting members including purlins	V		C	Drawing	100%	L00	
12.21	HSFG bolts tightening							
	a) Ensure HSFG bolts are tightened by calibrated torque wrenches.	M		B		100%	L00	
	b) Check the tightness of HSFG bolts using calibrated torque wrench.	M	Torque Wrench	B	Drawing	100%	L00	

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SYSTEM : STRUCTURAL STEEL WORKS	**SUB-SYSTEM : ----**	**AREA : ERECTION** SHEET 14 / 14 SHEETS

S.NO.	CHARACTERISTICS	TYPE OF CHECK	INSTRUMENT	CLASS	REFERENCE DOCUMENT/ ACCEPTANCE STANDARD	QUANTUM / FREQUENCY OF CHECK	FORMAT OF RECORD	REMARKS
13.0	**WELDING & NDE**							
	a) Ensure qualified welders are engaged & qualified procedures are employed.	T / R		A	Welding Manual / NDE Manual / WPS	100%	L00	
	b) Ensure recommended welding consumable and methods are employed.	T / R		A	Tech Spec, Welding Manual / NDE Manual / WPS	100%	L00	
	c) Ensure recommended NDE Checks are carried out.	T	NDE Test Equipment	A	Welding Manual / NDE Manual / WPS	100%	L00	

STRUCTURE - ERECTION TOLERANCES

I	FOUNDATION	TOLERANCES
1.	Column pedestal top level	- 25 mm + 15 mm
2.	Dimension between individual column pedestal (adjacent)	1 mm per meter max. + 5 mm
3.	Adjacent column pedestal diagonal difference	1 mm per meter max. + 10 mm
4.	Foundation bolt pitch difference	+ 3 mm
5.	Foundation bolt diagonal difference	+ / - 5 mm
6.	Foundation bolt projection above nut	+ 15 mm min.
7.	Grouting gap	70 mm (Max.)

Note: Tolerance on thickness of grouting should not be allowed on negative side. The minimum thickness of grouting shall be thickness of grouting shown in the drawing.

II	COLUMNS	TOLERANCES
1.	Individual column piece camber	1 mm per meter Max. 10 mm
2.	Individual column piece sweep	1 mm per meter Max. 10 mm
3.	Total length after pre-assembly	± 15 mm
4.	Camber for the length of the column	1 mm per meter Max. 15 mm
5.	Sweep for the total length of column	1 mm per meter Max. 15 mm
6.	Out of verticality of the column	1 mm per meter max. 25 mm
7.	Elevation of column at reference level	5 mm Max.

III	TRUSS COLLAR BEAMS OF PURLINS	TOLERANCES
1.	Deviation in level of supporting joint of trusses	+ 5 mm
2.	Deviation of upper chord (in the middle of span) from vertical plane running through center of support.	1/250 of structure height
3.	Deflection of straight section of compression chord from the plane of truss, collar beam or girder.	1/1500 of span but not more than 10 mm.
4.	Deviation of distance between purling.	5 mm
5.	Crane Girder center to center spacing	+ 5 mm
6.	Crane Girder bracket top level	+ 5 mm
7.	Crane girder top flange level	+ 5 mm

IV	GENERAL	TOLERANCES
1.	Tolerance on platform level	+ 5mm
2.	Other requirement shall be as per drawings	As per Drawing
3.	HT Bolts - Normal tightening	Normal tightening
4.	HSFG BOLTS : Cross checked by calibrated torque wrench.	calibrated torque wrench

V STURCTURE - NDE REQUIREMENTS FOR COLUMNS, CRANE GIRDER FRAME BEAMS TRUSS ETC. COVERING ALL THE STRUCTURES UNDER THE CONTRACT

1.0 FLAME CUT EDGES

Flame cut edges for thickness over 50mm - 100% LPI to be done. However for thickness 63 mm and above only 100% MPI shall be done on the flame cut edges.

2.0 BUTT WELDS

2.1 100 % LPI for root run after back gouging.

2.2 100% Ultrasonic testing (UT) on tension zone welds and 10% UT on compression zone welds of crane & bunker girder shall be carried out.

2.3 Extent of Ultrasonic test for the balance butt weld shall be carried out as per Drawing/Welding schedule/NDE Manual.

3.0 FILLET WELDS

3.1 Each weld shall be checked for size and visual defects.

3.2 10% weld length on tension members shall be subjected to LPI examination.

3.3 Where the thickness of both the members is greater than 25 mm, LPI shall be done on entire weld length.

3.4 On all other fillet welds, LPI shall be done on minimum 5% of total weld length at random with minimum 300 mm at a particular location.

4.0 COLUMNS:BASE/TOP

100 % LPI

5.0 COAL BUNKERS AND BUNKER SUPPORTING STRUCTURE

10% DPT/LPI after back gauging.

10% spot UT on Butt welds.

Apart from manufacturer's TC of structural materials, site shall organise sample test of steel material and welding electrodes at established laboratory/ independent testing house during various stages of project activities as per decision of BHEL/ Customer. Adequate number of safe platforms and easy approach both from bunker floor as well as from feeder floor are to be provided for inspection of fit-up and welding of joints.

1.0	**REQUIREMENT OF MINIMUM PREHEATING & INTERPASS TEMPERATURE**		
	Thickness of thickest part at the point of welding	Other than low hydrogen welding electrodes	Low hydrogen electrodes / submerged arc welding
	Upto 20 mm (including)	None	None
	Over 20 mm to 40 mm (including)	65° C	20° C
	Over 40 mm to 63 mm (including)	110° C	66° C
	Over 63 mm	150° C	110° C
2.0	**CUTTING TOLERANCES AND DIMENSIONAL VARIATIONS DURING FABRICATION**		**AS PER TABLE A1**
3.0	**TOLARABLE DEVIATIONS OF FARICATED MEMBERS FROM GEOMENTRICAL SHAPE**		**AS PER TABLE A2**
4.0	**DEVIATIONS**		
4.1	**ACCEPTABLE DEVIATIONS IN AS FARICATED STEEL STRUCTURES**		**AS PER TABLE A3**
4.2	**SPECIFICATION FOR PERMISSIBLE DEVIATION IN BOLT HOLES.**		**AS PER TABLE A4**
4.3	**SPECIFICATION FOR PERMISSIBLE DEVIATION OF STRUCTURAL STEEL.**		**AS PER TABLE A5**
4.4	**MAXIMUM PERMISSIBLE TOLERANCES IN ERECTED STEEL STRUCTURES.**		**AS PER TABLE A6**

TABLE - A1

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Tolerable Deviation from designed linear dimensions in mm in the part & processed for fabrication.

Sl. No.	Characteristic	Deviation/Tolerances in mm					
		1.5 m &. below	1.5 m to 2.5 m	2.5 m to 4.5 m	4.5 m to 9.0 m	9.0 m to 15 m	15 m & above
1.	**a) Deviation in length and width, of part cut out by :**						
	i) Manual gas cutting	2.5	3.0	3.5	4.0	4.5	5.0
	ii) Gas cutting by automatic and semi-automatic machines	1.5	2.0	2.5	3.0	3.5	4.0
	iii) Shear or saw cutting	1.5	2.0	2.5	3.0	3.5	4.0
	iv) Parts machined by edge-planning or milling machines	0.5	1.0	1.5	2.0	2.5	3.0
	b) Difference in diagonal lengths of sheet parts:						
	i) For butt welding	4.0	4.0	4.0	5.0	6.0	6.0
	ii) For lap welding	5.0	5.0	5.0	8.0	10.0	10.0
	c) Deviation in distances between hole centers, formed as per:						
	i) Marking of extreme ones	2.0	2.0	2.5	3.0	3.5	4.0
	ii) Marking of adjacent ones	1.5	1.5	1.5	1.5	1.5	1.5
2.	**Deviation in the dimensions of dispatch members after finishing :**						
	a) When assembled upon assembly benches as per marking.	3.0	4.0	5.0	7.0	10.0	*15.0*
	b) When assembled In the Jig and other devices fastening with fixtures,	2.0	2.0	3.0	5.0	7.0	10.0
	c) Dimensions (length and breath) between milled surface (after finishing)	0.5	1.0	1.5	2.0	2.5	3.0
3.	**Distance between groups of erection holes (in finished members)**						
	a) Formed during machining of separate parts installed when assembling as per marking.	3.0	4.0	5.0	7.0	10.0	15.0
	b) Formed during machining of parts, installed when assembling with the help of fixtures.	2.0	2.0	3.0	5.0	7.0	10.0
	c) Drilled with the help of templates in finished members.	0.5	1.0	1.5	2,0	2.5	4.0

TABLE A.2

Tolerable deviations of fabricated member from designed geometrical shape

S. No.	Characteristic	Deviation	Remarks
1.	**Curvature of assembly Parts**		
	a) Gap between a sheet and a steel rule face over 1 m length	1.5 mm	
	b) Gap between a taut string and vertex face of an angle flange or web of channel and joist.	0.001 L, but not greater than 10 mm	L - length of member
2.	**Deviation of edge line steel sheet parts from theoretical profile:**		
	a) During butt and toe welding.	2 mm	
	b) During lap welding	5 mm	
3.	**Deviation of radius of the bend:**		
	a) Clearance between template and the surface of rolled sheet flange or face of cold bend profile.	2 mm	Template length (1.5 m along the curve)
	b) Clearance between template and the surface of rolled sheet flange or face of hot bend profile	3 mm	-do-
	c) Ellipticity (difference of diameters) in space sheet structures.	0.005D	D-diameter of circumference
	d) Ellipticity (difference of diameters) in erection joints	0.003D	-do-
4.	**Deformation of dispatch members:**		
	a) Inclination of flanges with the web:		
	i) at Junction point	0.005b	b-width of flange
	ii) at other places	O.Olb	b-width of flange
	b) Transverse bending of flanges:		
	i) at junction with members	0.005b	b- width of flange
	ii) at other places	O.Olb	b-width of flange
	c) Warping of the web	0.003h	h-depth of the member
	d) Sag of member	L/750 but not more than 15mm	L-length of the member
5.	**Other Deviations:**		
	a) Shifting of axes or riveting / bolting lines for lattice structures from theoretical eccentricity.	3.0 mm	
	b) Inclination of the milled surface from designed position.	1/1500	

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Acceptance Deviations in as fabricates steel structures.

Sl. No.	Characteristic	Deviation / Tolerance
1.	**COLUMNS**	
a)	Deviation in length 'L' measured distance from bottom surface of the column footings, to the group of holes for trusses, fasteners, collar beams, purlins and other elements to be connected to column.	
	When L is under 10 m	± 10 mm
	When L is over 10 m	± l5 mm
b)	Deviation in distance 'L' from bottom surface of the column footing to the top of crane brackets.	
	When L is under 10 m	± 5 mm
	when L is over 10 m	± 10 mm
c)	Deviation in distance from bearing surface of the bracket to the first fastener of the element to the connected to column.	± 1 mm
d)	Deviation in distance between any group of holes for connection of bracings to column.	± 2 mm
e)	Sag of column element (curvature)	1/1000 of length element but not more
f)	Difference in web depth of column	
	i) At splice joint	± 2 mm
	ii) At any other location	± 10 mm
g)	Deviation in distance from supporting surface of milled end of the despatch element of column to the clear or heating plate or column to the cleat or seating plate for fastening of collar beams, purlins, girders. etc. (Fish plates, brackets)	± 3 mm
2.	**TRUSSES**	
a)	Deviation in span 'L' of the truss between end erection holes in gussets of supporting units or between external planes of supporting gussets or angles when trusses are resting on brackets or supports:	
	When L is under 25 m	± 7 mm
	When L is over 25 m	1/2500 but not more than 10 mm
b)	b) Deviation in distance between the centres of holes or webs of angles for fastening bracing, purlins, monitors etc	± *3* mm
c)	Deviation in distance between the first row of erection holes and the bearing surface at cleat or seating plate.	± 1 mm
d)	Distance between holes for fasteners to top and bottom chords of trusses on supports.	± 3 mm
e)	Sag of separate elements between node points.	1/1500 of length of element but not more than 10 mm.

Sl. No	Characteristic	Deviation/ Tolerance
3.	**BEAMS**	
	a) Deviation in span L of beams between bend erection holes, outer Surfaces of end plates:	
	When L is under 25 m	± 10 mm
	When T is over 25 m	± 1/2500 Length but not more than 15 mm
	b) Deviation in the height of beam as measured from the bearing surface to the top of upper flange.	± 3 mm
	c) Deviation in distance between the group of holes for fastening of purlins, monitors, bracings, bracing grids etc.	± 3 mm
	d) Sag (curvature) of the girder despatch member	1/1000 length but not more than 15 mm
4.	**ELEMENTS OF FRAMEWORK BRACINGS, PURLINS ETC.**	
	a) Deviation in distance between end erection holes, determining the span of element.	± 13 mm
	b) Sag of despatch members	1/1000 length but not more than 15 mm
	c) Deviation in distance between the groups of erection holes of the element.	± 3 mm
	d) Gratings, Stair / Railings, ladders etc.	± 12 mm
5.	**SHOP ASSEMBLY (Before DESPATCH FOR ERECTION)**	
	a) Columns weighing more than 20 T	Every first and further every fourth set of identical structure to be put for control assembly,
	b) Roof trusses of 30 m or more span	
	c) Crane girders with span more than 18 m	Number of erection bolts shall be at least 30% of the total No. of holes.
	d) Bunkers	

Acceptable Deviation in Holes for Bolts

S.No,	Characteristic	Deviation	Tolerance No. of deviation in each group
1,	a) Deviation of dia of holes for rivet and bolts		
	Upto 16 mm	+ 1 mm	No limit
	Over 16 mm	+ 1.5 mm	
	b) Deviations *of* dia of turned and fitted bolts: Nominal dia of bolts and holes	Upper limit: +0.125 mm Lower limit: 0.00	No limit
2.	Ovalness (difference between the greatest and lesser dia)		
	Upto 16 mm hole dia	+ 1 mm	No limit
	Over 16 mm hole dia	+ 1.5 mm	
3.	Deformity in size greater than 1.5 mm and cracks in the edge of holes.	Not permitted	
4.	Misalignment of holes in separate plates in the joints:		
	i) Upto 1 mm		Upto 50%
	ii) From 1 to 1.5 mm		Upto 10%
NOTE : Burrs in holes shall be removed, the depth and width of countersunk hole shall not deviate from the standard by more than 1.5 mm.			

Permissible Fabrication Deviation of Structural Steel

S No.	Type of Structures and Constructions	Name of Deviations	Value of Deviation (Tolerance)
1.	**Column** a)	**Assembly Fits** Base plate and column	0.1 mm
	b)	Frame Joints	2.0 mm
	c)	Web and flange	1.5 mm
	d)	Web & stiffeners	1.5 mm
	e)	Flange & stiffeners Intermediate stiffeners & Bearing stiffeners:	1.5 mm
	f)	Cap plate & column	0.1 mm
	g)	Crane girder seat	0 .1 mm
	h)	Beam brackets	2 .0 mm
2.	Beams	(c), (d),(e) of S.No.l above	1.5 mm
3.	Crane Girders	(c), (d), (e) of S.No.l above and knife edge supports	0.1 mm
4.	Bunkers & Hoppers		
	a)	Ring beam and Wall	1.5 mm
	b)	Stiffeners and walls	1.5 mm
	c)	Stiffeners and ring beams	1.5 mm
	d)	Deflection of straight section of compression c -rd from the plane of truss, collar beam or girder	1/1500 of span but not more than 10mm
5.	Purlin	Deviation in distance between purlins.	5 mm

Maximum Permissible & Tolerances in Erected Steel Structures

Sl. No.	Description	Tolerance
1	**Erected steel columns:**	
	i) Deviation of column axis at foundation top level with respect to true axis:	
	a) in longitudinal direction	± 5 mm
	b) in lateral direction	± 5 mm
	ii) Deviation in the level of bearing surface of columns at foundation top with respect *to* true level	± 5 mm
	iii) Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top:	
	a) For columns without any special requirements:	
	1) upto and including 30 m height	± H/1000 or ± 25 mm whichever is less
	2) over 30 m height	± H/1200 or ± 35 mm whichever is less
	b) For column with special requirements like cranes or such similar requirements:	
	1) Upto and including 30 m height	± H/1000 or ± 20 mm whichever is less
	2) Over 30 m height	± H/1500 or ± 25 mm whichever is less
	iv) Deviation in straightness in longitudinal and transverse of column at any point along the height.	± H/1500 or ± 10 mm whichever is less
	v) Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to connecting trusses/ beams with respect to true distance.	± 5 mm
	vi) Deviation in any bearing or seating level with respect to true level.	± 5 ram
	vii) Deviation in difference in bearing levels of a member on adjacent pair of columns both across and along the building.	± 5 mm
	NOTE 1. Tolerance specified under iii (a) and iii (b) should be read in conjunction with iv and v. 2. 'H' is the column height in mm.	

S. No.	Description	Tolerance
2.0	**Erected Steel trusses**	
	i) Shift, at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord.	± 1/250 of height of truss in mm at centre of span or ± 15 mm Whichever is less
	ii) Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	± 1/1500 of span of truss in mm or 10 mm whichever is less
	iii) Lateral shift in location of truss from its true axis in plan	± 10 mm
	iv) Lateral shift in location of purlin From true position	± 5 mm
	v) Deviation in difference or bearing levels of trusses from the true difference.	± 1/1200 of span of truss in mm or ± 20 mm whichever is less
3.	**Erected Crane Girder and Rails**	
	i) Shift in the centre line of crane rail with respect to centre line of web crane girder.	± {(Web thk in mm) + 2mm} / 2
	ii) Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point,	± *5* mm
	iii) Deviation in crane track gauge with respect to the gauges	
	a) For track gauge up to and including 15 mm	+ 5 mm
	b) For track gauge more than 15 m	± (5 + 0.25(S-15)) mm subject to a maximum of ±10 mm, where S in meters is true track gauge.
	iv) Deviation in the crane rail level at any point from true level	± 10 mm
	v) Difference in levels between crane track rails at:	
	a) Supports of crane girders	15 mm
	b) mid span of crane girders	20 mm
	vi) Relative shift of crane rail surface at a joint in plan and elevation.	2 mm subject to grinding of surfaces for smooth transition

PSER	FIELD QUALITY PLAN FOR **STRUCTURAL STEEL WORKS** (ERECTION)	FQP. NO.: QPE:STD:500:CL:03
		REV. NO. : R02
		SHEET 1 / 1 SHEETS

DOCUMENTS REFERRED IN QUALITY PLAN

Sl. No.	Reference Document	Issuing Authority
1	WPS	Trichy
2	Welding Manual	PS-ER
3	NDE Manual	PS-ER
4	IS 817, IS 7215, IS 12843, IS 1852, IS 2062, IS 9595, IS 3502, IS 1239, IS 3589 and other relevant codes	Bureau of India Standards (BIS)

PSER

RECORED OF QUALITY CHECKS

SHEET NO. OF FQP	CHECK NO.	RESULTS ACHIEVED OK / NOT OK	DRAWING / DOCUMENT REFERENCE	FORMAT OF RECORD	INSPECTED BY SIGN. & DATE	CLEARED BY SIGN. & DATE	REMARKS

Note : Any protocol made is to be numbered & mentioned in “Format of Record” column.

		SYSTEM	SUB-SYSTEM	AREA	FQP. NO.: QPE:STD:500:CL:03
PROJECT					REV. NO. : R02
UNIT NO.					LOG SHEET NO. L-00
RATING					SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

QUALITY CERTIFICATE OF CIVIL FOUNDATIONS

Project :
Unit No. :
Customer :
Sub-contractor :

Foundation for :
BHEL input
Date Reference :
Main Construction
Drawing No. :

Construction period : From :…… to ……
Status : Complete / Incomplete

Handed over to BHEL by sub-contractor on (Date) ……

Certified that the above foundation has been constructed as IS 456. It is declared fit for erection work of …… based on the following details :

1. Foundation cast -- As per IS
2. Shuttering and re-enforcement — As per construction Drawing ……
3. Test for strength of concrete — As per IS 456
   Results — Acceptable / Not Acceptable
4. Curing time …….. days.
5. Dimensions, sizes position of inserts and pockets, verticality, level, etc. have been checked, logged and found OK.
6. Details of defects detected visually / by NDE, pre-disposed non-conformances and corrective action are enclosed. (Reference : Annexure-I)

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOGSHEET NO. L-01
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

FOUNDATION - POWER HOUSE STRUCTURE

TOP OF PEDESTALS

Elevation of top pedestal as per drawing …… mm.

All dimensions are in mm.

Column No.	Top Elevation measurement	Deviation from drawing value	Column No.	Top Elevation measurement	Deviation from drawing value

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOGSHEET NO. L-02
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

FOUNDATION - POWER HOUSE STRUCTURE

COLUMN PEDESTALS SPACING

All dimensions are in mm.

Column No.		Spacing		Column No.		Spacing	
From	To	Drawing	Actual	From	To	Drawing	Actual

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOGSHEET NO. L-03
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

FOUNDATION - POWER HOUSE STRUCTURE

DIAGONAL BETWEEN COLUMN PEDESTALS

All dimensions are in mm.

Column No.		Diagonal D1	Column No.		Diagonal D2	Difference between D1 & D2
From	To		From	To		

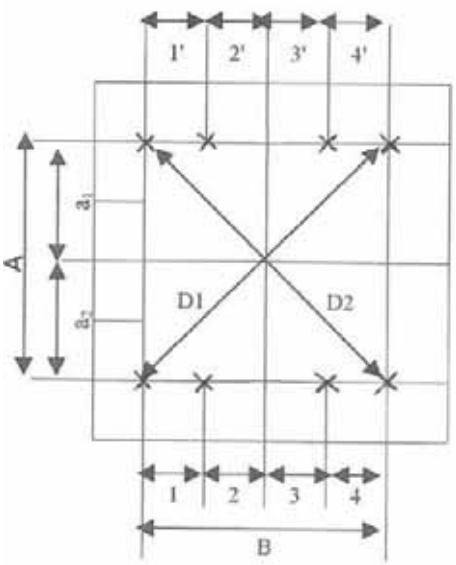
			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		ACCEPTED BY			LOGSHEET NO. L-04
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

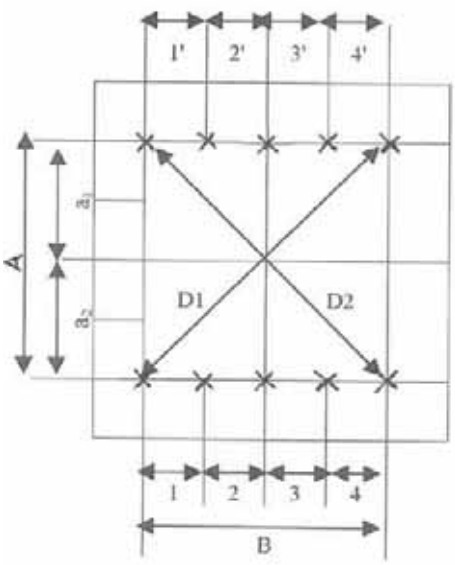
PITCH DISTANCE OF FOUNDATION BOLTS & DIAGONALS

N

TYPE -I



TYPE -II



TYPE - I

Column No.	A	B	a_1	a_2	1	2	3	4	1'	2'	3'	4'	D1	D2
As per drawing														

TYPE - II

Column No.	A	B	a_1	a_2	1	2	3	4	1'	2'	3'	4'	D1	D2
As per drawing														

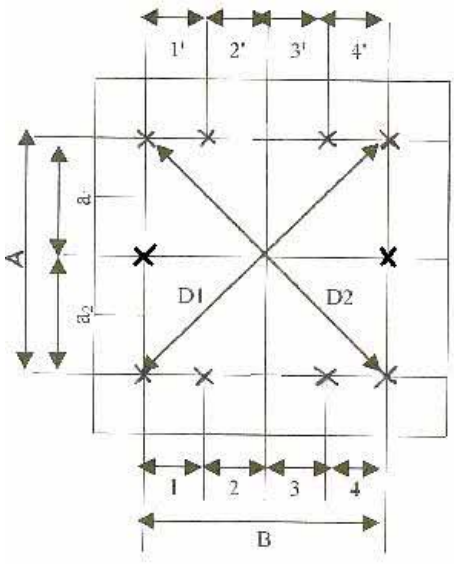
			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		ACCEPTED BY			LOGSHEET NO. L-05
RATING		CUSTOMER			SHEET 1 / 4 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

PITCH DISTANCE OF FOUNDATION BOLTS & DIAGONALS

N

TYPE - III



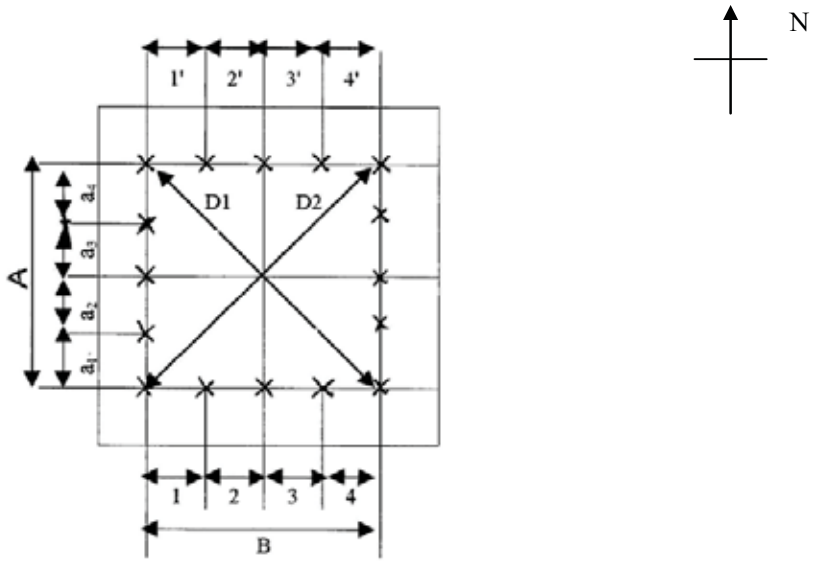
Column No.	A	B	a_1	a_2	1	2	3	4	1'	2'	3'	4'	D1	D2
As per drawing														

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOGSHEET NO. L-05
RATING		CUSTOMER			SHEET 2 / 4 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

PITCH DISTANCE OF FOUNDATION BOLTS & DIAGONALS

Type IV



Type - IV

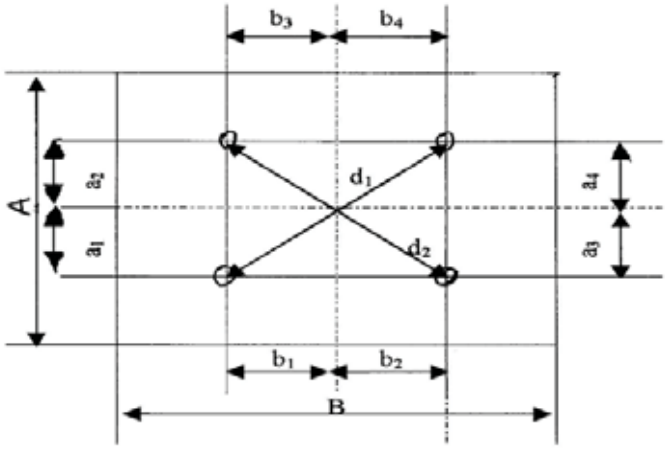
Column No.	A	B	a_1	a_2	a_3	a_4	1	2	3	4	1'	2'	3'	4'	D1	D2
As per drawing																

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOGSHEET NO. L-05
RATING		CUSTOMER			SHEET 3 / 4 SHEETS

PSER	INSTRUMENT REG. NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

PITCH DISTANCE OF FOUNDATION BOLTS & DIAGONALS

Type - V



Type-V

Column No.	A	B	a_1	a_2	a_3	a_4	b_1	b_2	b_3	b_4	d_1	d_2

			NAME	SIG. / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOGSHEET NO. L-05
RATING		CUSTOMER			SHEET 4 / 4 SHEETS

PSER	INSTRUMENT REG. NO./TAG NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

CAMBER, SWEEP AND LENGTH OF COLUMN PIECES

INDIVIDUAL PIECE TOLERANCE : 1mm / M Max. 10 mm

Column No.	Camber			Sweep			Length
Piece No.	T	M	B	T	M	B	

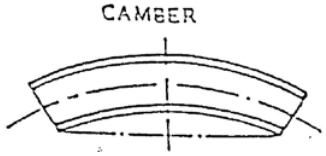
T – Top of the Piece M – Middle of the Piece B – Bottom of the Piece

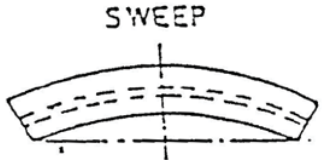
			NAME	SIG./DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOG SHEET NO. L-06
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO.							
	DATE OF INSPECTION							
	DRAWING / DOCUMENT REF.							

TRIAL ASSEMBLY OF COLUMN PIECES

COLUMN NO. :

	Assembled Piece Tolerance 1 mm / M Max. 15 mm	Elevation Level From Bottom									

	Assembled Piece Tolerance 1 mm / M Max. 15 mm	Elevation Level From Bottom									

Note : Measure at every 5 Meter level. (Fix Piano wire to full length of column) Measure the reading and only deviation in "+" or "_" Values

	J1	J2	J3	J4	J5	J6
Match mark						

TOTAL LENGTH : As Per Drg. MEASURED : DIFFERENCE : TOLERANCE : ± 15 mm

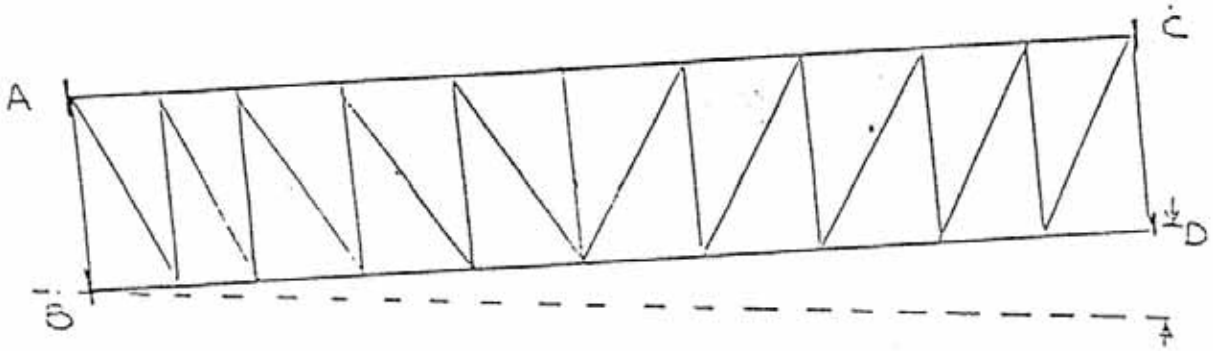
			NAME	SIGNATURE / DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOG SHEET NO. L-07
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO./TAG NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

ROOF TRUSS PRE – ASSEMBLY

A & C – End plate at top angle side.

B & D – End plate at bottom angle side.



SLOPE at " D "

Slope actual	
As Per Drawing	

CAMBER AND SWEEP

LOCATION						
CHAMBER						
SWEEP						

Match Mark : Indicate OK if it is correct and if any deviation inform through SAR.

Location			
Match Mark			

TOTAL LENGTH

As Per Drawing	Measured	Difference	Tolerance
			± 5 mm

			NAME	SIG./DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOG SHEET NO. L-08
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO./TAG NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

GROUTING GAP

(All Measurements in mm)

Column No.		Column No.		Column No.	

			NAME	SIG./DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOG SHEET NO. L-09
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO./TAG NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

COLUMN VERTICALITY MEASUREMENT

(Note :To be checked with theodolite and cross checked with plumb bob.)

(All Measurements in mm)

Column No.	Inclined to wards				Column No.	Inclined towards			
Location	Left	Right	Front	Rear	Location	Left	Right	Front	Rear

(Tolerance 1 mm / Meter Max. 25 mm)

			NAME	SIG./DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOG SHEET NO. L-10
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO./TAG NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

CRANE GIRDER

Crane girder bracket top level				Crane girder top flange level			
Column No.	Level	Column No.	Level	Column No.	Level	Column No.	Level

Tolerance Max. 5 mm

All Dimension in mm.

			NAME	SIG./DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		ACCEPTED BY			LOG SHEET NO. L-11
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO./TAG NO.				
	DATE OF INSPECTION				
	DRAWING / DOCUMENT REF.				

CRANE GIRDER CENTER TO CENTER SPACING

Tolerances : ± 5 mm

All dimensions in mm.

Location	Measured Length	Deviation

Location	Measured Length	Deviation

			NAME	SIG./DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			LOG SHEET NO. L-12
RATING		CUSTOMER			SHEET 1 / 1 SHEETS

PSER	INSTRUMENT REG. NO./TAG		
	DATE OF INSPECTION		
	DRAWING / DOCUMENT REF.		

PROTOCOL

			NAME	SIGNATURE & DATE	FQP. NO.: QPE:STD:500:CL:03
PROJECT		INSPECTED BY			REV. NO. : R02
UNIT NO.		CLEARED BY			PROTOCOL NO.
RATING		CUSTOMER			PAGE:

PSER

FEEDBACK ON FIELD QUALITY PLAN

In the Field Quality Plan, following Checks / Log sheets may be added / rewritten / deleted (cannot be carried out / not required) due to reasons as mentioned below :

Sheet No. of FQP	Check No. / Log Sheet No.	Proposed Change / Reasons / Remarks

PROJECT		From :	To 1. Head (Quality) PS-ER Kolkata-91	FQP. NO.: QPE:STD:500:CL:03
UNIT NO.				REV. NO. : R02
RATING				SHEET 1 / 1 SHEET