Corrigendum 6 dated September 03, 2021 to Tender Specification BHEL PSSR SCT 1979 for the works of Part A: Balance works for Civil, Structural and Architectural works of various buildings/structures including Ground improvement works (Inside plant boundary) and Balance works for construction of RCC Chimney and Part B: Providing, installing and handing over of two covered coal sheds covering three coal stock piles using tubular steel sections conforming to IS 1161 / IS 4923 and Steel structural sections conforming to IS 2062-2006, Roof monitor if required shall be provided on full length as per the requirement. Scope is inclusive of Design, supply, fabrication, welding, handling, assembling & erection in position of tubular space frame structure or Steel framed structure, cladding sheets (roof and side sheeting) and handing over to customer (as per specification) At 2 X 660 MW Ennore SEZ TPP (Unit 1 and 2)

A. Some of the Bidders had raised queries on the published tender Specifications. The clarifications are furnished below:

Sl. No.	Reference clause of Tender Document	Existing provision	Bidder's query	BHEL's clarification
1.	Volume-II, Price Bid Part C : Bill of Quantities pertaining to "Scope of Works-Part A" titled "Tender Specification BHEL:PSSR:SCT:1979_PART_A", Ref. No. A1820	Stainless steel component mentioned under ST No. 1819/A1819/A1821/B1821	BOQ is not clear. Please provide the detail BOQ description for the same.	Item description is clear. Payment for weight of stainless steel component mentioned under item A1819 and A1821 shall be paid under item A1820.
2.	Volume-II, Price Bid Part C : Bill of Quantities pertaining to "Scope of Works-Part A" titled "Tender Specification BHEL:PSSR:SCT:1979_PART_A", Ref. No. A1004(a)	A1004: Providing brick soling including spreading of earth, ramming, watering including 25mm thick cushion of sand complete but excluding excavation and disposal of surplus earth (excavation and disposal of surplus earth shall be measured under applicable item). Using brick on edge. (a) Using fly ash lime/cement bricks confirming to IS 12894 with crushing strength of 75 kg/cm2	Please provide the thickness of Brick soling	Brick on edge soling thickness shall be approximately 110mm.

Sl. No.	Reference clause of Tender Document	Existing provision	Bidder's query	BHEL's clarification
3.	Volume-II, Price Bid Part C : Bill of Quantities pertaining to "Scope of Works-Part A" titled "Tender Specification BHEL:PSSR:SCT:1979_PART_A", Ref. No. A1005(a)	A1005: Providing brick soling including spreading of earth, ramming, watering including 25mm thick cushion of sand complete but excluding excavation and disposal of surplus earth (excavation and disposal of surplus earth shall be measured under applicable item.).- Using flat bricks. (a) Using fly ash lime/cement bricks confirming to IS 12894 with crushing strength of 75 kg/cm2	Please provide the thickness of Brick soling	Flat brick soling thickness shall be approximately 75mm.
4.	General: Soil Investigation Report		Please provide the Soil Investigation Report	Relevant excerpt of geotech report is enclosed as Annexure-A to this Corrigendum.
5.	General: All BOQ Items Sand		We request to allow M-Sand for all concrete, Masonry & other civil related works instead of River Sand / Sand due to restriction from TN Government. For Plastering works P-Sand instead of River Sand. Please confirm	As per clause no. 1.3.6.1.5 of TCC (in Chapter –III in Part-I of Volume IA Technical Conditions of Contract), Fine aggregate source shall be manufactured crushed stone or rock sand commonly known as M-sand…. this is applicable for all concrete, Masonry & other civil related works. P-sand may be utilised for plastering works after approval from customer.

Sl. No.	Reference clause of Tender Document	Existing provision	Bidder's query	BHEL's clarification
6.	BOQ Civil		Please Provide the List of Approved Make	List of approved make for Civil, water supply, sanitary works, rainwater downtake pipe etc. is not available. However, as specified in the technical specification, bidder has to take prior approval from BHEL site/ Customer TANGEDCO before procurement.
7.	BOQ Water Supply		Please Provide the List of Approved Make	
8.	BOQ Sanitary Works		Please Provide the List of Approved Make	
9.	BOQ Rain Water Down take		Please Provide the List of Approved Make	
10.	BOQ Electrical		Please provide the Technical Specification, List of approved make & Single line Drawings	Technical specification for chimney electrical works enclosed as Annexure B to this Corrigendum. List of approved vendor for Electrical works is enclosed as Annexure-C to this Corrigendum. In this list, vendors against which "submit credentials" is written shall be taken for approval later. Single line drawing of power distribution arrangement has to be prepared by successful bidder.
11.	Volume IC Book II General Conditions of Contract	2.17.1 In order to take care of variation in cost of execution of work on either side, due to variation in the	We request you to accept that PVC shall be applicable for the entire original contract period and the	Tender condition prevail.

Sl. No.	Reference clause of Tender Document	Existing provision	Bidder's query	BHEL's clarification
	Clause 2.17.1 under Price Variation Compensation	index of LABOUR, HIGH SPEED DIESEL OIL, WELDING ROD, CEMENT, STEEL, MATERIALS, Price Variation Formula as described herein shall be applicable (only for works executed during extended period, if any, subject to other conditions as described in this section).	extended contract period. Please Confirm.	
12.	Volume IC Book II General Conditions of Contract Clause 2.7.9 on Liquidated Damages/ Penalty	At the end of total work completion ……..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 a maximum of 10% of the contract value…….	We request you to limit the max 5% of Contract Value with rate of 0.25% per week. This shall be applicable for Overall Completion only.	Tender condition prevails.
13.	Structural Steel Reconciliation	Allowable wastage: - 4% (FOUR percent) of the theoretical consumption shall be considered. Wastage shall be considered as cut pieces and scrap material, measured as per actual weighment basis……	We request you to consider the allowable wastage as 5%, Rolling margin to be considered for reconciliation & Usable material classification based on shop drawings.	Tender condition prevail.
14.	Performance		Many of works are partial completed in nature. In this regard it is informed that performance of each Buildings / scope shall be restricted to work done by contractor only. It is noted that existing material / Formwork to be lowered & removed in chimney.	The performance of the structures shall be limited to the scope of work of the bidder. BHEL shall make arrangements for lowering & removal of slipform material

Sl. No.	Reference clause of Tender Document	Existing provision	Bidder's query	BHEL's clarification
			Provide necessary BOQ item in other Areas for this & Similar item of works.	fixed at top of the chimney before commencement of works. As the balance work is to be completed on as is where is basis, bidder is requested to quote accordingly.
15.	Volume IC Book II General Conditions of Contract Clause 2.12.3.5 under Overrun Compensation	2.12.3.5: The maximum amount of ORC payable for the month shall be limited to Rs. 5,00,000/-.	Clause: 2.12.3.5 is contradict in compensation. Hence, we request you to remove this clause.	Tender condition prevails.

Annexures:

1) Annexure A referred at Sl. No.4 above.
2) Annexure B referred at Sl. No.10 above.
3) Annexure C referred at Sl. No.10 above.

ALL OTHER CONDITIONS REMAIN UNCHANGED.

BIDDERS ARE REQUESTED TO CONSIDER THIS CORRIGENDUM AS PART OF TENDER SPECIFICATION AND QUOTE ACCORDINGLY.

-Sd-
(Gurupriya L)
Manager/SCT

Annexure A to Corrigendum 6 dated September 03, 2021 to Tender Specification BHEL PSSR SCT 1979

TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

2X660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI

CONSULTANT: DESEIN PRIVATE LIMITED

GEOTECHNICAL INVESTIGATION REPORT

DOCUMENT NO. PE-DC-412-602-C001

REV-02

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
NOIDA-201301

PREFACE

PART-I

This report consists of lab test results and field test results along with pile capacity of various foundation system **before ground improvement** for Main Plant & BOP Area excluding CHP, AHP and Facilities outside Plant Boundary)

PART-II

Part-II comprises of Design of ground improvement along with the recommendation of pile capacity/bearing capacity of open foundation to be adopted **after ground improvement** for Main Plant & BOP Area excluding CHP, AHP and Facilities outside Plant Boundary)

Job No: 3388

PART-I

REPORT ON

GEOTECHNICAL INVESTIGATION WORK FOR

2 x 660MW ENNORE SEZ COAL BASED STPP

AT ASH DYKE OF NCTPS, CHENNAI, TAMILNADU

VOLUME 1

(***Main Report with Conclusions***)

Client:

M/s, Bharat Heavy Electricals Limited
Power Sector - Southern Region
690, Annasalai, Nandanam,
Chennai - 600035

Foundation Consultants:

C. E. Testing Company Pvt. Limited
An ISO 9001, 14001& OHSAS 18001 Certified Company
NABL Accredited Laboratory
124A, N.S.C. Bose Road : Kolkata - 700 092
Phones: 2428-6221/6222/6223 Fax: (033) 2428-6220
Email: cetest@cetestindia.com

March – 2015

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REPORT ON
GEOTECHNICAL INVESTIGATION WORK FOR
2 x 660MW ENNORE SEZ COAL BASED STPP
AT ASH DYKE OF NCTPS, CHENNAI, TAMILNADU

1. INTRODUCTION

The **Tamilnadu Generation and Distribution Corporation Limited (TANGEDCO)** has proposed 2 x 660MW coal based STPP at Ennore SEZ, Chennai, Tamilnadu & the job was awarded to **M/s. Bharat Heavy Electricals Limited**. For designing of Foundation Structures coming under this project, it was necessary to conduct a Detailed Geotechnical Investigation Work and **M/s Bharat Heavy Electricals Limited**, in turn awarded the job to **M/s. C. E. Testing Company Pvt. Ltd., Kolkata.**

The scope of the work comprised of sinking 119 nos. bore holes. The scope also includes PLT (Plate Load Tests – 8Nos.), CPLT (Cyclic Plate Load Tests – 2 Nos.), TP (Trial Pit – 14Nos.), Field Permeability – 20Nos., Field CBR – 5Nos., ERT (Electrical Resistivity Tests – 27 Nos.), CST (Cross Hole Tests – 6 Nos.), PMT (Pressure meter Test – 4Nos.), SCPT (Static Cone Penetration Tests – 10 Nos.), DCPT (Dynamic Cone Penetration Tests – 22 Nos.).

The boreholes of 150 mm diameter were advanced by Shell and Auger/rotary mud circulation method. The scope also included conducting Standard Penetration Tests, collecting disturbed samples at regular intervals for identification and logging purposes, collecting undisturbed tube samples at suitable intervals or at change of strata whichever is earlier and testing these in the laboratory.

Based on the above, this report presents the Bore Logs, Soil Profile, laboratory and field Test Results. On the basis of field tests and laboratory test results and their analysis thereof, the most suitable type of foundation is suggested. The field profile is sometimes changed in the light of laboratory test results.

The subsoil is characterised by a filled up soil/ash followed by very loose to loose clayey silty sand / very soft silty clay. Below this, medium silty clay followed by stiff to very stiff silty clay layer was observed. After that dense to very dense silty sand / hard silty clay layer was found alternatively and that continued upto the terminating depth of the all boreholes.

Considering the nature of the subsoil as revealed from field tests, shallow foundation is recommended. However, this is discussed in details later.

The Geotechnical report has been divided into two parts (volumes). The first volume deals with subsoil condition and foundation recommendations, the second volume contains the borelog data sheets, field and laboratory test results.

- **Volume – 1:– Main Report with Recommendations.**
- **Volume – 2:– Borelogs, Field & Laboratory Test Results.**

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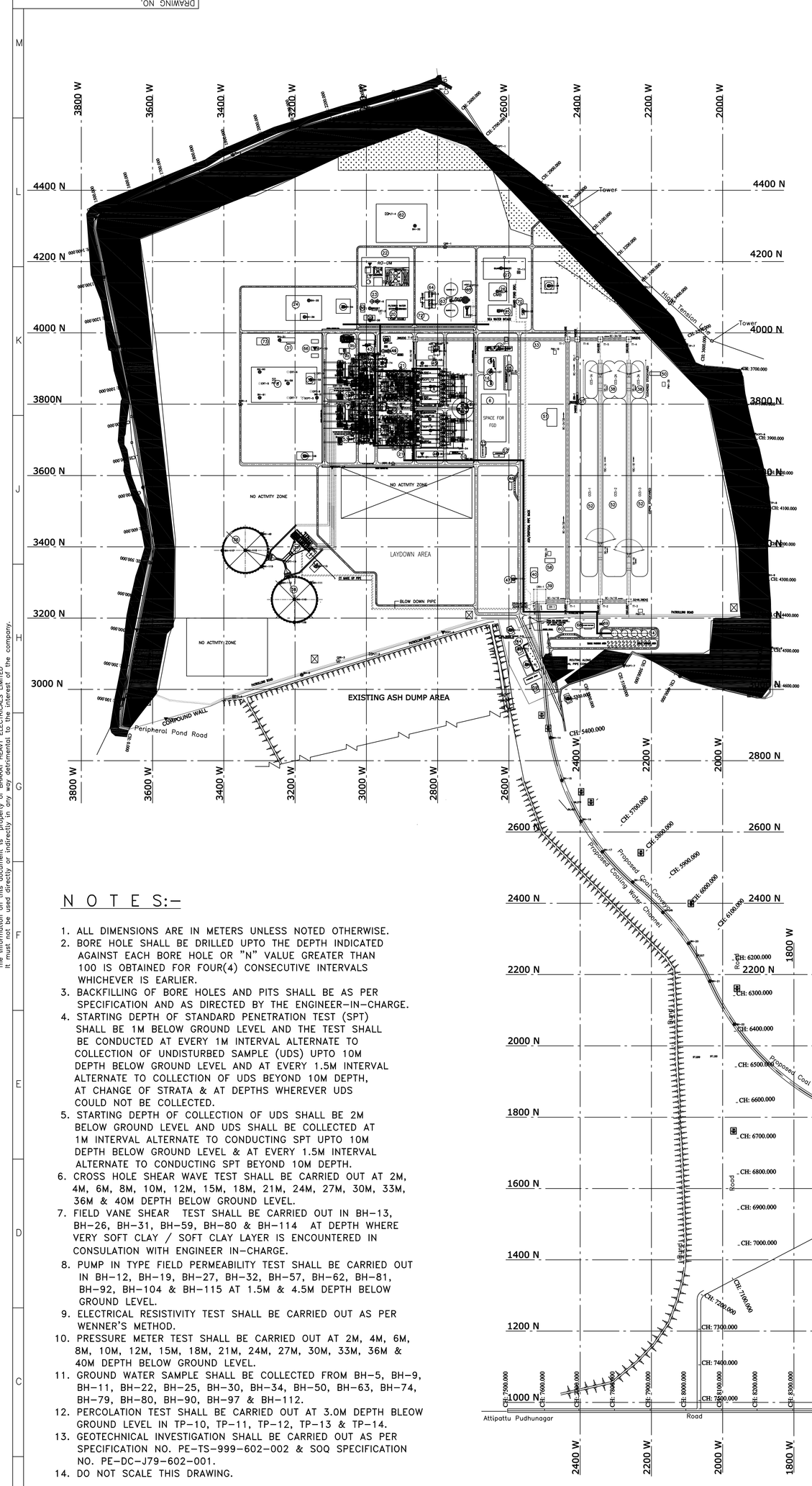
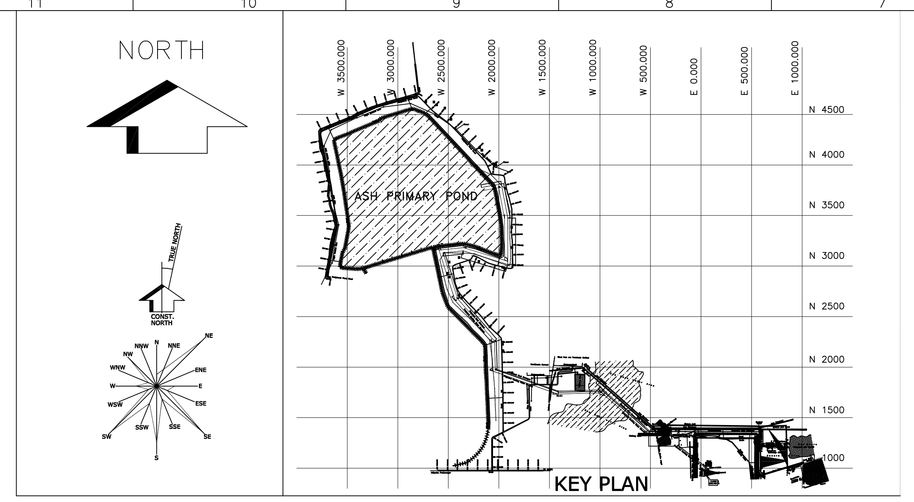
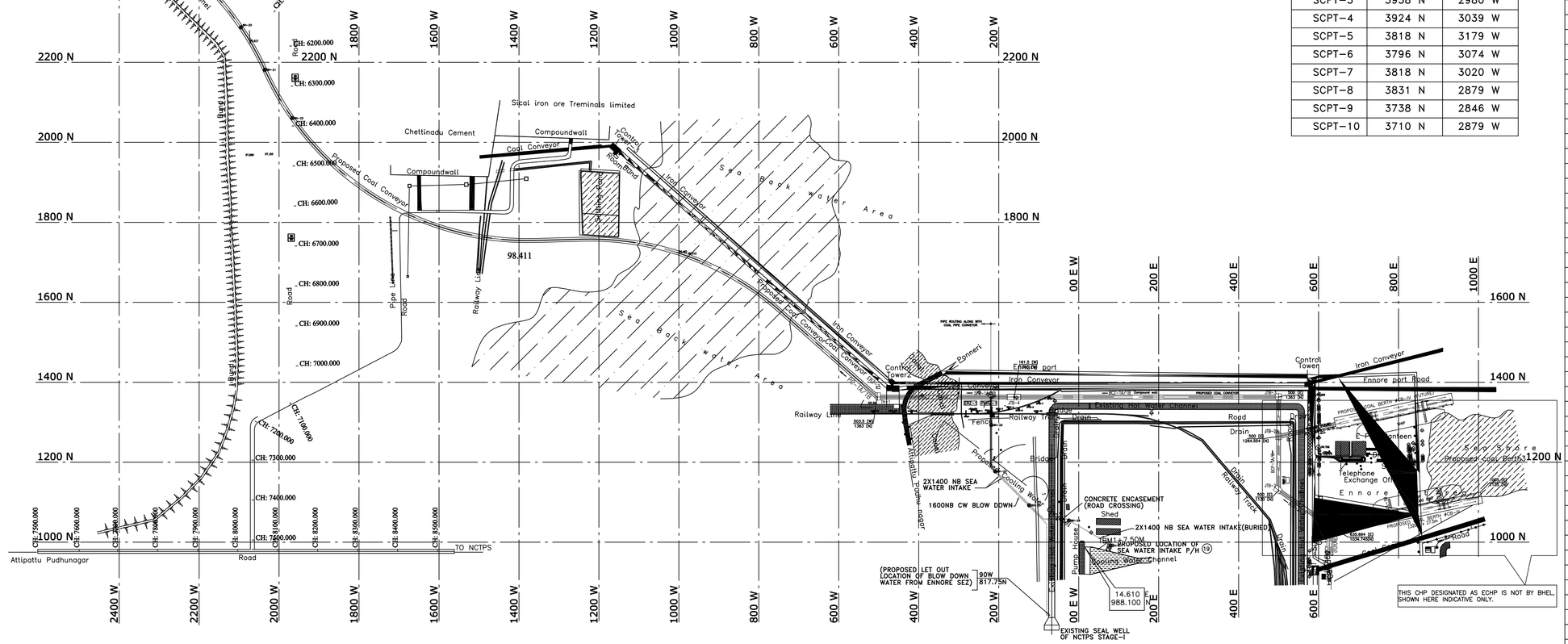
DRAWING NO. PE-DG-412-602-C001

FIRST ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM







N O T E S:-

1. ALL DIMENSIONS ARE IN METERS UNLESS NOTED OTHERWISE.
2. BORE HOLE SHALL BE DRILLED UPTO THE DEPTH INDICATED AGAINST EACH BORE HOLE OR "N" VALUE GREATER THAN 100 IS OBTAINED FOR FOUR(4) CONSECUTIVE INTERVALS WHICHEVER IS EARLIER.
3. BACKFILLING OF BORE HOLES AND PITS SHALL BE AS PER SPECIFICATION AND AS DIRECTED BY THE ENGINEER-IN-CHARGE.
4. STARTING DEPTH OF STANDARD PENETRATION TEST (SPT) SHALL BE 1M BELOW GROUND LEVEL AND THE TEST SHALL BE CONDUCTED AT EVERY 1M INTERVAL ALTERNATE TO COLLECTION OF UNDISTURBED SAMPLE (UDS) UPTO 10M DEPTH BELOW GROUND LEVEL AND AT EVERY 1.5M INTERVAL ALTERNATE TO COLLECTION OF UDS BEYOND 10M DEPTH, AT CHANGE OF STRATA & AT DEPTHS WHEREVER UDS COULD NOT BE COLLECTED.
5. STARTING DEPTH OF COLLECTION OF UDS SHALL BE 2M BELOW GROUND LEVEL AND UDS SHALL BE COLLECTED AT 1M INTERVAL ALTERNATE TO CONDUCTING SPT UPTO 10M DEPTH BELOW GROUND LEVEL & AT EVERY 1.5M INTERVAL ALTERNATE TO CONDUCTING SPT BEYOND 10M DEPTH.
6. CROSS HOLE SHEAR WAVE TEST SHALL BE CARRIED OUT AT 2M, 4M, 6M, 8M, 10M, 12M, 15M, 18M, 21M, 24M, 27M, 30M, 33M, 36M & 40M DEPTH BELOW GROUND LEVEL.
7. FIELD VANE SHEAR TEST SHALL BE CARRIED OUT IN BH-13, BH-26, BH-31, BH-59, BH-80 & BH-114 AT DEPTH WHERE VERY SOFT CLAY / SOFT CLAY LAYER IS ENCOUNTERED IN CONSULATION WITH ENGINEER IN-CHARGE.
8. PUMP IN TYPE FIELD PERMEABILITY TEST SHALL BE CARRIED OUT IN BH-12, BH-19, BH-27, BH-32, BH-57, BH-62, BH-81, BH-92, BH-104 & BH-115 AT 1.5M & 4.5M DEPTH BELOW GROUND LEVEL.
9. ELECTRICAL RESISTIVITY TEST SHALL BE CARRIED OUT AS PER WENNER'S METHOD.
10. PRESSURE METER TEST SHALL BE CARRIED OUT AT 2M, 4M, 6M, 8M, 10M, 12M, 15M, 18M, 21M, 24M, 27M, 30M, 33M, 36M & 40M DEPTH BELOW GROUND LEVEL.
11. GROUND WATER SAMPLE SHALL BE COLLECTED FROM BH-5, BH-9, BH-11, BH-22, BH-25, BH-30, BH-34, BH-50, BH-63, BH-74, BH-79, BH-80, BH-90, BH-97 & BH-112.
12. PERCOLATION TEST SHALL BE CARRIED OUT AT 3.0M DEPTH BLEOW GROUND LEVEL IN TP-10, TP-11, TP-12, TP-13 & TP-14.
13. GEOTECHNICAL INVESTIGATION SHALL BE CARRIED OUT AS PER SPECIFICATION NO. PE-TS-999-602-002 & SOQ SPECIFICATION NO. PE-DC-J79-602-001.
14. DO NOT SCALE THIS DRAWING.

GEOTECHNICAL INVESTIGATION LEGEND:

1. BOREHOLE (BH) . . . . . ●
2. PLATE LOAD TEST (PLT) . . . . . ⊠
3. CYCLIC PLATE LOAD TEST (CPLT) . . . . . ⊡
4. DYNAMIC CONE PENETRATION TEST (DCPT) . . . . . ◥
5. STATIC CONE PENETRATION TEST (SCPT) . . . . . ▽
6. TRIAL PIT (TP) . . . . . ▨
7. CROSSHOLE SHEAR TEST (CST). . . . . ⊙
8. FIELD CBR TEST (CBR). . . . . ⛶
9. PRESSURE METER TEST (PMT). . . . . ◆
10. ELECTRICAL RESISTIVITY TEST (ERT) . . . . . ◎

REF DRG :

PE-DG-412-100-M001, REV-R0 "PLOT PLAN (INCLUDING OUTSIDE PLANT BOUNDARY)".

FIELD CBR TEST			DEPTH (M)
MARKING	CO-ORDINATES		
CBR-1	4241 N	2779 W	0.5
CBR-2	3780 N	1952 W	0.5
CBR-3	3078 N	3079 W	0.5
CBR-4	3800 N	3354 W	0.5
CBR-5	3633 N	2925 W	0.5

CYCLIC PLATE LOAD TEST (CPLT)			DEPTH (M)
MARKING	CO-ORDINATES		
CPLT-1	3778 N	2980 W	1.30#
CPLT-2	3754 N	2730 W	1.20#

PRESSURE METER TEST (PMT)		
MARKING	CO-ORDINATES	
PMT-1	3898 N	3020 W
PMT-2	3866 N	2920 W
PMT-3	3738 N	3020 W
PMT-4	3710 N	2920 W

CROSS HOLE SHEAR TEST (CST)		
MARKING	CO-ORDINATES	
CST-1	3877 N	3000 W
CST-2	3866 N	2879 W
CST-3	3822 N	2763 W
CST-4	3754 N	3000 W
CST-5	3745 N	2879 W
CST-6	3699 N	2730 W

DYNAMIC CONE PENETRATION TEST (DCPT)		
MARKING	CO-ORDINATES	
DCPT-1	4524 N	2640 W
DCPT-2	4578 N	3187 W
DCPT-3	4324 N	3760 W
DCPT-4	3168 N	3645 W
DCPT-5	2918 N	3563 W
DCPT-6	3161 N	2785 W
DCPT-7	3067 N	2277 W
DCPT-8	3116 N	1864 W
DCPT-9	3716 N	1912 W
DCPT-10	3957 N	3144 W
DCPT-11	4067 N	2718 W
DCPT-12	3869 N	2846 W
DCPT-13	3858 N	2980 W
DCPT-14	3790 N	3039 W
DCPT-15	3790 N	2900 W
DCPT-16	3778 N	2846 W
DCPT-17	3699 N	2980 W
DCPT-18	3624 N	3096 W
DCPT-19	3360 N	3232 W
DCPT-20	4194 N	2990 W
DCPT-21	3661 N	2853 W
DCPT-22	3395 N	3159 W

ELECTRICAL RESISTIVITY TEST (ERT)		
MARKING	CO-ORDINATES	
ERT-1	4154 N	2979 W
ERT-2	4055 N	2961 W
ERT-3	4109 N	2823 W
ERT-4	4050 N	2718 W
ERT-5	3858 N	3299 W
ERT-6	3891 N	3220 W
ERT-7	3818 N	3220 W
ERT-8	3836 N	3155 W
ERT-9	3887 N	3144 W
ERT-10	3915 N	3074 W
ERT-11	3898 N	3039 W
ERT-12	3898 N	3000 W
ERT-13	3916 N	2803 W
ERT-14	3866 N	2900 W
ERT-15	3836 N	2846 W
ERT-16	3831 N	2920 W
ERT-17	3805 N	3039 W
ERT-18	3778 N	3000 W
ERT-19	3750 N	3074 W
ERT-20	3738 N	2920 W
ERT-21	3705 N	3000 W
ERT-22	3710 N	2900 W
ERT-23	3694 N	2795 W
ERT-24	3668 N	2730 W
ERT-25	3858 N	3076 W
ERT-26	3983 N	3064 W
ERT-27	3430 N	3195 W

STATIC CONE PENETRATION TEST (SCPT)		
MARKING	CO-ORDINATES	
SCPT-1	4135 N	2717 W
SCPT-2	4082 N	2821 W
SCPT-3	3938 N	2980 W
SCPT-4	3924 N	3039 W
SCPT-5	3818 N	3179 W
SCPT-6	3796 N	3074 W
SCPT-7	3818 N	3020 W
SCPT-8	3831 N	2879 W
SCPT-9	3738 N	2846 W
SCPT-10	3710 N	2879 W

BORE HOLE (BH)			DEPTH (M) (REFER NOTE-2)
MARKING	CO-ORDINATES		
BH-1	4678 N	2800 W	40
BH-2	4500 N	3374 W	40
BH-3	4156 N	3737 W	40
BH-4	3567 N	3627 W	40
BH-5	2973 N	3681 W	40
BH-6	3041 N	3181 W	40
BH-7	4273 N	2359 W	40
BH-8	3894 N	1953 W	31.32*
BH-9	3315 N	1876 W	40
BH-10	3037 N	2120 W	40
BH-11	3167 N	2596 W	40
BH-12**	3081.141N	2507.411W	40
BH-13	2974 N	2435 W	40
BH-14**	2873 N	2446.114W	40
BH-15**	2756.123N	2408.524W	40
BH-16**	2654.231N	2328.524W	40
BH-17**	2536.638N	2344.182W	40
BH-18	2460 N	2253 W	40
BH-19	2375 N	2168 W	40
BH-20	2288 N	2095 W	35.85*
BH-21	2182 N	2036 W	40
BH-22	2061 N	1967 W	40
BH-23	1293 N	219 W	29.88*
BH-24	1177 N	209 W	29.88*
BH-25	1092 N	124 W	31.40*
BH-26	1054 N	24 W	40
BH-27	992 N	79 E	34.35*
BH-28	4061 N	2560 W	40
BH-29	4132 N	2487 W	40
BH-30	4182 N	2622 W	40
BH-31	3980 N	3244 W	40
BH-32	4300 N	2864 W	40
BH-33	4176 N	2917 W	40
BH-34	4073 N	3065 W	40
BH-35	4091 N	3161 W	40
BH-36	4045 N	3174 W	40
BH-37	4069 N	2990 W	40
BH-38	4036 N	2990 W	40
BH-39	4067 N	2915 W	40
BH-40	4116 N	2632 W	40
BH-41	4062 N	2628 W	40
BH-42	3952 N	2804 W	40
BH-43	4090 N	2762 W	40
BH-44	3981 N	2943 W	40
BH-45	3966 N	3000 W	40
BH-46	3938 N	3020 W	40
BH-47	3916 N	3000 W	40
BH-48	3898 N	2980 W	40
BH-49	3436 N	3294 W	40
BH-50	3891 N	3074 W	40
BH-51	3883 N	3039 W	40
BH-52	3858 N	3059 W	40
BH-53	3858 N	3020 W	40
BH-54	3845 N	3000 W	40
BH-55	3831 N	3039 W	40
BH-56	3818 N	3074 W	40
BH-57	3818 N	3139 W	40
BH-58	3869 N	3155 W	40
BH-59	3858 N	3220 W	40
BH-60	3891 N	3299 W	40
BH-61	3818 N	3299 W	40
BH-62	3818 N	2980 W	40
BH-63	3796 N	3000 W	40
BH-64	3778 N	3020 W	40
BH-65	3771 N	3074 W	40
BH-66	3760 N	3039 W	40
BH-67	3738 N	3059 W	40
BH-68	3738 N	2980 W	40
BH-69	3726 N	3000 W	40
BH-70	3714 N	3039 W	40
BH-71	3699 N	3074 W	40
BH-72	3699 N	3020 W	40
BH-73	3983 N	3045 W	40
BH-74	3916 N	2955 W	40
BH-75	3883 N	2940 W	40
BH-76	3883 N	2900 W	40
BH-77	3849 N	2940 W	40
BH-78	3849 N	2900 W	40
BH-79	3816 N	2940 W	40
BH-80	3816 N	2900 W	40
BH-81	3816 N	2846 W	40
BH-82	3790 N	2940 W	40
BH-83	3760 N	2940 W	40
BH-84	3760 N	2900 W	40
BH-85	3726 N	2940 W	40
BH-86	3726 N	2900 W	40
BH-87	3694 N	2940 W	40
BH-88	3694 N	2900 W	40
BH-89	3694 N	2846 W	40
BH-90	3915 N	2843 W	40
BH-91	3883 N	2795 W	40
BH-92	3875 N	2756 W	40
BH-93	3849 N	2820 W	40
BH-94	3849 N	2780 W	40
BH-95	3822 N	2736 W	30.45$
BH-96	3796 N	2795 W	40
BH-97	3790 N	2720 W	40
BH-98	3785 N	2741 W	40
BH-99	3758 N	2822 W	40
BH-100	3760 N	2775 W	30.45$
BH-101	3726 N	2820 W	40
BH-102	3726 N	2780 W	40
BH-103	3699 N	2756 W	40
BH-104	3660 N	2800 W	40
BH-105	3309 N	2588 W	40
BH-106	3956 N	2627 W	40
BH-107	3890 N	2653 W	40
BH-108	3655 N	3173 W	40
BH-109	3188 N	3202 W	40
BH-110	3253 N	3202 W	40
BH-111	3298 N	3156 W	40
BH-112	3299 N	3242 W	40
BH-113	3346 N	3142 W	40
BH-114	3410 N	3182 W	40
BH-115	3345 N	3294 W	40
BH-116	3390 N	3340 W	40
BH-117	3390 N	3404 W	40

IDENTIFICATION NUMBER	DESCRIPTION
1	TG BUILDING
2	SWITCH GEAR ROOM, CONTROL ROOM, AC PLANT ROOM
3	STEAM GENERATOR
4	ESP
5	CHIMNEY
6	SPACE FOR FGD PLANT
7	TRANSFORMER YARD
8	400KV GIS SWITCHYARD
9a	DG SET
9b	COMPRESSOR HOUSE
10	TRANSPORT AIR COMPRESSOR HOUSE
11	BOTTOM ASH SLURRY PUMP HOUSE
12	ASH WATER PUMP HOUSE
13	BUFFER HOPPER TOWER
14	FLY ASH SILOS
15	HFO/LDO UNLOADING AREA
16	HFO/LDO STORAGE TANK DYKE AREA
17	HFO/LDO FORWARDING PUMP HOUSE
18	ELECTRO CHLORINATION BUILDING
19	SEA WATER INTAKE PUMP HOUSE (OUTSIDE PLANT BOUNDARY)
20	FILTERED WATER AND FIRE WATER STORAGE TANK AND PUMP HOUSE
21	MILL REJECT SILO
22	RO-DM CUM DESALINATION PLANT
23	DM STORAGE TANKS & PUMP HOUSE
24	STORAGE YARD (WITH COMPOUND WALL, COVERED STORES & OFFICE)
25	ETP
26	CENTRAL MONITORING BASIN
27	GUARD POND
28	BULK CHEMICAL AREA
29	CPU REGENERATION BUILDING
30	NEUTRALISING PIT
31	WORKSHOP
32	SWITCH YARD CONTROL ROOM
33	CONVEYOR
34	ADMINISTRATION BUILDING
35	CANTEEN
36	NDCT
37	COOLING WATER PUMP HOUSE
38	STACKER CUM RECLAIMER
39	CRUSHER HOUSE
40	CHP CONTROL ROOM-1
41	DISPENSARY AND FIRST AID CENTER
42	ADDITIONAL CANTEEN
43	SERVICE BUILDING
44	DORMITORY
45	ESP CONTROL ROOMS
46	CONDENSATE STORAGE TANK
47	FIRE STATION
48	ROAD WEIGH BRIDGE BUILDING
49	MAIN GATE & TIME OFFICE CUM SECURITY COMPLEX
50	DOZER SHED & REPAIR SHOP
51	COAL PILE RUN OFF PIT
52	COAL STOCK PILE
53	AIR WASHER ROOM
54	BHEL SITE OFFICE
55	WATCH TOWERS
56	FIRE WATER BOOSTER PUMP HOUSE
57	EMERGENCY RECLAIM HOPPER
58	COAL HANDLING CONTROL ROOM-2
59	33KV CONSTRUCTION TERMINAL POINT
60	WEIGH BRIDGE BUILDING ASH SILO AREA
61	H_2 PLANT
62	RAIN WATER HARVESTING POND
63	CLARIFIER
64	CLARIFIED WATER STORAGE TANK
65	SLUDGE SUMP
66	FIELD MAINTENANCE BUILDINGS
67	VACUUM PUMP HOUSE UNIT-1 & 2
68	FA SLURRY PUMP HOUSE
69	SILO UTILITY BUILDING
70	STP
71	AUX. BOILER
72	SERVICE WATER OVERHEAD TANK
73	CUSTOMER'S SITE OFFICE

TRIAL PIT (TP)			DEPTH (M)
MARKING	CO-ORDINATES		
TP-1**	4626.136N	2993.162W	3.10#
TP-2**	4411.203N	3555.193W	3.20#
TP-3**	3962.003N	3689.089W	3.30#
TP-4**	3355.111N	3601.102W	3.30#
TP-5**	2982.143N	3371.139W	3.90#
TP-6**	4410.214N	2502.043W	3.20#
TP-7**	3962.123N	2108.058W	3.05#
TP-8**	3522.186N	1876.103W	3.30#
TP-9**	3086.953N	1993.729W	3.20#
TP-10**	3142.457N	2571.729W	3.40#
TP-11	4170 N	2573 W	2.45#
TP-12	3949 N	2944 W	2.90#
TP-13	3875 N	2730 W	3.10#
TP-14	3951 N	3061 W	3.10#

PLATE LOAD TEST (PLT)			DEPTH (M)
MARKING	CO-ORDINATES		
PLT-5	4143 N	2949 W	1.30#
PLT-6	4088 N	2977 W	1.25#
PLT-8	3893 N	2604 W	1.30#

Note :

* – Borehole depth reduced as N>100 is obtained for 4 consecutive intervals.
** – Coordinates changed
# – PLT, CPLT & TP depth reduced in consultation with Engineering-in-Charge

THIS DRAWING SHALL BE READ IN WITH DRAWING NO. IS-1-GA-688-100-C001

REV.	DATE	ALTD	CHD	APPD

REV.	DATE	ALTD	CHD	APPD
01	18.11.2014/PK	–sd– V. V/TMSR	–sd– S.PK	–sd–

01 DRAWING IS GENELLARY REVISED DUE TO CHANGE IN PLOT PLAN AND INCORPORATING THE CUSTOMER COMMENTS DATED 06.11.2014.

PROJECT: 2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI

CUSTOMER: TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)

CONSULTANT: DESEIN PRIVATE LIMITED, DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI

JOB NO. 412
STATUS AS BUILT
DISTRIBUTION
TO
No. OF

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI

DEPT CODE		NAME	SIGN	DATE
C	DRN	S.ND	–sd–	16.10.2014
	DESN	PK	–sd–	16.10.2014
	CHD	V V/TMSR	–sd–	16.10.2014
	APPD	CPK	–sd–	16.10.2014

TITLE: GEOTECHNICAL INVESTIGATION LAYOUT

DEPT. SCALE: DRAWING NO. PE-DG-412-602-C001
SIGN
DATE
SHEET 1 OF 1 REV. 01

FORMAT SIZE A0

ELECTRONIC FILE NAME:

2. FIELD INVESTIGATION

2.1. GENERAL:

In an attempt for finalisation in the design of foundation for these proposed structures to be constructed at this site, Geotechnical Investigation was envisaged. The entire Investigation programme had been divided mainly into two parts, I) Field works & II) Laboratory tests.

I) Field works unfold the sub-surface deposit types and their characteristics and

II) Laboratory tests part would help determining the relevant physical and geotechnical properties of the sub-surface deposits leading to finalisation of foundation depths of the structures and the bearing capacity with particular reference to the sub-surface types and their strength parameters and settlement potentials at the site.

A list of the bore holes with the reduced level and standing water level are presented in a tabular form below:

Name of Structure	Bore Hole No.	Co-ordinate, (M)		G.L. (M)	Terminating Depth (m)	Standing Water Level (m)
		Easting	Northing			
Boundary Wall	BH-01	-2800.000	4678.000	8.407	40	0.70
	BH-02	-3374.000	4500.000	8.390	40	0.80
	BH-03	-3737.000	4156.000	8.454	40	0.85
	BH-04	-3627.000	3567.000	8.525	40	1.00
	BH-05	-3681.000	2973.000	8.857	40	1.10
	BH-06	-3181.000	3041.000	9..731	40	0.80
	BH-07	-2359.000	4273.000	8.330	40	0.50
	BH-08	-1953.000	3894.000	8.000	31.32	0.48
	BH-09	-1876.000	3315.000	8.409	40	0.60
	BH-10	-2120.000	3037.000	7.931	40	0.60
Additional Canteen	BH-11	-2596.000	3167.000	8.083	40	0.71
Administration Building	BH-12	-2507.411	3081.141	7.838	40	0.67
Main Gate & Time Office cum Security Complex	BH-13	-2435.000	2974.000	7.853	40	0.55
Proposed coal conveyor	BH-14	-2446.114	2873.000	7.838	40	0.52
	BH-15	-2408.524	2756.123	7.891	40	0.29
	BH-16	-2328.524	2654.231	7.915	40	0.38
	BH-17	-2344.182	2536.638	7.884	40	0.43
	BH-18	-2253.000	2460.000	7.427	40	0.41
	BH-19	-2168.000	2375.000	7.143	40	0.35
	BH-20	-2095.000	2288.000	7.780	35.85	0.10
	BH-21	-2036.000	2182.000	7.243	40	0.15
	BH-22	-1967.000	2061.000	8.599	40	0.35

Name of Structure	Bore Hole No.	Co-ordinate, (M)		G.L. (M)	Terminating Depth (m)	Standing Water Level (m)
		Easting	Northing			
Proposed Cooling Water Channel	BH-23	-219.000	1293.000	10.345	29.88	4.50
Proposed Cooling Water Channel	BH-24	-209.000	1177.000	10.192	29.88	4.80
	BH-25	-124.000	1092.000	10.282	31.40	2.90
	BH-26	-24.000	1054.000	9.790	40	2.60
Sea Water Intake Pump House	BH-27	-79.000	992.000	10.226	34.35	3.05
STP	BH-28	-2560.000	4061.000	9.081	40	0.55
H2 Plant	BH-29	-2487.000	4132.000	9.494	40	0.75
Guard Pond	BH-30	-2622.000	4182.000	9.074	40	0.65
Workshop	BH-31	-3244.000	3980.000	9.264	40	0.60
Rain Water Harvesting Pond	BH-32	-2864.000	4300.000	9.892	40	0.75
RO-DM cum Desalination Plant	BH-33	-2917.000	4176.000	8.746	40	0.45
Canteen	BH-34	-3065.000	4073.000	9.222	40	0.55
Storage Yard	BH-35	-3161.000	4091.000	9.037	40	0.60
	BH-36	-3174.000	4045.000	9.164	40	0.55
Near Neutralising Pit	BH-37	-2990.000	4069.000	8.803	40	0.45
CPU Regeneration Building	BH-38	-2990.000	4036.000	8.592	40	0.40
Filtered Water and Fire Water Storage Tank and Pump House	BH-39	-2915.000	4067.000	8.941	40	0.40
Central Monitoring Basin	BH-40	-2632.000	4116.000	8.988	40	0.50
ETP	BH-41	-2628.000	4062.000	8.918	40	0.50
Aux. Boiler	BH-42	-2804.000	3952.000	9.004	40	0.50
Clarifier	BH-43	-2762.000	4090.000	8.576	40	0.45
Bulk Chemical Area	BH-44	-2943.000	3981.000	8.802	40	0.45
Service Building	BH-45	-3000.000	3966.000	8.910	40	0.45
Power House / TG Building	BH-46	-3020.000	3938.000	8.906	40	0.55
	BH-47	-3000.000	3916.000	8.880	40	0.45
	BH-48	-2980.000	3898.000	8.600	40	0.45
NDCT	BH-49	-3294.000	3436.000	9.269	40	0.57
Transformer Yard	BH-50	-3074.000	3891.000	9.245	40	0.45
	BH-51	-3039.000	3883.000	9.049	40	0.60
	BH-52	-3059.000	3858.000	8.939	40	0.50
Power House / TG Building	BH-53	-3020.000	3858.000	8.991	40	0.40
	BH-54	-3000.000	3845.000	9.026	40	0.45
Transformer Yard	BH-55	-3039.000	3831.000	8.935	40	0.50
	BH-56	-3074.000	3818.000	9.021	40	0.45

Name of Structure	Bore Hole No.	Co-ordinate, (M)		G.L. (M)	Terminating Depth (m)	Standing Water Level (m)
		Easting	Northing			
400 KV GIS Switch Yard & Switch Yard Control Room	BH-57	-3139.000	3818.000	9.258	40	0.50
	BH-58	-3155.000	3869.000	9.123	40	0.70
400 KV GIS Switch Yard & Switch Yard Control Room	BH-59	-3220.000	3858.000	9.362	40	0.65
	BH-60	-3299.000	3891.000	9.764	40	0.80
	BH-61	-3299.000	3818.000	10.338	40	1.10
Power House / TG Building	BH-62	-2980.000	3818.000	9.082	40	0.60
	BH-63	-3000.000	3796.000	8.926	40	0.50
	BH-64	-3020.000	3778.000	8.926	40	0.55
Transformer Yard	BH-65	-3074.000	3771.000	9.140	40	0.55
	BH-66	-3039.000	3760.000	9.035	40	0.60
	BH-67	-3059.000	3738.000	9.122	40	0.55
Power House / TG Building	BH-68	-2980.000	3738.000	8.964	40	0.55
	BH-69	-3000.000	3726.000	8.723	40	0.45
Transformer Yard	BH-70	-3039.000	3714.000	8.937	40	1.20
Air Washer Room	BH-71	-3074.000	3699.000	9.328	40	1.20
Power House / TG Building	BH-72	-3020.000	3699.000	8.874	40	0.50
Compressor House	BH-73	-3045.000	3983.000	9.225	40	0.60
Near Condensate Storage Tank	BH-74	-2955.000	3916.000	8.613	40	0.45
Boiler & Mill-Bunker Area	BH-75	-2940.000	3883.000	8.741	40	0.45
	BH-76	-2900.000	3883.000	9.152	40	0.55
	BH-77	-2940.000	3849.000	8.726	40	0.45
	BH-78	-2900.000	3849.000	9.231	40	0.60
	BH-79	-2940.000	3816.000	8.977	40	0.50
	BH-80	-2900.000	3816.000	9.165	40	0.65
ESP	BH-81	-2846.000	3816.000	9.173	40	1.25
Boiler & Mill-Bunker Area	BH-82	-2940.000	3790.000	8.784	40	0.45
	BH-83	-2940.000	3760.000	8.714	40	0.85
	BH-84	-2900.000	3760.000	8.831	40	0.50
	BH-85	-2940.000	3726.000	8.841	40	0.50
	BH-86	-2900.000	3726.000	8.862	40	0.50
	BH-87	-2940.000	3694.000	8.977	40	0.35
	BH-88	-2900.000	3694.000	8.757	40	0.47
ESP	BH-89	-2846.000	3694.000	9.386	40	0.55
ESP Control Room	BH-90	-2843.000	3915.000	9.140	40	0.50
ESP	BH-91	-2795.000	3883.000	9.206	40	0.65
ID Fan	BH-92	-2756.000	3875.000	9.150	40	0.55
ESP	BH-93	-2820.000	3849.000	9.174	40	0.50
	BH-94	-2780.000	3849.000	9.241	40	0.60
ID Fan	BH-95	-2736.000	3822.000	9.265	30	0.60

Name of Structure	Bore Hole No.	Co-ordinate, (M)		G.L. (M)	Terminating Depth (m)	Standing Water Level (m)
		Easting	Northing			
	BH-95(R1)	-2738.473	3820.773	9.265	40	0.60
ESP	BH-96	-2795.000	3796.000	9.431	40	0.60
Chimney	BH-97	-2720.000	3790.000	9.320	40	0.55
	BH-98	-2741.000	3785.000	9.451	40	0.60
ESP	BH-99	-2822.000	3758.000	9.124	40	0.55
ID Fan	BH-100	-2775.000	3760.000	9.234	30	0.60
	BH-100(R1)	-2775.642	3758.627	9.234	40	0.60
ESP	BH-101	-2820.000	3726.000	9.224	40	0.65
ESP	BH-102	-2780.000	3726.000	9.370	40	0.70
ID Fan	BH-103	-2756.000	3699.000	9.524	40	0.95
ESP Control Room	BH-104	-2800.000	3660.000	9.174	40	1.25
Fire Station	BH-105	-2588.000	3309.000	8.701	40	0.43
HDO/LDO Forwarding Pump House	BH-106	-2627.000	3956.000	9.960	40	0.85
HDO/LDO Storage Tank Dyke Area	BH-107	-2653.000	3890.000	9.118	40	0.45
BHEL Site Office	BH-108	-3173.000	3655.000	9.139	40	0.60
NDCT	BH-109	-3202.000	3188.000	8.775	40	0.45
	BH-110	-3202.000	3253.000	9.035	40	0.60
	BH-111	-3156.000	3298.000	9.143	40	0.60
	BH-112	-3242.000	3299.000	8.564	40	0.45
Electro Chlorination Building	BH-113	-3142.000	3346.000	8.834	40	0.50
CW Pump House	BH-114	-3182.000	3410.000	8.935	40	0.65
NDCT	BH-115	-3294.000	3345.000	9.239	40	0.70
	BH-116	-3340.000	3390.000	10.188	40	0.75
	BH-117	-3404.000	3390.000	10.775	40	0.68

2.2. BORING:

Boring was carried out by Shell and Auger / rotary mud circulation method to sink nominal 150mm diameter bore holes to depths envisaged by using a mechanical winch. Undisturbed soil samples were collected at suitable intervals or at change of strata whichever is earlier by open drive sampling method since it was intended to ascertain the sub-soil characteristics.

2.3. SAMPLING:

Nominal 100 mm diameter undisturbed samples were recovered. The sampling equipment used consists of a two-tier assembly of sample tubes 450 mm in length fitted at its lower end. The sampling assembly was driven by means of a jarring link to its full length or as far

downs as was found practicable. As the soil is very stiff to hard and contains sand mixtures / calcareous nodules, cutting shoe was used with a area ratio < 20%. After withdrawal the ends of the tubes were sealed with wax and capped before onward transmission to the laboratory. At close intervals in depth disturbed samples were collected for identification and logging purpose. These were tagged and packed in polythene packets and transported to the laboratory.

2.4. STANDARD PENETRATION TESTS:

Standard Penetration Tests were conducted in the bore holes at intervals of 1.5M to 3.0M depth or at change of strata whichever is earlier using a split spoon sampler. The split spoon sampler used is of a Standard design having an outer diameter of 50.8 mm and inner diameter of 35 mm, driven with a monkey weighing 63.5 kgs, falling freely through 75cms. A record of the number of blows required to penetrate every 15cms to a maximum depth of 45cms was made. The first 15cm of drive are considered to be seating drive and are neglected. The total blows required for second & third 15cm of penetration is counted and termed as penetration resistance "N". On completion of a test, the split spoon sampler was opened and soil specimens were preserved in polythene bags for logging purpose.

All the boreholes were sunk with winch. However, raising of hammer for SP Tests were done manually. Hence there will not be any inertia loss and the efficiency of hammer blows should be considered as 100%.

2.5. MEASUREMENT OF WATER TABLE:

Standing water level after 24 hours of removal of casing was also noted and shown in the profile.

2.6. TRIAL PITS:

14 nos. Trial Pits were excavated for physical verification of subsoil with depth. The co-ordinates of the Trial Pit locations are presented below.

Trial Pit No.	Co-ordinate (M)			Depth (M)	Standing Water Level(M)
	Easting	Northing	G.L.		
TP – 1	-2993.162	4626.136	9.832	3.10	1.85
TP – 2	-3555.193	4411.203	9.923	3.20	1.80
TP – 3	-3689.089	3962.003	9.584	3.30	1.85
TP – 4	-3601.102	3355.111	9.648	3.30	1.60
TP – 5	-3371.139	2982.143	9.893	3.90	1.70
TP – 6	-2502.043	4410.214	9.598	3.20	1.80

Trial Pit No.	Co-ordinate (M)			Depth (M)	Standing Water Level(M)
	Easting	Northing	G.L.		
TP – 7	-2108.058	3962.123	9.629	3.05	1.90
TP – 8	-1876.103	3522.186	9.926	3.30	2.25
TP – 9	-1993.729	3086.953	9.665	3.20	1.35
TP – 10	-2571.729	3142.457	9.132	3.40	1.30
TP – 11	-2573.000	4170.000	9.011	2.45	1.05
TP – 12	-2944.000	3949.000	8.742	2.90	1.10
TP – 13	-2730.000	3875.000	9.033	3.10	1.15
TP – 14	-3061.000	3951.000	9.027	3.10	1.10

2.7. FIELD PERMEABILITY TEST:

20 Nos. Field Permeability Tests shall be conducted as per IS: 5529 (Part 1 & 2) in ten (10) locations using falling head, Single Packer and Double Packer method. The test locations are presented below.

Test Locations	Co-ordinates (M)			Type of Test	Depth of Test (M)
	Easting	Northing	G.L.		
BH-12	-2507.411	3081.141	7.838	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-19	-2168.000	2375.000	7.143	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-27	-79.000	992.000	10.226	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-32	-2864.000	4300.000	9.892	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-57	-3139.000	3818.000	9.258	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-62	-2980.000	3818.000	9.082	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-81	-2846.000	3816.000	9.173	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-92	-2756.000	3875.000	9.150	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-104	-2800.000	3660.000	9.174	Falling Head	1.30-2.00
				Falling Head	4.30-5.00
BH-115	-3294.000	3345.000	9.239	Falling Head	1.30-2.00
				Falling Head	4.30-5.00

2.8. FIELD CBR TEST:

The tests were carried out in accordance with IS 2720 (Part 31): 1969 (and Amendment 1).

Apparatus used: Jacks, proving ring of capacity 500kg with a dial gauge to read to an accuracy of 0.002mm, metal penetration piston, extension rods, MS truss, connector, surcharge weight etc.

Test Procedure & Loading Arrangement: A pit was excavated of a suitable size upto the desired depth. A truss, used for providing reaction for loading was suitably anchored. The loading arrangement was made with sand bags. The sand bags were loaded on the truss suitably. The equipment used to provide load reaction was located at the centre of the truss against which the loading jack worked. The proving ring was connected to the bottom end of the jack and the piston connector to the bottom of the proving ring. Then the piston was connected using extension rods. The dial gauge was fitted suitably. It was ensured that the entire assembly was plumbed and the loading jack should be clamped in position. The surcharge weight of 10 kg was kept in position on the test surface. The penetration piston was seated with the smallest possible load. Then the load was applied on the penetration piston to penetrate approximately 1.25mm / minute. Then the load reading was recorded at penetration of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0 & 12.5mm. Then the set up was dismantled. In this manner the test was conducted in unsoaked & soaked condition.

Total 5nos. Field C.B.R. Test (soaked) was conducted. The co-ordinates of the test locations are presented below. The test results & curves are presented at the end of the report.

FCBR No.	Co-ordinate (M)			Depth (M)
	E	N	G.L.	
CBR-01	-2779.000	4241.000	9.139	0.50
CBR-02	-1952.000	3780.000	8.224	0.50
CBR-03	-3079.000	3078.000	9.230	0.50
CBR-04	-3354.000	3800.000	8.989	0.50
CBR-05	-2925.000	3633.000	9.205	0.50

2.9. DYNAMIC CONE PENETRATION TEST:

Total 22 nos. Dynamic Cone Penetration Tests were conducted at the following locations. The co-ordinates at each DCPT locations are presented below. The DCPT values vs. depth plots are presented in Volume-2.

DCPT No.	Co-ordinate (M)			Depth (M)	
	E	N	G.L.	Starting depth	Ending Depth
1	-2640.000	4524.000	8.359	0.00	12.20
2	-3187.000	4578.000	8.410	0.00	12.20
3	-3760.000	4324.000	8.513	0.00	12.00
4	-3645.000	3168.000	8.630	0.00	13.50
5	-3563.000	2918.000	8.742	0.00	12.90
6	-2785.000	3161.000	9.345	0.00	12.30
7	-2277.000	3067.000	8.017	0.00	13.50
8	-1864.000	3116.000	8.392	0.00	12.60
9	-1912.000	3716.000	8.064	0.00	12.30

DCPT No.	Co-ordinate (M)			Depth (M)	
	E	N	G.L.	Starting depth	Ending Depth
10	-3144.000	3957.000	9.048	0.00	15.00
11	-2718.000	4067.000	9.048	0.00	12.90
12	-2846.000	3869.000	9.124	0.00	14.70
13	-2980.000	3858.000	8.885	0.00	13.80
14	-3039.000	3790.000	9.059	0.00	13.80
15	-2900.000	3790.000	9.256	0.00	13.20
16	-2846.000	3778.000	9.317	0.00	12.60
17	-2980.000	3699.000	8.751	0.00	13.20
18	-3096.000	3624.000	9.313	0.00	12.30
19	-3232.000	3360.000	9.159	0.00	12.90
20	-2990.000	4194.000	8.998	0.00	12.60
21	-2853.000	3661.000	9.205	0.00	13.20
22	-3159.000	3395.000	9.091	0.00	13.20

2.10. STATIC CONE PENETRATION TEST (SCPT):

The test was carried out in 10 locations as per IS-4968 (Part-III) 1976. Among the field sounding tests, this test is the best for recording the in-situ variation of soil properties. The results are useful to determine the bearing capacity of shallow footings. It is most widely used to determine the frictional resistance of piles and also the required termination depth. Both cone and frictional resistance were measured at an interval of 200mm. The tests were carried out till the desired depth wherever possible otherwise till it struck refusal (i.e. the soft disintegrated rock). At site both cone resistance and frictional resistance are measured. In the Appendix, cone resistance, q_c, frictional resistance f_s and friction ratio f_r are shown for the seven test locations. From a plot of 'f_r' VS 'q_c', the attribute (it shows the granulometry of soil) at each point is determined. Based on the attribute and q_c the average profiles are drawn.

SCPT No.	Co-ordinate (M)			Depth of Test (M)
	Easting	Northing	G.L.	
SCPT-1	-2717.000	4135.000	8.982	20.80
SCPT-2	-2821.000	4082.000	9.133	20.20
SCPT-3	-2980.000	3938.000	8.878	20.80
SCPT-4	-3039.000	3924.000	8.920	20.40
SCPT-5	-3179.000	3818.000	9.099	17.80
SCPT-6	-3074.000	3796.000	9.156	18.40
SCPT-7	-3020.000	3818.000	8.896	20.20
SCPT-8	-2879.000	3831.000	9.309	19.80
SCPT-9	-2846.000	3738.000	9.279	20.20
SCPT-10	-2879.000	3710.000	9.315	20.80

2.11. PLATE LOAD TESTS:

Plate Load Tests were conducted using a **600mm** square plate. Test is continued upto a maximum desired loading intensity or specified plate settlement which ever is earlier. The load is applied through a hydraulic jack. The reaction for applying the load on the plate is obtained by a loading platform with sandbags. After applying the load increments, settlement records are made at intervals of 1, 2.25, 4, 6.25, 9, 16, 25, 60, 90 & 120 minutes and thereafter at an interval of an hour. When the rate of plate settlement reduced to 0.02 mm per minute, the final readings of the dial gauges is recorded. The coordinate of test locations are given below.

PLT No.	Type of Tests	Plate size (mm x mm)	Co-ordinates(M)		Ground Level (M)	Depth (M)
			E	N		
PLT-05	Routine Type	600 x 600	-2949.000	4143.000	9.128	1.30
PLT-06	Routine Type	600 x 600	-2977.000	4088.000	8.982	1.25
PLT-08	Routine Type	600 x 600	-2604.000	3893.000	8.996	1.30
CPLT-01	Cyclic Type	600 x 600	-2980.000	3778.000	8.992	1.30
CPLT-02	Cyclic Type	600 x 600	-2730.000	3754.000	9.215	1.20

2.12. ELECTRICAL RESISTIVITY TESTS:

Twenty seven (27) nos. Electrical Resistivity Tests were carried out at the following locations. The test procedure and results are presented under Section-8.

ERT No.	Co-ordinate (M)		G.L. in metre	ERT No.	Co-ordinate (M)		G.L. in metre
	E	N			E	N	
1	-2979.000	4154.000	9.339	14	-2900.000	3866.000	9.156
2	-2961.000	4055.000	8.787	15	-2846.000	3836.000	9.055
3	-2823.000	4109.000	9.130	16	-2920.000	3831.000	8.905
4	-2718.000	4050.000	9.155	17	-3039.000	3805.000	9.327
5	-3299.000	3858.000	10.536	18	-3000.000	3778.000	8.628
6	-3220.000	3891.000	9.402	19	-3074.000	3750.000	9.116
7	-3220.000	3818.000	9.207	20	-2920.000	3738.000	8.743
8	-3155.000	3836.000	8.858	21	-3000.000	3705.000	8.774
9	-3144.000	3887.000	8.871	22	-2900.000	3710.000	9.291
10	-3074.000	3915.000	9.056	23	-2795.000	3694.000	9.351
11	-3039.000	3898.000	8.917	24	-2730.000	3668.000	9.270
12	-3000.000	3898.000	8.898	25	-3076.000	3858.000	9.185
13	-2803.000	3916.000	9.110	26	-3064.000	3983.000	9.184
				27	-3195.000	3430.000	9.132

2.13. CROSS HOLE SHEAR TEST:

Six (6) nos. Cross Hole Shear Test were carried out to determine the dynamic properties of the layer for the construction of machine foundations at the following locations. The test procedure and results are presented and discussed under Section-9.

CHT No.	Co-ordinates (M)		Ground Level (M)
	E	N	
CST -1	-3000.000	3877.000	8.907
CST -2	-2879.000	3866.000	9.016
CST -3	-2763.000	3822.000	9.094
CST -4	-3000.000	3754.000	8.761
CST -5	-2879.000	3745.000	10.061
CST -6	-2730.000	3699.000	9.286

2.14. PRESSURE METER TESTS:

Total 4nos. Pressure Meter Tests were conducted. The test procedure and results are presented in Section-10.

PMT No.	Co-ordinates (M)		Ground Level (M)
	E	N	
PMT - 1	-3020.000	3898.000	8.992
PMT - 2	- 2920.000	3866.000	8.976
PMT - 3	-3020.000	3738.000	8.914
PMT - 4	-2920.000	3710.000	8.753

3. LABORATORY TESTING

For proper identification and classification of the sub-soil deposits and for deriving adequate information regarding its relevant physical and geotechnical properties at the site under investigation, the following laboratory tests were conducted on the soil samples collected from the exploratory bore holes:

1. **Grain size analysis (Sieve as well as Hydrometer).**
2. **Determination of Liquid Limit, Plastic Limit and Shrinkage Limit.**
3. **Determination of Natural Moisture Content.**
4. **Determination of Specific Gravity.**
5. **Determination of Bulk & Dry Unit Weight.**
6. **Strength determination by Triaxial Unconsolidated Undrained Test (UU).**
7. **Strength Determination of Unconfined Compression Test on "UDS" (UNCONFD).**
8. **Strength Determination of Unconfined Compression Test on REMOULDED samples.**
9. **Strength determination by Direct Shear Test under Quick condition (CQ).**
10. **One-dimensional Consolidation Test for determining settlement potentiality.**
11. **Determination of Free Swelling Index & Swelling Pressure.**
12. **Conducting Standard and Modified Proctor Compaction Test to determine Optimum Moisture Content (OMC) and Maximum Dry Density (MDD).**
13. **Conducting CBR test (soaked) on sample prepared at MDD.**
14. **Chemical tests on soil and water samples to determine pH value, Sulphate, Chloride content etc.**

Laboratory test results are presented in a tabular form in Volume - 2. The results are self explanatory except that of consolidation tests. The compressibility for a pressure range has been separated into 2 components through the compression ratio. As a first step dial gauge reading is plotted against square root of time and by extrapolation dial reading at zero time, is obtained. The compression ratio is given as

$r = (d_i - d_s)/(d_i - d_f)$, where

d_i = Initial reading of dial before load application

d_s = Dial reading corresponding to theoretical zero time

d_f = Final dial reading after 24 hrs.

Now we write $m_{vc} = (1- r) \times m_v$

All the tests were conducted as per relevant Indian Standard Specifications.

4. SUBSOIL CONDITION, STRATIFICATION AND PROPERTIES

4.1. SUB-SOIL CONDITIONS:

The boring records showing the various soils met with are enclosed in Volume-2. These are prepared from field logs after proper modifications in the light of the laboratory test results and observation of disturbed and penetrometer soil samples. The results of the Standard Penetration Tests are given as 'N' values in these boring records. The sub-soil profiles (as obtained from field and Laboratory test results) across the bore holes are shown under Figs. 2.01 to 2.51 giving description, consistency and colour of each strata. The "N" values are shown in the profiles as well as presented in the borelogs in Volume-2. The laboratory test results and the back up sheets are also presented there.

4.2. SUB-SOIL STRATIFICATIONS:

The subsoil is characterised by a filled up soil/ash followed by very loose to loose clayey silty sand / very soft silty clay. Below this, medium silty clay followed by stiff to very stiff silty clay layer was observed. After that dense to very dense silty sand / hard silty clay layer was found alternatively and that continued upto the terminating depth of the all boreholes. The description of each layer is presented below.

4.2.1. FILL:

Fill consists of very loose fly ash. The only UDS that could be collected from this layer show the following properties. However these properties may not truly represent the properties of the whole stratum.

GRAIN SIZE	
Sand %	39
(Silt + Clay) %	61

4.2.2. STRATUM - I:

The soil in this layer consists of very soft, silty clay / clayey silt with sand mixture. The average properties of this layer are presented below.

Bulk Density, gms/cc	1.99	Specific gravity	2.65
Dry Density, gms/cc	1.59	Void Ratio	0.700
Natural Water Content %	25	Liquid limit %	31
TRSH-UU:		Plastic Limit %	15
Cohesion kg/sqcm	0.21	Shrinkage Limit %	13
Friction angle °	1°		

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai. CETEST

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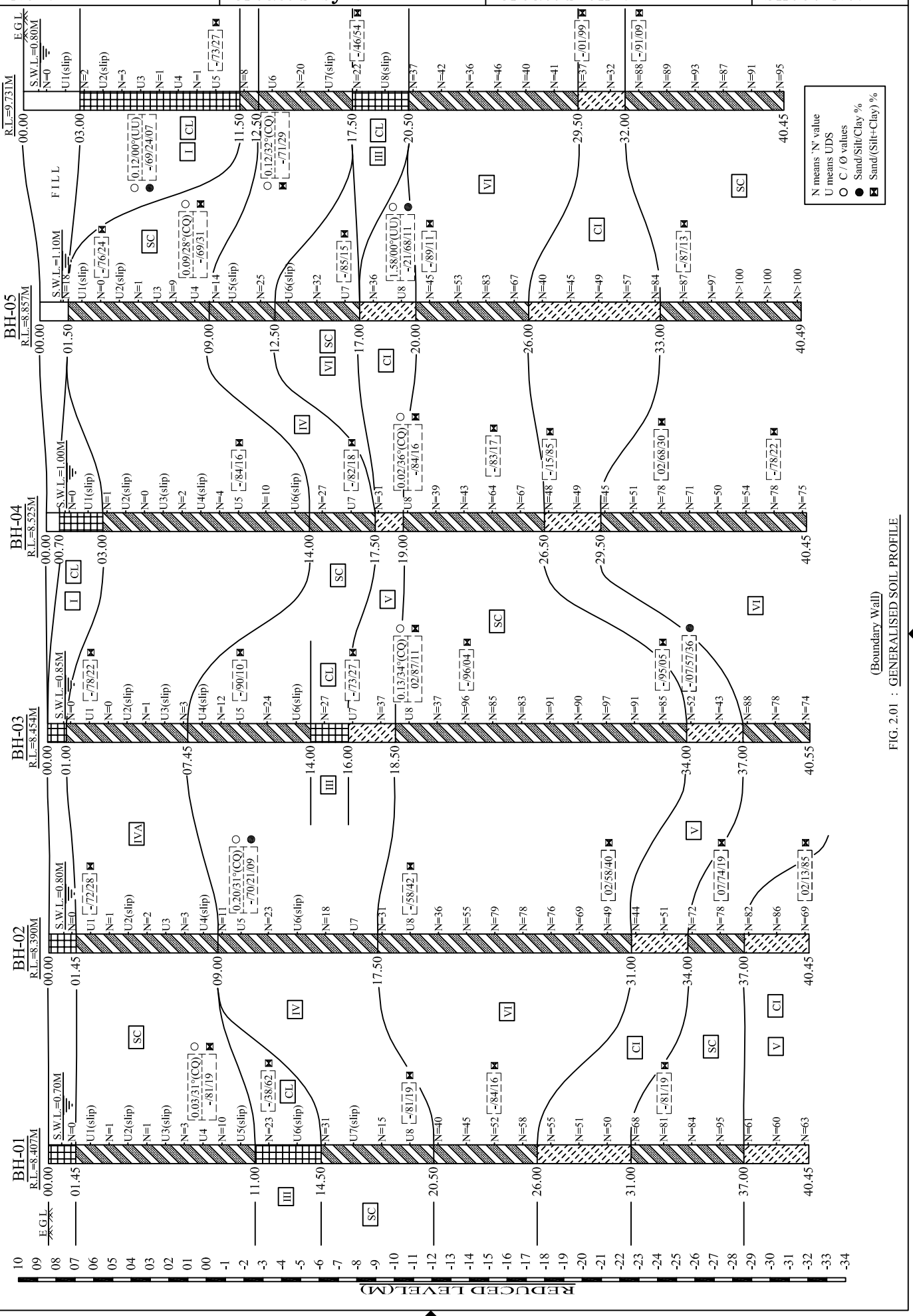

FIG. 2.01 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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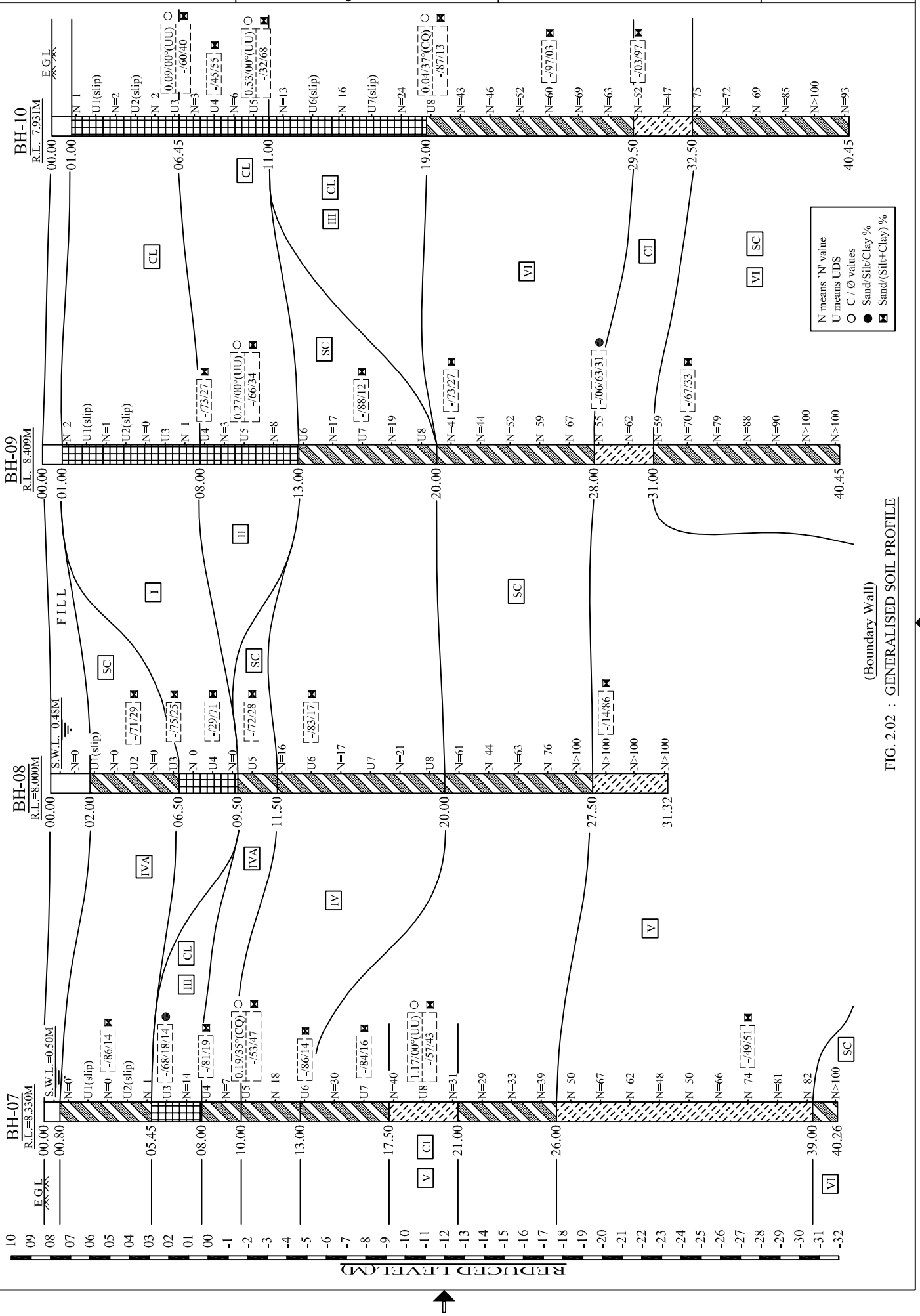

FIG. 2.02 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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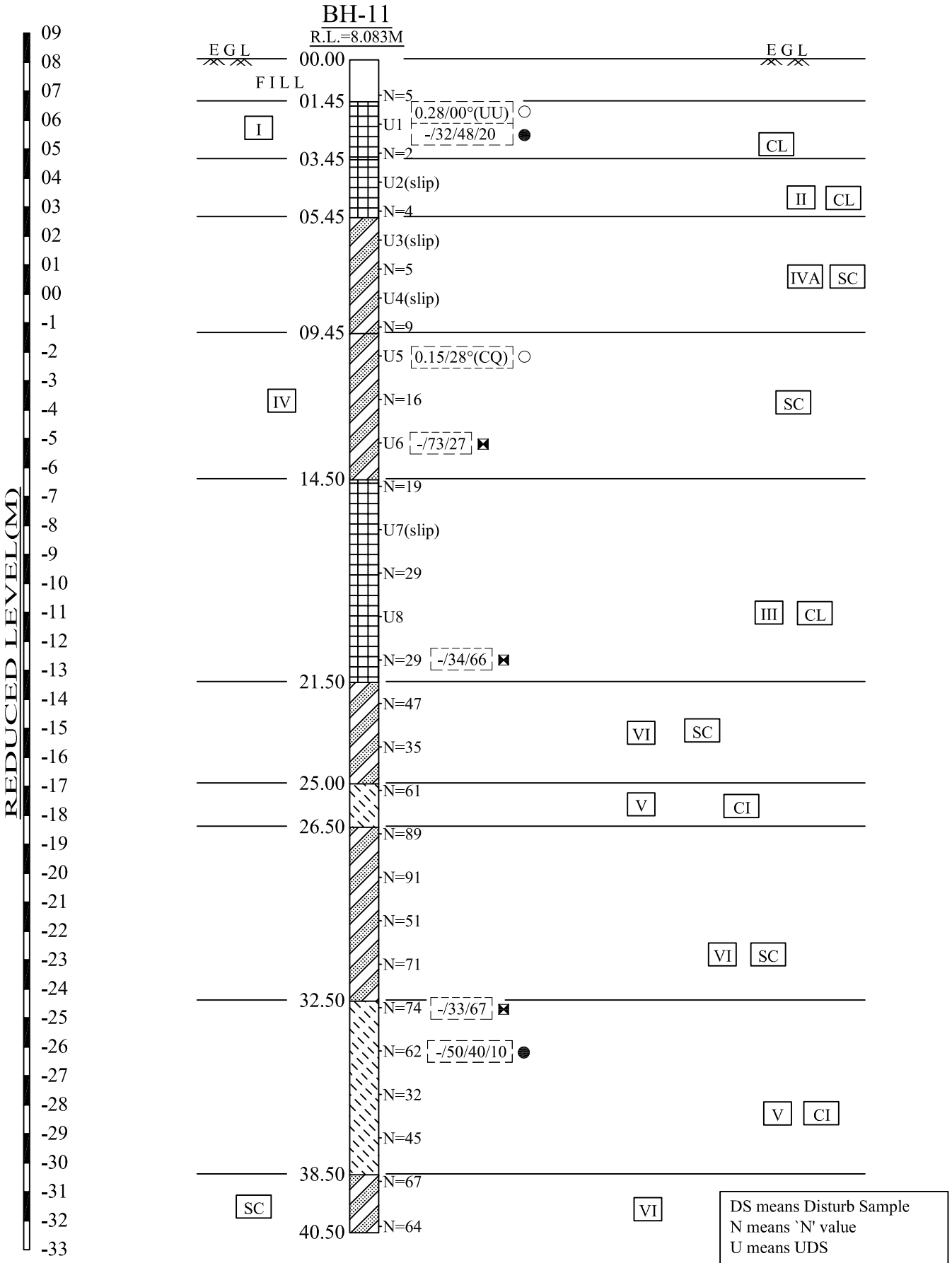

(Additional Canteen)

FIG. 2.03 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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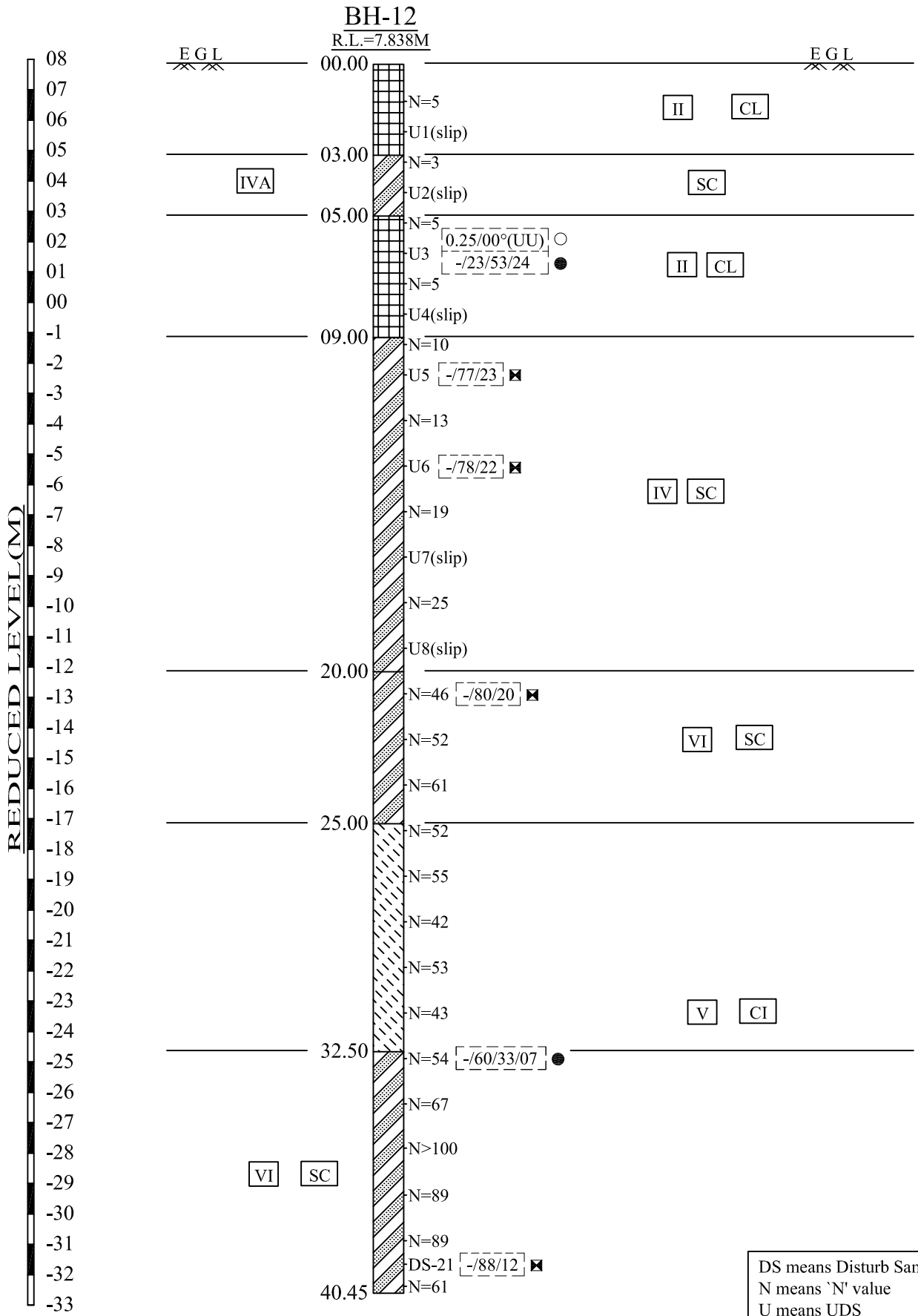

(Administration Building)

FIG. 2.04 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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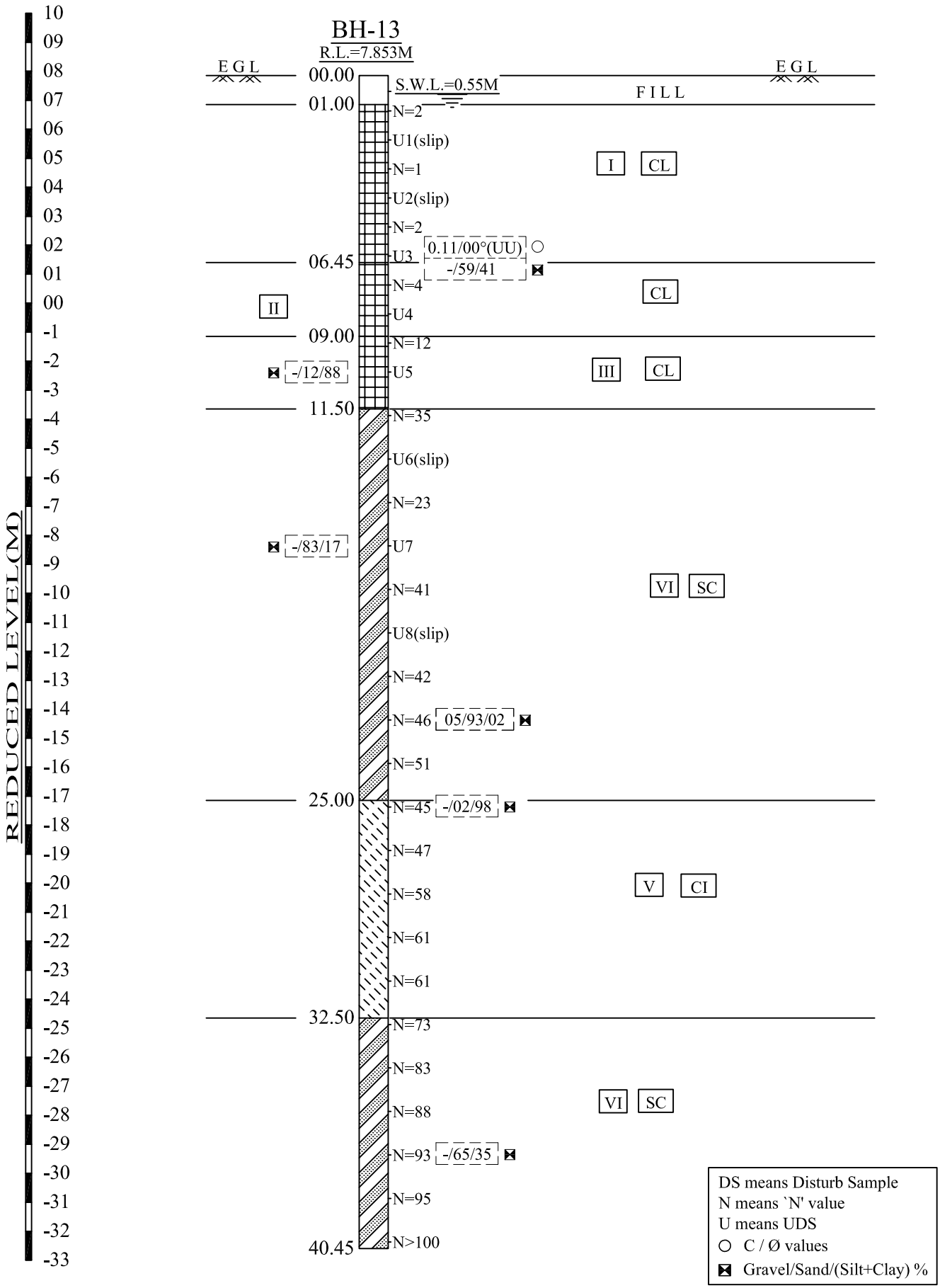

(Main Gate & Time Office Cum Security Complex)

FIG. 2.05 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.		
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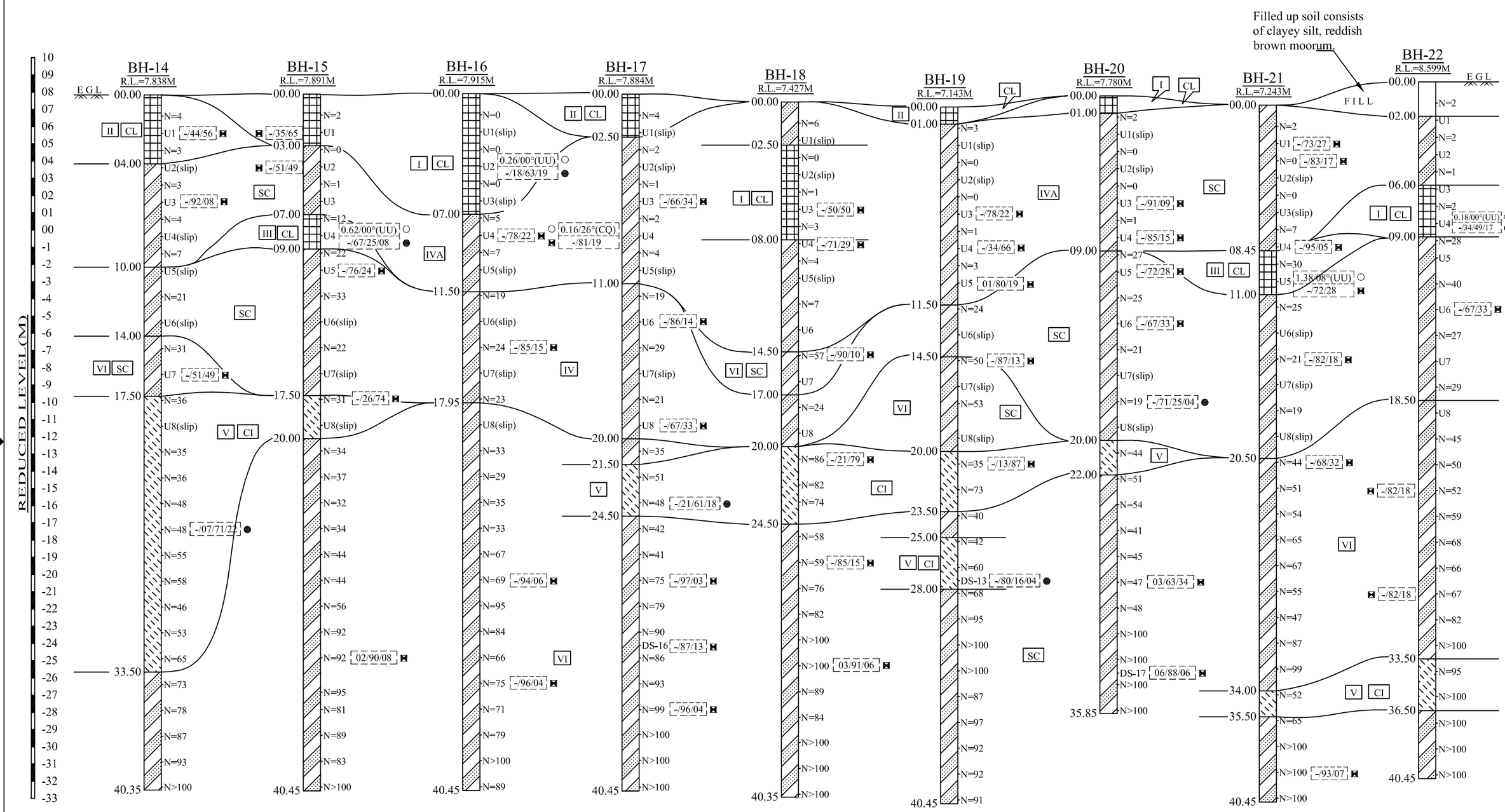

(Proposed Coal Conveyor)

FIG. 2.06 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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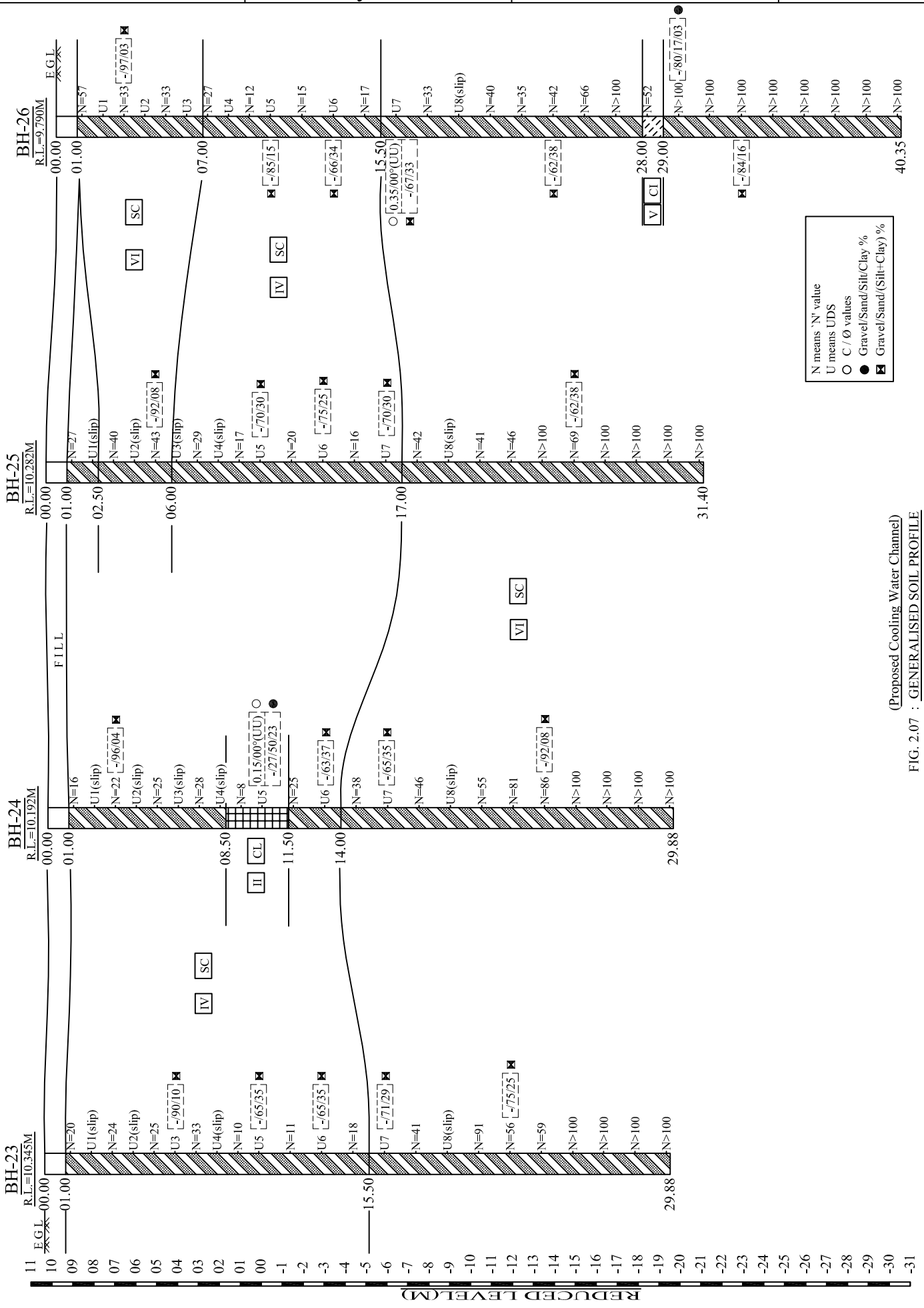

(Proposed Cooling Water Channel)

FIG. 2.07 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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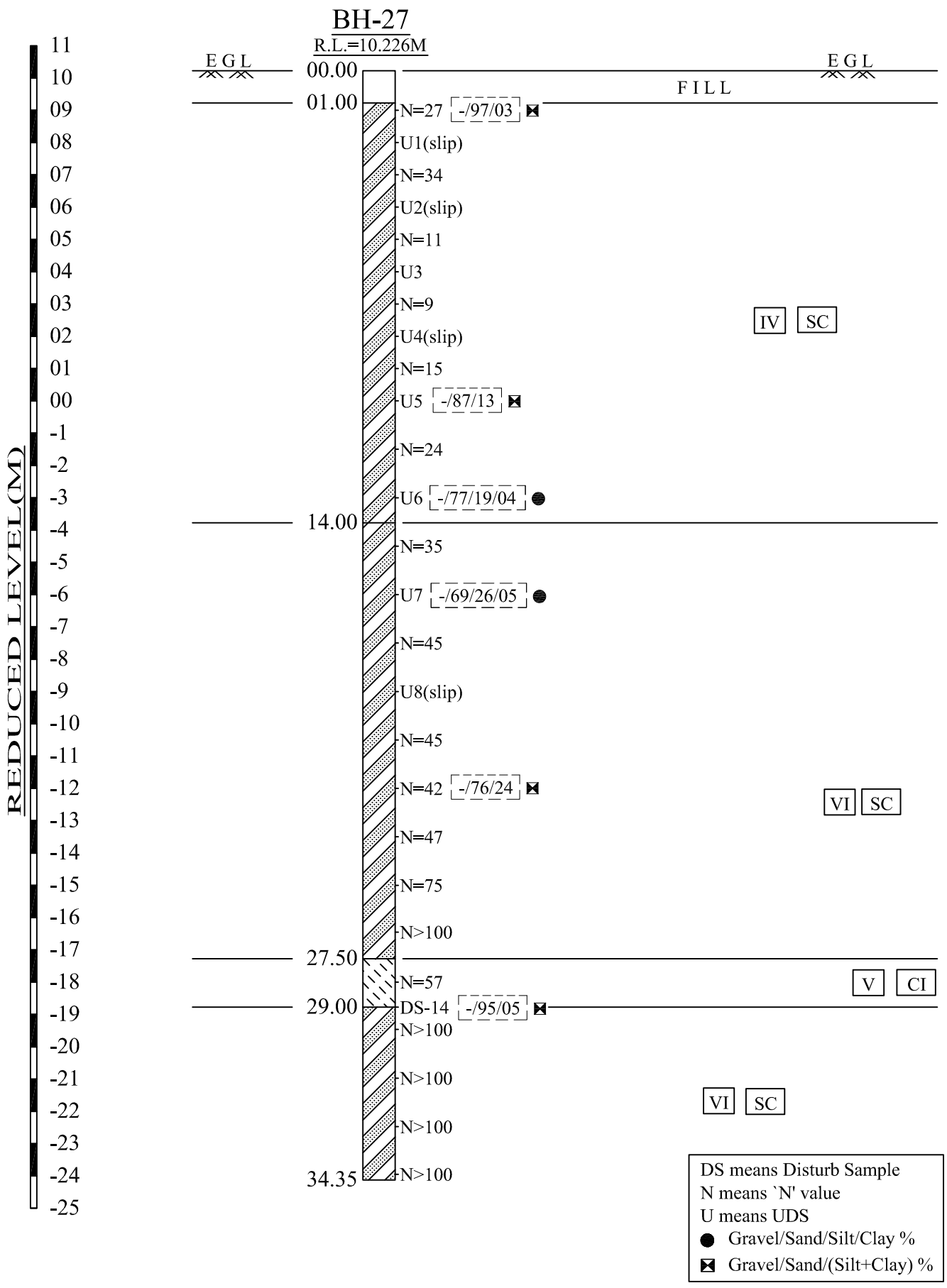

(Sea Water Intake Pump House)

FIG. 2.08 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.		CETEST
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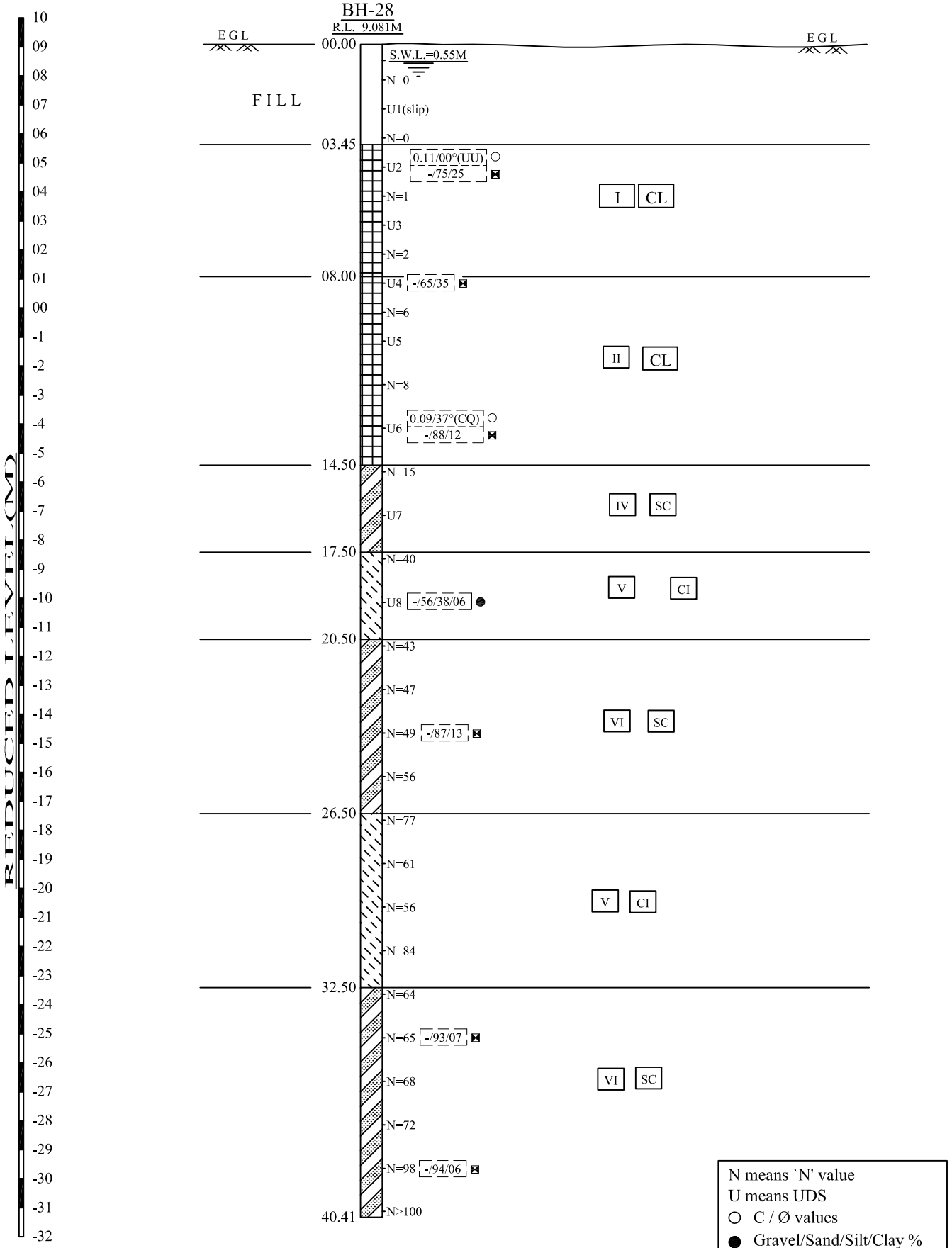

(STP)

FIG. 2.09 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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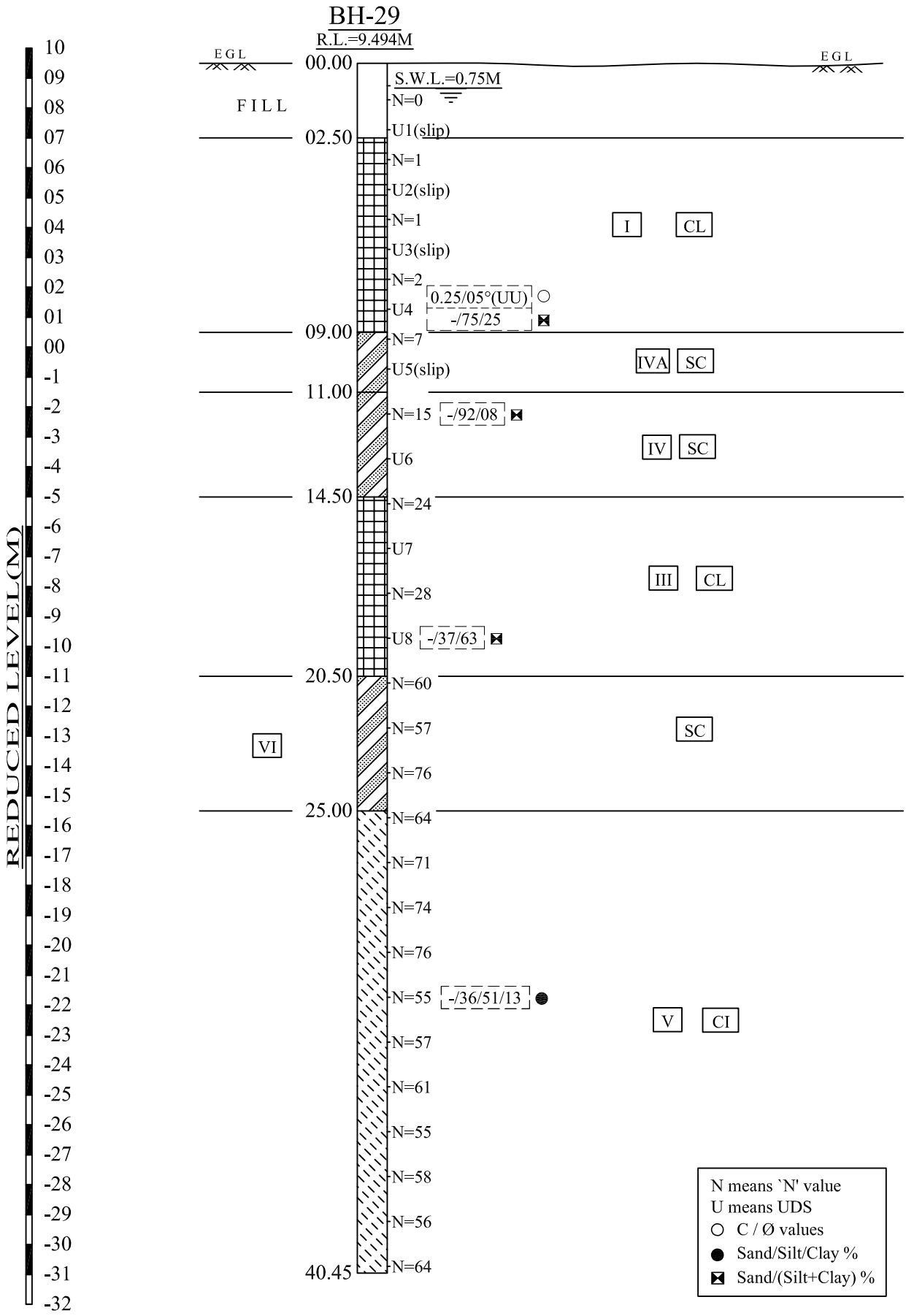

(H2Plant)

FIG. 2.10 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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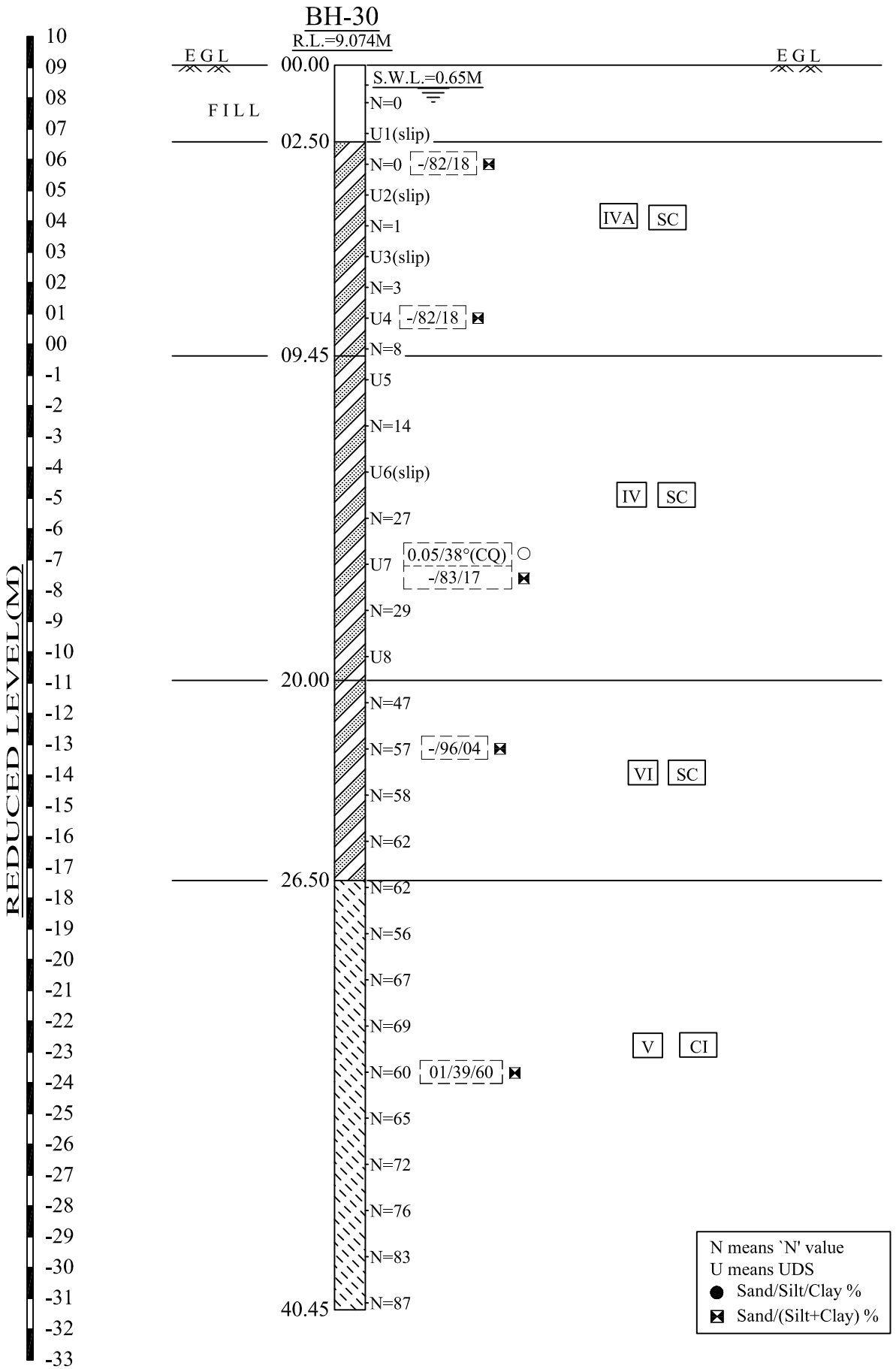

(Guard Pond)

FIG. 2.11 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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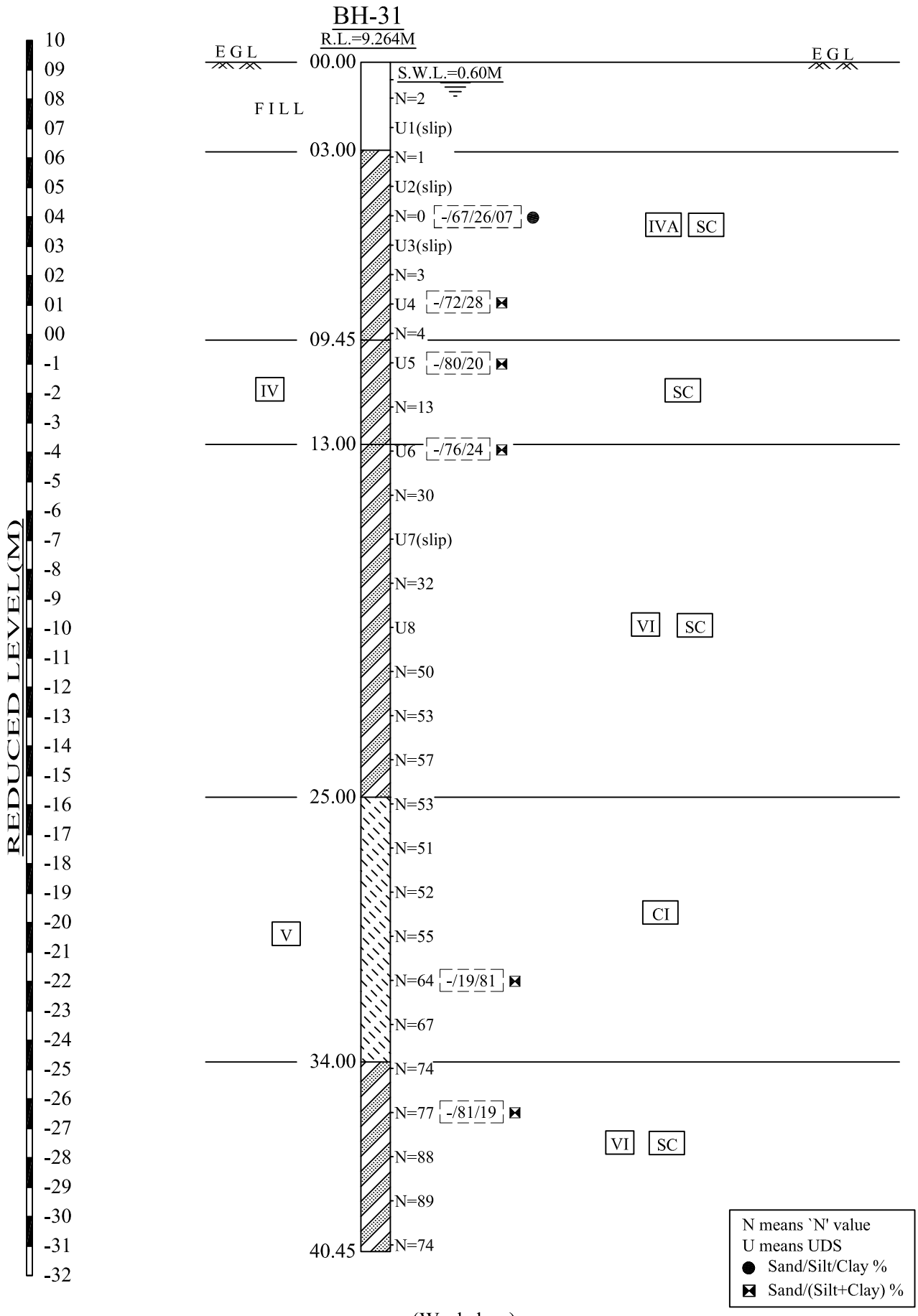

(Workshop)

FIG. 2.12 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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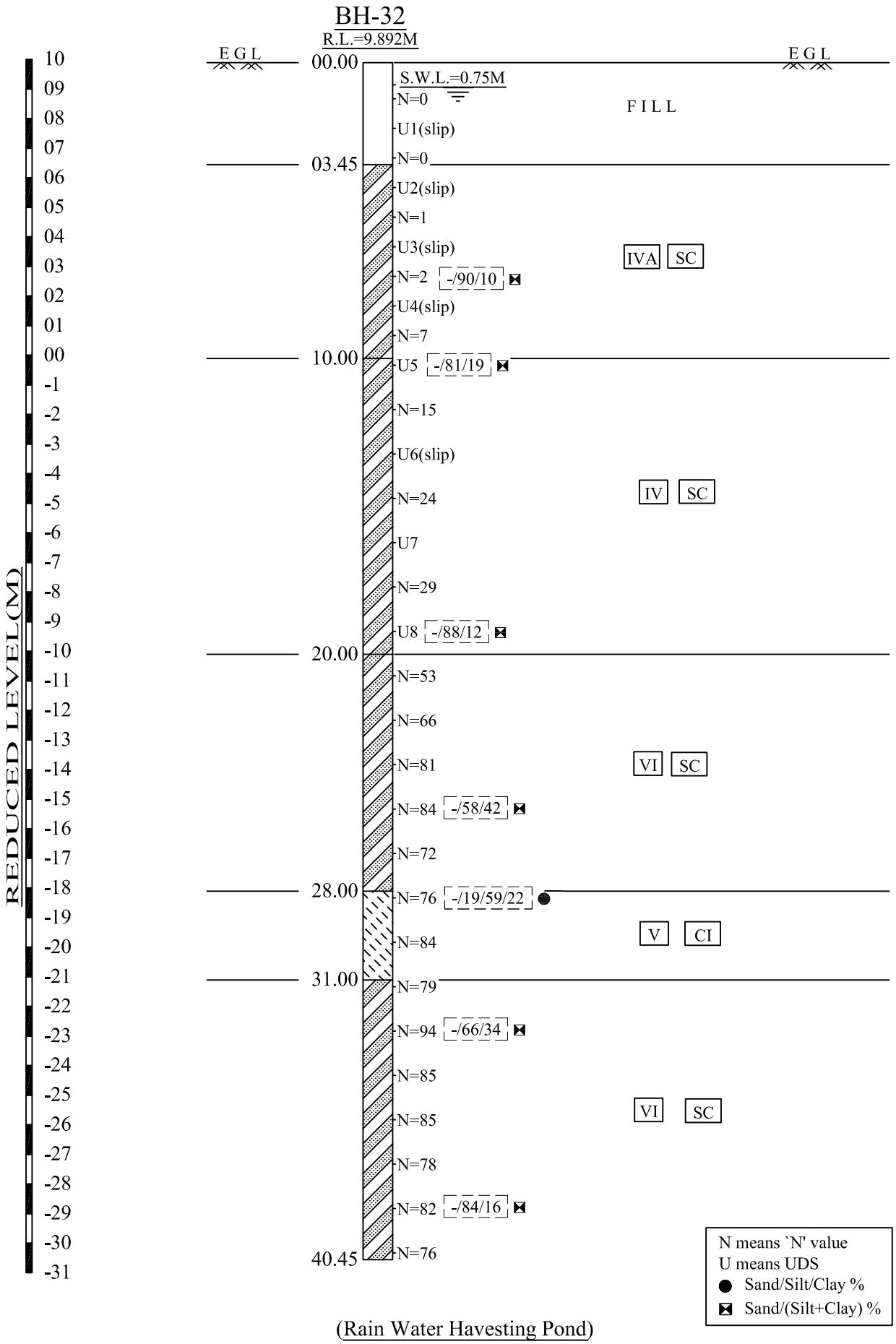

(Rain Water Havesting Pond)

FIG. 2.13 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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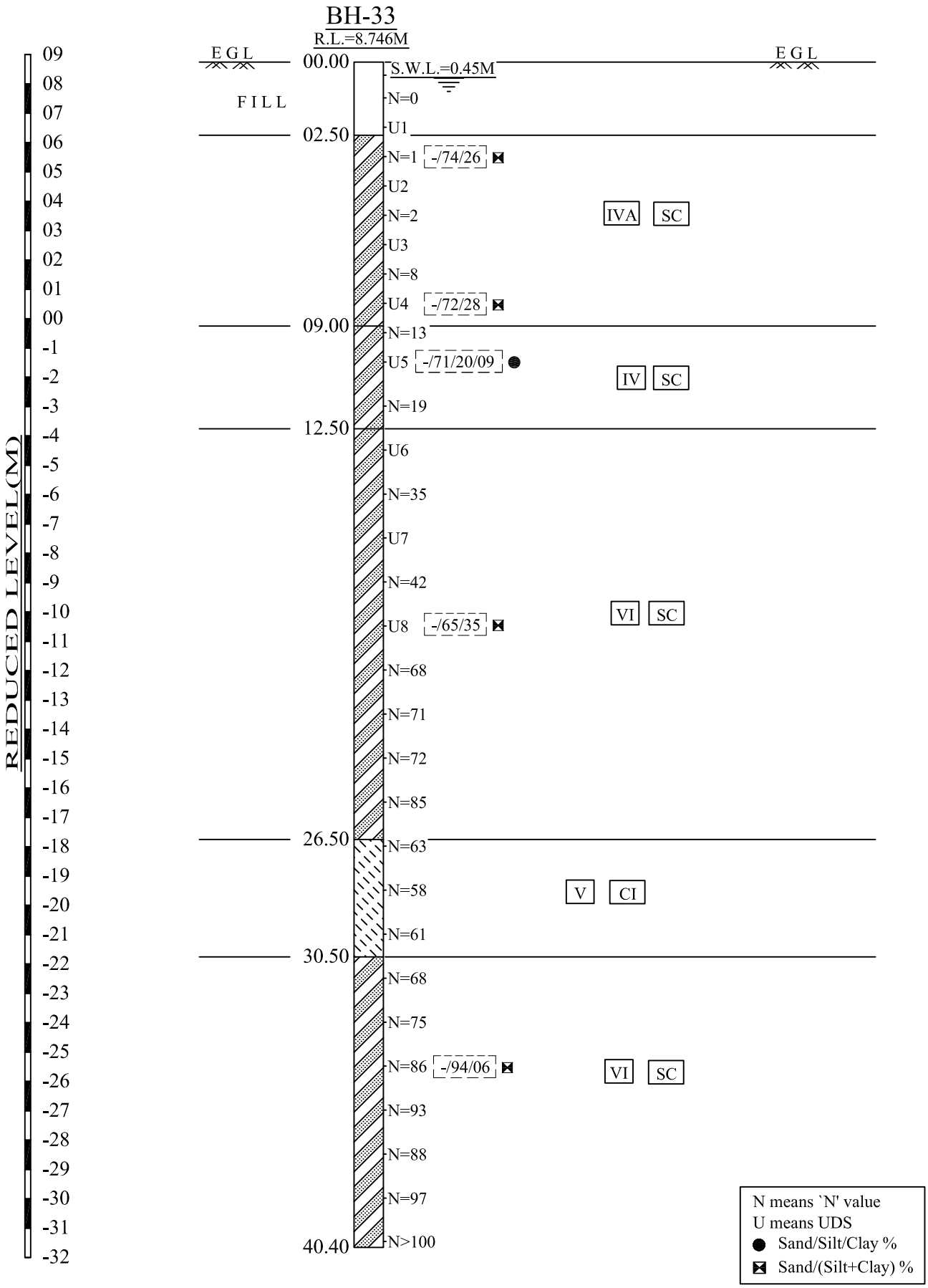

(RO-DM cum Desalination Plant)

FIG. 2.14 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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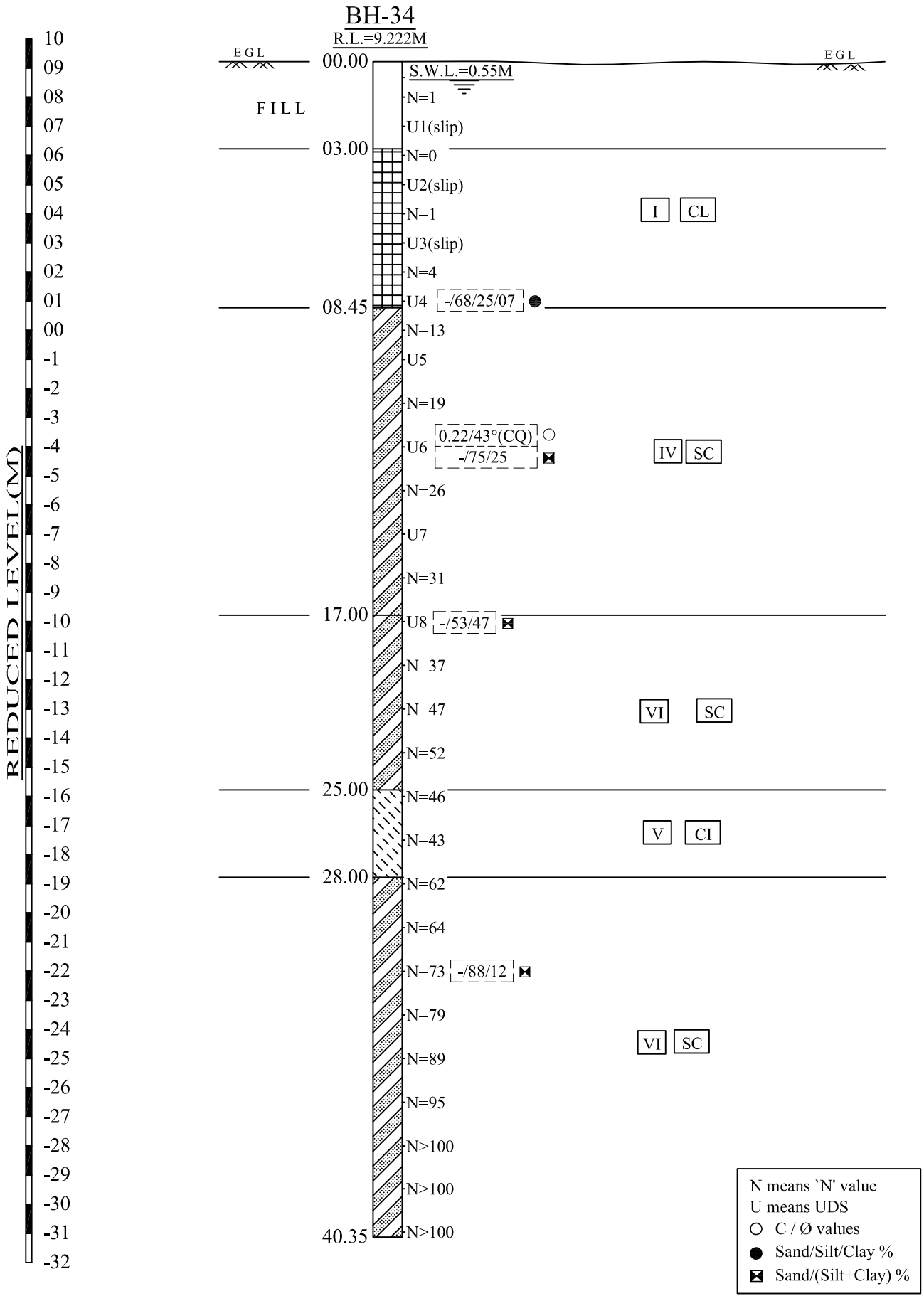
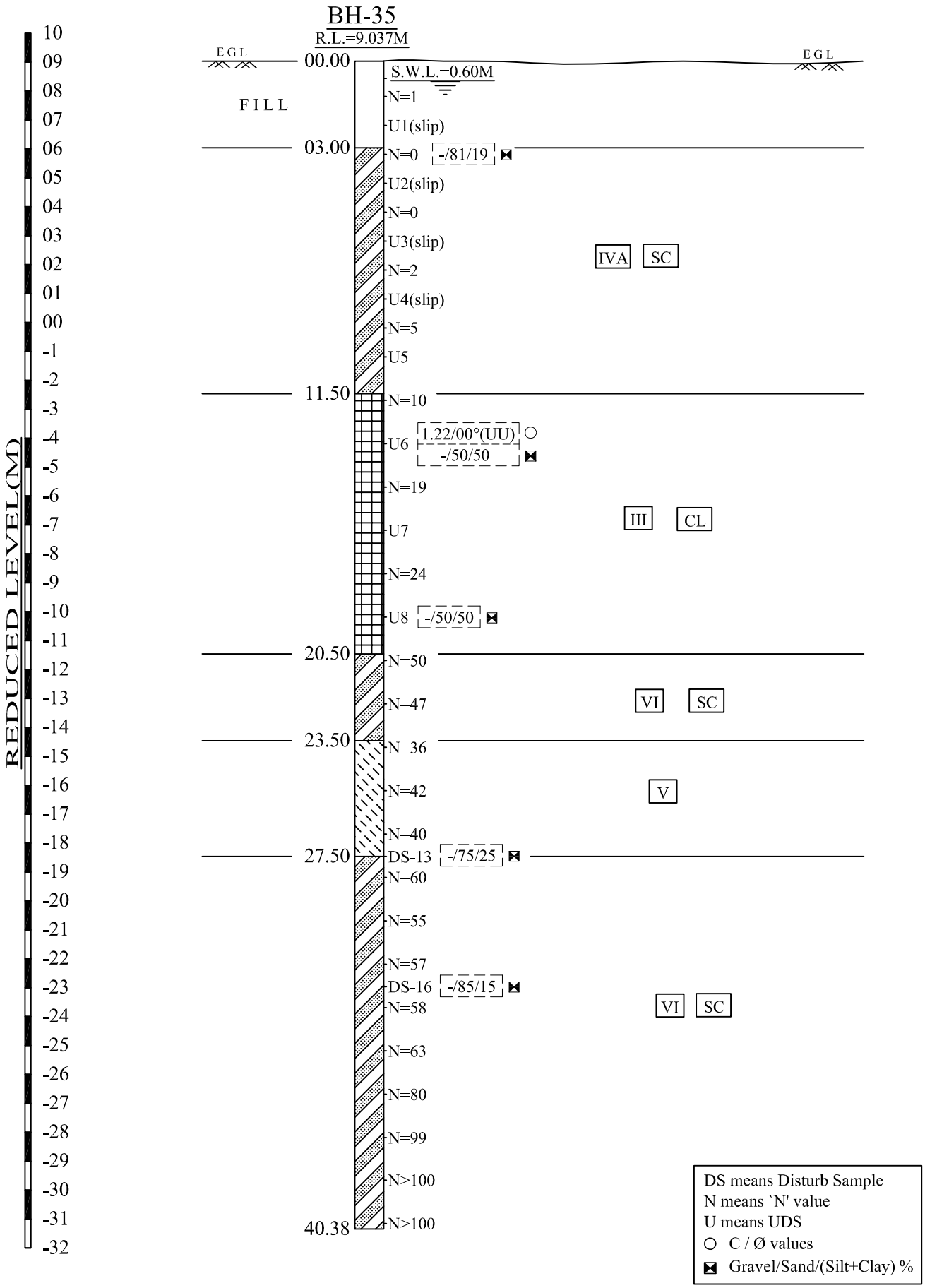


(Canteen)

FIG. 2.15 : GENERALISED SOIL PROFILE



(Storage Yard)

FIG. 2.16 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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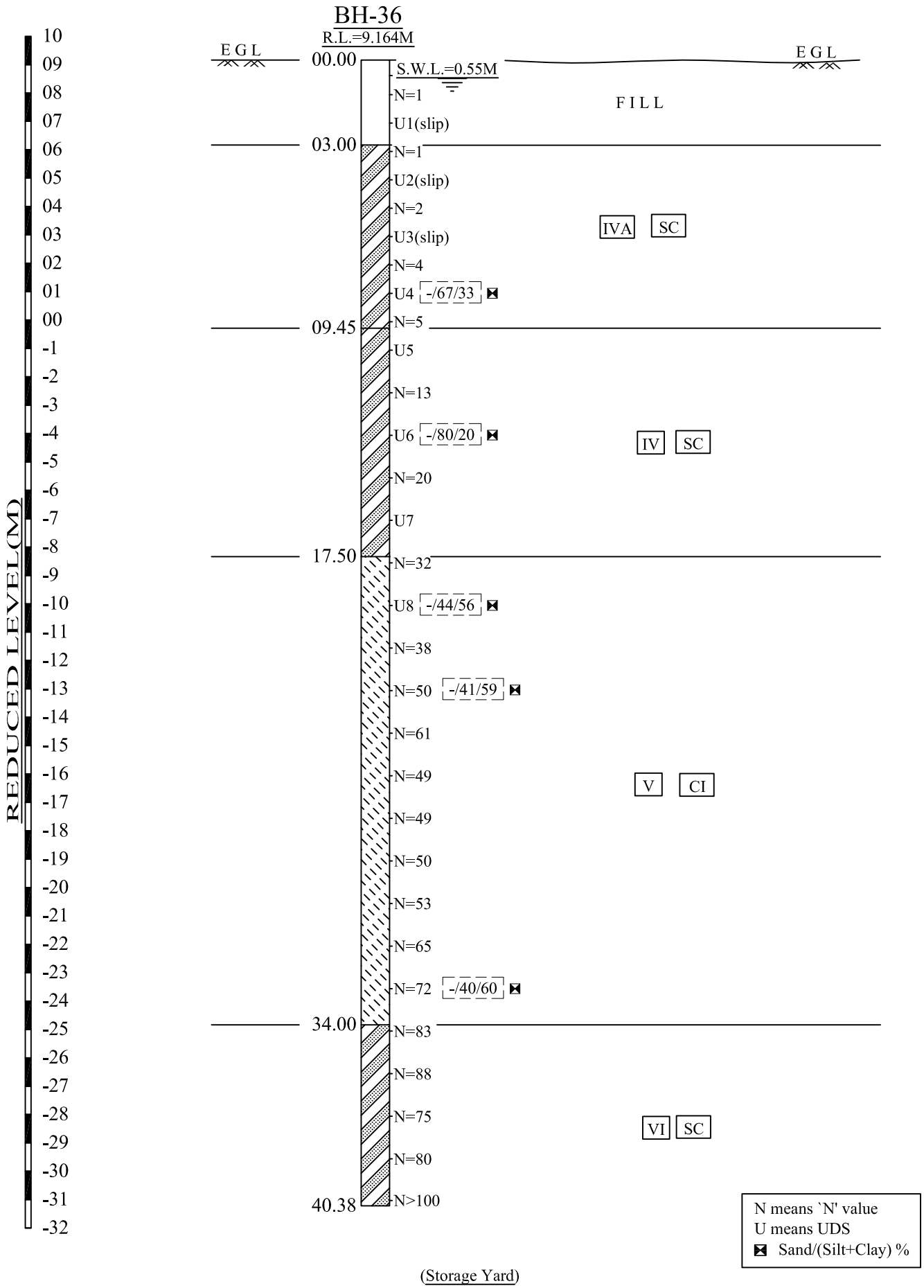

(Storage Yard)

FIG. 2.17 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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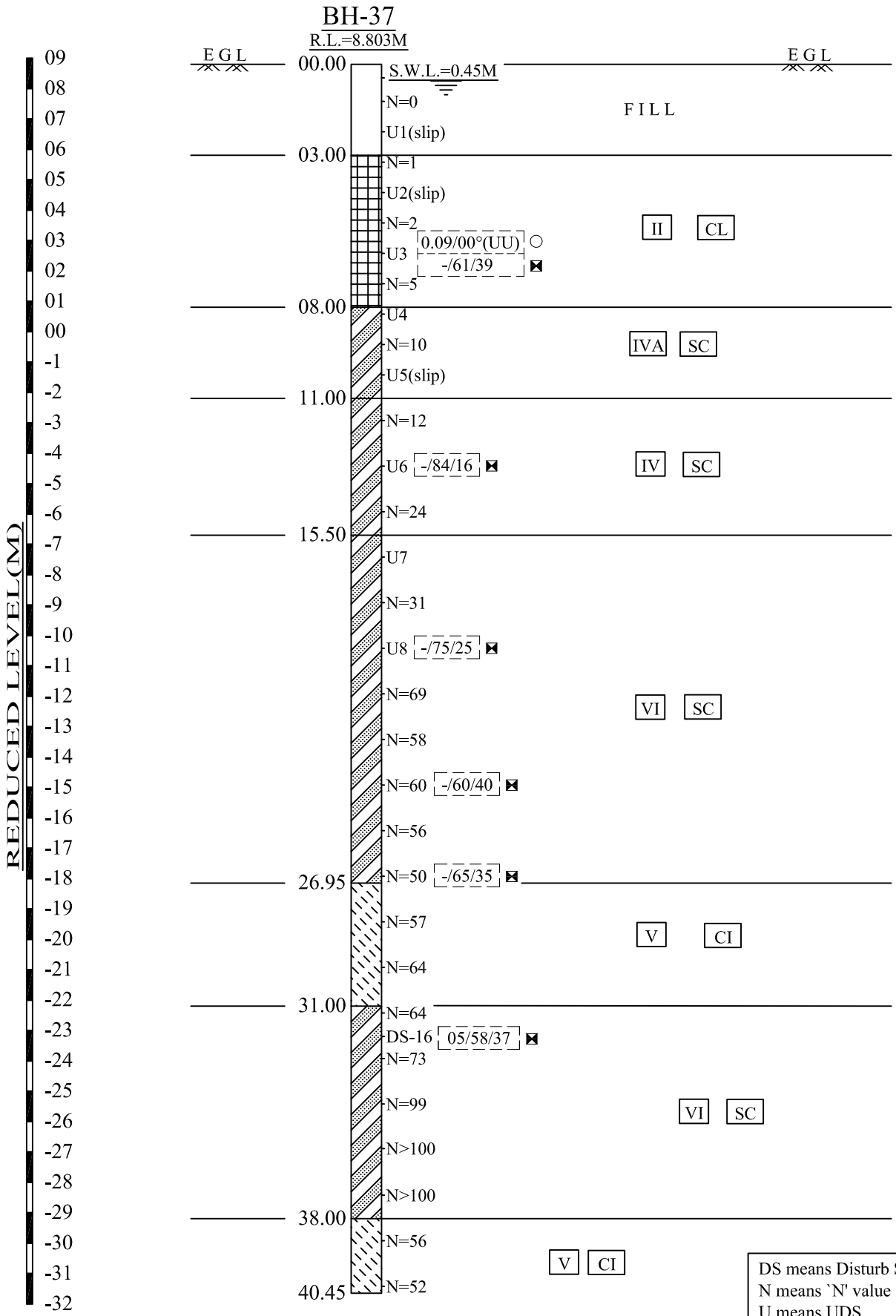

(Near Neutralising Pit)

FIG. 2.18 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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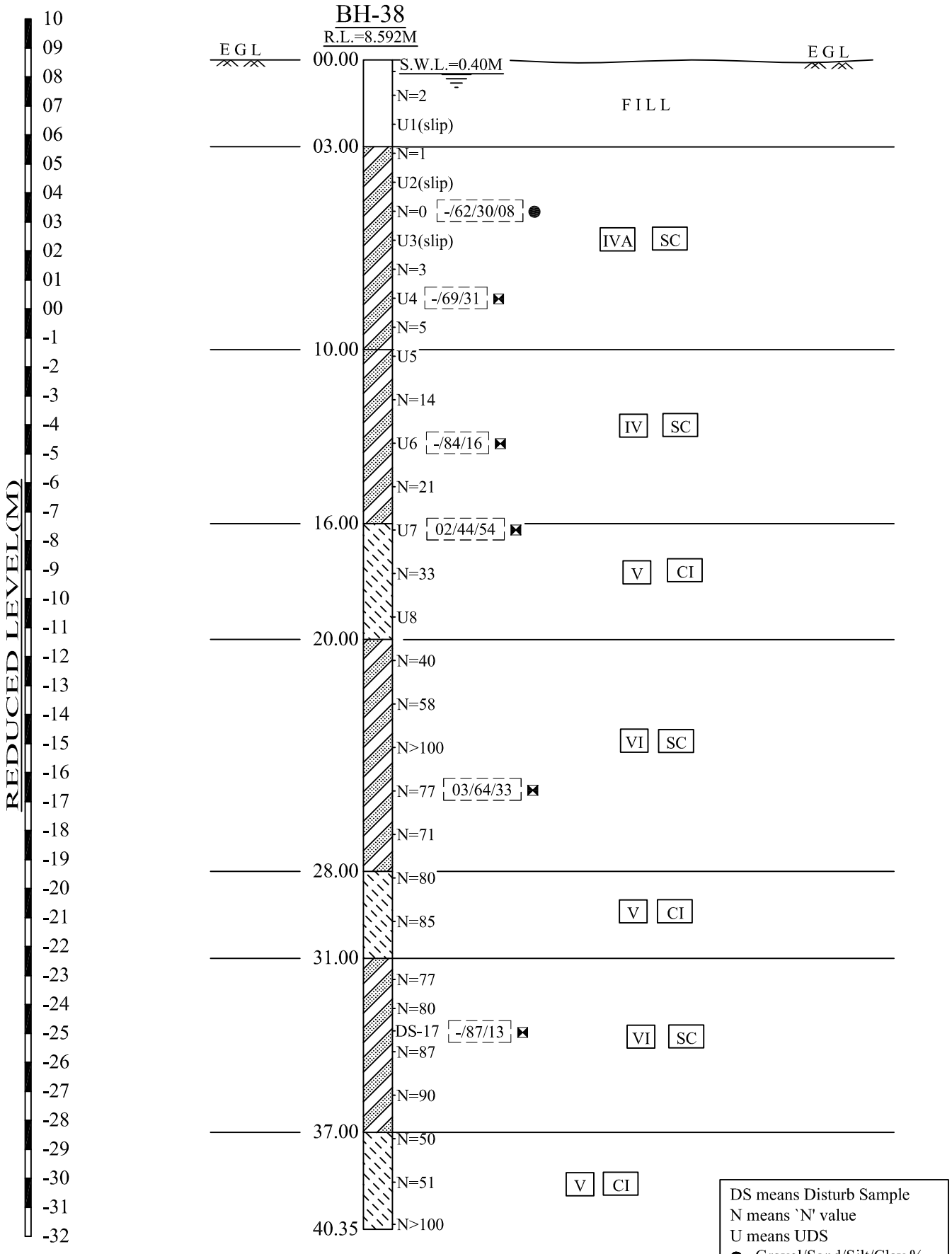

(CPU Regeneration Building)

FIG. 2.19 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
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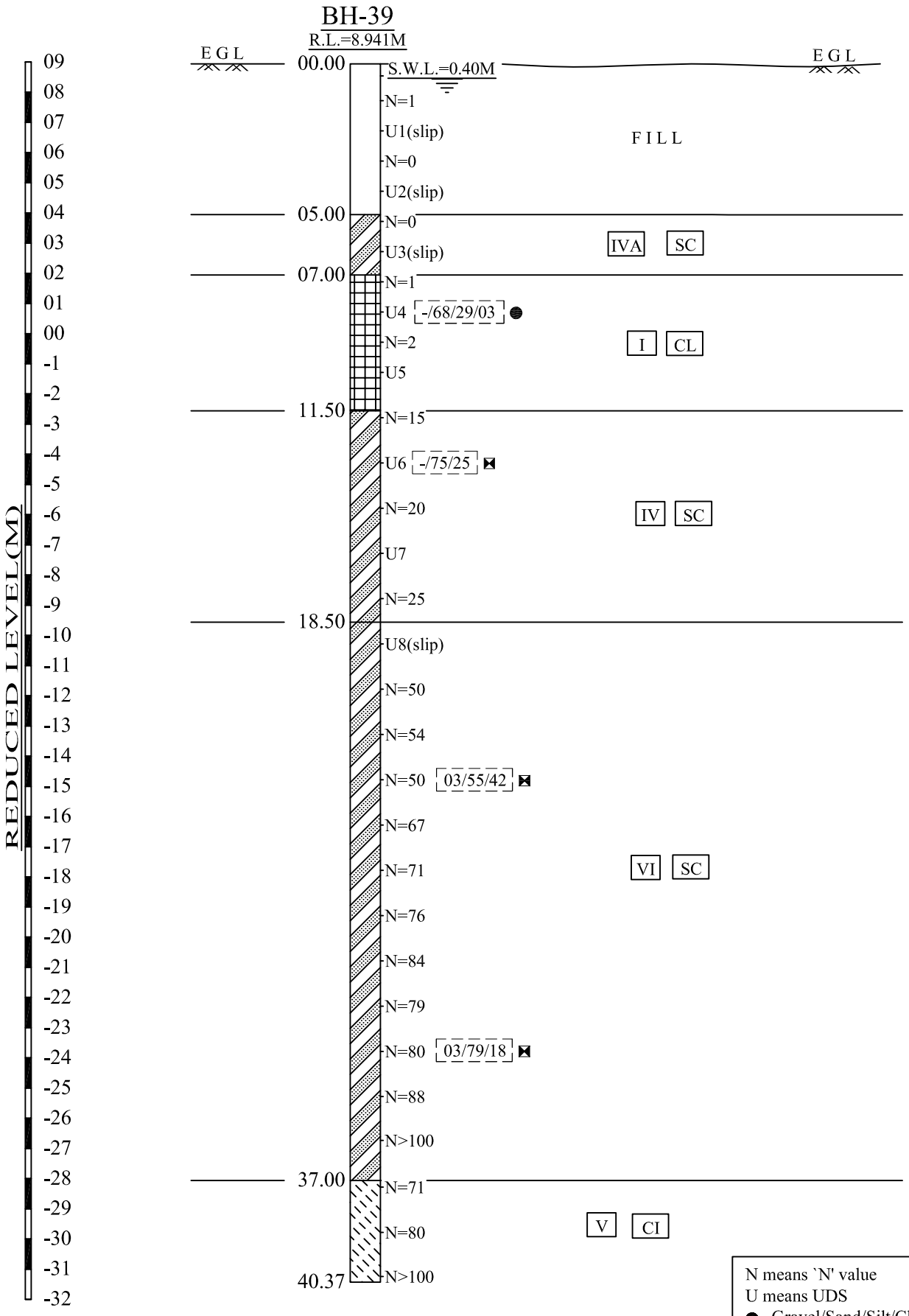
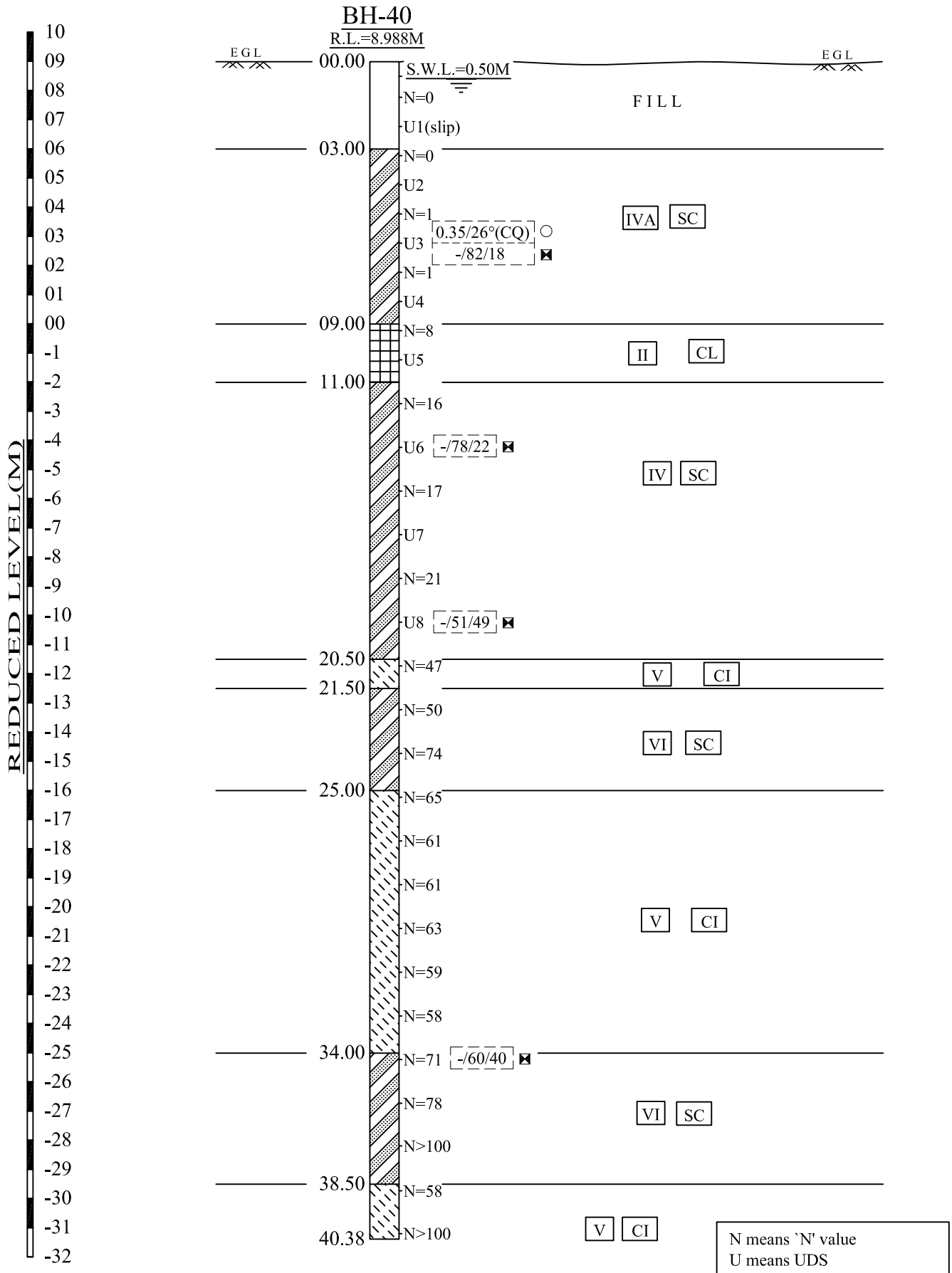


(Filtered Water & Fire Water Storage Tank & Pump House)

FIG. 2.20 : GENERALISED SOIL PROFILE

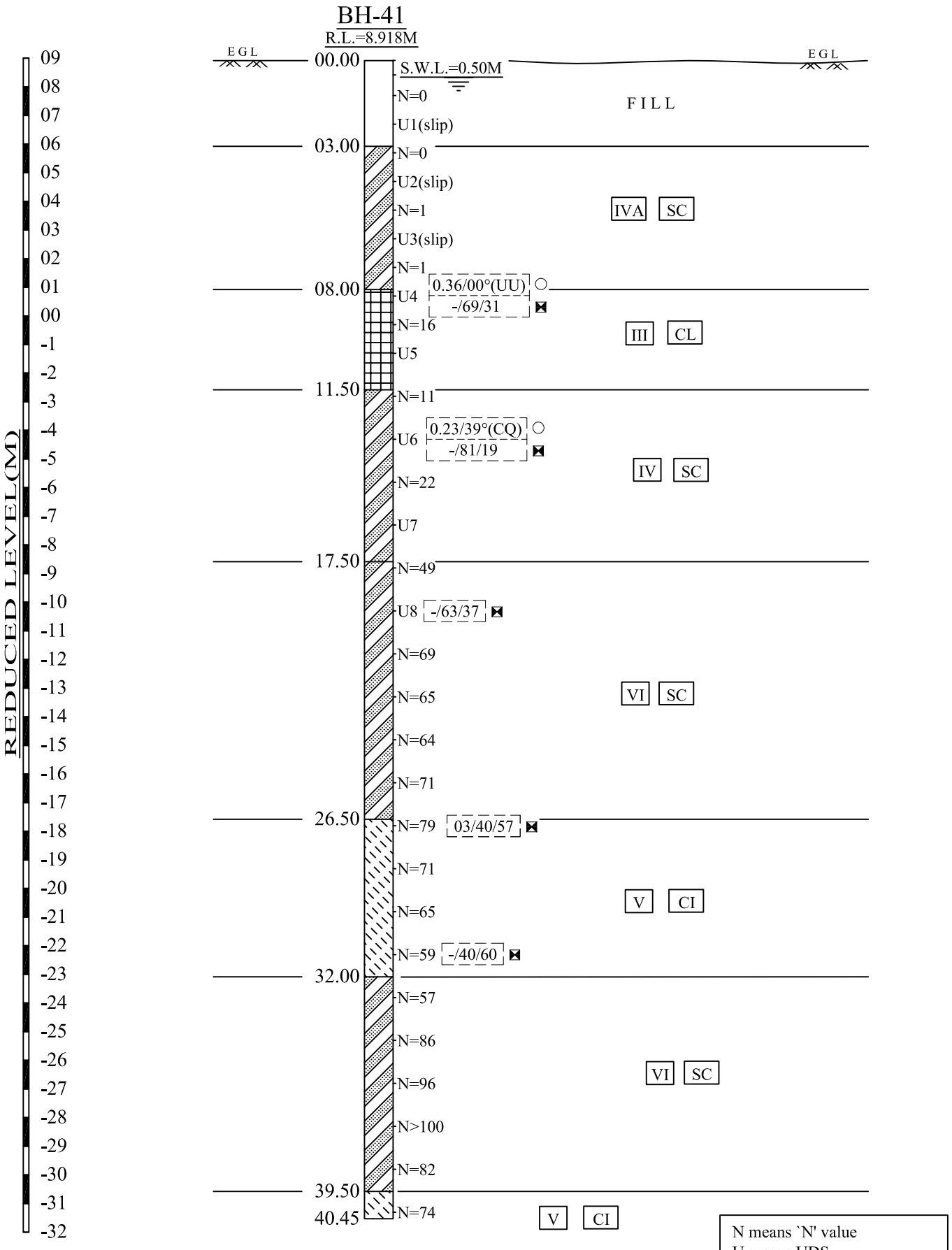
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 02 / 01 / 2015	Sheet No:	



(Aux. Central Monitoring Basin)

FIG. 2.21 : GENERALISED SOIL PROFILE

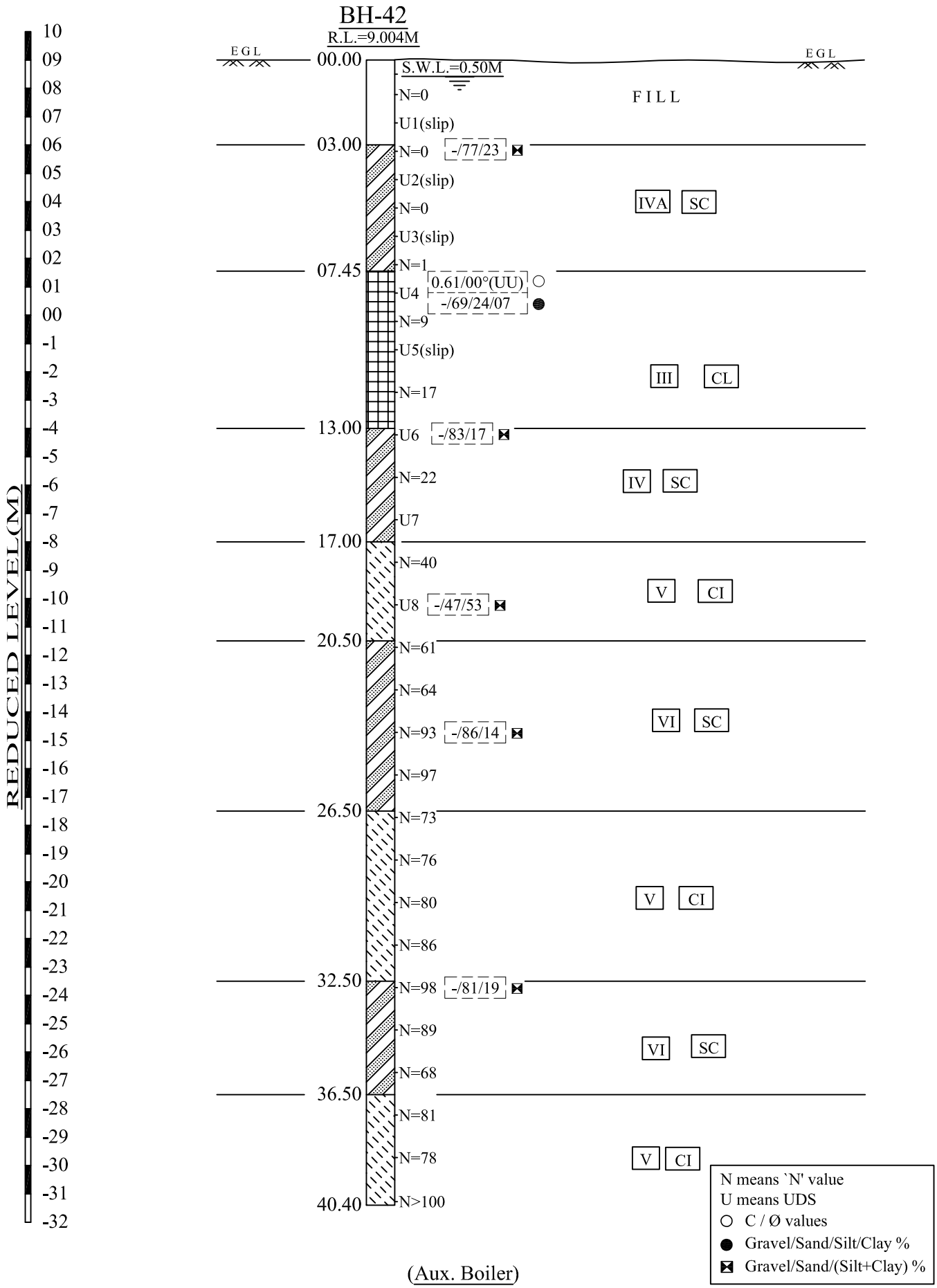
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 02 / 01 / 2015	Sheet No:	



(ETP)

FIG. 2.22 : GENERALISED SOIL PROFILE

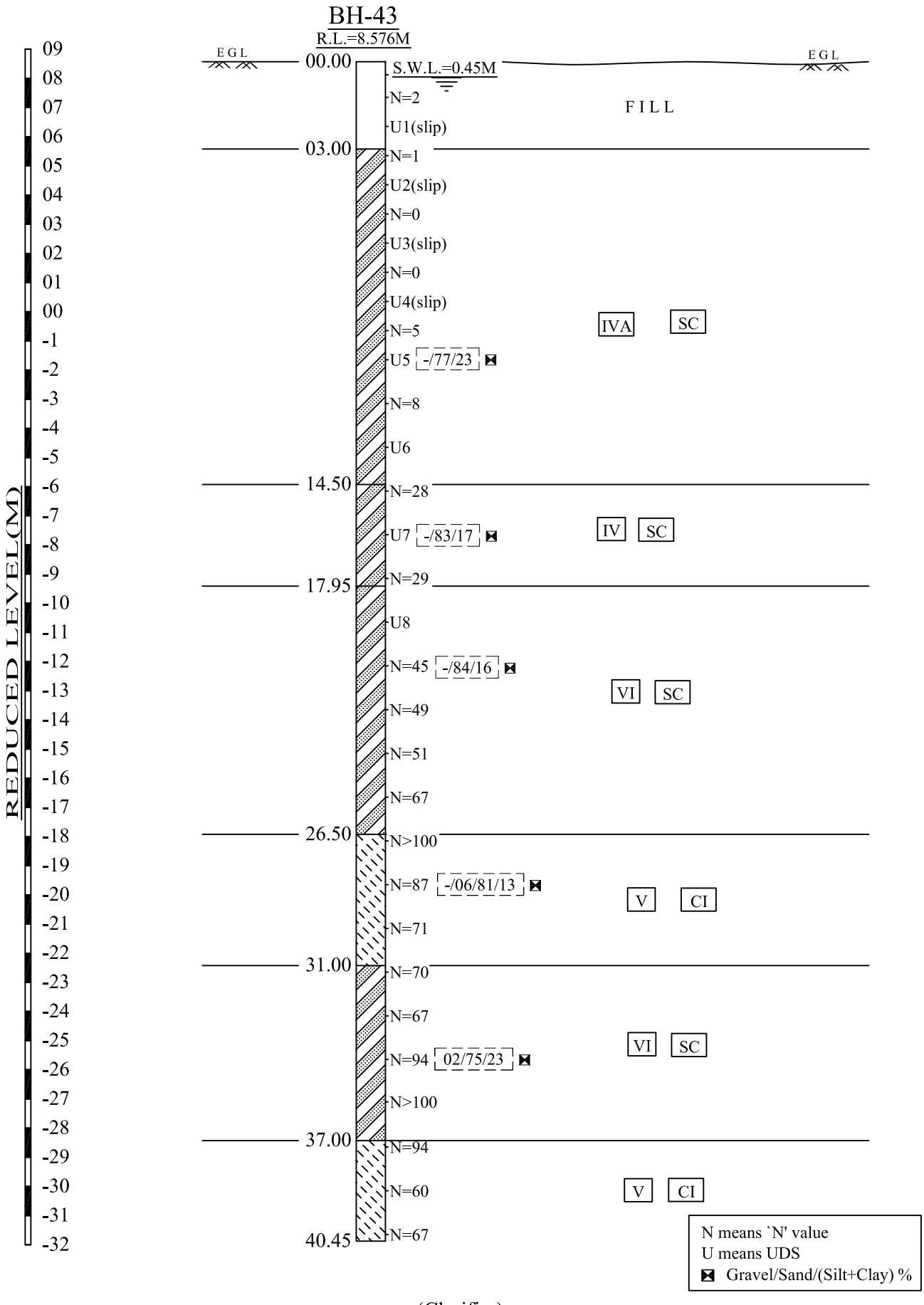
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 02 / 01 / 2015	Sheet No:	



(Aux. Boiler)

FIG. 2.23 : GENERALISED SOIL PROFILE

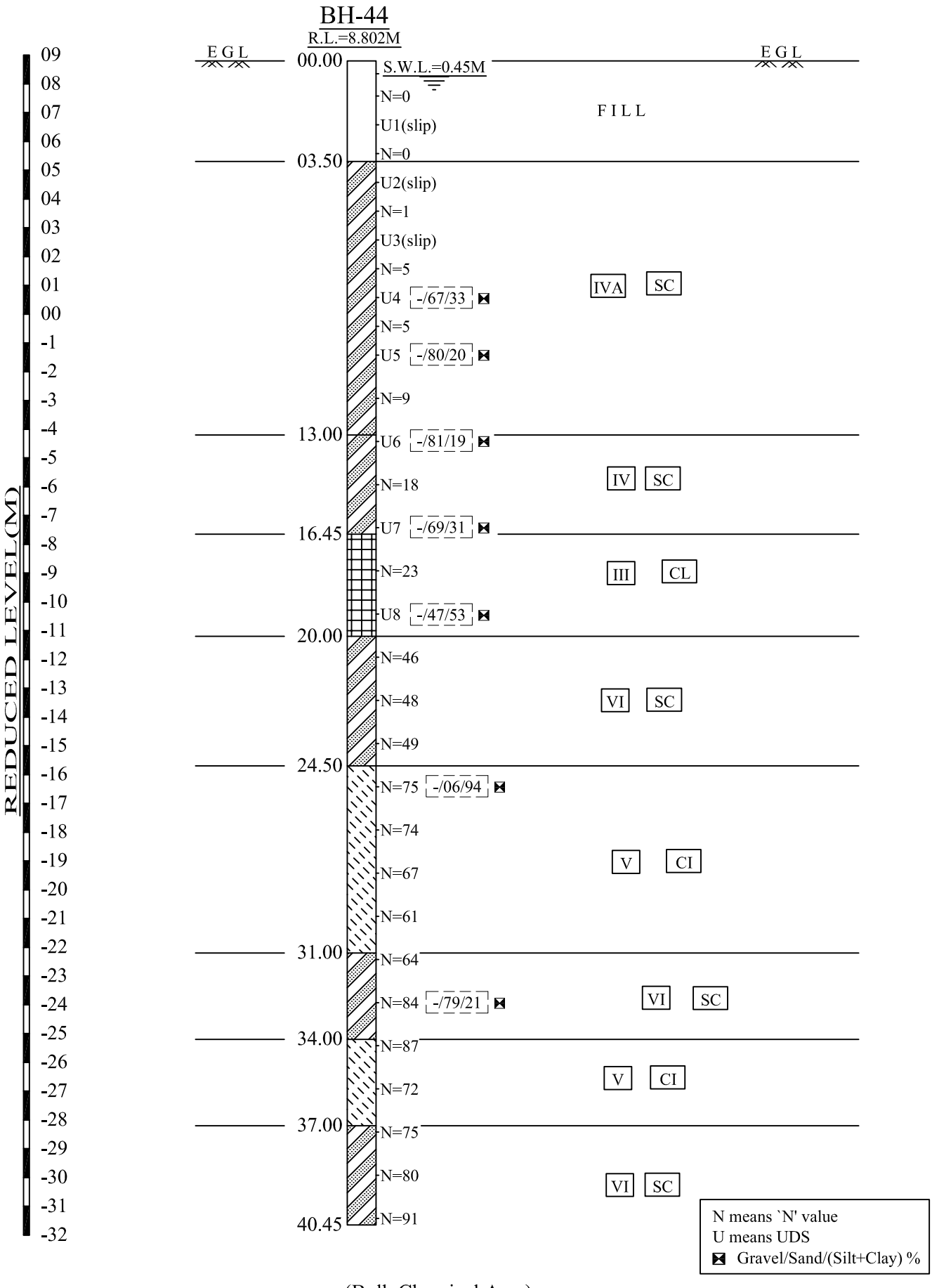
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 12 / 01 / 2015	Sheet No:	



(Clarifier)

FIG. 2.24 : GENERALISED SOIL PROFILE

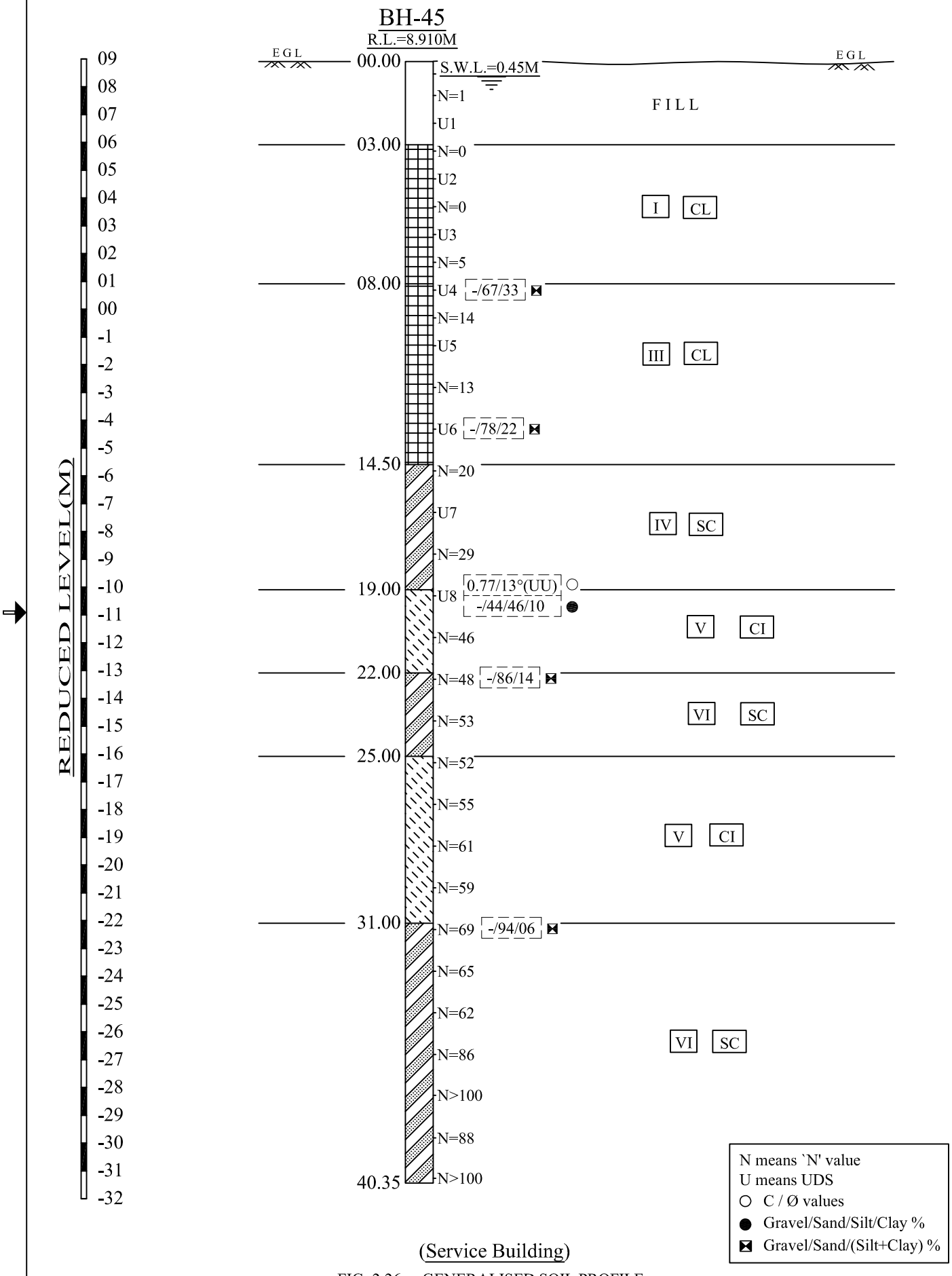
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 30 / 01 / 2015	Sheet No:	



(Bulk Chemical Area)

FIG. 2.25 : GENERALISED SOIL PROFILE

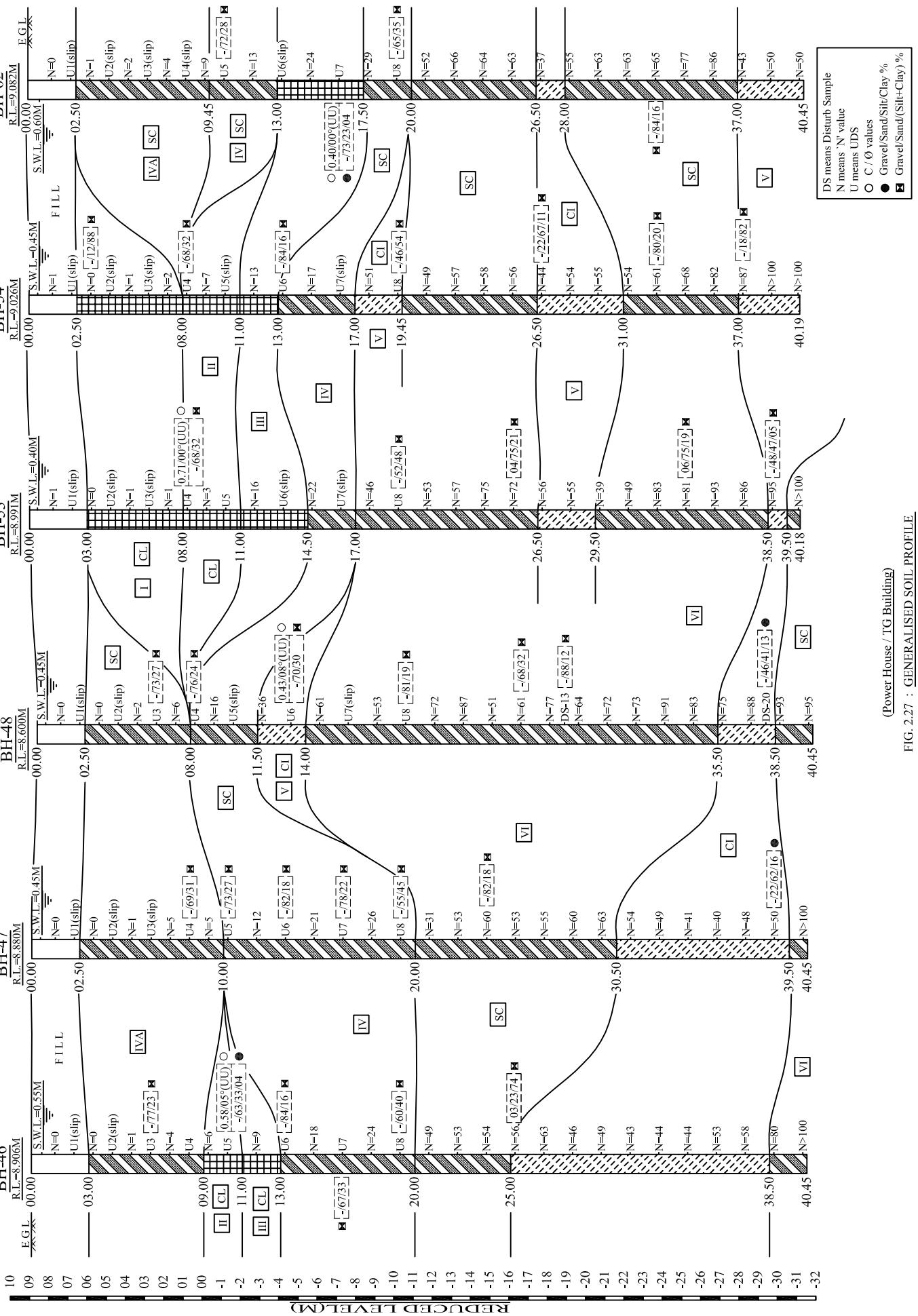
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 02 / 01 / 2015	Sheet No:	



(Service Building)

FIG. 2.26 : GENERALISED SOIL PROFILE

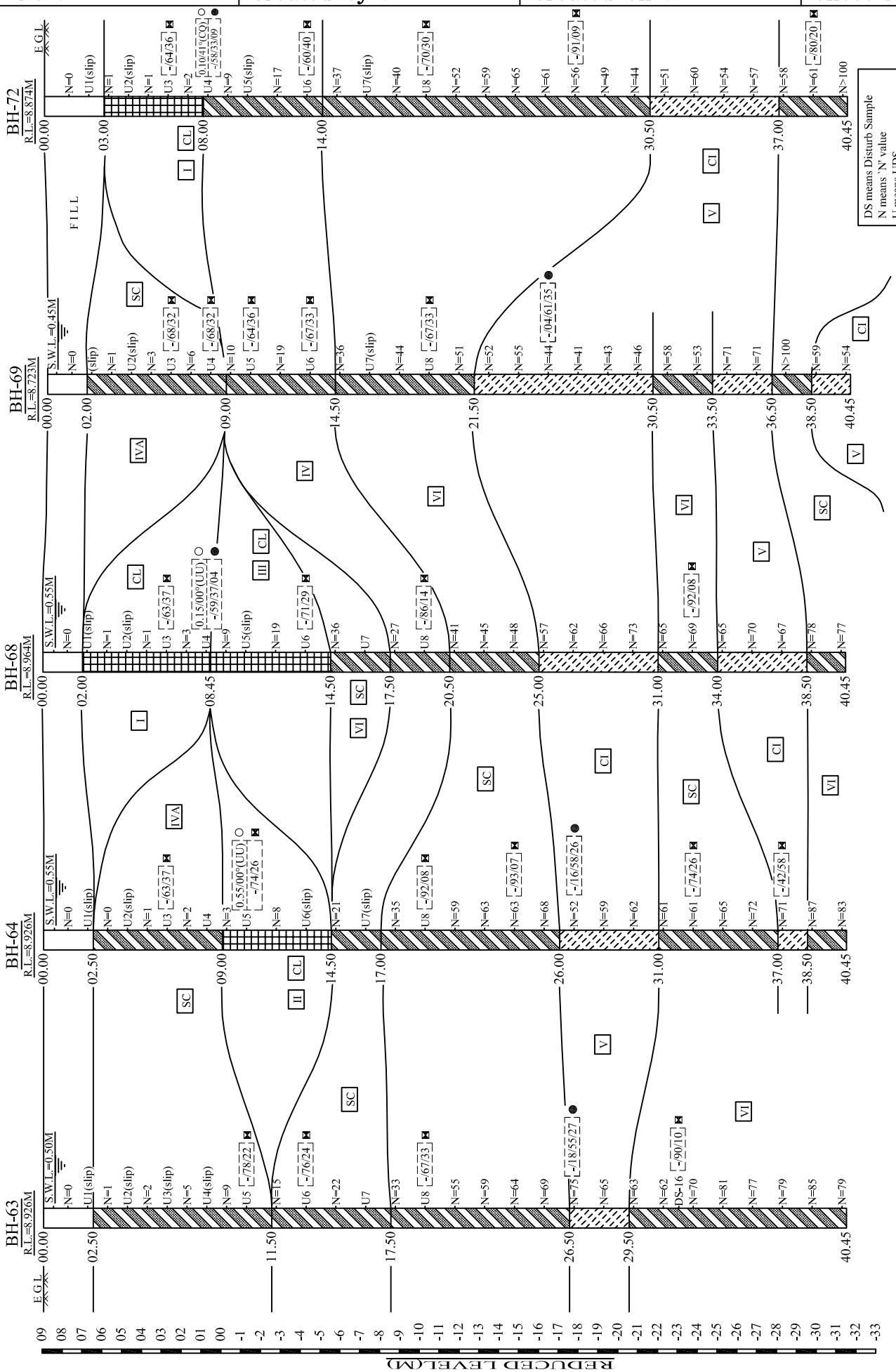
Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 04 / 02 / 2015	Sheet No:



(Power House / TG Building)

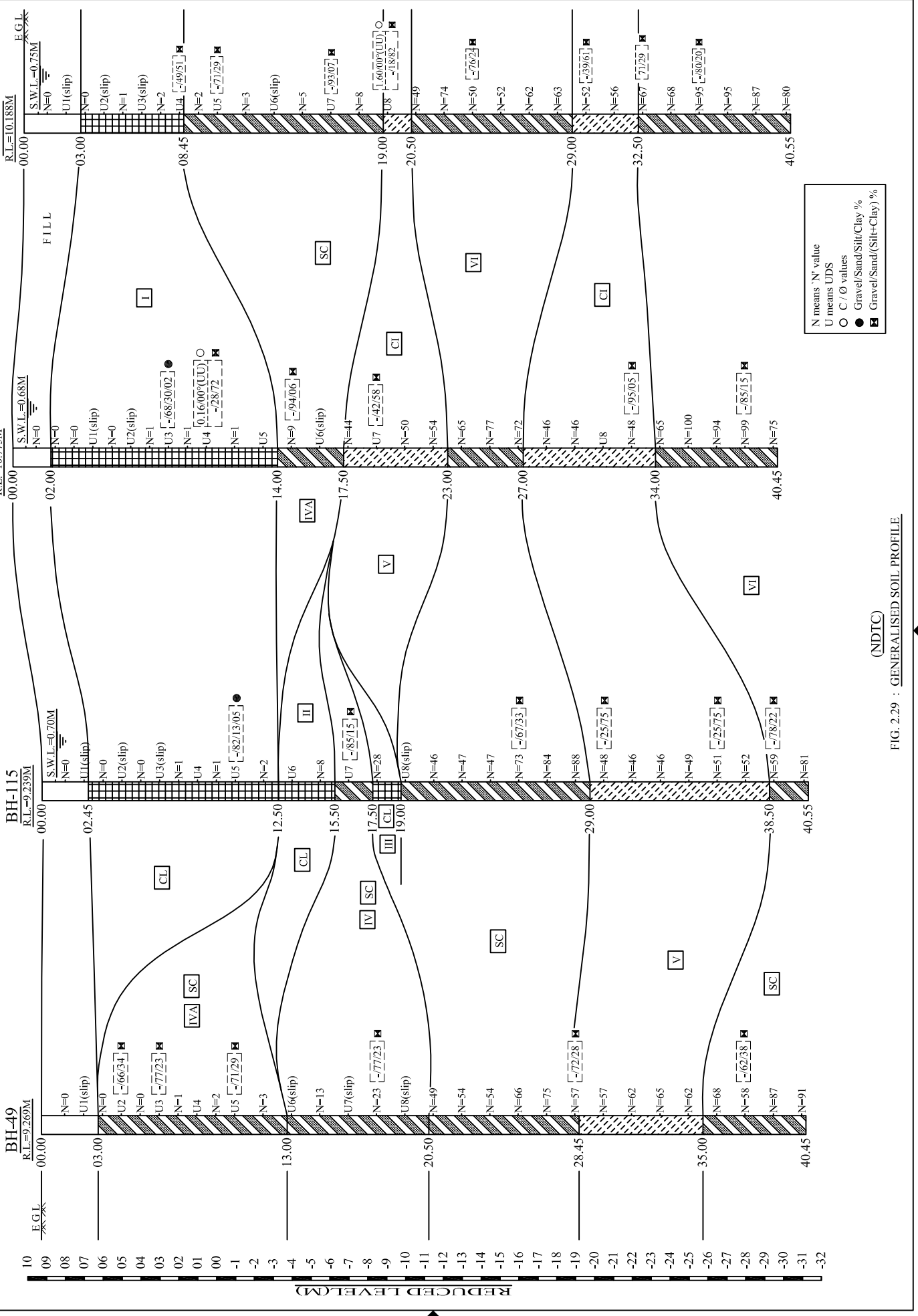
FIG. 2.27 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 04/02/20158	Sheet No:



(Power House / TG Building)

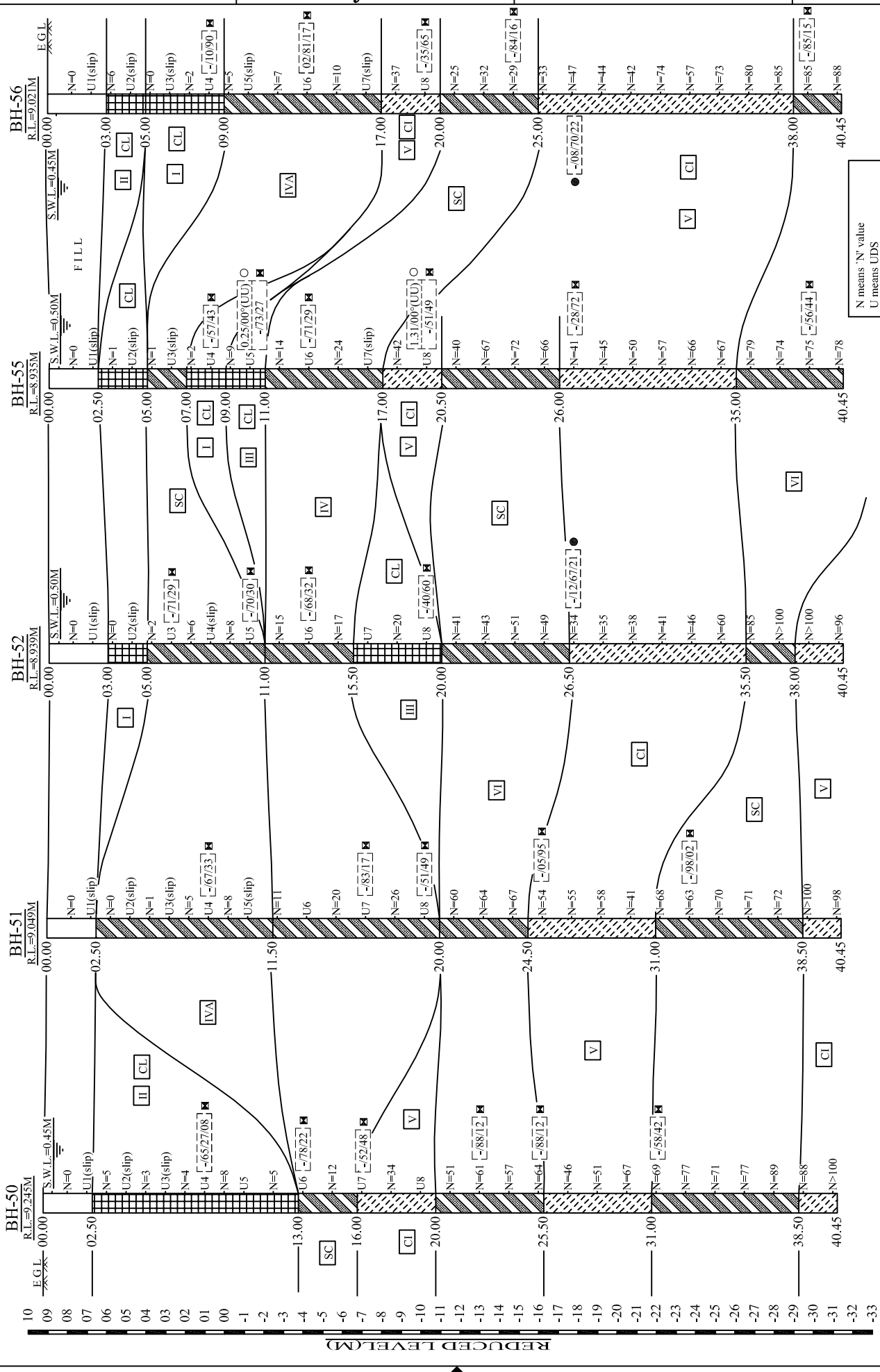
FIG. 2.28 : GENERALISED SOIL PROFILE



(NDTC)

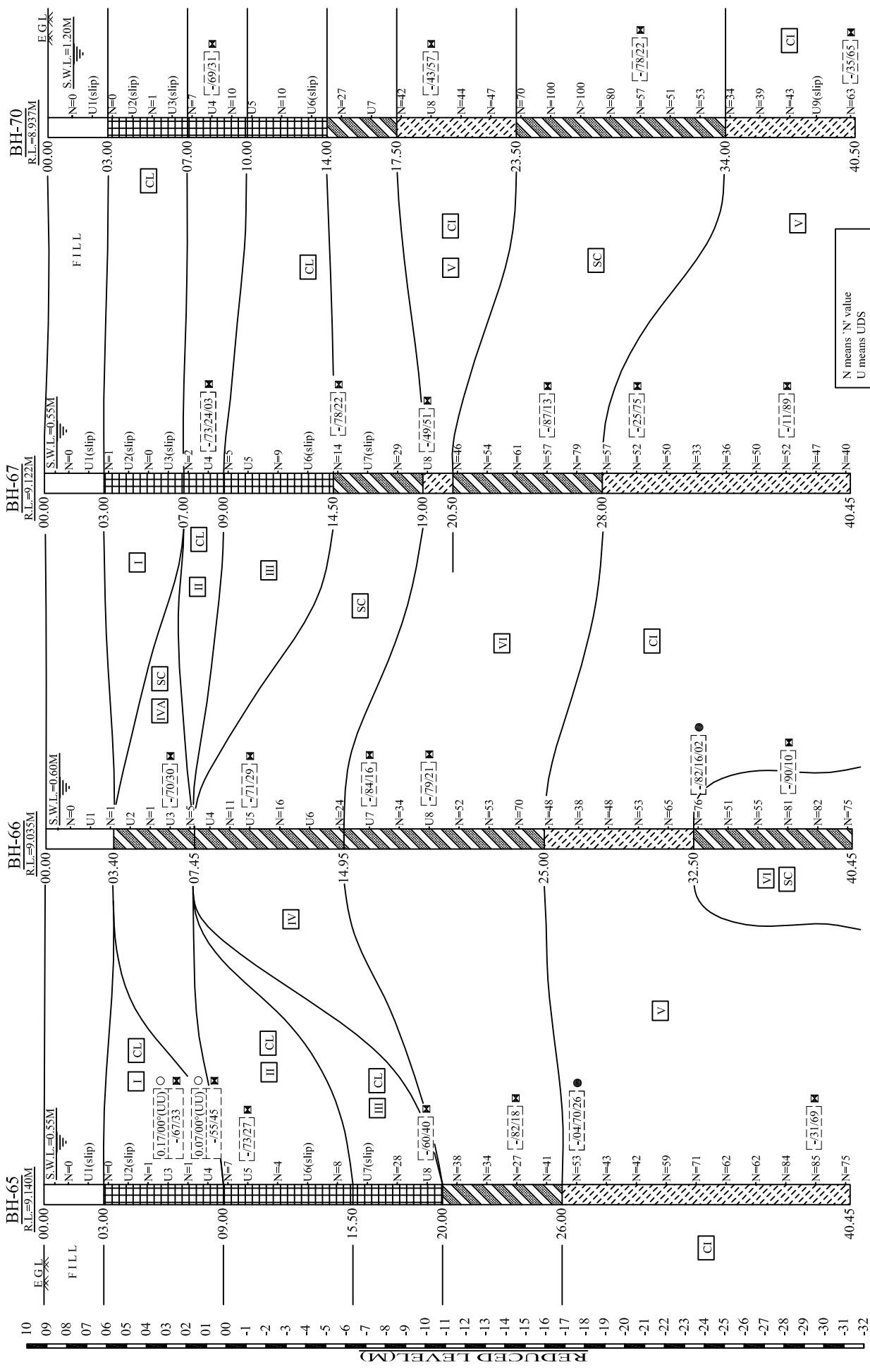
FIG. 2.29 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 20/12/2014	Sheet No:



(Transformer Yard)

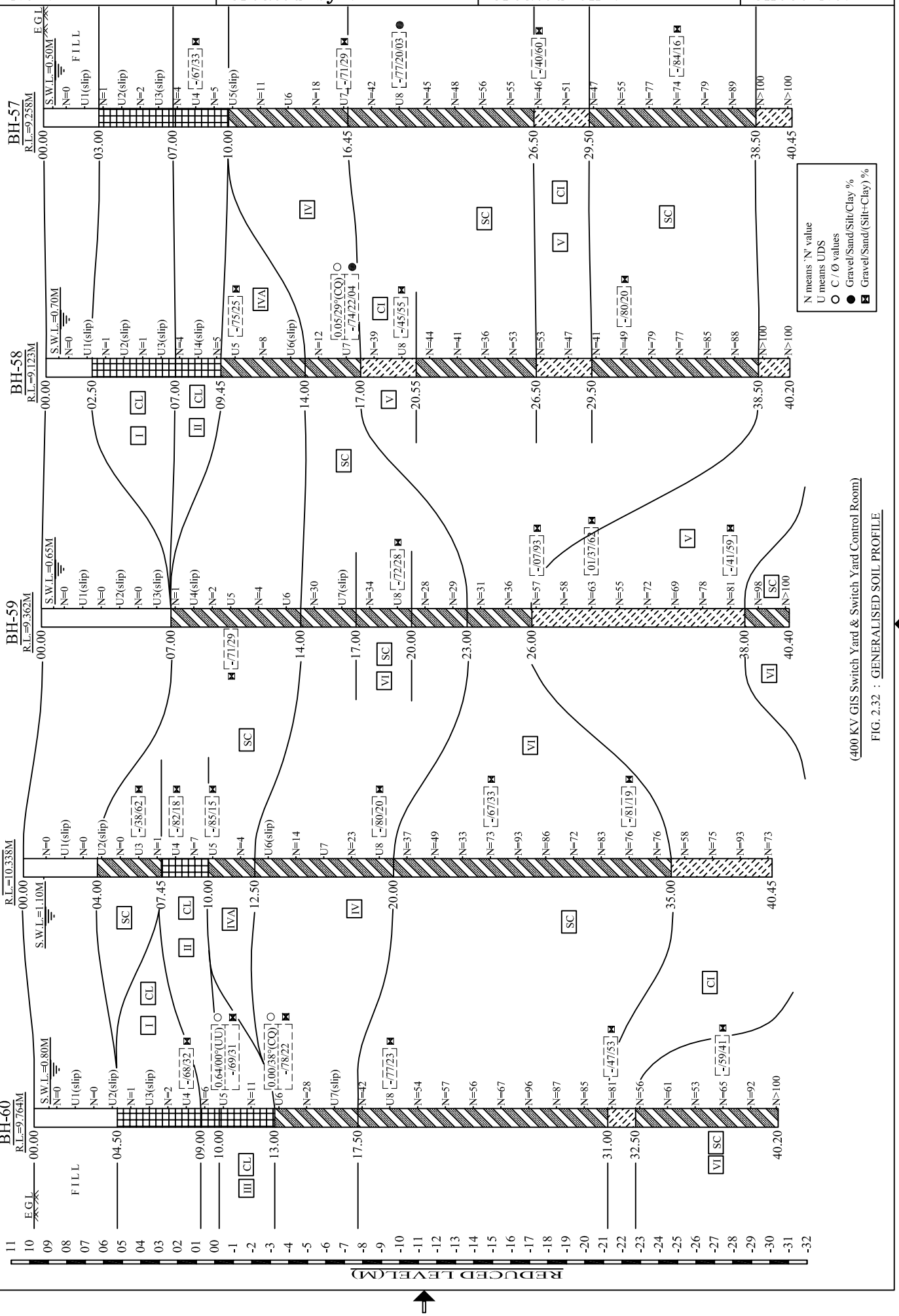
FIG. 2.30 : GENERALISED SOIL PROFILE



(Transformer Yard)

FIG. 2.31 : GENERALISED SOIL PROFILE

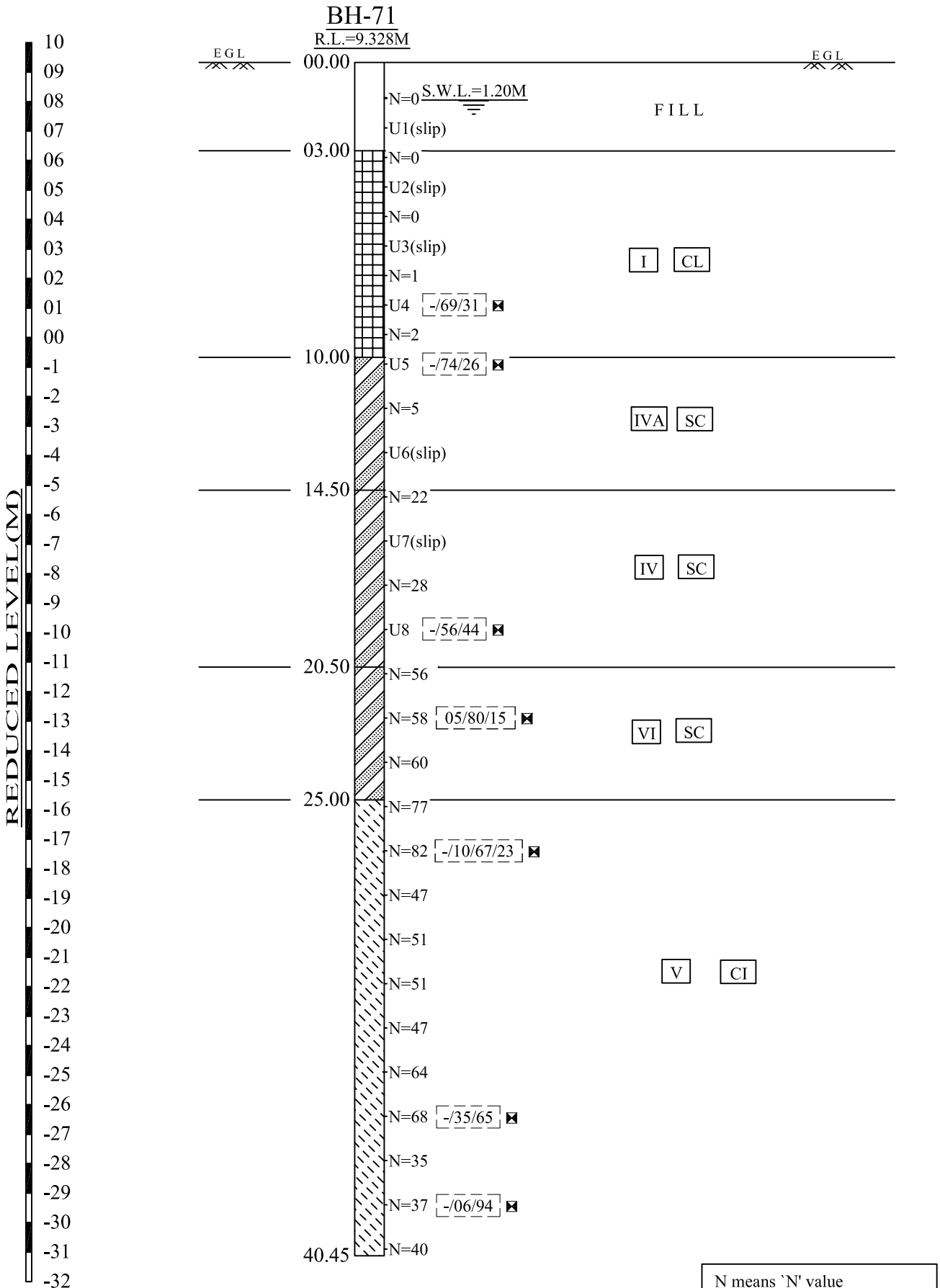
Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 20/12/2014	Sheet No:



(400 KV GIS Switch Yard & Switch Yard Control Room)

FIG. 2.32 : GENERALISED SOIL PROFILE

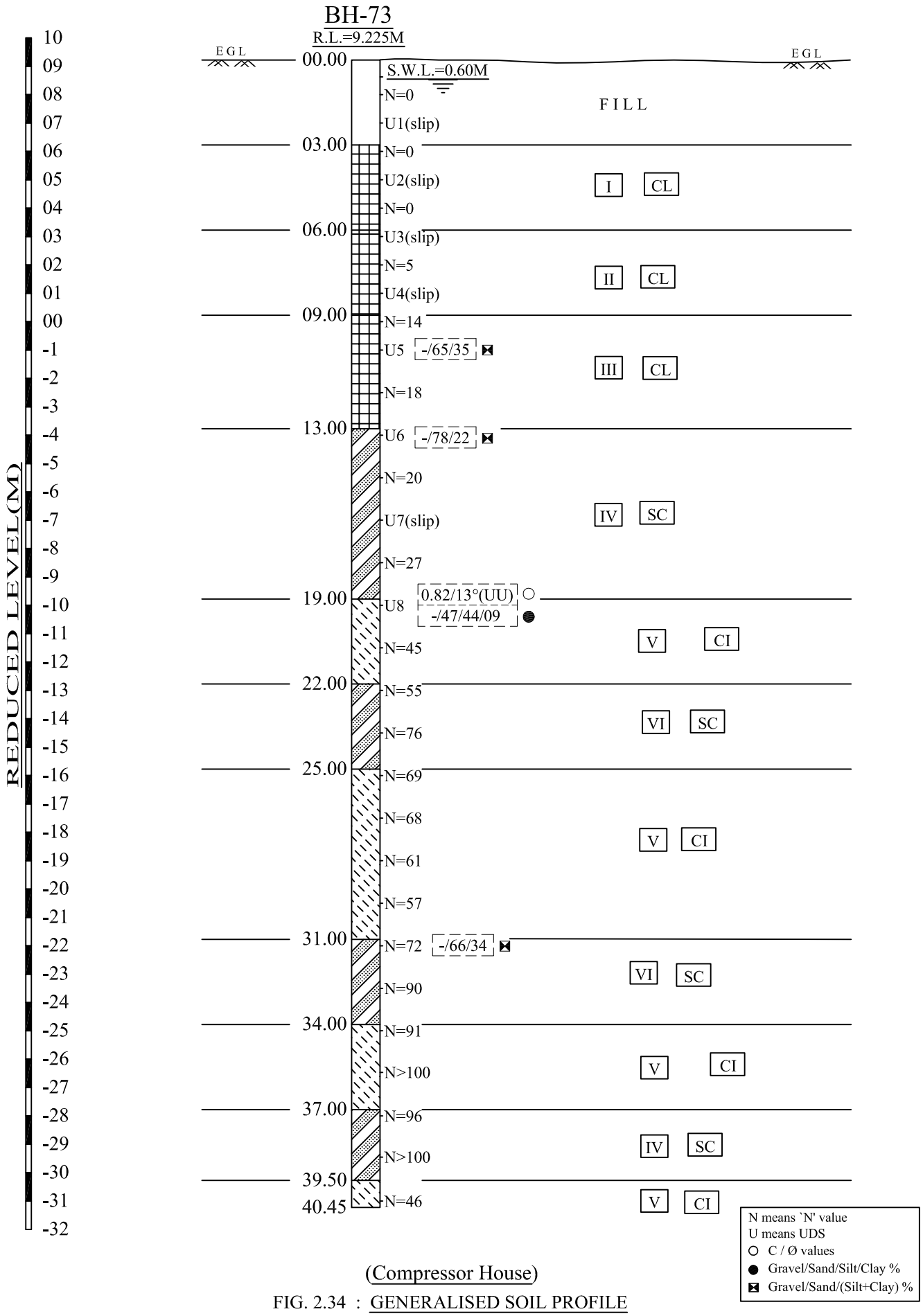
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 02 / 01 / 2015	Sheet No:	



(Air Washer Room)

FIG. 2.33 : GENERALISED SOIL PROFILE

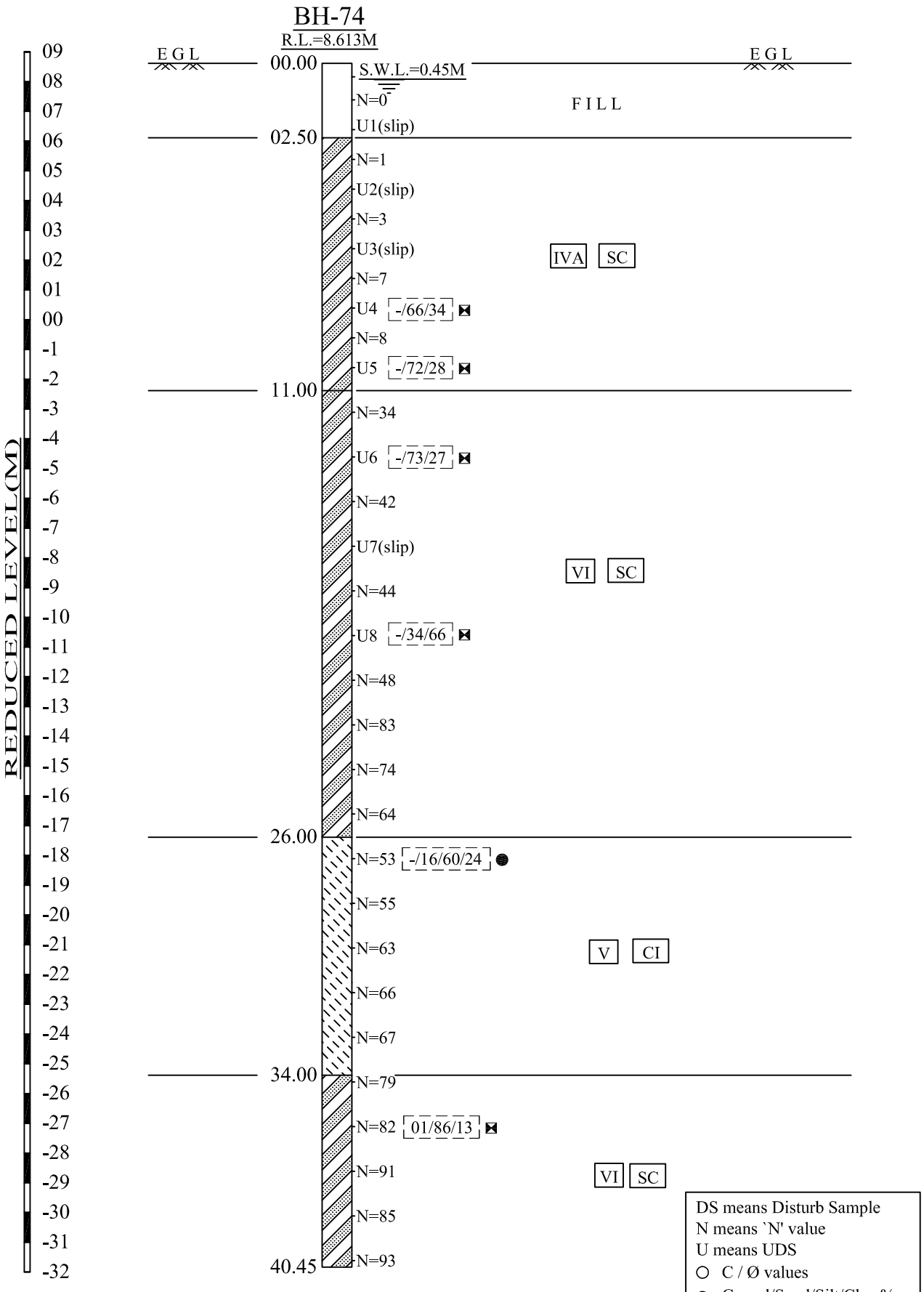
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 05 / 01 / 2015	Sheet No:	



(Compressor House)

FIG. 2.34 : GENERALISED SOIL PROFILE

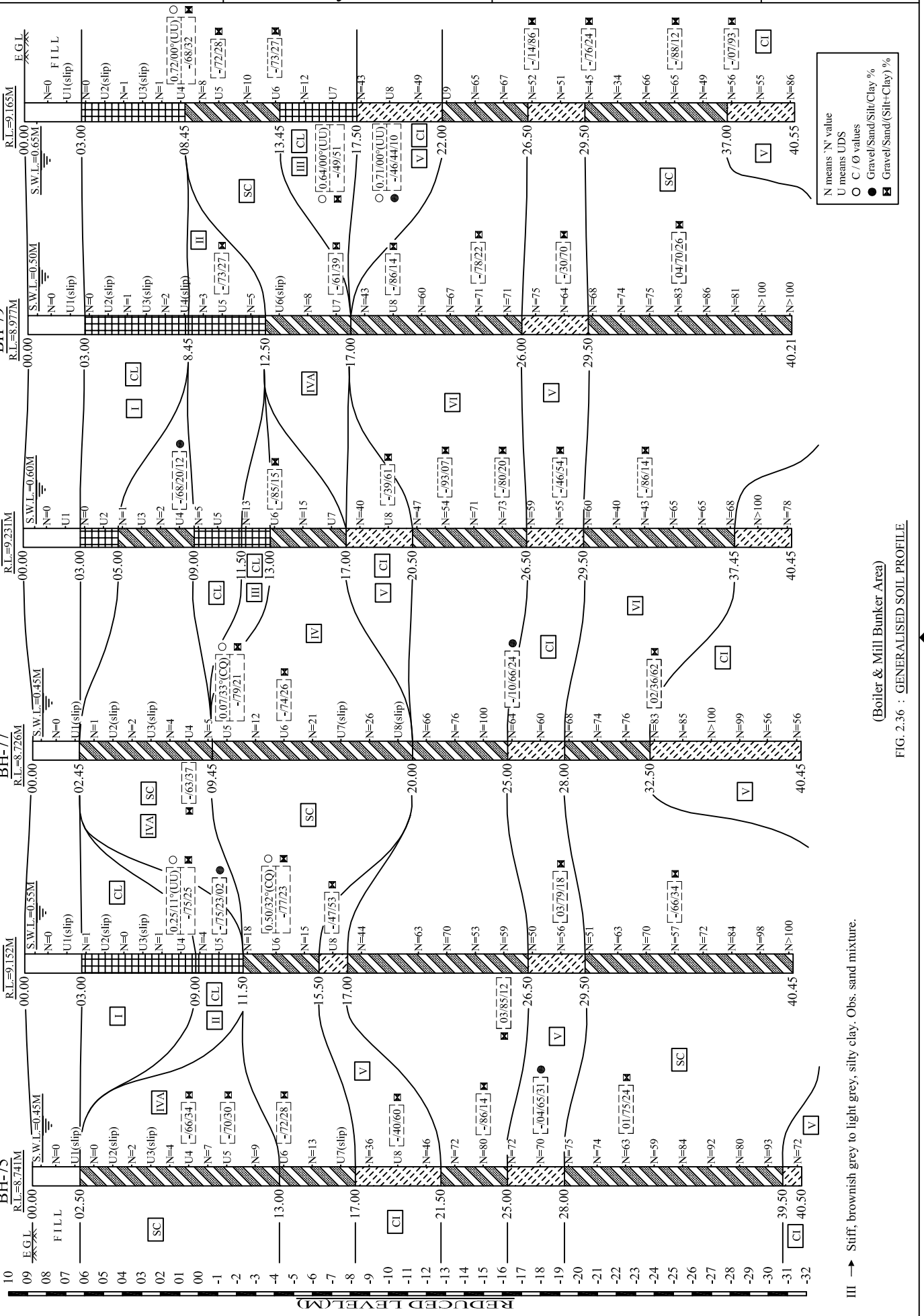
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 04 / 02 / 2015	Sheet No:	



(Near Condensate Storage Tank)

FIG. 2.35 : GENERALISED SOIL PROFILE

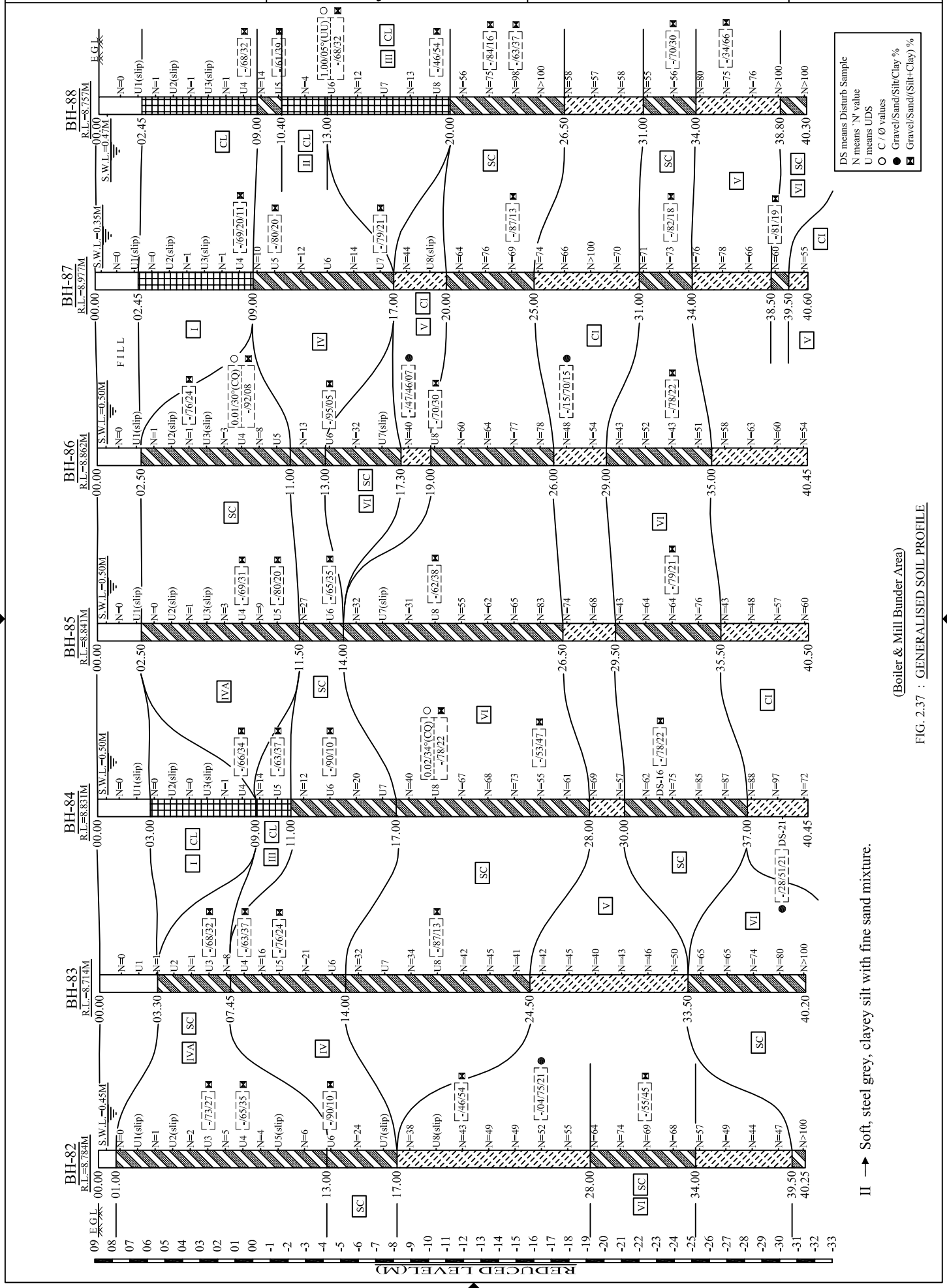
Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3 3 8 8	Created by : Chandrani	Created on : 05 / 01 / 2015	Sheet No:



(Boiler & Mill Bunker Area)

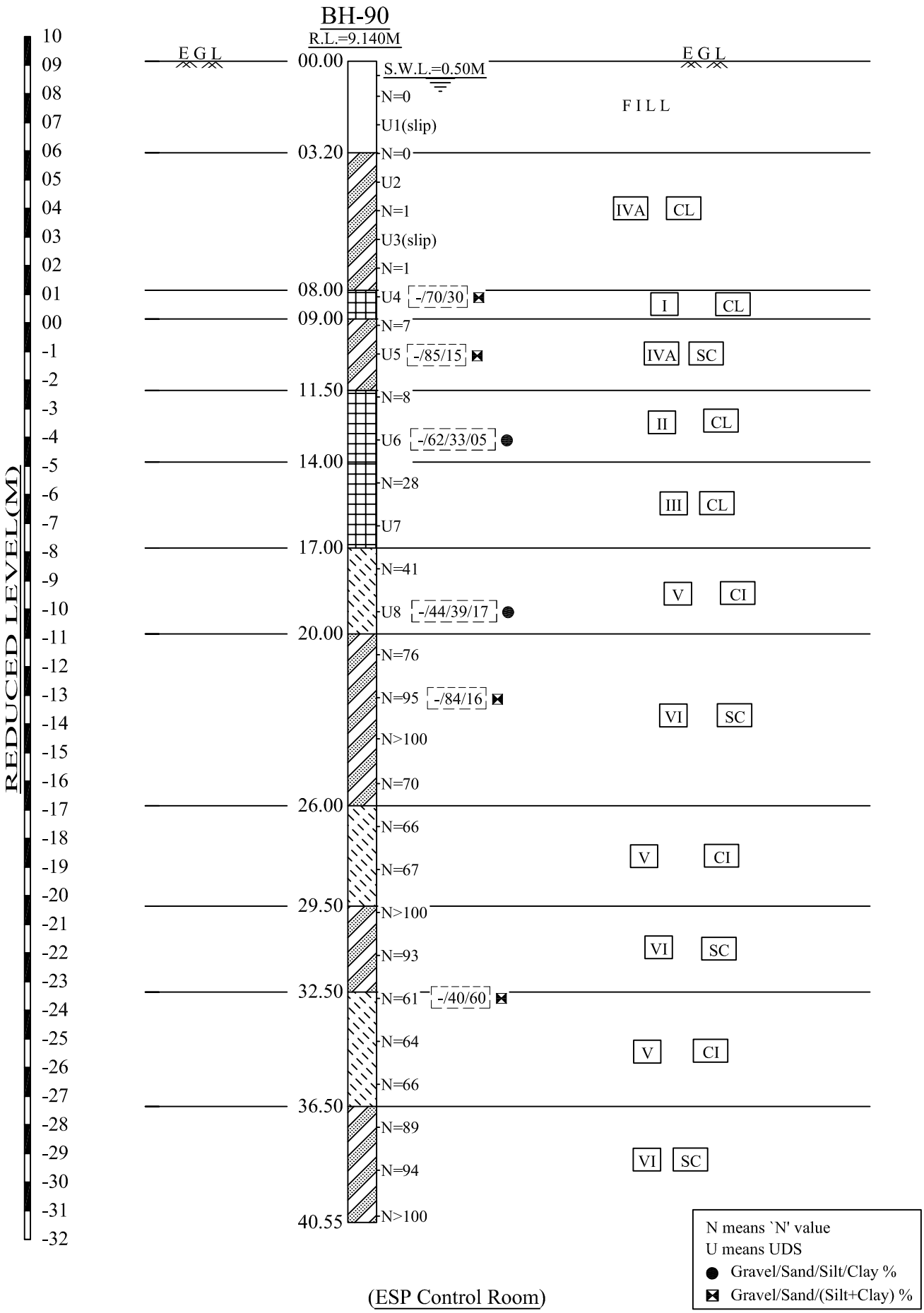
FIG. 2.36 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3 3 8 8	Created by : Chandrani	Created on : 04 / 02 / 2015	Sheet No:



(Boiler & Mill Bunder Area)

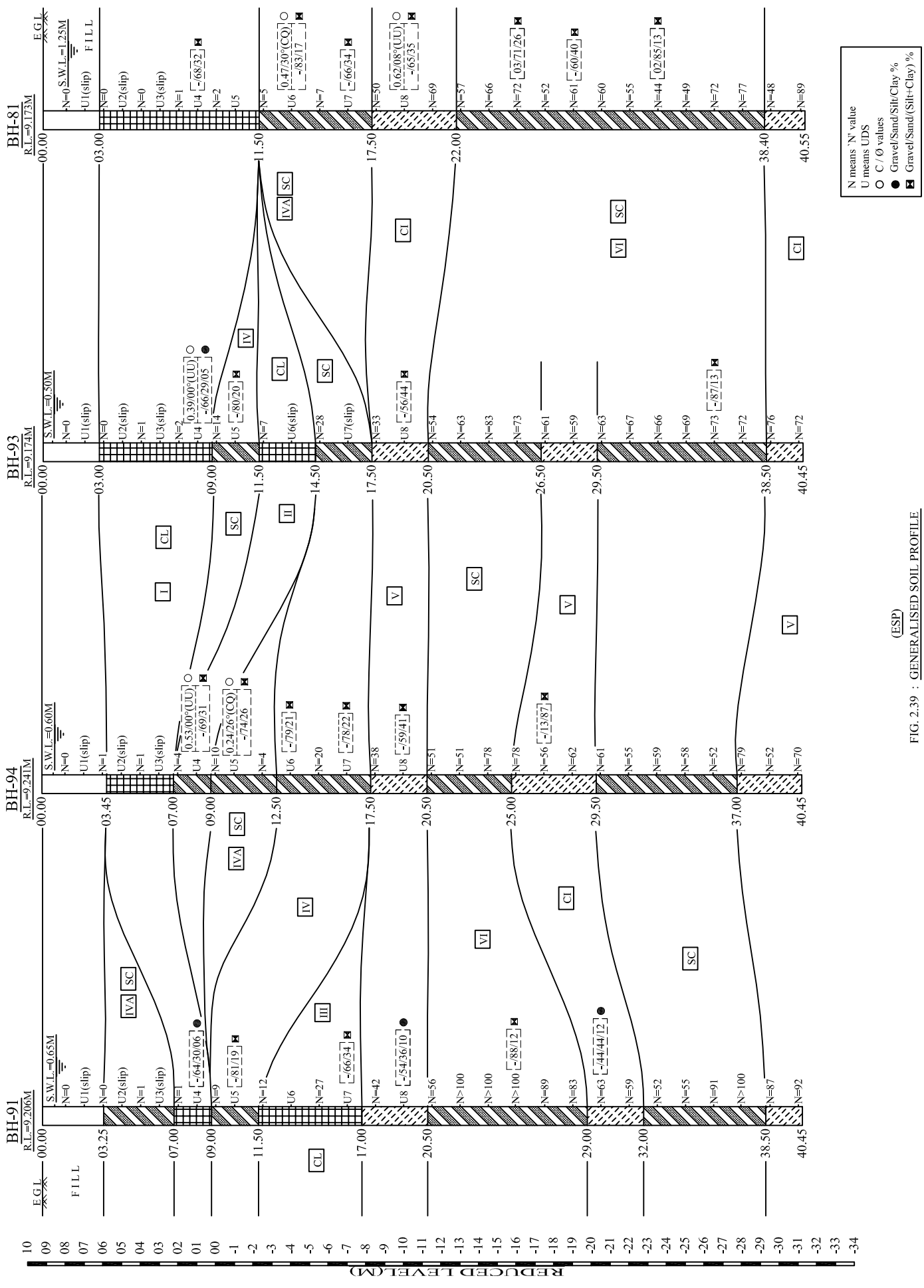
FIG. 2.37 : GENERALISED SOIL PROFILE



(ESP Control Room)

FIG. 2.38 : GENERALISED SOIL PROFILE

Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 27/01/2015	Sheet No:



(ESP)

FIG. 2.39 : GENERALISED SOIL PROFILE

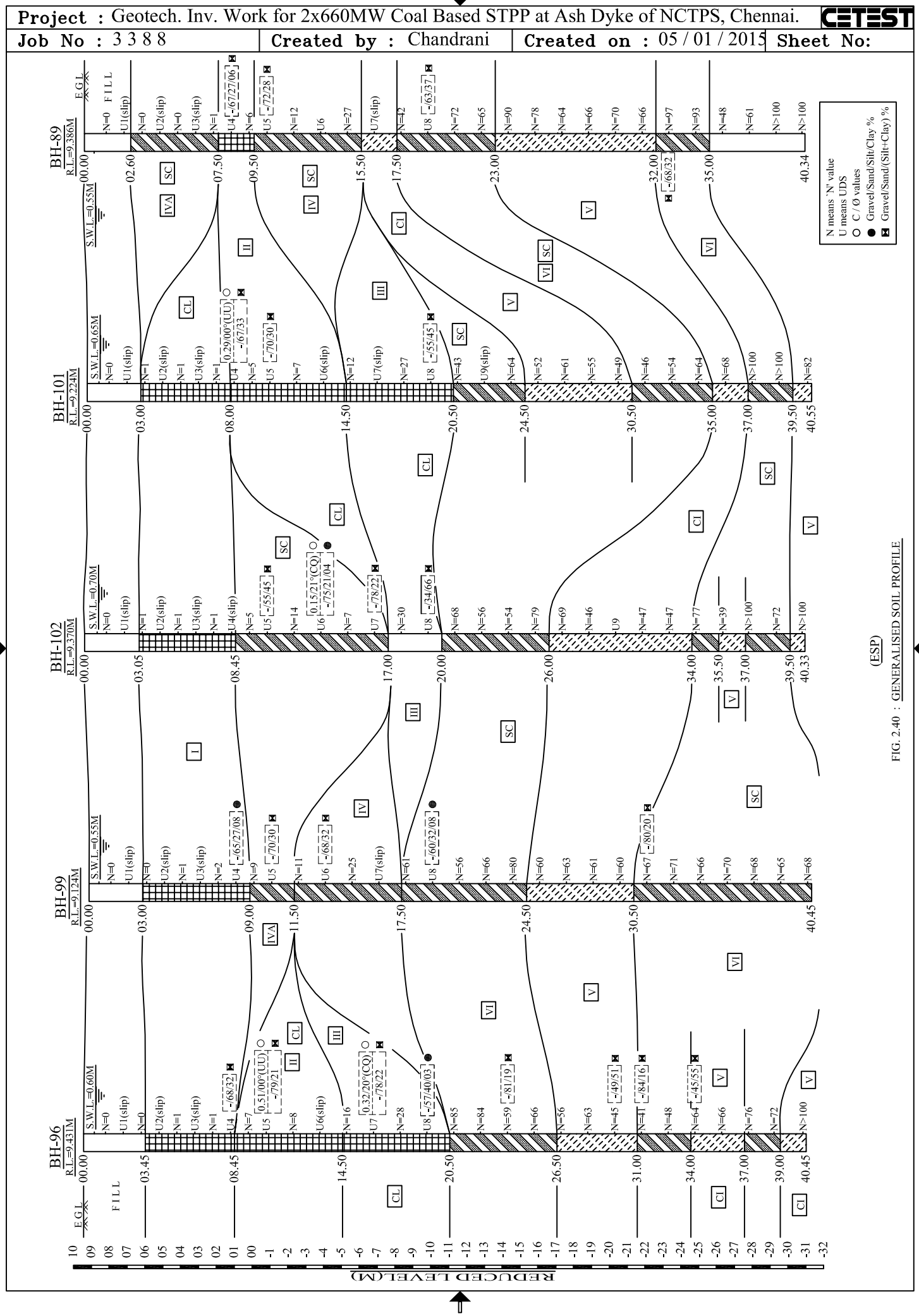
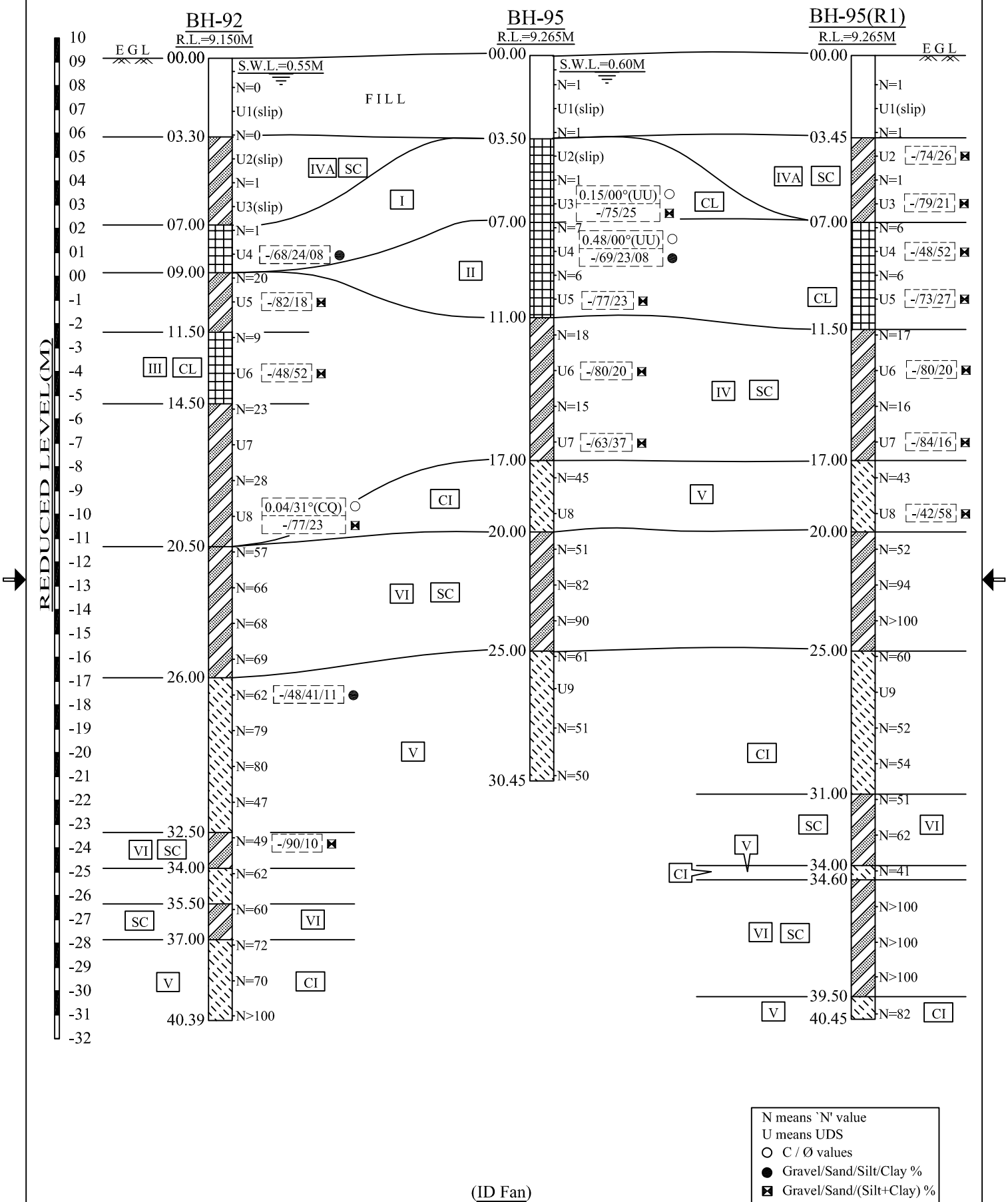


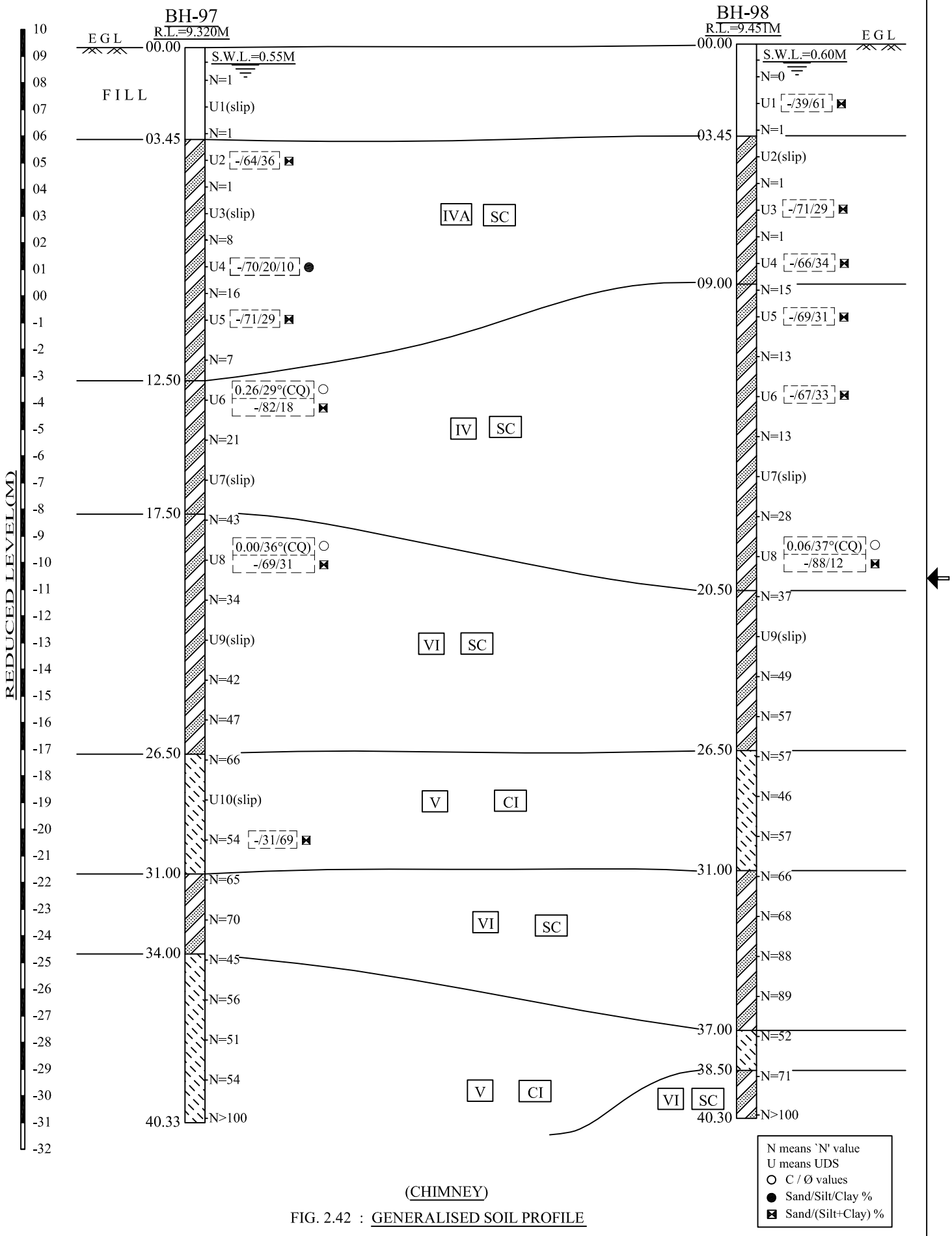
FIG. 2.40 : GENERALISED SOIL PROFILE



(ID Fan)

FIG. 2.41 : GENERALISED SOIL PROFILE

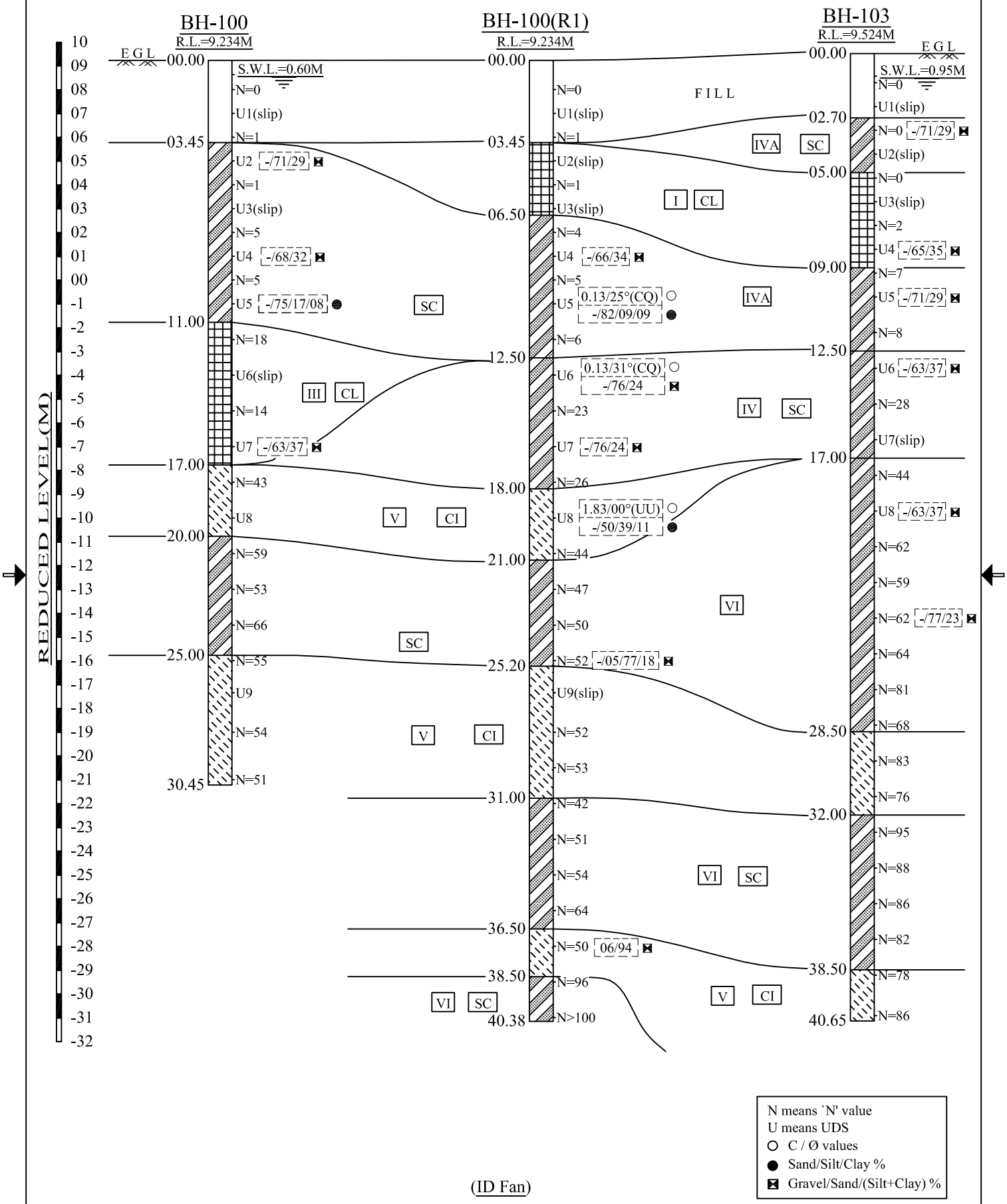
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.		CETEST
Job No : 3388	Created by : Chandrani	Created on : 18 / 12 / 2014	Sheet No:



(CHIMNEY)

FIG. 2.42 : GENERALISED SOIL PROFILE

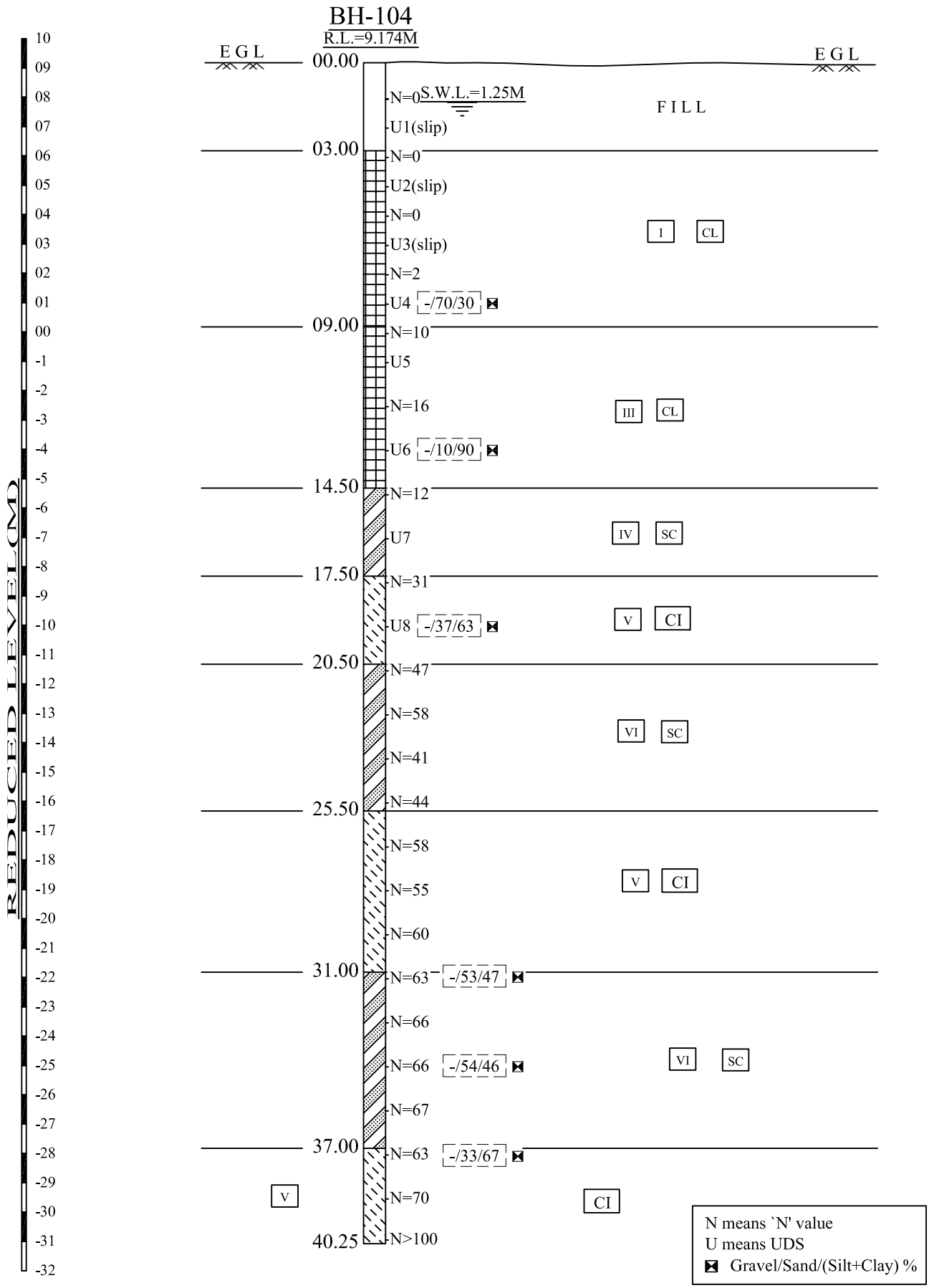
Project : Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : CHANDRANI	Created on : 02/12/2014	Sheet No:



(ID Fan)

FIG. 2.43 : GENERALISED SOIL PROFILE

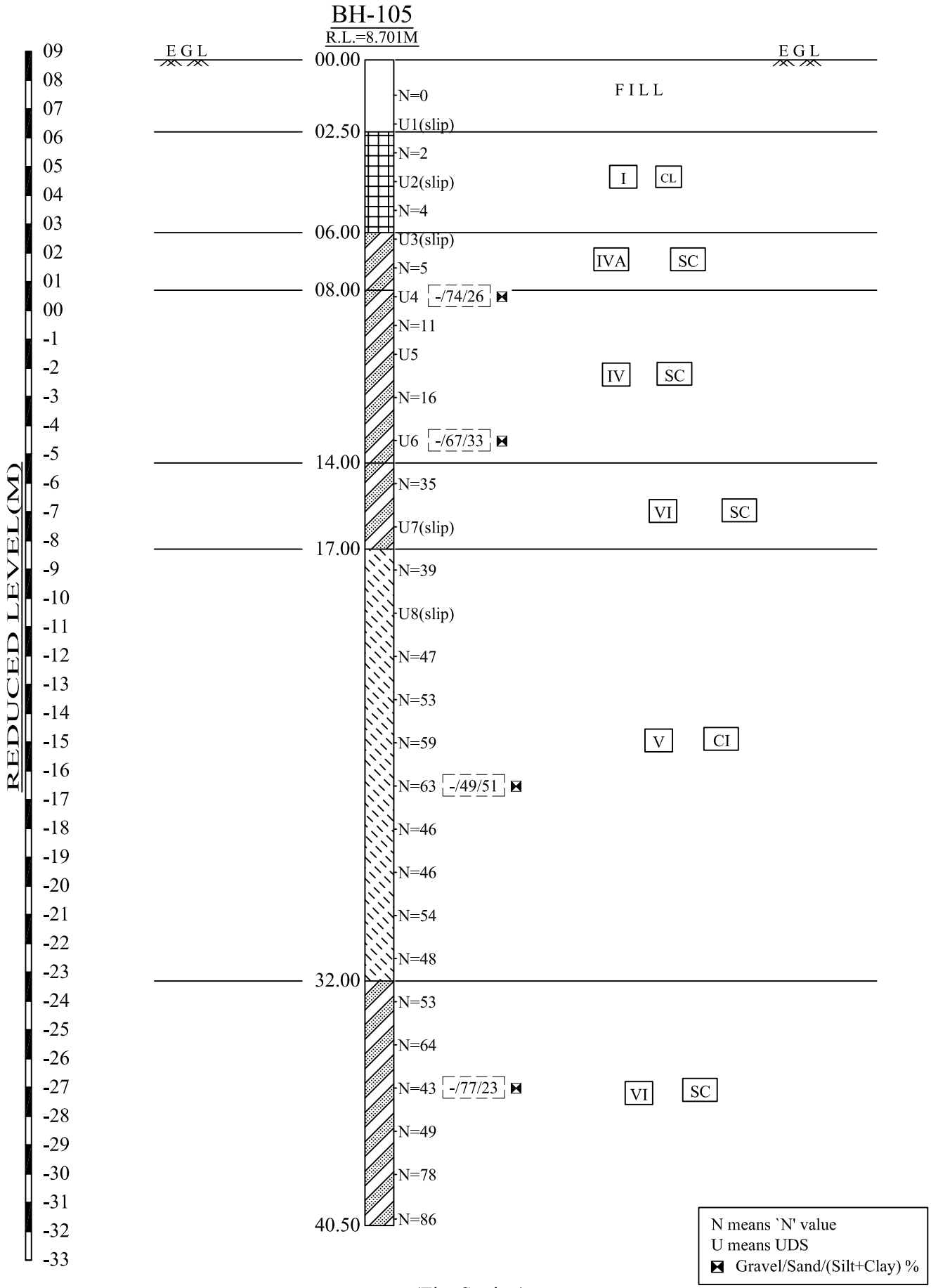
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 18 / 12 / 2014	Sheet No:	



(ESP Control Room)

FIG. 2.44 : GENERALISED SOIL PROFILE

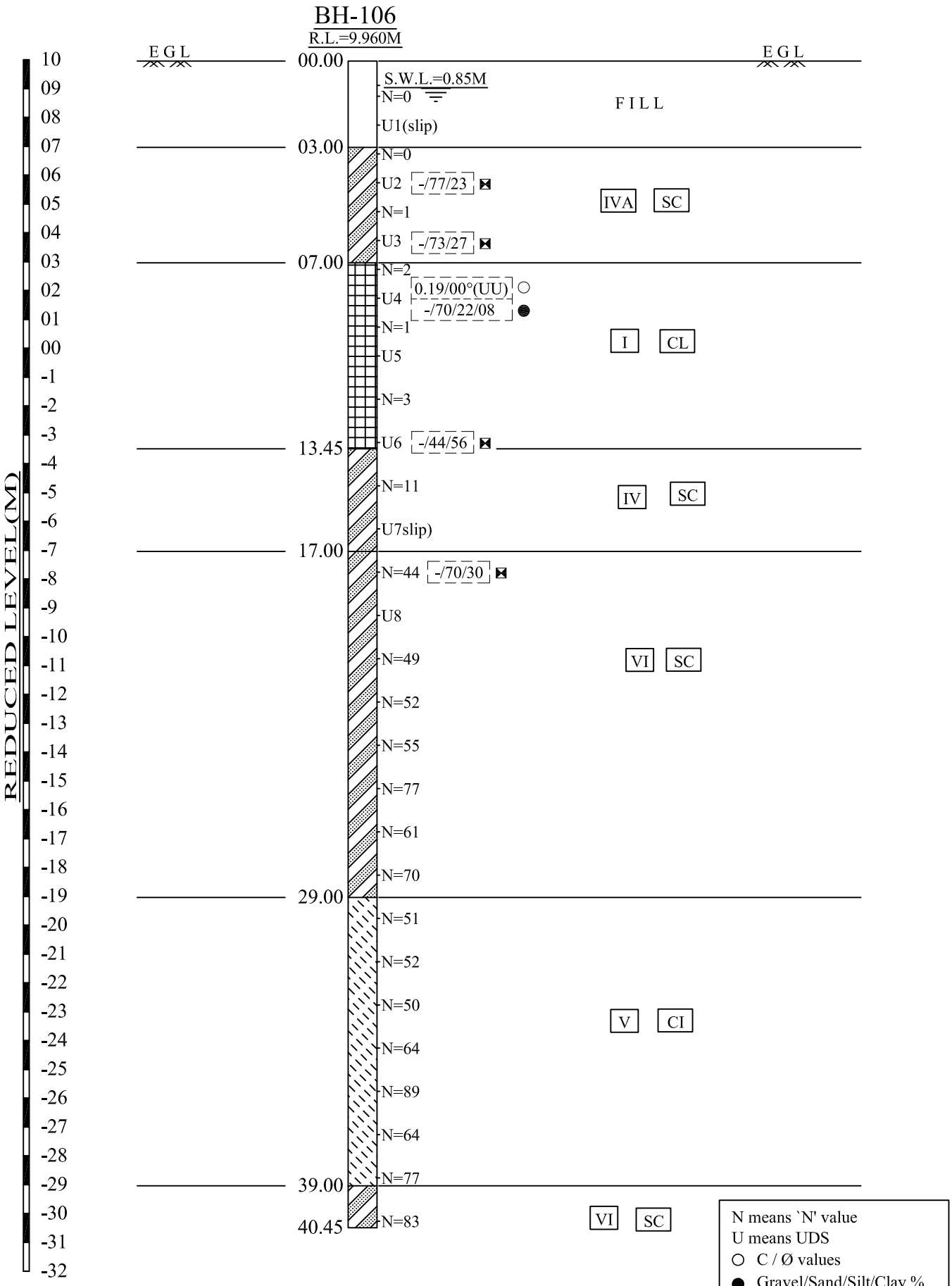
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 31 / 01 / 2015	Sheet No:	



(Fire Station)

FIG. 2.45 : GENERALISED SOIL PROFILE

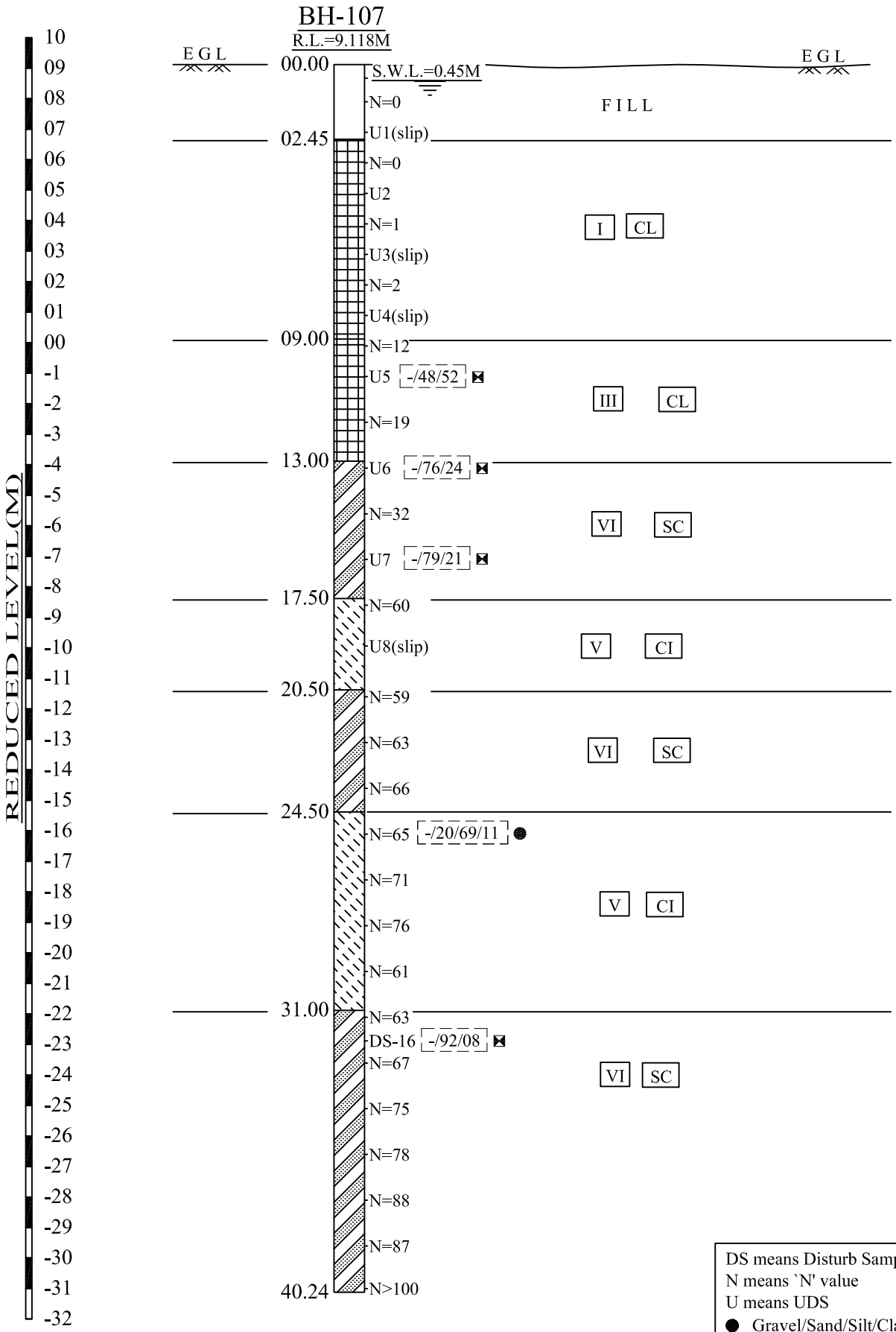
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 31 / 01 / 2015	Sheet No:	



(HDO / LDO Forwarding Pump House)

FIG. 2.46 : GENERALISED SOIL PROFILE

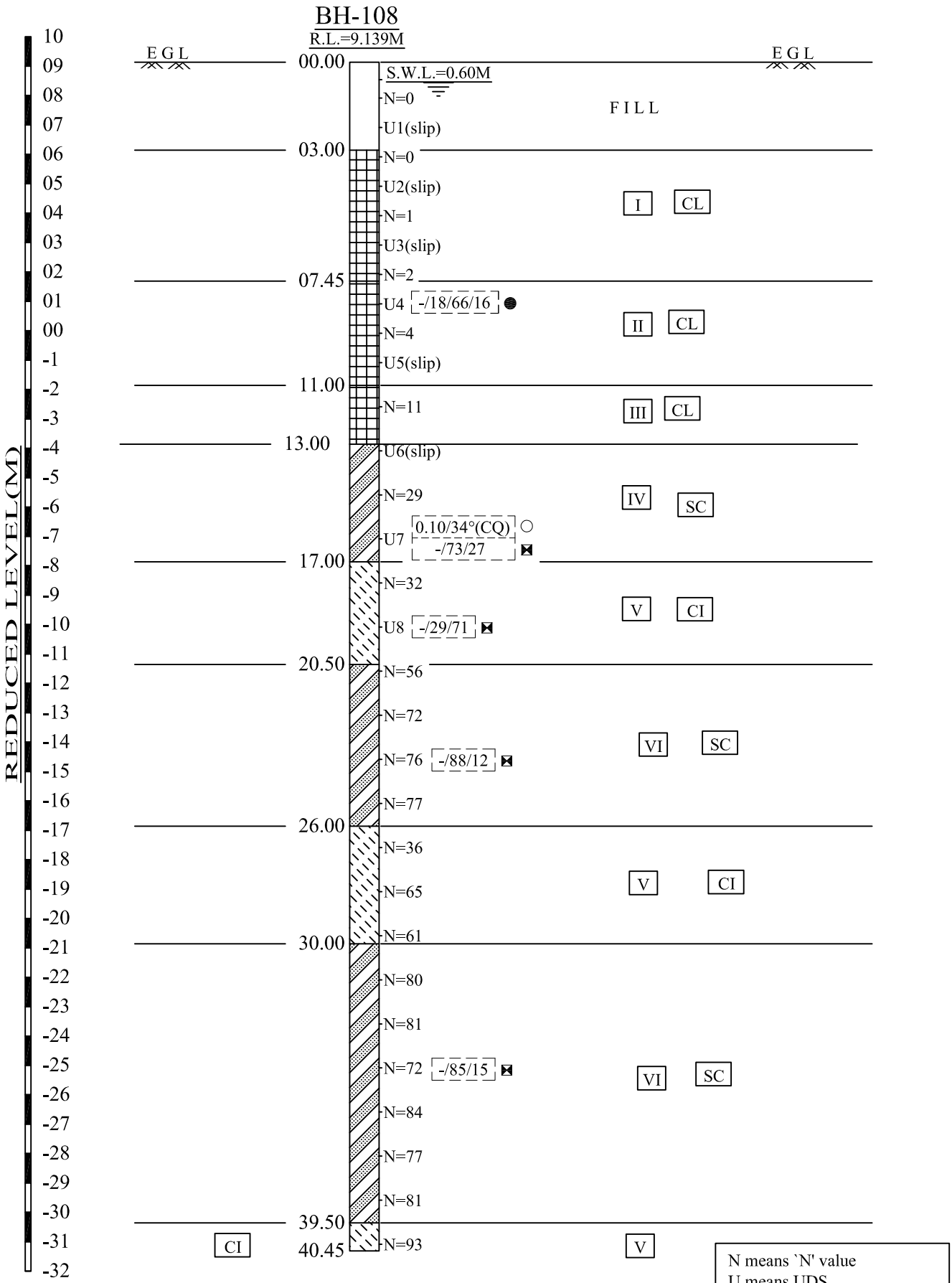
Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 02 / 01 / 2015	Sheet No:	



(HDO / LDO Storage Tank Dyke Area)

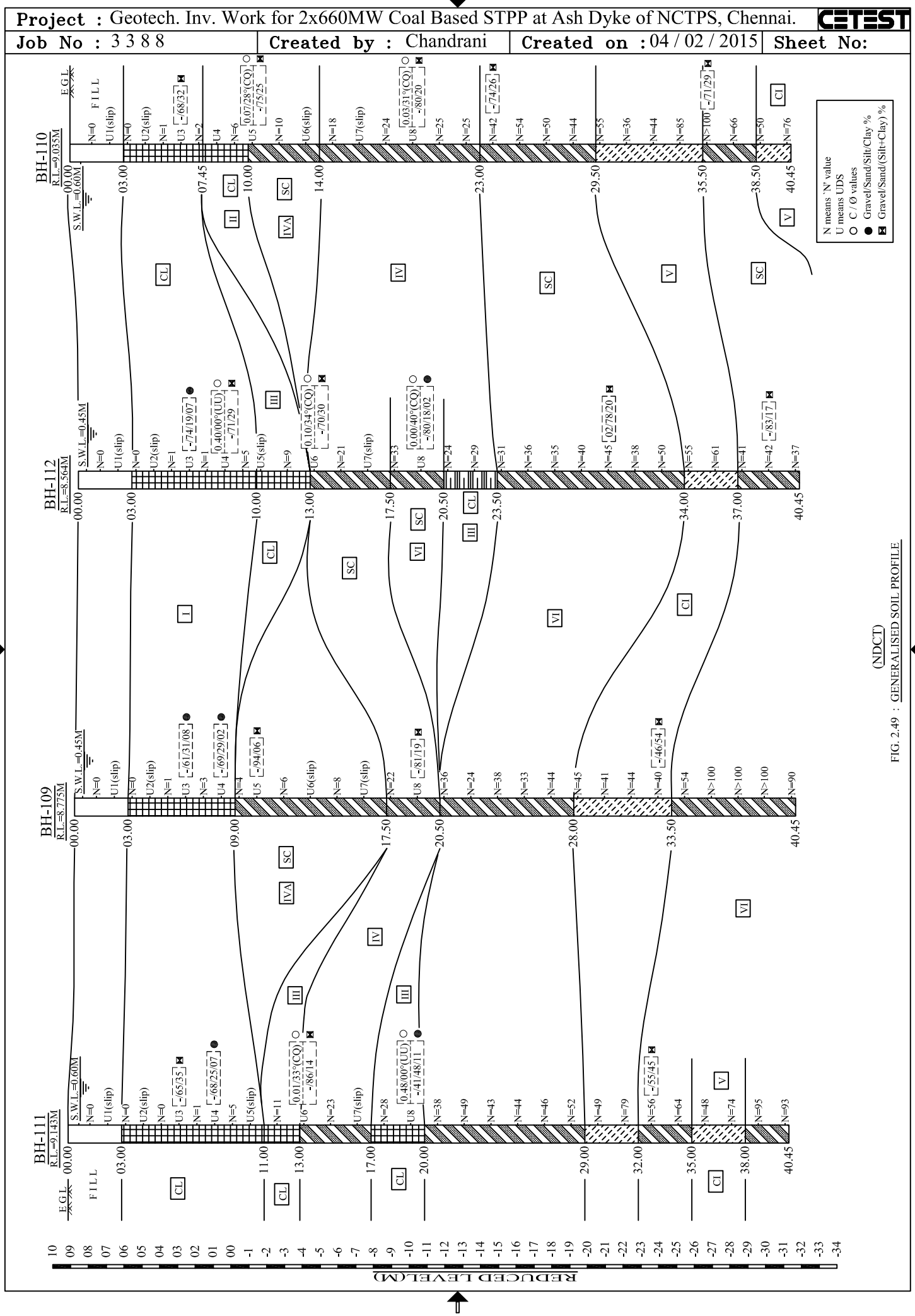
FIG. 2.47 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 02 / 01 / 2015	Sheet No:	



(BHEL Site Office)

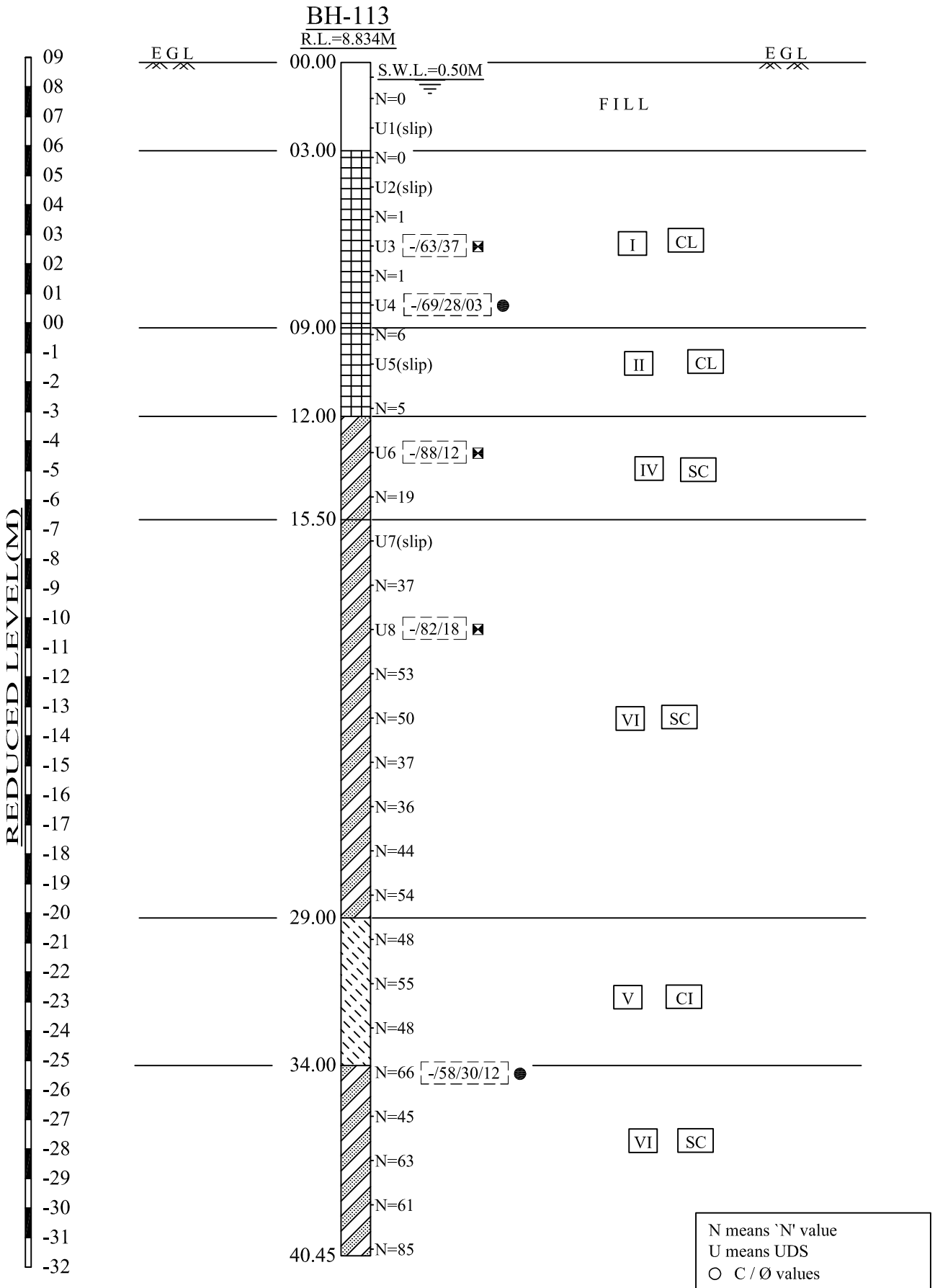
FIG. 2.48 : GENERALISED SOIL PROFILE



(NDCT)

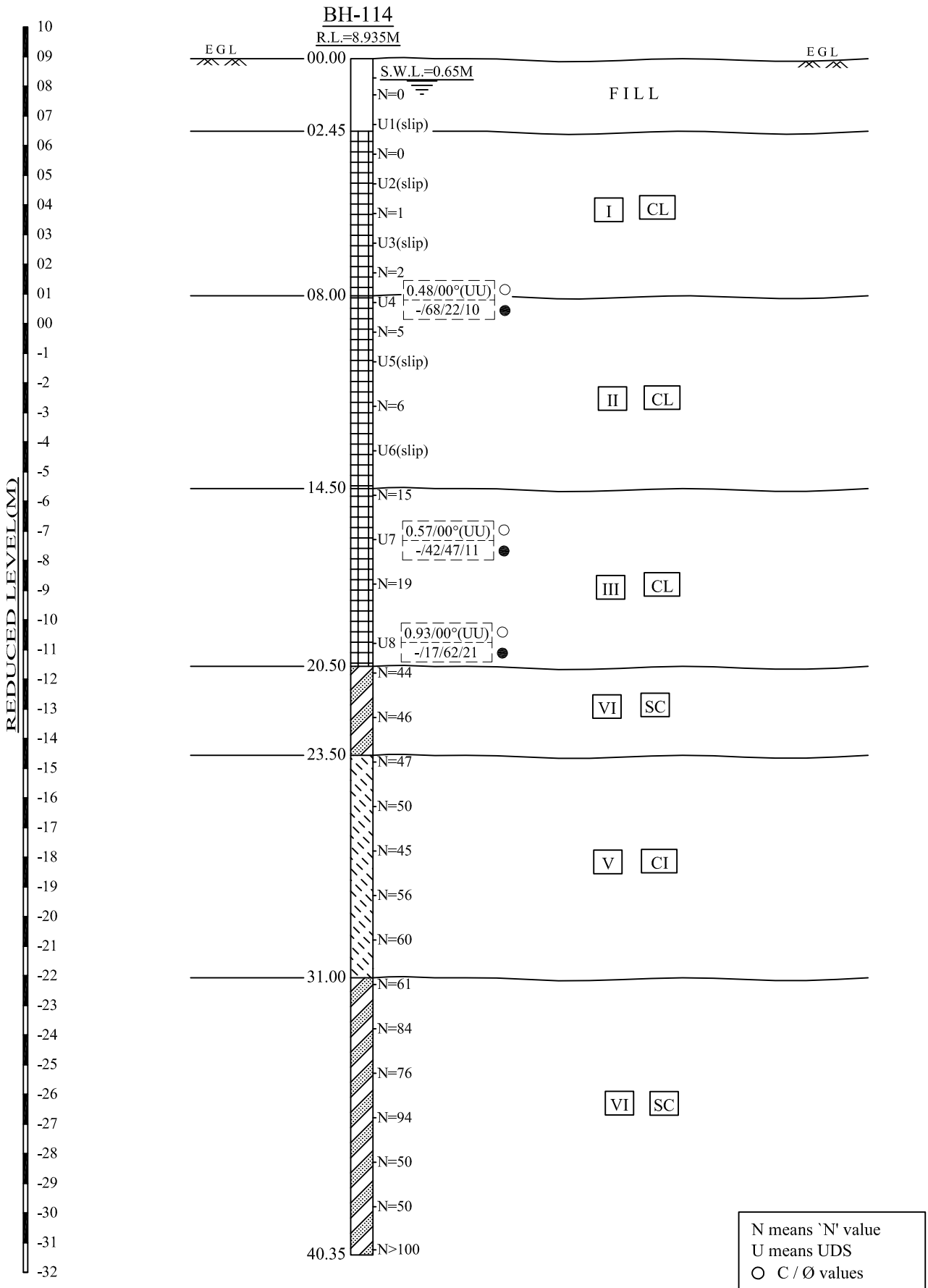
FIG. 2.49 : GENERALISED SOIL PROFILE

Project :	Geotech. Inv. Work for 2x660MW Coal Based STPP at Ash Dyke of NCTPS, Chennai.			CETEST
Job No : 3388	Created by : Chandrani	Created on : 27/01/2015	Sheet No:	



(Electro Chlorination Building)

FIG. 2.50 : GENERALISED SOIL PROFILE



(Cooling Water Pump House)

FIG. 2.51 : GENERALISED SOIL PROFILE

Unconfined cohesion, kg/sqcm	**0.21**	**GRAIN SIZE**	
Remoulded cohesion, kg/sqcm	**0.15**	Sand %	60
SENSITIVITY, S_t	**1.40**	(Silt + Clay) %	40

4.2.3. STRATUM - II:

The soil in this layer consists of soft to medium, clayey silt with high percentage of sand mixture. Steel grey patches have also been observed in this layer. The average properties of this layer are presented below.

Bulk Density, gms/cc	2.04	Specific gravity	2.65
Dry Density, gms/cc	1.65	Void Ratio	0.840
Natural Water Content %	24	Liquid limit %	31
TRSH-UU:		Plastic Limit %	16
Cohesion kg/sqcm	0.40	Shrinkage Limit %	12
Friction angle °	1°		
Unconfined cohesion, kg/sqcm	**0.27**	**GRAIN SIZE**	
Remoulded cohesion, kg/sqcm	**0.19**	Sand %	66
SENSITIVITY, S_t	**1.45**	(Silt + Clay) %	34

4.2.4. STRATUM - III:

This layer consists of stiff to very stiff, clayey silt with high percentage of sand. The average properties of this layer are presented below.

Bulk Density, gms/cc	2.04	Specific gravity	2.64
Dry Density, gms/cc	1.69	Void Ratio	0.477
Natural Water Content %	21	Liquid limit %	35
TRSH-UU:		Plastic Limit %	18
Cohesion kg/sqcm	0.69	Shrinkage Limit %	13
Friction angle °	1°		
Unconfined cohesion, kg/sqcm	**0.53**	**GRAIN SIZE**	
Remoulded cohesion, kg/sqcm	**0.41**	Sand %	51
SENSITIVITY, S_t	**1.31**	(Silt + Clay) %	49

4.2.5. STRATUM - IVA:

This is also a sand layer and this layer consists of very loose to loose silty sand. Kankar & gravels have also been observed in this layer. The average properties of this layer are presented below.

Bulk Density, gms/cc	2.02	Specific gravity	2.64
Dry Density, gms/cc	1.68	Liquid limit %	28
Natural Water Content %	20	Plastic Limit %	14
DRSH-CQ:		**GRAIN SIZE**	
Cohesion kg/sqcm	0.17	Sand %	74
Friction angle °	27°	(Silt + Clay) %	26

4.2.6. STRATUM - IV:

This layer consists of medium dense sandy silt / silty sand with clay binder. The average properties of this layer are presented below.

Bulk Density, gms/cc	2.04	Specific gravity	2.64
Dry Density, gms/cc	1.74	Liquid limit %	28
Natural Water Content %	17	Plastic Limit %	19
DRSH-CQ:		**GRAIN SIZE**	
Cohesion kg/sqcm	0.14	Sand %	76
Friction angle °	33°	(Silt + Clay) %	24

4.2.7. STRATUM - V:

The soil in this layer consists of hard, silty clay / clayey silt with sand mixture. Deep brown spots, kankar have also been observed in this layer. The average properties of this layer are presented below.

Bulk Density, gms/cc	2.01	Specific gravity	2.63
Dry Density, gms/cc	1.67	Void Ratio	0.615
Natural Water Content %	20	Liquid limit %	48
TRSH-UU:		Plastic Limit %	19
Cohesion kg/sqcm	1.08	Shrinkage Limit %	15
Friction angle °	4°		
Unconfined cohesion, kg/sqcm	**0.79**	**GRAIN SIZE**	
Remoulded cohesion, kg/sqcm	**0.58**	Sand %	31
SENSITIVITY, S_t	**1.35**	(Silt + Clay) %	69

4.2.8. STRATUM - VI:

This layer consists of dense to very dense, silty sand. Clay binders & kankar have also been observed in this layer. The average properties of this layer are presented below.

Bulk Density, gms/cc	1.97	Specific gravity	2.64
Dry Density, gms/cc	1.66	Liquid limit %	30
Natural Water Content %	18	Plastic Limit %	17
DRSH-CQ:		**GRAIN SIZE**	
Cohesion kg/sqcm	0.03	Sand %	78
Friction angle °	36°	(Silt + Clay) %	22

4.3. GRAPHICAL PRESENTATION:

The detailed Laboratory Test Results in tabular form are given in Volume-2. The back up sheets are also presented there as given in below:

1. ***Strength envelopes from Triaxial Tests.***
2. ***Normal Stress vs. Shear Stress from Direct Shear Tests.***
3. ***Standard and Modified Proctor Compaction Curves.***
4. ***CBR Curves.***
5. ***e-log p curves from consolidation tests.***
6. ***Grain size distribution curves for sieve and hydrometer tests.***

The consolidation test results are analysed by numerical methods and only the final output in a tabular form is given. The m_{vc} indicates the time dependent component of m_v and c_v is the co-efficient of consolidation.

5. DISCUSSION

5.1. PLATE LOAD TEST:

Total 5 nos. Plate Load Tests were conducted in the site (three nos. are of routine type & the two nos. are of cyclic type) in this zone at specified depths using 600mm square plate. Load (Vs.) settlement plots is made in arithmetic as well as log-log scale to calculate Allowable Bearing Capacity, Young's modulus. The calculations are presented below separately.

DETERMINATION OF SAFE BEARING CAPACITY:

PLT–05:

Ultimate Load corresponding double tangent method = 16.46 t/sqm, applying a factor of safety of 2.50, safe bearing capacity = 16.46/2.50 = 6.58 t/sqm.

The summarised test results are given below.

Test No.	Depth (M)	Safe Bearing Capacity, T/M^2
PLT - 05	1.30	6
PLT – 06	1.25	7
PLT - 08	1.30	6

SUBGRADE MODULUS:

Subgrade Modulus is obtained from Plate Load Tests as K = P/S. Where P = Plate Load corresponding to settlement S under working load. The final results values are presented in a tabular form below.

Test No.	Depth (M)	Subgrade Modulus for Plate as per IS 9214, Kg/cm^3	Subgrade Modulus for Plate, correcting as per IS 9214 Kg/cm^3
PLT-05	1.30	2.60	2.03
PLT-06	1.25	1.69	1.28
PLT-08	1.30	2.03	1.59
CPLT-01	1.30	1.73	1.35
CPLT-02	1.20	3.86	3.48

The Subgrade modulus value is inversely proportional to the square root of the foundation area up to a base area of 10 sqm and then remains constant. The calculated subgrade modulus values for different foundation areas are presented below.

Test No.	Depth (M)	Subgrade Modulus, (kg/cucm)			
		Foundation Area = 1 sqm	Foundation Area = 4 sqm	Foundation Area = 5 sqm	Foundation Area = 10 sqm or above
PLT-05	1.30	1.22	0.61	0.54	0.39
PLT-06	1.25	0.77	0.38	0.34	0.24

PLATE LOAD TEST NO. 05

Commenced on: 14/02/2015
Completed on: 14/02/2015
Pit size: 3.00mX3.00mX1.30m(depth)
Load on pr.guage/divn.=10Kg/sq.cm
Load on jack/divn. = 0.708t
Plate size: 0.60mX0.60m
Load on plate/divn. = 1.96t/sq.m.
Test Type: Routine PLT

Co-ordinates:
E = (-)2949.000M.
N = 4143.000M.
RL = 9.128M.

S.W.L. = 1.30m.

Description of Soil :-

(EGL - 1.30)m:- Light grey, fly ash.

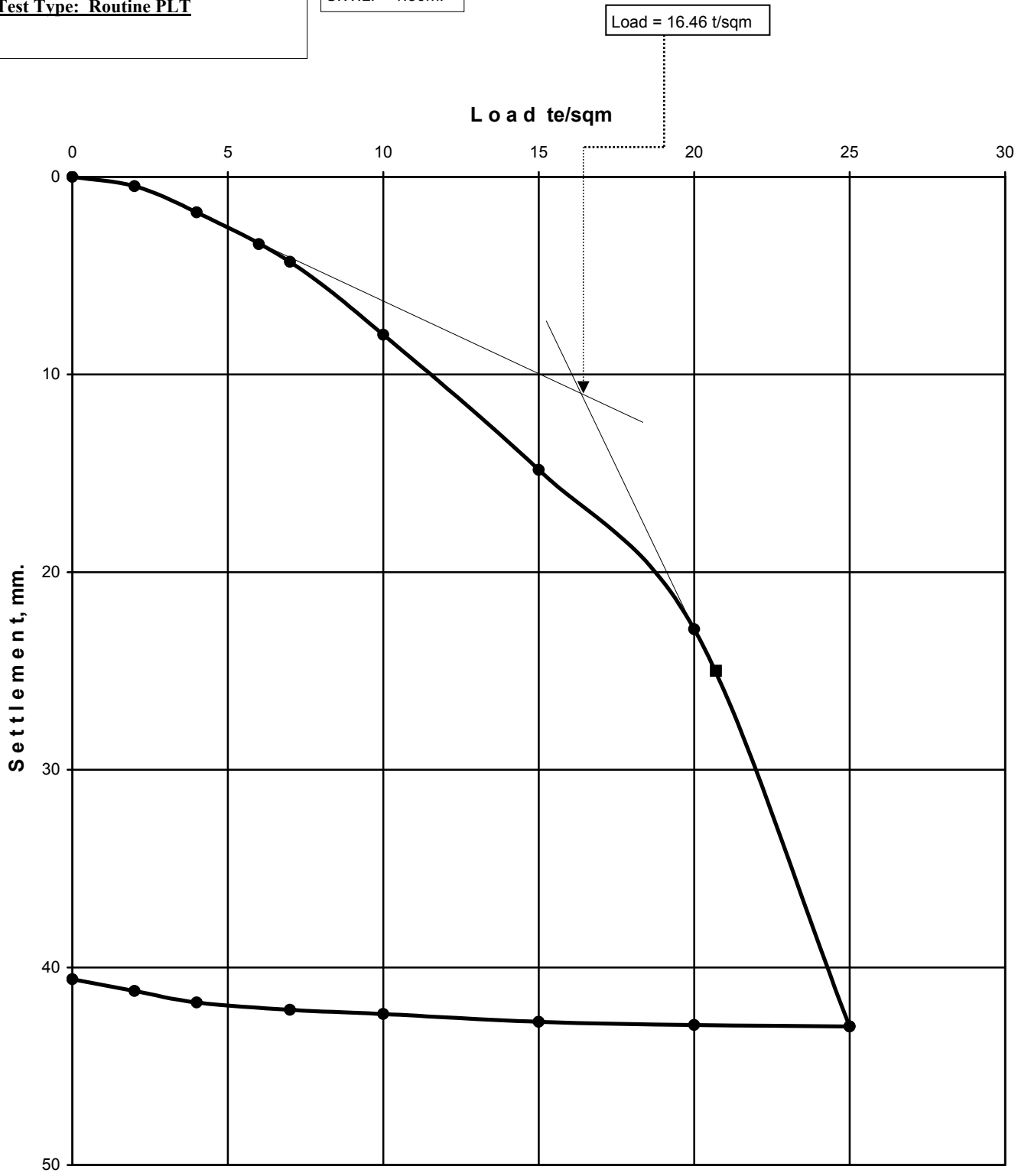


FIG. 3.01. LOAD VS SETTLEMENT GRAPH FOR PLT - 05

PLATE LOAD TEST NO. 06

Commenced on: 16/02/2015
Completed on: 16/02/2015
Pit size: 3.00mX3.00mX1.25m(depth)
Load on pr.guage/divn.=10Kg/sq.cm
Load on jack/divn. = 0.708t
Plate size: 0.60mX0.60m
Load on plate/divn. = 1.96t/sq.m.
Test Type: Routine PLT

Co-ordinates:
E = (-)2977.000M.
N = 4088.000M.
RL = 8.982M.

S.W.L. = 1.25m.

Description of Soil :-

(EGL - 1.25)m:- Light grey, fly ash.

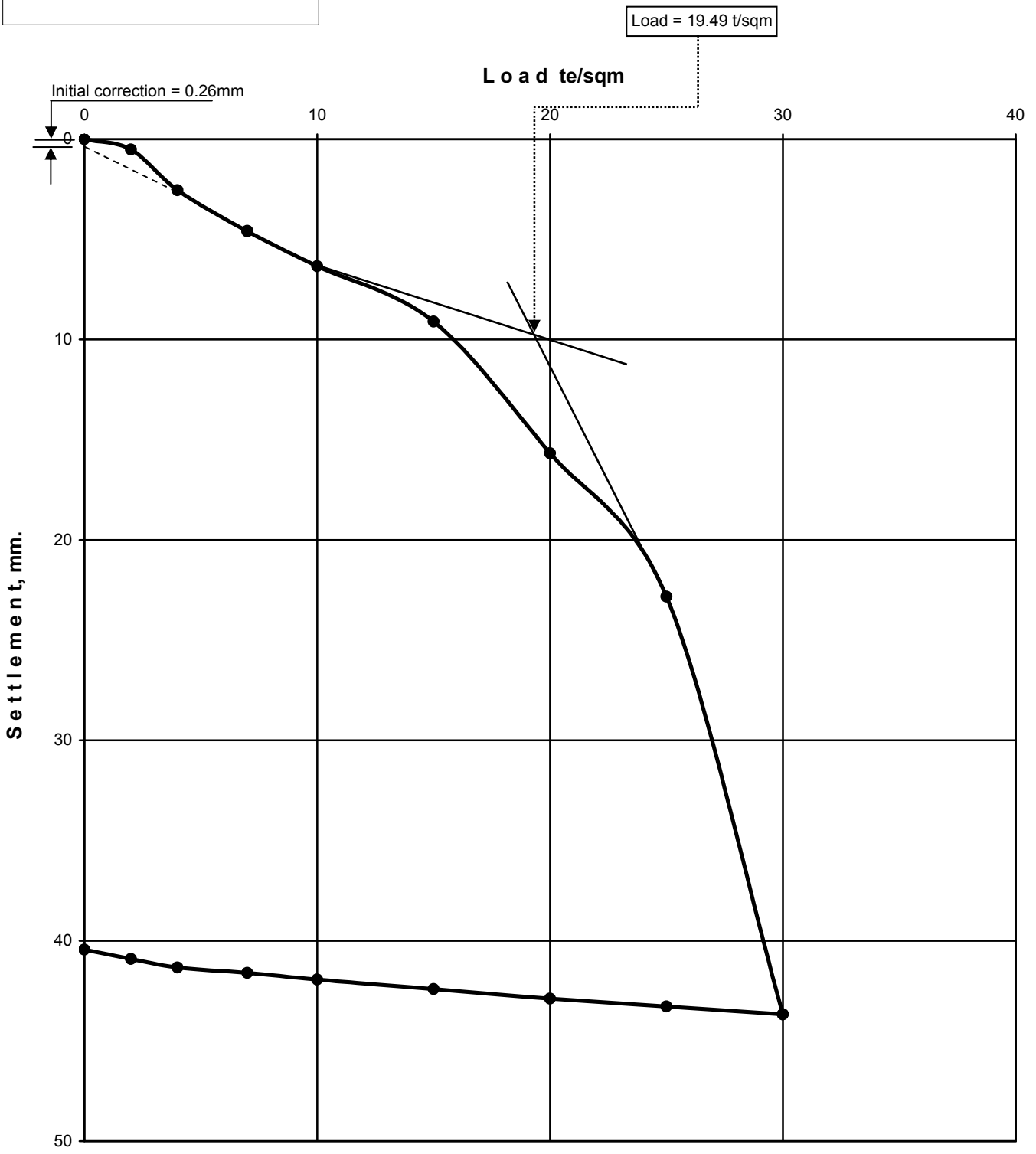


FIG. 3.02. LOAD VS SETTLEMENT GRAPH FOR PLT - 06

PLATE LOAD TEST NO. 08

Commenced on: 12/02/2015
Completed on: 12/02/2015
Pit size: 3.00mX3.00mX1.30m(depth)
Load on pr.guage/divn.=10Kg/sq.cm
Load on jack/divn. = 0.708t
Plate size: 0.60mX0.60m
Load on plate/divn. = 1.96t/sq.m.
Test Type: Routine PLT

Co-ordinates:
E = (-)2604.000M.
N = 3893.000M.
RL = 8.996M.

S.W.L. = 1.25m.

Description of Soil :-

(EGL - 1.30)m:- Light grey, fly ash.

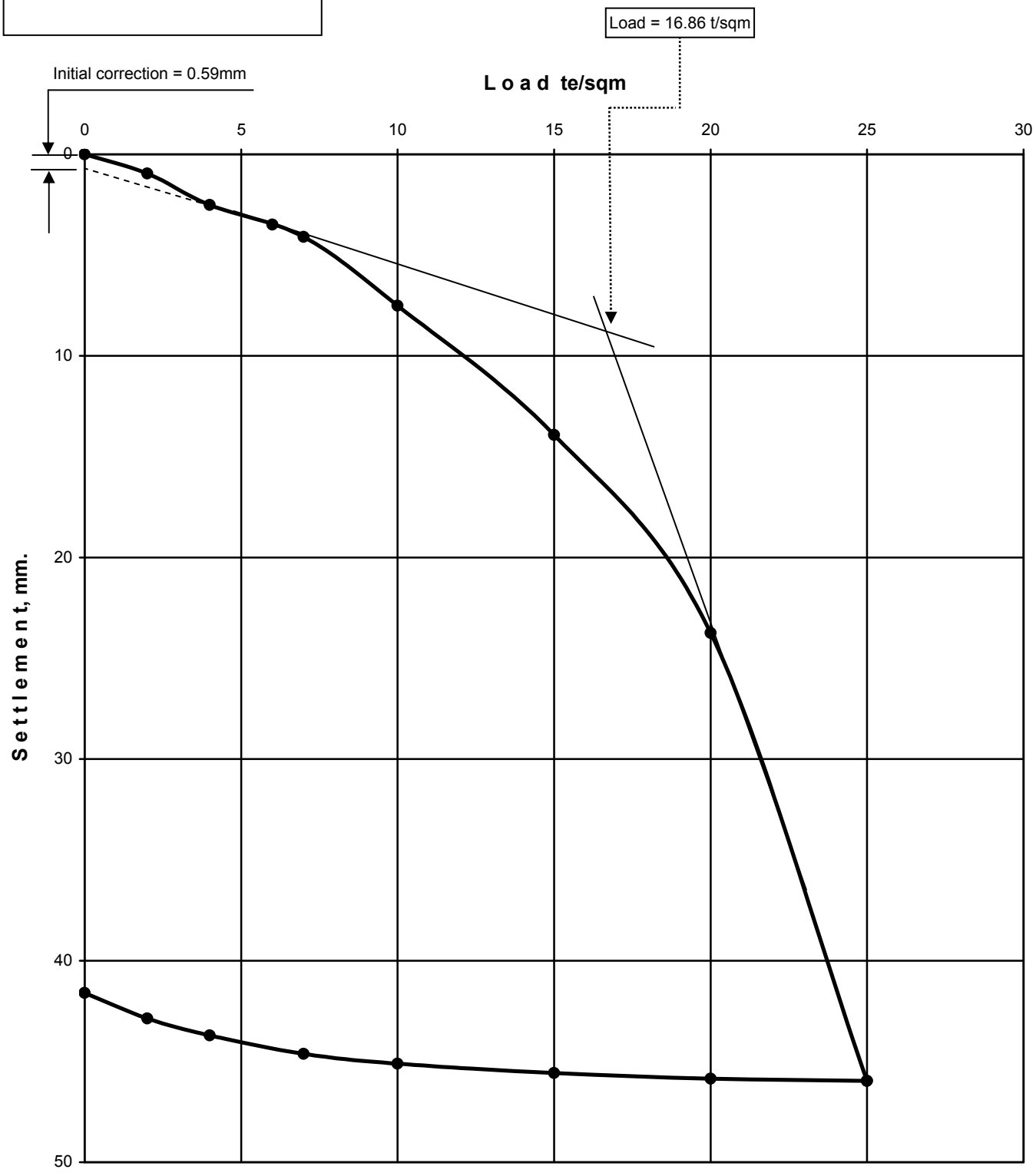


FIG. 3.03. LOAD VS SETTLEMENT GRAPH FOR PLT - 08

CYCLIC PLATE LOAD TEST NO. 01

Commenced on: 21/02/2015
Completed on: 22/02/2015
Pit size: 3.00mX3.00mX1.30m(depth)
Load on pr.guage/divn. = 10Kg/sq.cm
Load on jack/divn. = 0.708t
Plate size: 0.60mX060m
Load on plate/divn. = 1.96t/sq.m.
Test Type: Cyclic PLT

Co-ordinates:
E = (-)2980.000m.
N = 3778.000m.
RL = 8.992m.

S.W.L. = 1.30m.

Description of Soil :-

(EGL - 1.30)m:- Light grey, fly ash.

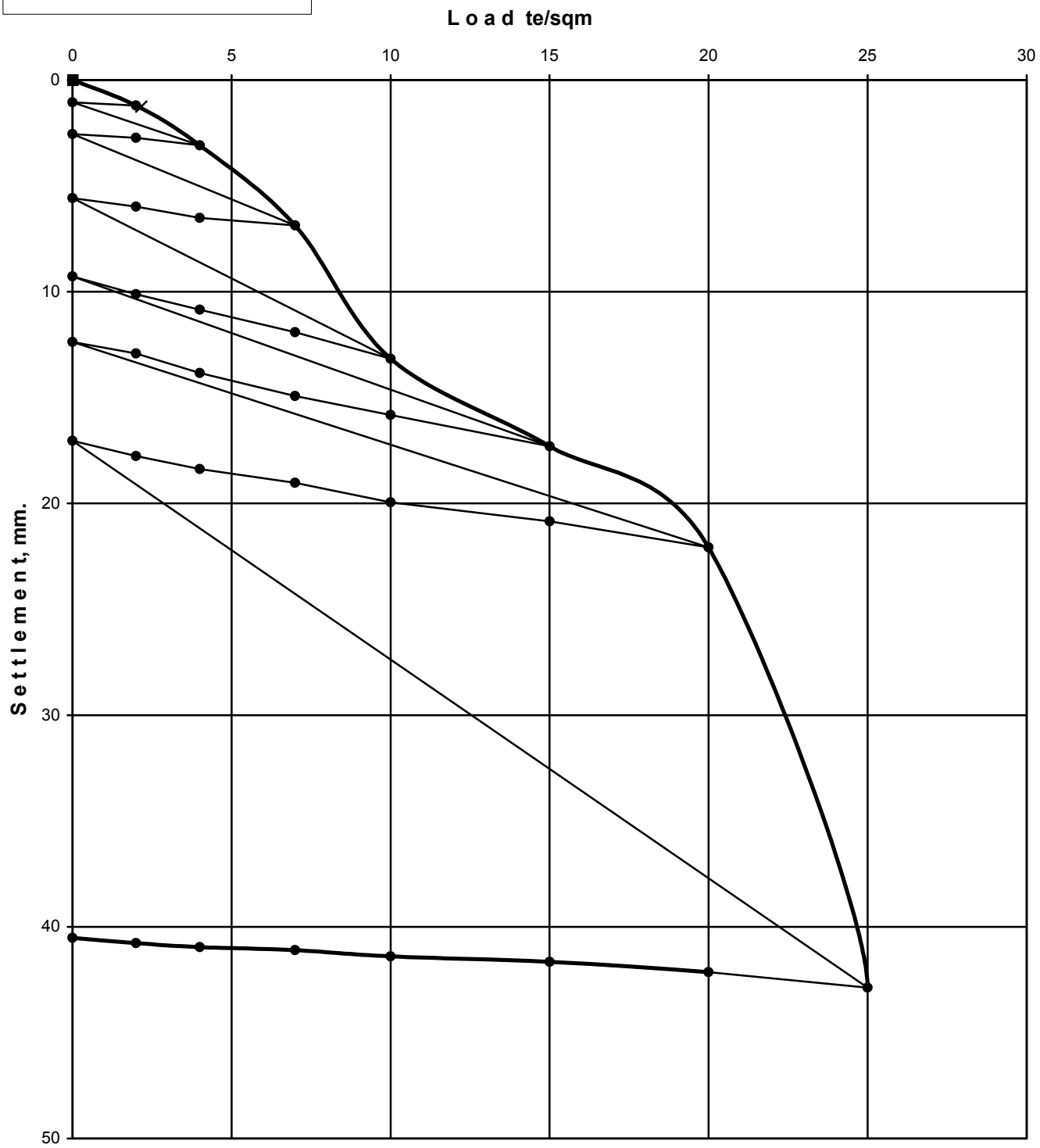


FIG.3.04. LOAD VS SETTLEMENT GRAPH FOR CPLT - 01

CYCLIC PLATE LOAD TEST NO. 02

Commenced on: 09/02/2015
Completed on: 10/02/2015
Pit size: 6.00mX6.00mX1.20m(depth)
Load on pr.guage/divn. = 10Kg/sq.cm
Load on jack/divn. = 0.708t
Plate size: 0.60mX060m
Load on plate/divn. = 1.96t/sq.m.
Test Type: Cyclic PLT

Co-ordinates:
E = (-)2730.000m.
N = 3754.000m.
RL = 9.215m.

S.W.L. = 1.25m.

Description of Soil :-

(EGL - 1.25)m:- Light grey, fly ash.

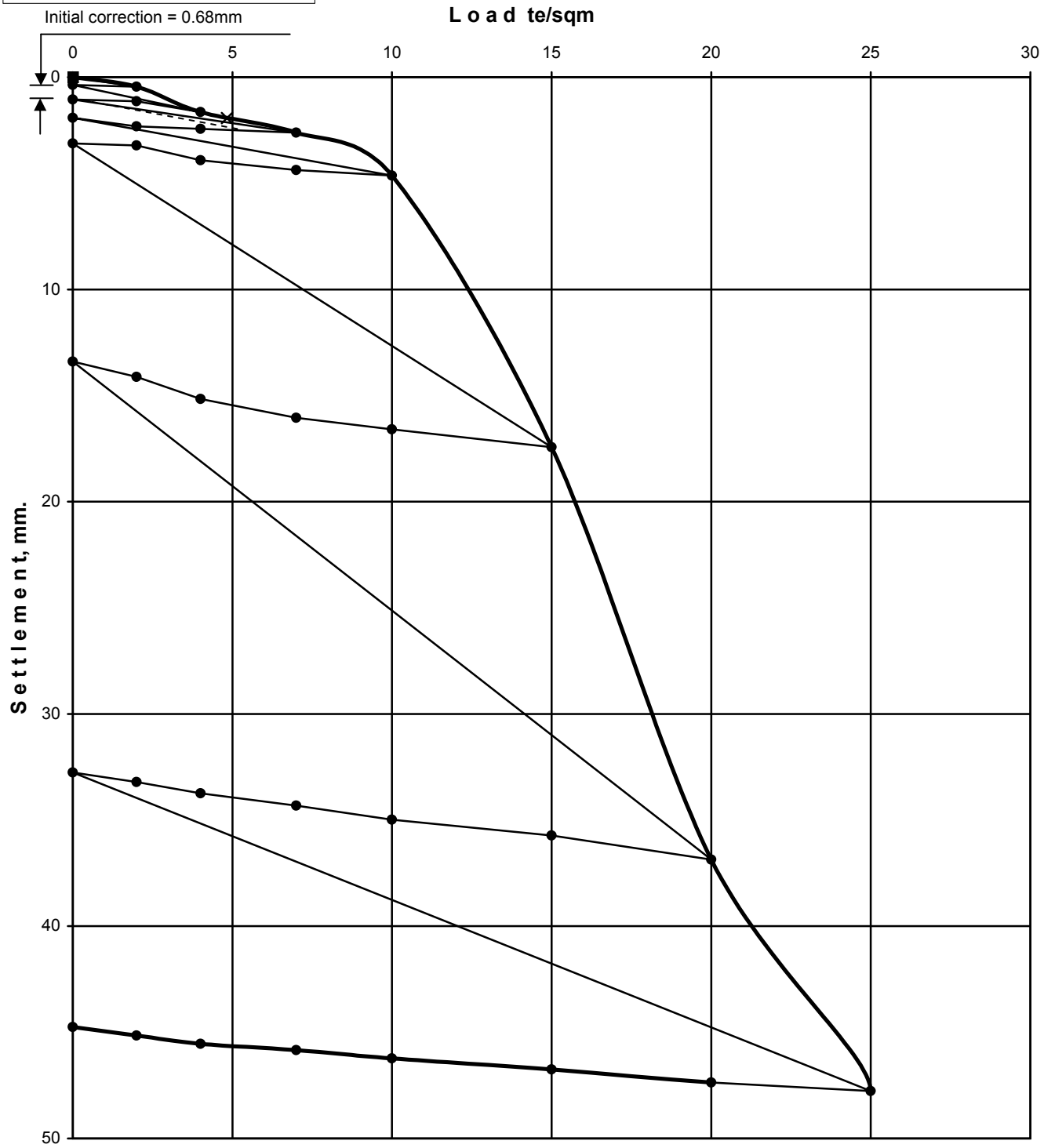


FIG.3.05. LOAD VS SETTLEMENT GRAPH FOR CPLT - 02

Test No.	Depth (M)	Subgrade Modulus, (kg/cucm)			
		Foundation Area = 1 sqm	Foundation Area = 4 sqm	Foundation Area = 5 sqm	Foundation Area = 10 sqm or above
PLT-08	1.30	0.95	0.48	0.43	0.30
CPLT-01	1.30	0.81	0.41	0.36	0.26
CPLT-02	1.20	2.09	1.04	0.93	0.66

Sample Calculation of Subgrade Modulus for foundation area 5 Sq.m of CPLT-02

For Plate

Safe Load, corresponding to 1.25mm settlement = 4.83 t/sqm
Subgrade Modulus for Plate, K = P/S = 4.83/1.25 = 3.86 Kg/cm^3
Since the test was conducted on 600mm square plate (i.e. smaller than 75cm dia,), corrected Subgrade Modulus as per Clause 5.1.1 & Fig.3 of IS:9214 = 3.86 / 1.28 = 3.02 Kg/cm^3
Again applying correction for plate bending, as per Clause 5.1.3 & Fig.5 of IS:9214, corrected Subgrade Modulus = 3.48 Kg/cm^3

For Foundation

Corrected Subgrade Modulus of plate = 3.48 Kg/cm^3
Area of plate = 60 x 60 sq.cm = 0.60 x 0.60 sq.m
Area of footing = 5 sq.m
Subgrade Modulus of foundation = 3.48 x $\sqrt{(0.60x0.60)/5}$ Kg/cm^3 = 0.93 Kg/cm^3

ELASTIC COMPRESSION:

For Cyclic Plate Load Tests, after application of each load increment and full stabilisation of plate settlement, the applied load was reduced to zero and the settlement records were noted till full stabilisation. Thereafter, the next load increment was applied.

The elastic rebounds at these load intensities are calculated from the field data and are graphically presented in graph (Ref. fig. no. 3.6 – 3.7). The coefficient of elastic uniform compression, C_u is obtained as $C_u = P / S_e$ kg/cucm

CPLT- 01:

From the load vs elastic rebound plot, the slope of the trend line = C_u = (10-5)/(2.83-1.42) = 3.55 kg/cucm

Now, for a foundation size of 10 sqm (3m x 3.33m, say), the corresponding value will be,

C_{u10sqm} = 3.55 x $\sqrt{[(0.600 \times 0.600) / 10]}$ = 0.67 kg/cucm

CPLT- 02:

From the load vs elastic rebound plot, the slope of the trend line = C_u = (10-5)/(2.144-1.074) = 4.67 kg/cucm

Now, for a foundation size of 10 sqm (3m x 3.33m, say), the corresponding value will be,

C_{u10sqm} = 4.67 x $\sqrt{[(0.600 \times 0.600) / 10]}$ = 0.89 kg/cucm

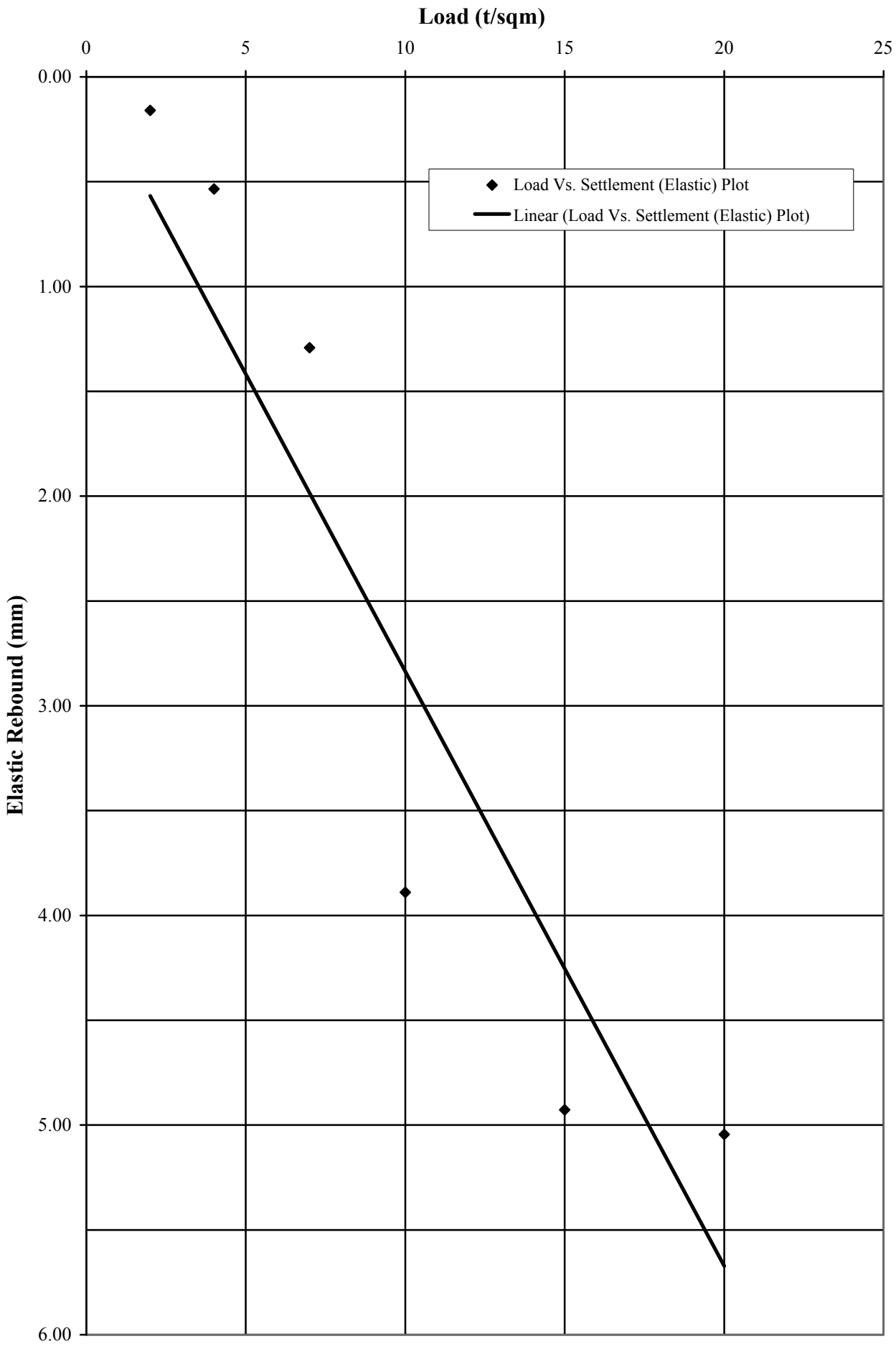


Fig. 3.6. Load vs. Elastic Rebound Plot (CPLT-01)

as per IS 5249 : 1992, Pg - 6

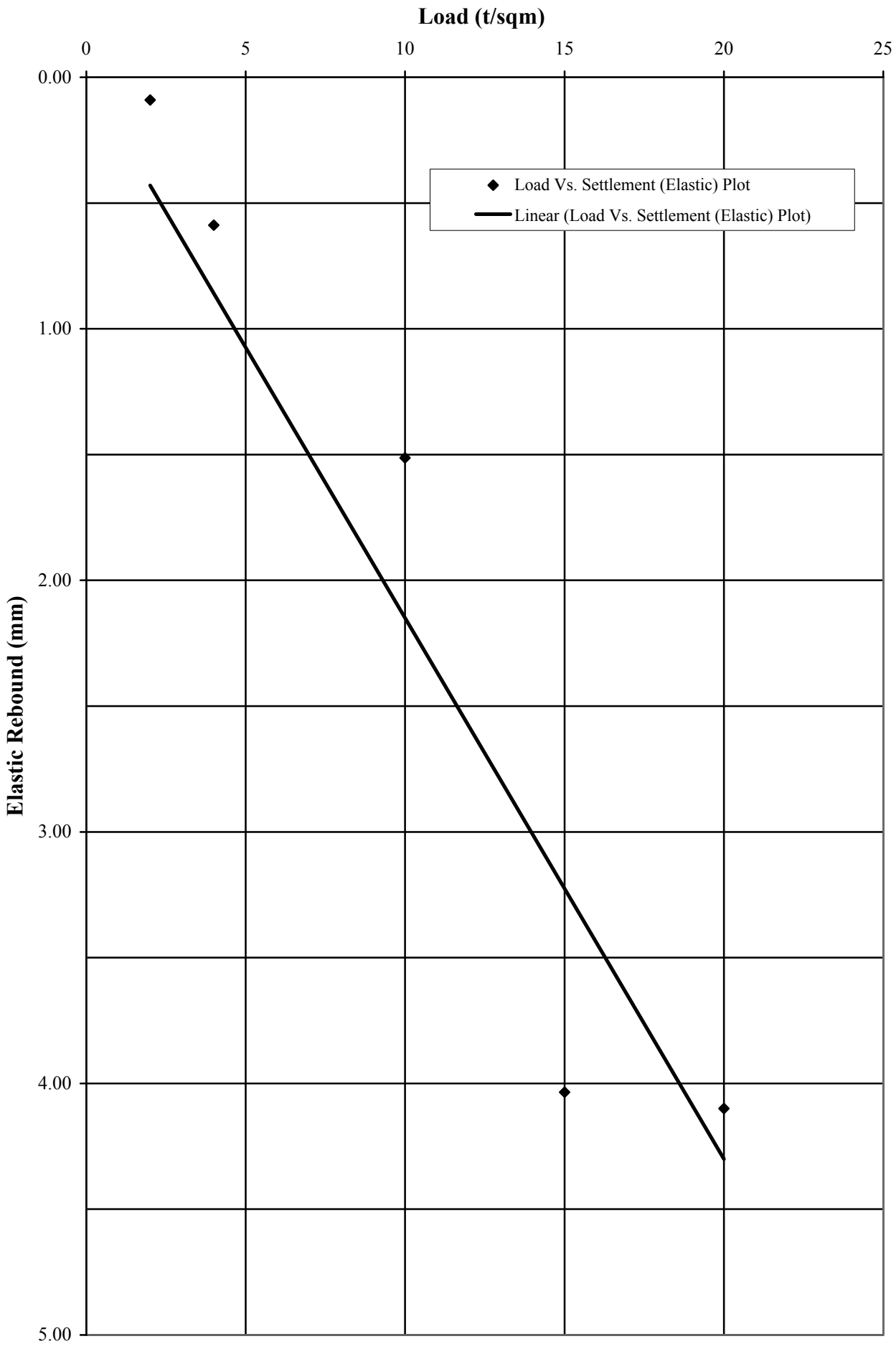


Fig. 3.7. Load vs. Elastic Rebound Plot (CPLT-02)

as per IS 5249 : 1992, Pg - 6

5.2. DETAILS OF STRUCTURES:

The subsoil quality, thickness of each layer varies widely within the zone of investigation. Again, the type of structures to be constructed is different with different requirement. Considering all these aspect, the entire area is subdivided in to the following.

Sl. No.	Structure Name	Bore Hole Points	Reference Figure No.
1	Boundary Wall	BH-01 to 06	2.01
2	Boundary Wall	BH-07 to 10	2.02
3	Additional Canteen	BH-11	2.03
4	Administration Building	BH-12	2.04
5	Main Gate & Time Office cum Security Complex	BH-13	2.05
6	Proposed coal conveyor	BH-14 to 22	2.06
7	Proposed Cooling Water Channel	BH-23 to 26	2.07
8	Sea Water Intake Pump House	BH-27	2.08
9	STP	BH-28	2.09
10	H2 Plant	BH-29	2.10
11	Guard Pond	BH-30	2.11
12	Workshop	BH-31	2.12
13	Rain Water Harvesting Pond	BH-32	2.13
14	RO-DM cum Desalination Plant	BH-33	2.14
15	Canteen	BH-34	2.15
16	Storage Yard	BH-35	2.16
17	Storage Yard	BH-36	2.17
18	Near Neutralising Pit	BH-37	2.18
19	CPU Regeneration Building	BH-38	2.19
20	Filtered Water and Fire Water Storage Tank and Pump House	BH-39	2.20
21	Central Monitoring Basin	BH-40	2.21
22	ETP	BH-41	2.22
23	Aux. Boiler	BH-42	2.23
24	Clarifier	BH-43	2.24
25	Bulk Chemical Area	BH-44	2.25
26	Service Building	BH-45	2.26
27	Power House / TG Building	BH-46, 47,48,53, 54, 62	2.27
28	Power House / TG Building	BH-63, 64, 68, 69, 72	2.28
29	NDCT	BH-49, 115, 116, 117	2.29
30	Transformer Yard	BH-50, 51, 52, 55, 56	2.30
31	Transformer Yard	BH-65, 66, 67, 70	2.31
32	400 KV GIS Switch Yard & Switch Yard Control Room	BH-57 to 61	2.32
33	Air Washer Room	BH-71	2.33
34	Compressor House	BH-73	2.34
35	Near Condensate Storage Tank	BH-74	2.35
36	Boiler & Mill-Bunker Area	BH-75 to 80	2.36
37	Boiler & Mill-Bunker Area	BH-82 to 88	2.37
38	ESP Control Room	BH-90	2.38
39	ESP	BH-81, 91, 93, 94	2.39
40	ESP	BH-89, 96, 99, 101, 102	2.40
41	ID Fan	BH-92, 95, 95R1	2.41
42	Chimney	BH-97, 98	2.42
43	ID Fan	BH-100, 100R1, 103	2.43
44	ESP Control Room	BH-104	2.44

Sl. No.	Structure Name	Bore Hole Points	Reference Figure No.
45	Fire Station	BH-105	2.45
46	HDO/LDO Forwarding Pump House	BH-106	2.46
47	HDO/LDO Storage Tank Dyke Area	BH-107	2.47
48	BHEL Site Office	BH-108	2.48
49	NDCT	BH-109 to 112	2.49
50	Electro Chlorination Building	BH-113	2.50
51	Cooling Water Pump House	BH-114	2.51

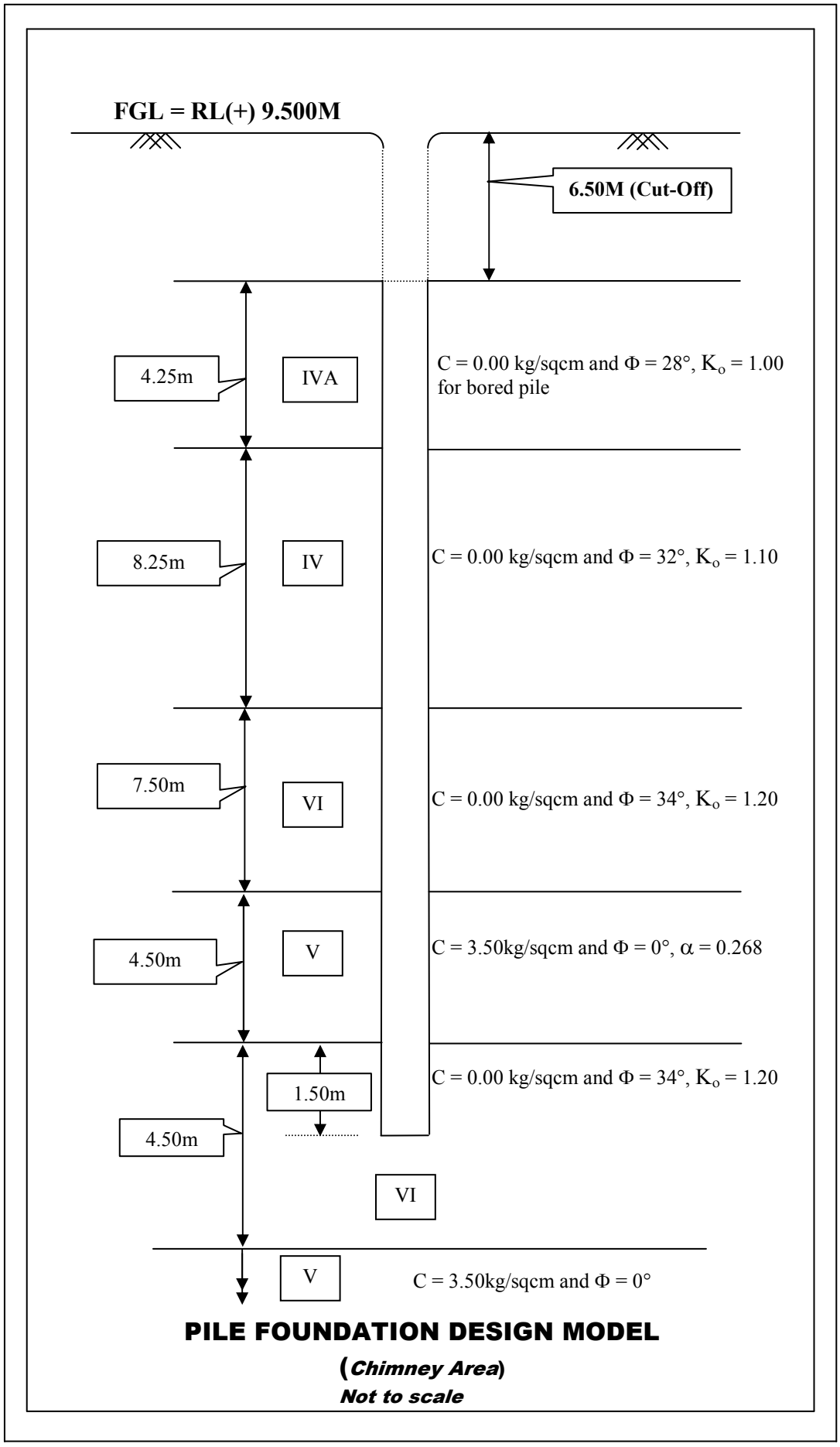
5.3. DISCUSSION ON FOUNDATION SYSTEM:

The subsoil is characterised by a filled up soil / ash followed by very loose to loose clayey silty sand / very soft silty clay. Below this, medium silty clay followed by stiff to very stiff silty clay layer was observed. After that dense to very dense silty sand / hard silty clay layer was found alternatively and continued upto the terminating depth of the all boreholes.

Considering the nature of the subsoil and the type of structures to be constructed at the present site, deep foundation in form of pile is suggested. Either bored cast in-situ or driven piles can be used.

5.4. USE OF DEEP FOUNDATION (R.C. BORED PILE):

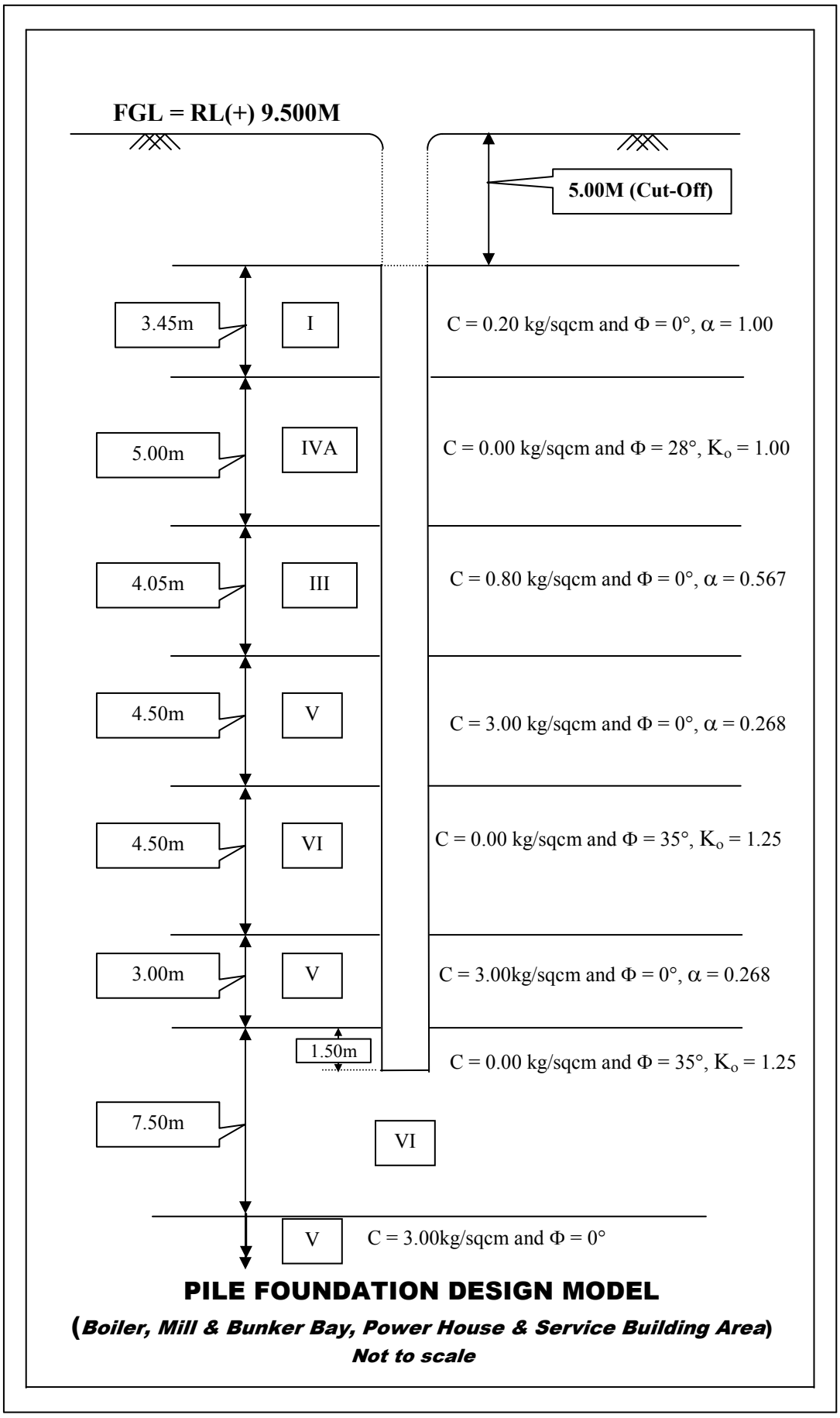
Based on the subsoil condition / desired pile capacity, several pile foundation design model are prepared. The pile capacity values (vertical, uplift & lateral) are calculated and presented afterwards. [FGL = RL(+)9.500M]



PILE FOUNDATION DESIGN MODEL

(*Chimney Area*)

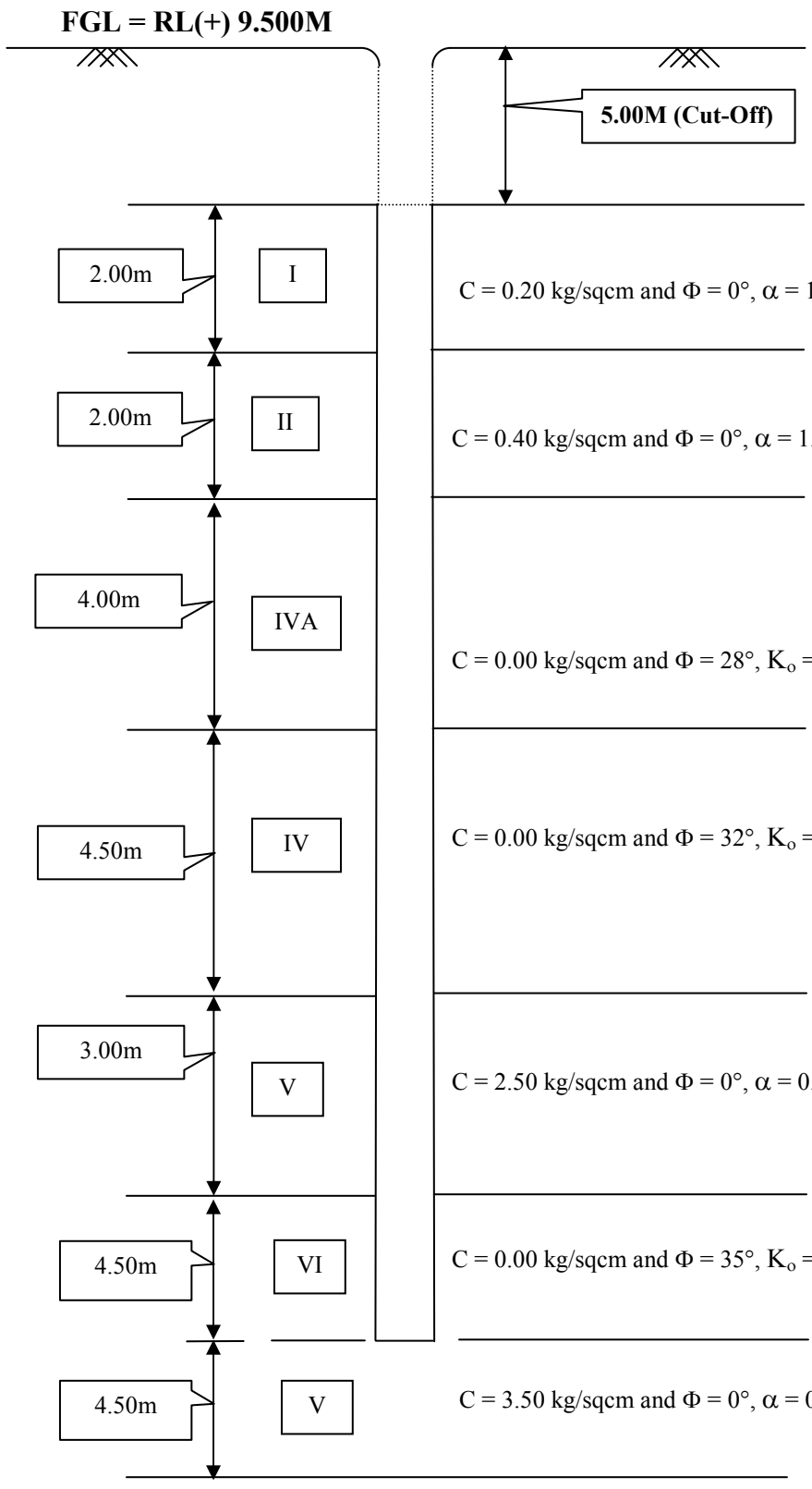
Not to scale



PILE FOUNDATION DESIGN MODEL

(***Boiler, Mill & Bunker Bay, Power House & Service Building Area***)

Not to scale



PILE FOUNDATION DESIGN MODEL

(*ESP Area*)

Not to scale

5.4.1. DETERMINATION OF VERTICAL PILE CAPACITY WITHOUT GROUND IMPROVMENT:

With reference to the above, the pile capacity values for different pile diameter are calculated and based on the above the following allowable vertical pile capacity values are presented below. A sample pile capacity calculation is presented in separate sheets. Based on the above and the following pile capacity values are recommended.

Location	Length of pile below cut-off (M)	Pile Dia (mm)	Recommended Vertical Pile Capacity (T)	
			Bored	Driven
Chimney	26.00 (Cut-off = 6.50m)	600	150	--
		760	240	--
ID Fan	26 (Cut-off = 3.0m)	600	140	--
		760	200	--
Boiler, Mill-Bunker, Power House, Service Building Area	26 (Cut-off = 5.0m)	600	150	--
		760	230	--
ESP & ESP Control Room	20 (Cut-off = 5.0m)	550	--	100
Transformer Yard, Switch Yard & Switch Yard Control Room	26 (Cut-off = 3.0m)	600	135	--
BOP Area excluding NDCT	26 (Cut-off = 3.0m)	600	135	--
	20 (Cut-off = 3.0m)	550	--	100
NDCT	25 (Cut-off = 4.0m)	600	130	--
		750	185	--
		760	190	--
		900	245	--
		1000	290	--
	26 (Cut-off = 4.0m)	600	135	--
		750	190	--
		760	195	--
		900	255	--
		1000	300	--
Proposed coal conveyor, Proposed Cooling Water Channel / Sea Water Intake Pump House	26 (Cut-off = 3.0m)	600	150	--
	20 (Cut-off = 3.0m)	550	--	100

5.4.2. DETERMINATION OF UPLIFT PILE CAPACITY WITHOUT GROUND IMPROVMENT:

Safe Uplift Capacity of Pile = 1/3rd of (Pile Shaft Resistance + self weight of pile (Buoyant))

With reference to the above, the uplift capacity values are calculated and presented in separate sheets.

Based on the calculation, the following Uplift pile capacity values are recommended.

Location	Length of pile below cut-off (M)	Pile Dia (mm)	Recommended Uplift Pile Capacity (T)	
			Bored	Driven
Chimney	26.00 (Cut-off = 6.50m)	600	100	--
		760	150	--
ID Fan	26 (Cut-off = 3.0m)	600	90	--
		760	130	--
Boiler, Mill-Bunker, Power House, Service Building Area	26 (Cut-off = 5.0m)	600	95	--
		760	135	--
ESP & ESP Control Room	20 (Cut-off = 5.0m)	550	--	60
Transformer Yard, Switch Yard & Switch Yard Control Room	26 (Cut-off = 3.0m)	600	85	--
BOP Area excluding NDCT	26 (Cut-off = 3.0m)	600	90	--
	20 (Cut-off = 3.0m)	550	--	55
NDCT	25 (Cut-off = 4.0m)	600	85	--
		750	120	--
		760	122	--
		900	155	--
		1000	180	--
	26 (Cut-off = 4.0m)	600	90	--
		750	125	--
		760	128	--
		900	160	--
		1000	185	--
Proposed coal conveyor, Proposed Cooling Water Channel / Sea Water Intake Pump House	26 (Cut-off = 3.0m)	600	100	--
	20 (Cut-off = 3.0m)	550	--	60

5.4.3. DETERMINATION OF LATERAL PILE CAPACITY WITHOUT GROUND IMPROVMENT:

Refer to IS : 2911 (Part I/Sec 2) - 2010, Appendix - C

Constant Factor, η_h = 0.20 kg/cucm corresponding to "N" value = 13 [Assuming Submerged Sand]

$T = [EI/\eta_h]^{1/5}$

Now, $I = 0.64 \times 10^6$ cm^4 [for 600mm dia pile]

$E = 5000 \times (f_{ck})^{0.5} = 5000 \times (30)^{0.5} = 27386$ N/sqmm $= 2.74 \times 10^5$ kg/sqcm

Hence, T = 243.20 cm

From Graph (Fig.4), $L_f = 2.18 \times T = 530.18$ cm [Assuming Fixed Head Piles in Sands]

Pile Head deflection, $Y = H \times L_f^3 / 12EI = 0.7128$mm for 1T load

So, for 5mm horizontal deflection, H = 7.01T, say 7T

Similarly for 760mm dia pile, H = 10T.

Location	Length of pile below cut-off (M)	Pile Dia (mm)	Recommended Lateral Pile Capacity (T)
Chimney	26.00 (Cut-off = 6.50m)	600	7.0
		760	10.0
ID Fan	26 (Cut-off = 3.0m)	600	7.0
		760	10.0
Boiler, Mill-Bunker, Power House, Service Building Area	26 (Cut-off = 5.0m)	600	3.5
		760	4.5
ESP & ESP Control Room	20 (Cut-off = 5.0m)	550	4.5
Transformer Yard, Switch Yard & Switch Yard Control Room	26 (Cut-off = 3.0m)	600	3.5
BOP Area excluding NDCT	26 (Cut-off = 3.0m)	600	3.5
	20 (Cut-off = 3.0m)	550	3.5
NDCT	25 (Cut-off = 4.0m)	600	3.5
		750	4.5
		760	4.5
		900	5.5
		1000	6.0
	26 (Cut-off = 4.0m)	600	3.5
		750	4.5
		760	4.5
		900	5.5
		1000	6.0
Proposed coal conveyor, Proposed Cooling Water Channel / Sea Water Intake Pump House	26 (Cut-off = 3.0m)	600	3.5
	20 (Cut-off = 3.0m)	550	3.5

5.4.4. SAFE LOAD CARRYING CAPACITY OF PILE WITHOUT GROUND IMPROVEMENT:

Location	Length of pile below cut-off (M)	Pile Dia (mm)	Recommended Vertical Pile Capacity (T)		Recommended Uplift Pile Capacity (T)		Recommended Lateral Pile Capacity (T)
			Bored	Driven	Bored	Driven	
Chimney	26.00 (Cut-off = 6.50m)	600	150	--	100	--	7.0
		760	240	--	150	--	10.0
ID Fan	26 (Cut-off = 3.0m)	600	140	--	90	--	7.0
		760	200	--	130	--	10.0
Boiler, Mill-Bunker, Power House, Service Building Area	26 (Cut-off = 5.0m)	600	150	--	95	--	3.5
		760	230	--	135	--	4.5
ESP & ESP Control Room	20 (Cut-off = 5.0m)	550	--	100	--	60	4.5
Transformer Yard, Switch Yard & Switch Yard Control Room	26 (Cut-off = 3.0m)	600	135	--	85	--	3.5
BOP Area excluding NDCT	26 (Cut-off = 3.0m)	600	135	--	90	--	3.5
	20 (Cut-off = 3.0m)	550	--	100	--	55	3.5
NDCT	25 (Cut-off = 4.0m)	600	130	--	85	--	3.5
		750	185	--	120	--	4.5
		760	190	--	122	--	4.5
		900	245	--	155	--	5.5
		1000	290	--	180	--	6.0
	26 (Cut-off = 4.0m)	600	135	--	90	--	3.5
		750	190	--	125	--	4.5
		760	195	--	128	--	4.5
		900	255	--	160	--	5.5
		1000	300	--	185	--	6.0
Proposed coal conveyor, Proposed Cooling Water Channel / Sea Water Intake Pump House	26 (Cut-off = 3.0m)	600	150	--	100	--	3.5
	20 (Cut-off = 3.0m)	550	--	100	--	60	3.5

Note: The pile capacity values recommended in section 5.4.1 to 5.4.4 are under present condition i.e. before any ground improvement. The pile capacity may be recalculated based on the modified strength parameters of the improved ground after ground improvement.

5.5. POSSIBILITY OF SUBSOIL LIQUEFACTION DUE TO EARTHQUAKE:

The liquefaction potential of sandy soil is evaluated as per provision laid down in *"Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils"* by Dr. Gonzalo Castro et al. published in *"Journal of Geotechnical and Geoenvironmental Engineering"*, October' 2001.

Based on the SPT values in boreholes, the liquefaction resistance of all the boreholes were evaluated for zone – III ($a_{max}/g = 0.16$) and presented in a separate sheet.

Based on the earthquake zone and project location, the maximum possible earthquake intensity here is considered as 6.5, corresponding Magnitude Scaling Factor, MSF = 1.44

The ratio of $(CRR_{7.5}/CSR)MSF \geq 1.0$ indicates the soil is non liquefiable.

Based on the above two approaches, the observations are tabulated below.

Location	Depth below natural ground level upto which subsoil is prone to Liquefaction (M)
Chimney	8.00
ID Fan	9.00
Boiler, Mill-Bunker, Power House, Service Building Area	9.80
ESP & ESP Control Room	12.20
Switch Yard & Switch Yard Control Room, Transformer Yard	12.10
BOP Area excluding NDCT	10.00
NDCT	18.00
Proposed Coal Conveyor, Proposed Cooling Water Channel / Sea Water Intake Pump House	9.80

Thus the soil is liquefiable and suitable ground improvement measures shall be adopted. The pile capacity values recommended in section 5.4.1 to 5.4.4 are under present condition i.e. before any ground improvement. The pile capacity may be recalculated based on the modified strength parameters of the improved ground after ground improvement.

Structure Location	Avg Depth	Field N	Total OVP (t/sqm)	Effective OVP (t/sqm)	CN	CE	CB	CS	CR	(N1)	FC	α	β	Corr. (N1)	r_d	CSR	$CRR_{7.5}$	FOS	Remarks
Chimney	5.23	1	8.55	3.33	1.70	1.00	1.05	1.10	0.85	1.7	29	4.64	1.15	6.5	0.96	0.26	0.08	0.5	Liquafiable
	7.23	1	12.35	5.12	1.40	1.00	1.05	1.10	0.95	1.5	34	4.93	1.19	6.8	0.95	0.24	0.09	0.5	
	8.00	6	13.82	5.82	1.31	1.00	1.05	1.10	0.95	9.2	34	4.93	1.19	15.9	0.94	0.23	0.17	1.1	
	9.23	15	16.17	6.95	1.20	1.00	1.05	1.10	0.95	19.7	31	4.77	1.16	27.7	0.92	0.22	0.38	2.1	
	11.73	13	21.17	9.45	1.03	1.00	1.05	1.10	1.00	15.4	33	4.88	1.18	23.1	0.86	0.20	0.26	1.8	
	14.73	13	27.17	12.45	0.90	1.00	1.05	1.10	1.00	13.5	33	4.88	1.18	20.6	0.77	0.17	0.23	1.9	Non-Liquefiable
	17.73	28	33.17	15.45	0.80	1.00	1.05	1.10	1.00	26.0	12	1.55	1.03	28.4	0.67	0.15	0.38	3.7	
	20.73	37	39.17	18.45	0.74	1.00	1.05	1.10	1.00	31.5	12	1.55	1.03	34.0	Non liquefiable				
	23.73	49	45.17	21.45	0.68	1.00	1.05	1.10	1.00	38.6	12	1.55	1.03	41.4	Non liquefiable				
	25.23	57	48.17	22.95	0.66	1.00	1.05	1.10	1.00	43.5	12	1.55	1.03	46.4	Non liquefiable				
ID Fan	3.23	0	5.05	1.82	1.70	1.00	1.05	1.10	0.80	0.0	29	4.64	1.15	4.6	0.98	0.28	0.07	0.4	Liquafiable
	5.23	0	8.85	3.62	1.66	1.00	1.05	1.10	0.85	0.0	29	4.64	1.15	4.6	0.96	0.24	0.07	0.4	
	7.23	2	12.65	5.42	1.36	1.00	1.05	1.10	0.95	3.0	29	4.64	1.15	8.1	0.95	0.23	0.10	0.6	
	9.00	6	16.02	7.02	1.19	1.00	1.05	1.10	0.95	8.4	30	4.71	1.15	14.4	0.92	0.22	0.15	1.0	
	9.23	7	16.45	7.22	1.18	1.00	1.05	1.10	0.95	9.0	35	5.00	1.20	15.8	0.92	0.22	0.17	1.1	Non-Liquefiable
	11.73	8	21.20	9.47	1.03	1.00	1.05	1.10	1.00	9.5	29	4.64	1.15	15.5	0.86	0.20	0.17	1.2	
	14.73	28	27.12	12.40	0.90	1.00	1.05	1.10	1.00	29.0	37	5.00	1.20	39.9	Non liquefiable				
Boiler, Mill-Bunker, Power House, Service Building Area	3.23	0	5.13	1.90	1.70	1.00	1.05	1.10	0.80	0.0	31	4.77	1.16	4.6	0.98	0.27	0.07	0.4	Liquafiable
	5.23	1	8.93	3.70	1.64	1.00	1.05	1.10	0.85	1.6	31	4.77	1.16	6.6	0.96	0.24	0.08	0.5	
	7.23	5	12.73	5.50	1.35	1.00	1.05	1.10	0.95	7.4	31	4.77	1.16	13.4	0.95	0.23	0.14	0.9	
	9.23	5	16.53	7.30	1.17	1.00	1.05	1.10	0.95	6.4	31	4.77	1.16	12.2	0.92	0.22	0.13	0.9	
	9.80	7	17.62	7.82	1.13	1.00	1.05	1.10	0.95	8.2	31	4.77	1.16	14.5	0.91	0.21	0.15	1.0	Non-Liquefiable
	11.73	12	23.35	10.63	0.97	1.00	1.05	1.10	1.00	13.4	27	4.48	1.13	19.7	0.86	0.20	0.21	1.5	
	14.73	21	29.35	13.63	0.86	1.00	1.05	1.10	1.00	20.8	18	3.23	1.07	25.4	0.77	0.17	0.30	2.5	
	17.73	26	35.35	16.63	0.78	1.00	1.05	1.10	1.00	23.3	22	3.93	1.09	29.4	0.67	0.15	0.43	4.1	
ESP & ESP Control Room	5.23	01	8.55	3.32	1.70	1.00	1.05	1.10	0.85	1.7	32	4.83	1.17	6.8	0.96	0.26	0.09	0.5	
	7.23	04	12.37	5.15	1.39	1.00	1.05	1.10	0.95	6.1	31	4.77	1.16	11.9	0.95	0.24	0.13	0.8	Liquafiable
	9.23	10	16.35	7.12	1.18	1.00	1.05	1.10	0.95	13.0	26	4.39	1.12	19.0	0.92	0.22	0.20	1.3	Non-Liquefiable
	11.73	4	21.10	9.37	1.03	1.00	1.05	1.10	1.00	4.8	26	4.39	1.12	9.7	0.86	0.20	0.11	0.8	Liquafiable
	12.20	7	22.00	9.80	1.01	1.00	1.05	1.10	1.00	7.6	26	4.39	1.12	12.9	0.85	0.20	0.14	1.0	Non-Liquefiable
	14.73	20	27.02	12.30	0.90	1.00	1.05	1.10	1.00	20.8	21	3.78	1.09	28.4	0.77	0.18	0.32	2.6	
Switch Yard & SY Control Room, Transformer Yard	7.23	1	10.93	3.70	1.64	1.00	1.05	1.10	0.95	1.8	29	4.64	1.15	6.7	0.95	0.29	0.09	0.4	
	9.23	2	14.73	5.50	1.35	1.00	1.05	1.10	0.95	3.0	29	4.64	1.15	8.0	0.92	0.26	0.10	0.5	
	11.73	4	19.48	7.75	1.14	1.00	1.05	1.10	1.00	5.2	29	4.64	1.15	10.7	0.86	0.23	0.12	0.8	Liquafiable
	12.10	7	20.19	8.09	1.11	1.00	1.05	1.10	1.00	9.3	30	4.71	1.15	15.5	0.85	0.22	0.16	1.1	
	14.73	30	25.25	10.53	0.97	1.00	1.05	1.10	1.00	33.8	29	4.64	1.15	43.3	Non liquefiable				Non-Liquefiable
	17.73	34	31.25	13.53	0.86	1.00	1.05	1.10	1.00	33.8	28	4.56	1.14	43.0	Non liquefiable				
	20.73	28	37.25	16.53	0.78	1.00	1.05	1.10	1.00	25.2	28	4.56	1.14	33.2	Non liquefiable				
	22.23	29	40.25	18.03	0.74	1.00	1.05	1.10	1.00	24.9	28	4.56	1.14	33.0	Non liquefiable				
BOP Area excluding NDCT	5.23	1	8.55	3.32	1.70	1.00	1.05	1.10	0.85	1.7	35	5.00	1.20	7.0	0.96	0.26	0.09	0.5	
	7.23	2	12.35	5.12	1.40	1.00	1.05	1.10	0.95	3.1	29	4.64	1.15	8.2	0.95	0.24	0.10	0.6	Liquefiable
	9.23	7	16.15	6.92	1.20	1.00	1.05	1.10	0.95	9.2	10	0.87	1.02	10.3	0.92	0.22	0.12	0.7	
	9.99	9	17.60	7.61	1.15	1.00	1.05	1.10	0.95	11.9	10	0.87	1.02	13.0	0.91	0.22	0.14	0.9	
	10.00	9	17.62	7.62	1.15	1.00	1.05	1.10	1.00	12.5	19	3.43	1.07	16.9	0.90	0.22	0.18	1.2	
	11.73	15	21.07	12.62	0.89	1.00	1.05	1.10	1.00	15.4	19	3.43	1.07	20.0	0.86	0.15	0.22	2.1	Non-Liquefiable
	14.73	24	27.07	21.62	0.68	1.00	1.05	1.10	1.00	18.9	19	3.43	1.07	23.7	0.77	0.10	0.27	3.8	
	17.73	29	33.07	26.62	0.61	1.00	1.05	1.10	1.00	20.5	19	3.43	1.07	25.5	0.67	0.09	0.30	5.0	
NDCT	3.23	0	4.93	1.70	1.70	1.00	1.05	1.10	0.80	0.0	51	5.00	1.20	5.0	0.98	0.29	0.07	0.4	
	5.23	1	8.73	3.50	1.69	1.00	1.05	1.10	0.85	1.7	51	5.00	1.20	7.0	0.96	0.25	0.09	0.5	
	7.23	2	12.53	5.30	1.37	1.00	1.05	1.10	0.95	3.0	51	5.00	1.20	8.6	0.95	0.23	0.10	0.6	
	9.23	2	16.53	7.10	1.19	1.00	1.05	1.10	0.95	2.6	29	4.64	1.15	7.8	0.92	0.22	0.09	0.6	Liquefiable
	11.73	3	21.08	9.35	1.03	1.00	1.05	1.10	1.00	3.0	29	4.64	1.15	8.7	0.86	0.20	0.10	0.7	
	14.73	5	26.78	12.05	0.91	1.00	1.05	1.10	1.00	5.3	29	4.64	1.15	10.7	0.77	0.18	0.12	1.0	
	17.73	8	32.48	14.75	0.82	1.00	1.05	1.10	1.00	7.6	7	0.12	1.01	7.8	0.67	0.15	0.09	0.9	
	18.00	12	33.00	15.00	0.82	1.00	1.05	1.10	1.00	11.1	7	0.12	1.01	11.3	0.67	0.15	0.12	1.2	
	20.73	49	36.35	18.63	0.78	1.00	1.05	1.10	1.00	43.9	82	5.00	1.20	57.7	Non liquefiable				
	22.23	74	39.35	18.13	0.74	1.00	1.05	1.10	1.00	63.5	82	5.00	1.20	81.2	Non liquefiable				
	23.73	50	42.35	19.63	0.71	1.00	1.05	1.10	1.00	41.2	24	4.18	1.11	49.8	Non liquefiable				Non-Liquefiable
	25.23	52	45.35	21.13	0.69	1.00	1.05	1.10	1.00	41.3	24	4.18	1.11	49.9	Non liquefiable				
	26.73	62	48.35	22.63	0.66	1.00	1.05	1.10	1.00	47.6	24	4.18	1.11	56.9	Non liquefiable				
	28.23	63	51.35	24.13	0.64	1.00	1.05	1.10	1.00	46.8	24	4.18	1.11	56.1	Non liquefiable				
Proposed Coal Conveyor, Proposed Cooling Water Channel / Sea Water Intake Pump House	3.23	0	5.73	2.50	1.70	1.00	1.05	1.10	0.80	0.0	22	3.93	1.09	3.9	0.98	0.23	0.06	0.4	
	5.23	0	9.53	4.30	1.52	1.00	1.05	1.10	0.85	0.0	22	3.93	1.09	3.9	0.96	0.22	0.06	0.4	Liquefiable
	7.23	1	13.33	6.10	1.28	1.00	1.05	1.10	0.95	1.4	22	3.93	1.09	5.5	0.95	0.21	0.08	0.5	
	9.23	3	17.13	7.90	1.12	1.00	1.05	1.10	0.95	3.7	22	3.93	1.09	8.0	0.92	0.21	0.10	0.7	
	9.80	6	18.22	8.42	1.09	1.00	1.05	1.10	0.95	9.4	22	3.93	1.09	14.2	0.91	0.20	0.15	1.1	
	11.73	24	24.90	11.18	0.95	1.00	1.05	1.10	1.00	26.2	19	3.43	1.07	31.6	0.86	0.20	0.64	4.6	Non-Liquefiable
	14.73	50	30.90	14.18	0.84	1.00	1.05	1.10	1.00	48.5	13	1.89	1.04	52.2	Non liquefiable				
	17.23	53	35.90	16.68	0.77	1.00	1.05	1.10	1.00	47.4	13	1.89	1.04	51.0	Non liquefiable				

1) C_N = Correction for Overburden pressure limited to 1.70

$C_N = \left(\frac{P_a}{\sigma'_v}\right)^{\alpha}$

P_a = 1 Atmospheric pressure = 10t/sqm

σ'_v = Vertical effective stress at the depth of SPT

2) C_E = Correction for Level of energy delivered by SPT Hammer = 1.00

3) C_B = Correction for Borehole Diameter = 1.05 for 150mm borehole dia.

4) C_S = Correction for SPT sampler use = 1.10 for sampler without liner

5) C_R = Correction for short length of drill rod

Rod lengths(m)	C_R	Rod lengths(m)	C_R
<3	0.75	6-<10	0.95
3-<4	0.80	10-30	1.00
4-<6	0.85		

(N1) = N C_N C_E C_B C_S C_R

Fine content means particles smaller than 75 micron

For Fine Content=5 α = 0 and β = 1

For Fine Content=5 AND <35 α = EXP(1.76-(190/FC^2)) and β = 0.99+(FC^1.5/1000)

For Fine Content=35 α = 5 and β = 1.20

Corrected (N1)$_{7.5}$ = αe$^{\beta}$(N1)

r_d=1.0-0.4113 z$^{0.5}$+0.04052 z^2-0.00478 z^3 for z ≤ 9.15 m; r_d=1.0-0.4177 z$^{0.5}$+0.05729 z^2-0.006205 z^3+0.001210 z^4 for z > 9.15 m

CSR = 0.65(σ$_{vo}$/σ'$_{vo}$)(r_d) (σ$_{vo}$ = Total Overburden pressure, σ'$_{vo}$ = Effective Overburden pressure)

$CRR_{7.5}$ = 1/(34-(Final N1)$_{7.5}$)+(Final N1)$_{7.5}$/135+50/(10*(Final N1)$_{7.5}$+45)^2-1/200

FOS against Liquefaction = $CRR_{7.5}$/CSR | MSF

For calculation of CSR & CRR, water level is considered at ground level.

5.6. SWELLING CHARACTERISTICS:

The swelling pressure and Free Swell Index tests were performed on few samples and the test results are presented at the end of Volume-2. The average swelling pressure and Free Swell Index as found from the tests are 0.01kg/sqcm and 20.15% respectively. It is seen that the subsoil has low swelling characteristics. So, no problem with respect to the swelling of the subsoil is anticipated.

5.7. FIELD PERMEABILITY TEST RESULTS:

20 Nos. Field permeability test was conducted at different depths in ten bore holes by falling head method and the test results are presented below. A sample calculation is also enclosed at the end of Volume-2.

Test Locations	Depth of Test (M)	Permeability (cm/sec)
FPT-01 (BH-12)	1.30-2.00	5.944×10^{-5}
	4.30-5.00	2.026×10^{-5}
FPT-02 (BH-19)	1.30-2.00	1.571×10^{-5}
	4.30-5.00	2.025×10^{-5}
FPT-03 (BH-27)	1.30-2.00	5.504×10^{-6}
	4.30-5.00	1.505×10^{-6}
FPT-04 (BH-32)	1.30-2.00	8.810×10^{-7}
	4.30-5.00	1.559×10^{-5}
FPT-05 (BH-57)	1.30-2.00	1.003×10^{-6}
	4.30-5.00	8.786×10^{-5}
FPT-06 (BH-62)	1.30-2.00	1.279×10^{-5}
	4.30-5.00	4.571×10^{-6}
FPT-07 (BH-81)	1.30-2.00	1.847×10^{-4}
	4.30-5.00	1.931×10^{-4}
FPT-08 (BH-92)	1.30-2.00	1.183×10^{-6}
	4.30-5.00	2.391×10^{-6}
FPT-09 (BH-104)	1.30-2.00	3.428×10^{-5}
	4.30-5.00	8.778×10^{-5}
FPT-10 (BH-115)	1.30-2.00	6.554×10^{-6}
	4.30-5.00	2.744×10^{-6}

5.8. FIELD CBR TEST RESULTS:

Only soaked field CBR test were conducted at site and the test results are presented below.

Sl No.	Test Location	Depth of Test (m)	Soaked		
			2.50mm Penetration	5.00mm Penetration	Average
1	FCBR-01	0.50	8.55 7.09 8.72	6.99 6.24 7.80	8.12
2	FCBR-02	0.50	0.98 5.61 5.38	0.90 4.66 4.55	3.99
3	FCBR-03	0.50	4.80 5.45 4.78	4.60 5.26 4.86	5.01
4	FCBR-04	0.50	2.38 1.70 2.38	1.98 1.95 2.13	2.15
5	FCBR-05	0.50	11.99 5.78 7.54	9.47 5.86 6.71	8.44

5.9. CHEMICAL TESTS:

Chemical tests were performed on few soil & water samples for determining the pH value, Sulphate, Chloride content etc. The results are given in a tabular form below:

CHEMICAL TEST RESULTS ON SOIL SAMPLES:

BH/Sample No.	Depth (m)	pH value	Sulphate as SO_3 (%)	Sulphate as SO_3 (gm/litre) in 2:1 water : soil extract	Chloride as Cl (%)	Carbonate as Co_3 (%)	Organic Matter (%)
BH-01 / UDS-04	8.00	6.71	0.25	1.25	0.2912	0.32	0.54
BH-08 / UDS-02	4.00	7.89	0.20	1.05	0.6107	0.30	0.92
BH-09 / UDS-05	10.00	7.52	0.35	1.80	1.2428	0.40	0.55
BH-15 / UDS-02	4.00	7.85	0.25	1.25	0.5681	0.45	0.97
BH-26 / UDS-05	10.00	7.99	0.10	0.55	0.0853	0.28	0.95
BH-39 / UDS-04	8.00	10.36	0.15	0.75	0.1166	0.36	0.42
BH-44 / UDS-04	8.00	8.21	0.25	1.30	0.3054	0.20	0.47
BH-50 / UDS-04	8.00	7.28	0.10	0.50	0.1506	0.22	0.38
BH-59 / UDS-05	10.00	7.02	0.25	1.20	0.4474	0.40	0.66
BH-66 / UDS-03	6.00	9.93	0.20	1.00	0.1565	0.54	0.44
BH-72 / UDS-03	6.00	8.10	0.20	1.05	0.1494	0.22	0.47
BH-89 / UDS-04	8.00	6.63	0.15	0.80	0.4048	0.26	0.42
BH-98 / UDS-01	2.00	7.60	0.20	1.00	0.5397	0.32	0.97
BH-109 / UDS-03	6.00	7.88	0.25	1.30	0.3764	0.42	0.95
BH-115 / UDS-07	16.00	7.19	0.20	1.00	0.3125	0.28	0.42

CHEMICAL TEST RESULTS ON WATER SAMPLES: -

BH/Sample No.	Depth (M)	pH value	Sulphate as (mg/litre)	Chloride as (gm/litre)	Carbonate as (mg/litre)	Nitrate as (mg/litre)	Organic Matter (mg/litre)
05	1.10	6.00	480	2.72	18	0.06	20.45
09	0.60	7.05	540	3.10	20	0.07	15.48
11	0.71	7.35	540	3.30	22	0.08	13.46
22	0.35	6.89	480	2.50	16	0.11	30.48
25	2.90	7.25	540	2.88	10	0.14	26.50
30	0.65	7.10	480	2.64	22	0.16	25.00
34	0.55	5.99	480	2.63	14	0.12	14.55
50	0.60	7.01	540	3.34	16	0.10	38.53
63	0.50	7.45	540	3.20	20	0.06	24.32
74	0.45	6.10	480	2.77	18	0.12	20.19
79	0.50	7.03	540	3.48	22	0.14	30.44
80	0.65	7.10	540	3.41	20	0.08	16.49
90	0.50	7.22	540	3.27	22	0.14	26.97
97	0.55	7.48	540	3.20	18	0.11	21.93
112	0.45	6.25	480	2.70	20	0.12	19.24

It is seen that the values are within permissible limits (as per IS:456-2000) except high sulphate and chloride content.

So, **Ordinary Portland Cement with C_3A content from 5 to 8 percent shall be desirable to be used in concrete.**

Alternatively, Portland slag cement conforming to IS 455 having more than 50 percent slag or a blend of ordinary Portland cement and slag may be used.

5.10. STANDARD & MODIFIED PROCTOR COMPACTION & CBR TEST:

Standard and Modified Proctor Compaction tests were carried out in the laboratory to determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). Thereafter, CBR (4 days soaked) tests were carried out on the samples prepared at MDD. The test results are presented below and the graphs are presented in Volume 2.

SL No	Test No.	Sample No	Depth (M)	Description	Standard Proctor Compaction Test		CBR (%) Soaked Condition		Modified Proctor Compaction Test		CBR (%) Soaked Condition		Recommended CBR Value (%)
					OMC (%)	MDD (gm/cc)	2.50mm Penetration	5.00mm Penetration	OMC (%)	MDD (gm/cc)	2.50mm Penetration	5.00mm Penetration	Soaked Condition
1	TP01	DS01	0.50	Fly ash	27.31	1.190	22.55	16.93	--	--	--	--	22
2	TP02	DS01	0.50	Fly ash	26.16	1.151	--	--	--	--	--	--	--
2	TP02	DS02	1.50	Fly ash	--	--	--	--	23.57	1.293	22.81	17.62	22
3	TP03	DS02	1.50	Brownish grey, clayey silt with sand mixture.	12.08	1.948	--	--	--	--	--	--	--
4	TP04	DS01	0.50	Fly ash	--	--	--	--	22.88	1.273	--	--	--
5	TP05	DS01	0.50	Brownish grey, clayey silt with traces of kankars.	23.63	1.606	2.17	1.80	21.27	1.767	--	--	2
6	TP06	DS02	1.50	Fly ash	23.00	1.274	13.45	13.08	--	--	--	--	13
7	TP07	DS03	2.50	Brownish grey, clayey silt with sand mixture.	12.75	1.931	--	--	--	--	--	--	--
8	TP08	DS02	1.50	Fly ash	29.83	1.142	18.91	13.95	--	--	--	--	18
9	TP09	DS03	2.50	Brownish grey, clayey silt with sand mixture & traces of kankars.	--	--	--	--	12.22	1.948	--	--	--
10	TP10	DS01	0.50	Brownish grey, clayey silt / silty clay with traces of sand mixture.	18.39	1.723	--	--	--	--	--	--	--
11	TP11	DS01	0.50	Fly ash	--	--	--	--	21.99	1.330	16.24	12.94	16
12	TP12	DS03	2.50	Light grey, clayey silt with sand mixture & traces of kankars.	13.58	1.888	13.28	13.17	11.95	2.115	--	--	13
13	TP13	DS02	1.50	Fly ash	--	--	--	--	19.21	1.325	--	--	--
14	TP14	DS02	1.50	Fly ash	30.30	1.225	--	--	--	--	--	--	--
15	CBR01	DS01	0.50	Fly ash	29.93	1.130	--	--	26.03	1.221	32.65	25.56	32
16	CBR02	DS01	0.50	Fly ash	--	--	--	--	24.25	1.218	--	--	--
17	CBR03	DS01	0.50	Fly ash	29.30	1.139	--	--	--	--	--	--	--
18	CBR04	DS01	0.50	Fly ash	--	--	--	--	28.42	1.202	--	--	--
19	CBR05	DS01	0.50	Fly ash	--	--	--	--	25.57	1.214	37.60	29.42	37

5.11. SUITABILITY OF EXISTING SOIL FOR FILLING AND BACK-FILLING:

The subsoil at the site consists of silty clay / clayey silt / fly ash having low swelling properties. So, the soil can be used for filling and backfilling purposes with necessary compaction as required.

The soil can be compacted and will easily attain an average dry density (by standard proctor) of 1.17 gm/cc in case of fly ash or 1.80 gm/cc, in case of existing silty clay / clayey silt with sand available at top.

In case of modified proctor, the same can be considered as 1.25gm/cc & 1.90 gm/cc respectively.

5.12. SUITABILITY OF SOIL FOR CONSTRUCTION OF ROADS & PAVEMENT:

The subsoil at the site consists of silty clay / clayey silt / fly ash having low swelling properties. Thus the soil can be used for the construction of roads and pavement as a fill material.

Depending on the use of fly ash / existing silty clay / clayey silt with sand available at top, the CBR test results under different compaction condition (light or heavy) is already presented in Sec. 5.10 and shall be used for pavement subgrade design as the case may be.

6. SUMMARY & CONCLUSIONS

Based on the field and laboratory tests and the foregoing discussion the following are summarised.

1. The subsoil is characterised by a filled up soil/ash followed by very loose to loose clayey silty sand / very soft silty clay. Below this, medium silty clay followed by stiff to very stiff silty clay layer was observed. After that dense to very dense silty sand / hard silty clay layer was found alternatively and that continued upto the terminating depth of the all boreholes.
2. The standing water level was struck at an average depth of about 0.71m below existing ground level.
3. Using the elastic rebound as we obtain from CPLT, the dynamic properties are calculated and presented below.

Test No.	Depth (M)	$C_{u\ (10sqm\ fdn.size)}$ (kg/cucm)
CPLT-01	1.30	0.67
CPLT-02	1.20	0.89

4. Considering Subsoil condition it is suggested to go for deep foundation in form of pile depending on requirement. Either bored cast in-situ or driven piles can be used.
5. The determination of pile capacity is presented in the previous section. The recommended pile capacity values for different depths & pile diameters are presented below.

Location	Length of pile below cut-off (M)	Pile Dia (mm)	Recommended Vertical Pile Capacity (T)		Recommended Uplift Pile Capacity (T)		Recommended Lateral Pile Capacity (T)
			Bored	Driven	Bored	Driven	
Chimney	26.00 (Cut-off = 6.50m)	600	150	--	100	--	7.0
		760	240	--	150	--	10.0
ID Fan	26 (Cut-off = 3.0m)	600	140	--	90	--	7.0
		760	200	--	130	--	10.0
Boiler, Mill-Bunker, Power House, Service Building Area	26 (Cut-off = 5.0m)	600	150	--	95	--	3.5
		760	230	--	135	--	4.5
ESP & ESP Control Room	20 (Cut-off = 5.0m)	550	--	100	--	60	4.5
Transformer Yard, Switch Yard & Switch Yard Control Room	26 (Cut-off = 3.0m)	600	135	--	85	--	3.5
BOP Area excluding NDCT	26 (Cut-off = 3.0m)	600	135	--	90	--	3.5
	20 (Cut-off = 3.0m)	550	--	100	--	55	3.5
NDCT	25 (Cut-off = 4.0m)	600	130	--	85	--	3.5
		750	185	--	120	--	4.5
		760	190	--	122	--	4.5
		900	245	--	155	--	5.5
		1000	290	--	180	--	6.0
	26 (Cut-off = 4.0m)	600	135	--	90	--	3.5
		750	190	--	125	--	4.5
		760	195	--	128	--	4.5
		900	255	--	160	--	5.5
		1000	300	--	185	--	6.0
Proposed coal conveyor, Proposed Cooling Water Channel / Sea Water Intake Pump House	26 (Cut-off = 3.0m)	600	150	--	100	--	3.5
	20 (Cut-off = 3.0m)	550	--	100	--	60	3.5

Note: The pile capacity values recommended above are under present condition i.e. before any ground improvement. The pile capacity may be recalculated based on the modified strength parameters of the improved ground after ground improvement.

6. The discussion on swelling characteristics is given in Section 5.6.

7. It is seen that the values are within permissible limits (as per IS:456-2000) except high sulphate and chloride content. So, **Ordinary Portland Cement with C_3A content from 5 to 8 percent shall be desirable to be used in concrete. Alternatively, Portland slag cement conforming to IS 455 having more than 50 percent slag or a blend of ordinary Portland cement and slag may be used.**

8. Standard and Modified Proctor Compaction tests were carried out in the laboratory to determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). Thereafter, CBR (soaked) tests were also carried out on the samples prepared at MDD. The summarised test results and the graphs are presented in Volume 2.

9. The possibility of subsoil liquefaction due to earthquake is given in Section 5.5.

10. The geological report is presented under Section 7.

11. 27 (twenty seven) nos. ERT were performed at the site and the test results are discussed and presented in Section - 8.

12. 6 (six) nos. Cross Hole Shear Tests were performed at the site and the test results are discussed and presented in Section - 9. For dynamic properties of subsoil strata, Cross Hole Shear test results shall be referred.

13. 4 (Four) nos. Pressure meter Tests were performed at the site and the test results are discussed and presented in Section - 10.

For C. E. Testing Company Private Limited,

Prepared By	Checked By	Approved By
S. Sarkar	Sudip Nath	
(S. SARKAR)	**(S. NATH)**	**(DR. M. NAYAK)**

Annexure B to Corrigendum 6 dated September 03, 2021 to Tender Specification BHEL PSSR SCT 1979

2x600 MW ENNORE TPS

TECHNICAL SPECIFICATION FOR REINFORCED CONCRETE CHIMNEY

VOLUME - II

SECTION-C

SPECIFIC TECHNICAL REQUIREMENTS FOR ELECTRICAL WORKS

SPECIFICATION NO. PE-TS----------

Note : In case of any conflict between section-C & section-D of electrical portion, section-C of electrical prevail.

Preparation of **AS-BUILT** drawings showing field modifications (if any).

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and testing of equipment shall be carried out as per the latest Indian/International Standards, Indian Electricity Rules, Relevant Code of Practices and requirements of Govt. of Tamil Nadu.

2.02.00 Equipment/components conforming to the latest editions of Standards of the International Standard Institutions, Institution of Electrical & Electronic Engineers, USA (IEEE), National Elect. Manufactures Association, USA (NEMA) or International Electro-Technical Commission (IEC) will also be acceptable provided these are either equivalent or more stringent.

IS-1913	IS-1977	IS-10322	IS-8623	IS-6064
IS-8828	IEC-598	IS-9224	IS-2959	IS-1248
IS-2705	IS-4160	IS-2713	IS-800	IS-2026
IS-2099	IS-694	IS-1554	IS-9537	IS-5133

3.06.00 The lighting system shall comprise of following sub-systems:-

i) Normal A.C. Lighting

a) This will be provided by A.C. lighting fixtures distributed throughout the plant. These lights will be ON as long as the A.C. supply is available.

b) A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be connected to main lighting distribution board. The main lighting distribution boards will be fed through respective lighting transformer, which forms a part of the MLDB. Normal A.C. supply thus made available by the MLDB is 415V-3ph-4W-50HZ effectively grounded. Both the MLDB and the lighting panels shall be provided with at least 20% spare outlets.

ii) Emergency A.C. Lighting

a) On failure of normal A.C. Supply, emergency A.C. lighting will be provided in service building, areas of the powerhouse, boiler area, boiler galleries etc for general visibility, safe movements and operation of important auxiliaries.

b) The emergency LDBs (ELDB) are similar to the MLDB except that lighting transformers in this case are fed from station A.C. Emergency bus having D.G. System backup. Thus power for A.C. emergency lighting is 415V-3ph-4W, 50HZ, effectively grounded.

c) At least 20% of the fixtures shall be fed from AC emergency source.

b) The DC Emergency Lighting Distribution Boards will be fed from two power

vi) Receptacles

To cater to welding and other low voltage power requirement of the plant 63A TPN welding socket fed from MCC/A.C. distribution board of respective area shall be provided. For other services 15A, 3pin socket shall be provided.

4.00.00 SYSTEM PARTICULARS

System particulars are as follows:

		415V AC System Incoming	415V AC System Outgoing	240V AC System	220VDC System
4.01.00	Nominal Voltage	415V	415 V	240V	220V

6.00.00 GENERAL REQUIREMENTS

6.01.00 Lighting Transformers

a) Lighting transformers shall be dry type, indoor type dust and vermin proof having single phase, 415 V/433 V, off load tap-changer with ± 2 x 2.5% on primary side. The vector-group shall be Dyn11. (The secondary side shall be solidly grounded through an additional neutral bushing exclusively used for grounding.) Rating of each lighting transformer shall be selected to cater to the maximum connected lighting and receptacle load on that transformer. The casing of the transformer shall be grounded at least at two (2) points. Rating of each transformer shall be decided to limit the fault level within 9kA.

b) Lighting Transformer shall be 2 x 100% for TG Building , Service building , Water treatment plant, ESP and Fuel oil pump house

c) If necessary, apart from the main lighting transformers, separate small additional lighting transformers may be used at distance lighting points.

6.02.00 Lighting Fixtures

a) Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.

b) Reflector shall be of sheet steel or aluminium, minimum 20 SWG thick, securely fixed by fastening device of captive type.

c) Fixture shall be suitable for 20 mm conduit entry and 16 SWG G.I. earth-wire connections. Fixture shall also be suitable for case coupling entry wherever required.

d) High bay fixtures shall have provision for vibration damper to ensure rated lamp life.

e) Fixture shall be furnished complete with lamps and integrally/non-integrally or separately mounted control gear & accessories or applicable for different types of fixtures. These shall include holders, ballast, capacitor, starter, igniters (separate type) etc.

f) Fixtures shall be fully wired up to respective terminal blocks, suitable for loop in and loop one connection of PVC wires of following sizes:-
   1. Lighting fixture : 2.5 Sq.mm Copper
   2. Flood Light fixture : 2x2.5 Sq.mm Copper

g) The distribution of lighting fixtures/receptacles shall be such that the loading on each phase of the LDB is approx. equal.

h) In indoor areas fixtures with suitable mounting accessories shall be used and shall not be directly mounted on walls.

i) Search lights having adequate coverage shall be provided in watch towers

6.03.00 Lamps

a) General lighting service (GLS) lamps shall be with clear glass and screwed caps.

b) All fluorescent lamp shall be bi-pin rotary type and cool daylight.

c) Lamps shall be suitable for use in position and capable of withstanding small vibrations. Restrictions and special features, if any, shall be clearly indicated in the bid.

d) CFL and T5 fluorescent tube with electronic ballast or tri phosphorous tube.

e) Latest energy saving LED type lighting fixture/ lamps

f) Light Emitting Plasma (LEP)

6.04.00 Ballast

a) Ballasts shall be heavy duty, low loss, and polyester-filled type with copper winding.

b) Ballasts shall be free from hum. Ballasts which produce humming sound shall be replaced without any implication.

c) In multi-lamp fixture, each lamp shall be provided with individual ballast.

d) Ballast windings shall have maximum operating temperature of 120 Deg.C without rated temperature rise marking.

e) Ballast for Control Room Area shall be heavy duty, low loss, high-grade silicon steel stampings; vacuum impregnated polyester resin filled with copper winding. Ballast for other area shall be electronic type, flicker free pre heat lamp start type having power consumption less than 3-watts per ballast, power factor less than 0.98 and THD less than 10%. Ballast shall operate at operating frequency of more than 40 kHz. Power consumption of ballast for 36W Fluorescent Tube shall be less than 9.5W.

6.05.00 Lighting Panel/Distribution Boards

a) Lighting Distribution Boards/panels shall be Fibre reinforced plastic (FRP) type, suitable for either wall/column mounting on brackets or floor mounting on channel sills.

b) Indoor Lighting Distribution Boards & Lighting Panels shall be dust and vermin-proof, IP-54. Outdoor panels shall be weather-proof with canopy, IPW-55 or better. The cubicle housing transformer shall be minimum IP-42.

c) Lighting Distribution Boards and Lighting Panels shall be so constructed as to permit free access to the terminal connections and easy replacement of parts. Front access doors shall have padlocking arrangements.

d) Lighting Distribution Boards shall have provision of cable entry from bottom and, panels shall have provision of cable entry from top and bottom, as required, with removable gland plates. Necessary double compression type brass cable glands, tinned copper/Aluminium cable lugs are to be furnished.

e) Two ground pads with M10 G.I. bolts and nuts shall be provided on each Lighting Distribution Board and Lighting Panel for connection to 25 x 3 mm G.I. flat.

f) Each Lighting Distribution Board shall be complete with designation and caution notice plates fixed on front cover and a directory plate fixed on inside of the front cover. This directory Plate shall contain details of the Lighting Panels being fed from the Distribution Board including their designation, location, loading etc. Each Lighting Panel shall be complete with designation and caution notice plates fixed on front cover and a circuit directory plate fixed on inside of the front cover. Circuit directory plate shall contain details of the points to be controlled by each circuit including the location of the point controlled, rating of the protective units and loading of each circuit. The plates shall be of anodized aluminium with inscriptions indelibly etched on it.

g) Bus bar shall be electrolytic grade hard drawn aluminium, colour coded for easy identification and designed for a maximum temperature of 85^{o}C. Minimum size shall be 25 x 6 mm.

h) Board / Panel shall be fitted with phase barriers such that it is not readily possible for personnel to touch the phase busbars. Insulation barriers shall preferably be fitted around the circuit breakers such that only the surface and the toggle of the circuit breaker are available on the front.

i) Incoming and outgoing circuits shall be terminated in suitable terminal blocks.

j) In lighting and receptacle panel 3-phase and 1-phase MCB should not be mixed.

6.06.00 Receptacles

a) Receptacles shall be heavy duty, complete with individual plug and switch.

b) The conduit box of the receptacle shall be provided with earthing screws with washer and nuts welded on the surface for grounding with 16 SWG G.I. wire.

Arrangement shall be provided inside the conduit box for grounding of third pin.

c) Shrouded type plug shall be provided with corresponding matching arrangement at sockets to prevent accidental contact with finger during plug insertion.

d) Receptacles shall be of following types:

1. Type RA-5A, 240V, 2 pole, 3 pin type with third pin grounded, suitable for flush mounting in MCC Room, office areas, control rooms, store rooms, cabins etc. The switch shall be of piano-key type, also flush mounted and decorative non-industrial type.

   In service building and administration building all the occupants shall be provided with 4 nos. of 5A, switches and telephone point in the modular furniture.

2. Type RB-15A, 240V, 2 pole, 3 pin Industrial type with third pin grounded, metal clad with gasket having 19mm conduit entry and a metallic screwed cover tied to it with a metallic chain and suitable for installation in clean/dusty areas. The receptacles located in switchgear rooms, MCC rooms and control room shall have IP-42 degree of protection and those located in other dusty areas shall have IP-62 degree of protection. These receptacles shall be located at an interval of 50M along length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper. Minimum one (1) no shall be provided in all equipment floor, feeder floor, boiler drum level, TPs Crusher House, Sub-station, Control Room, Pump House, Transformer Room, various levels of service building, RO plant, and at suitable location in all other areas as required. In fuel oil area receptacles will be of flameproof type.

3. Type RC-63A, 415V, 3 phase, 4 pin Industrial type interlocked plug and switch with earthing contact. Other requirements shall be same as Type RB. Interlocking shall be so selected that the switch can be put to `ON' position only when all the four (4) pins of the plug are housed with complete alignment. In `OFF' position of the switch the socket outlet shall be completely dead and outgoing terminals isolated. Welding receptacles shall be connected with each other in loop-in loop-out connection to the extent of 4 Nos., located at an interval of 50 M. along the length of conveyor gallery/tunnel starting from one end and both sides of Track Hopper and minimum one (1) no. shall be provided in all equipment floor, T.Ps, crusher house (2 nos. on each floor of crusher house) , wagon tippler, stacker

reclaimer machines, pump houses, substation buildings & Cable spreader room, transformer room, boiler platform, switchgear/ MCC rooms, Transformer yard, cooling tower, etc. Separate distribution boards with isolating transformers shall be used to feed these welding receptacles. At least one (1) no. shall also be provided in each offsite building, which will be fed from 415V MCC. In hazardous areas these receptacle shall be located in MCC rooms.

6.07.

6.08.

mounted type on brick wall with only the switch knob projecting outside.

6.11.00 Conduits and Accessories

a) Conduits shall be rigid steel, hot-dip galvanized, furnished in standard length of 3 metres, threaded at both ends.

b) Conduits upto and including 25 mm shall be of 16 SWG and conduits above 25 mm shall be of 14 SWG. Minimum size of conduits shall be 19 mm.

c) Each piece of conduit shall be straight, free from blister and other defects and covered with capped bushings at both ends.

d) Flexible conduits shall be made with bright, cold rolled annealed and electro-galvanized mild steel strips and coated with PVC.

6.12.00 Junction Box

a) Junction boxes shall be of 16 SWG sheet steel hot-dip galvanized, dust and damp proof, generally conforming to IP-66.

b) Junction boxes shall be complete with gasket inspection cover, conduit knock out/threaded hub and terminal blocks.

c) Junction boxes for outdoor use shall be FRP weatherproof IPW-66 and those for hazardous location shall be flame-proof type.

d) Junction boxes shall have following indelible markings :

1. Circuit nos. on top
2. Circuit nos. with ferrules (inside) as per drawing
3. DANGER sign in case of 415V circuit

6.13.00 Lighting Cables & Wires

6.13.01 All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.

6.13.02 Heavy duty AYWY FRLS cables will be used only for connections:

1. From main lighting distribution boards to area lighting panels
2. From street/area lighting panel to street light poles/towers.
3. From 415V MCCs to receptacles of 63A and above.

6.13.03 Lighting Cable shall be heavy duty, 1100 Volt grade, multi-core stranded aluminium conductor, PVC insulated, extruded PVC inner sheath, single round G.I. wire armoured and overall PVC sheathed conforming to IS 1554.

6.13.04 Lighting wires shall be 1100 Volt grade, PVC insulated, stranded conductor, single core cable conforming to IS 694, colour coded as below :

RED for R-Phase	BLACK for Neutral
YELLOW for Y-Phase	WHITE for +'Ve D.C.

BLUE for B-Phase GREY for -'Ve D.C.

6.13.05 Wire size shall be as follows:

For point wiring beyond lighting panel i.e. from lighting Panel to junction box (main run)	:	10 Sq.mm. Aluminium. Stranded conductor
From Junction box to lighting fixture	:	2.5 Sq.mm. Copper. Stranded conductor.

6.14.00 Terminals

6.14.01 Multi way terminal blocks of approved type, complete with screws, nuts, washers and marking strips shall be furnished for connection of incoming/outgoing wires.

6.14.02 Each terminal shall be suitable for connection upto 2 nos. 10 Sq.mm stranded aluminium conductors without any damage to the conductor or looseness of connectors.

7.00.00 ENERGY SAVING SYSTEM

appearance and shall be based on proven In-Tension design confirming to the standards referred to above, to give an assured performance, and reliable service. The structure shall be suitable for wind loading as per IS-875 Part-III, 1987. The masts dimensions shall be as per standards.

2. The Mast shall be of 30M height with lantern carriage to enable raising/lowering for ease of maintenance, including the Head Frame, Double Drum Winch, continuous stainless steel wire rope, in built power tool, luminaries, suitable aviation warning light, lightning along with necessary power cables within the mast. The mast shall be delivered only in three sections & shall be joined together by slip stressed fit method at site. No site welding or bolted joints shall be done on the mast.

9.00.00 CHIMNEY LIGHTING

9.01.00 Electrical System

415V, normal and emergency AC power supply for chimney shall be derived from main plant power supply system. Emergency supply shall feed 20% of platform lighting, 50% of staircase lighting, aviation obstruction lighting and elevator load. All other loads shall be connected on normal power supply.

Ambient temperature for design of all equipment shall be considered as 55°C, which is likely to be encountered inside the chimney.

The distribution boards of chimney shall comprise switch fuse units of appropriate ratings. Emergency board shall have two incomers, one from emergency supply and other from normal AC distribution board itself. Auto changeover scheme shall be provided in emergency board to enable changeover to healthy source on failure of any source.

Dry type isolating transformer of Dyn11 connection shall be provided in emergency board to obtain neutral lead, in case 3 – phase 3- wire, emergency supply is derived from main plant.

9.02.00 Lighting system

Various platforms shall be illuminated by 70/150W metal halide well glass lighting fixtures. Staircase lighting shall be with 70W metal halide well glass fixtures. Average

illuminations level of 150 lux shall be maintained on equipment and 50 lux on platforms/staircases. Lighting system shall be controlled through MCB provided in lighting panel. Six numbers of metal halide flood lights focused towards chimney shall be provided on each external platform for aesthetics view during night times.

Lighting and power panel each shall be located at grade level and at other in between levels as required. All distribution boards, aviation lighting controls, etc. shall be located at grade level only. At each platform, 1 No. 63A, 415V welding receptacle and 1 No. 15A, 240V receptacle shall be provided and shall be fed from power panel. Wiring installation for lighting fixture shall be of PVC insulated copper/aluminum wires through galvanized steel conduits. a

Aviations obstruction lighting system shall conform to the requirements of the latest rules and regulations of the International Civil Aviation Organization (ICAO), National Airports Authority (NAA) and Directorate of Air Routes and Aerodromes (DARA) or any other statutory body and also to conform to IS: 4998. The obstruction lighting shall be done as per Appendix 6 figure 6.2 of ICAO i.e. Combination of Low intensity (Multi LED type- B) & Medium intensity (Multi LED type- B). The life of light fittings shall be 20 years maintenance free. Minimum Low intensity fittings 12 nos. (1/6, 1/2 & 5/6 level) & Medium intensity fittings 12 nos. (1/3, 2/3 & top level) and marking/painting shall be done as per ICAO. A minimum of six levels will be provided with aviation obstruction lights and there will be four light units per level. Each aviation warning light shall be of neon type having two lamps. Only one (1) lamp in a given fitting would be ON at a time and if the lamp fails, its failure would initiate an alarm and the next lamp in that particular fitting would be switched on automatically. Necessary control panel for control and annunciation shall be supplied. The control scheme of the control panel shall be to the approved of OWNER/Consultant.

One (1) photo controller along with suitable controller arrangement to be supplied by the contractor to switch ON and OFF the aviation warning light automatically based on the intensity of natural light during day/night.

The top light or lights shall be so arranged as to mark the point or edge of the obstruction marking surface. The lights shall be placed between 1.5 meter and 3 meter below the top. The number and arrangements of lights at each level or platform be such that the obstruction is indicated from every angle in azimuths.

Aviation obstruction lighting shall be complete with lights, photocell, controller, special cables, etc. and IP65 shall be followed for all panels.

The warning lights shall be adequately secured to the chimney against the wind forces. The low intensity shall be of fixed red colour, medium intensity shall be flashing red and high intensity shall be of flashing white. Temporary aviation lights with infrared bulbs shall be installed at each of the levels as instructed by OWNER as the construction work progresses and also above the top most point of the obstruction as construction progresses. These lights need to be installed only after the level of obstruction is greater than 45 meter above grade level. The lights shall continue to exist till permanent arrangement to provide such lights are completed.

CHAPTER – 16

LV CABLES

1.00.00 CODES AND STANDARD

1.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS : 3961	Recommended current ratings for cables
IS : 3975	Low carbon galvanised steel wires, formed wires and tapes for armouring of cables.
IS : 4905	Methods for random sampling.
IS : 5831	PVC insulation and sheath of electrical cables.
IS:7098 (Part -I)	Cross linked polyethylene insulated PVC sheathed cables for working voltages up to and including 1100V.
IS : 8130	Conductors for insulated electrical cables and flexible cords.
IS : 10418	Specification for drums for electric cables.
IS : 10810	Methods of tests for cables.
ASTM-D -2843	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	Standard method for measuring the minimum oxygen concentration to support candle like combustion of plastics.
IEC-60754 (Part-I)	Test on gases evolved during combustion of electric cables.
IEEE-383	Standard for type test of Class IE Electric Cables.
IEC -60332	Tests on Electric cables under fire conditions.

	Part-3 : Tests on bunched wires or cables (catagory -B)
SS-4241475 classF3	Swedish Chimney test
NES-715-1	Temperature index

2.00.00 TECHNICAL REQUIREMENTS

2.01.01 The cables shall be suitable for laying on racks, in ducts, trenches, conduits and under ground buried installation with chances of flooding by water.

2.01.02 Cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

2.01.03 Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be multi stranded.

2.01.04 XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg. C and short circuit conductor temperature of 250°C.

2.01.05 The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS: 5831.

2.01.06 For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables armouring shall be of galvanised steel as follows : -

Calculated nominal dia of cable under armour	**Size and Type of armour**
i) Up to 13 mm	1.4mm dia GS wire
ii) Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
iii) Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
iv) Above 40 & upto 55mm	1.4 mm thick GS formed wire /2.5mm dia GS wire
v) Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
vi) Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

2.01.07 The aluminium used for armouring shall be of H4 grade as per IS:8130 with maximum resistivity of 0.028264 ohm mm^2 per meter at 20 deg C. Aluminium armouring shall be same as indicated above for galvanized steel.

2.01.08 The gap between armour wires / formed wires shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface of G.S.wire/ formed wire

2.01.09 Cable Identification

1. Outer sheath shall be of PVC (of suitable grade) & black in colour. In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

   (a.) Oxygen index of min. 21 (As per NES-715-1)

   (b.) Acid gas emission of max. 20% (As per IEC-60754-I).

   (c.) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.

2. Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

   1 core - Red, Black, Yellow or Blue

   2 core - Red & Black

   3 core - Red, Yellow & Blue

   4 core - Red, Yellow, Blue and Black

3. For reduced neutral conductors the core shall be black.

4. In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath.

   (a.) Cable size and voltage grade - To be embossed

(b.) Word 'FRLS' at every 5 metre - To be embossed

(c.) Sequential marking of length of the cable in metres at every one metre- To be embossed / printed

The embossing shall be progressive, automatic, in line and marking shall be legible and indelible.

5. Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.

1 core	-	Red, Black, Yellow, Blue
2 core	-	Red & Black
3 core	-	Red, Yellow & Blue

2.01.10 All cables shall meet the fire resistance requirement of IEEE - 383 with cable installations made in accordance with clause “Flammability test” and as per Category-B of IEC 60332 Part -3.

2.01.11 Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum over the declared value in the technical data sheets.

2.01.12 In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc, are not acceptable.

3.00.00 Cable selection & sizing

3.01.00 Cables shall be sized based on the following considerations:

i. Rated current of equipment.

ii. Maximum voltage drop limits under steady state and during starting for motor being fed from 415V switchgear restricted to 5% and 15% respectively.

Maximum voltage drop limits under steady state and during starting for motor being fed from 415V MCC restricted to 3% and 15% respectively.

Maximum voltage drop limits under steady state for feeder (i.e. Outgoing feeders being fed from 415V switchgear) restricted to 3%.

iii. For cables to motors and feeders protected by MCCBs the cross section will be chosen according to the tripping time of MCCBs.

3.02.00 Derating Factors

Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes:

i. Variation in ambient temperature for cables laid in air
ii. Grouping of cables
iii. Variation In ground temperature and soil resistivity for buried cables.

3.03.00 Cable lengths shall be considered in such ways that straight through cable joints are avoided.

3.04.00 Cables shall be armoured type if laid in switchyard area, coal handling area or directly buried.

3.05.00 All LV power cables except trailing cables shall be XLPE insulated FRLS.

3.06.00 All control cables shall be 2.5 Sq mm copper cable.

3.07.00 Multicore control cables will generally have spare conductor (s) in accordance with the following chart and cores of a single cable will not be split for different auxiliary/equipment:

Conductors	required Cables
1 or 2	1-3/C
3 or 4	1-5/C
5 or 6	1-7/C
7 or 8	1-10/C
9 or 10	1-12/C
11 or 12	1-16/C
13 or 14	1-18/C
Above 14 core	Two or more of above cables

4.00.00 CONSTRUCTIONAL FEATURES

04.01.00 1.1 KV Grade Power Cables

(d.) 1.1 KV grade XLPE power cables shall have compacted aluminium conductor for cables including 10 sq. mm and above and copper conductor for cables below 10 sq.mm, XLPE insulated, PVC inner-sheathed (as applicable), armoured, FRLS PVC outer-sheathed conforming to IS: 7098. (Part-I).

(e.) 1.1 KV grade Trailing cables shall have tinned copper (class 5) conductor, insulated with heat resistant elastomeric compound based on Ethylene Propylene Rubber (EPR) suitable for withstanding 90°C continuous conductor temperature and 250 deg C during short circuit, inner-sheathed with heat resistant elastomeric compound, nylon cord reinforced, outer-sheathed with heat resistant, oil resistant and flame retardant heavy duty elastomeric compound conforming to IS 9968

4.02.00 1.1 kV Grade Copper Conductor Fire Survival Power Cables

4.02.01 1100 volt grade, 90 Deg.C rating, Power cables with stranded Copper conductor, heat resistance elastomeric insulation generally conforming to Type IE-2 of IS: 6380-1984, extruded Halogen free or very low Halogen elastomeric inner sheath, generally conforming to Type SE-3 of IS-6380-1984, round wire/strip armour and extruded outer sheath of elastomeric material generally conforming to Type SE-3 of IS: 6380-1984.

4.02.02 The cables shall be generally manufactured in conformity to IS-9968 Part-1/1988.

4.02.03 The cables shall be rated for 3 hours fire rating.

4.02.04 Conductor shall be of stranded construction, consisting of high conductivity annealed plain copper wires conforming to Class-II of IS 8130.
A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

4.02.05 The insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.

4.02.06 The suitable fire retardant material fillers shall be used for filling in the interstices. Two layers of plain glass fiber binder tape shall be applied over the laid up cores.

4.02.07 Fire Survival Power & Control cables shall be provided for the following services:

(a.) DC emergency lube oil pump.
(b.) Turbine lube oil pump/barring gear.
(c.) Jacking oil pump.
(d.) Scanner air fan.
(e.) Incoming & outgoing cables for DC lighting distribution board.
(f.) Fire /smoke detection system.
(g.) DC seal oil pump.
(h.) DC emergency lighting cables for Main Plant Building.
(i.) Batteries to charger and DC distribution board.
(j.) Emergency turbine trip by push button in control room.
(k.) Boiler turbine: Generator inter-trip which includes the interconnecting cables between

1. Boiler master fuel trip and turbine trip relays
2. Generator trip relays and turbine trip relays
3. Generator trip relays and 400 kV circuit breaker
4. Generator trip relays and generator field breaker.
5. Generator trip relays and UAT breaker.

4.03.00 1.1 KV Grade Control Cable

Control cable shall be multi core, minimum 2.5 sq.mm cross section, stranded copper conductor, PVC insulated, inner PVC sheathed / galvanized steel wire armored and outer sheath made of FRLS PVC compound. In situation where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. 4 sq.mm copper conductors shall be used for CT circuits, all other specification remaining same. In 4 sq.mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.

Voltage Transformer leads shall be checked for voltage drop, which shall be limited to within 1 % for all cases other than tariff metering, for which the voltage drop shall be limited to 0.2 %. In case the voltage drop with 4 sq.mm Cu conductors exceeds this value, higher conductor sizes shall be used.

4.04.00 1.1 kV Copper Conductor Fire Survival Control Cables

4.04.01 Conductor shall be of stranded construction, consisting of high conductivity annealed tinned copper conductors conforming to IS 8130/1984 amended up to date.

4.04.02 A suitable heat barrier tape, preferably glass mica tape shall be provided over the conductor.

4.04.03 The conductor insulation shall consist of heat resisting elastomeric material EPR (Ethylene Propylene rubber) and shall conform to Type IE-2 of IS:6380/1984 amended up to date.

4.04.04 An inner sheath of extruded special low smoke and very low halogen content (acid gas generation shall be less than 2% by weight) elastomeric (HOFR) compound of black colour or any other natural colour with prior approval from Owner conforming to Type SE-3 of IS-6380/1984, amended up to date, shall be provided over the laid up cores.

4.04.05 The armouring over inner sheath shall consist of single layer of wire/round galvanized steel wire as per IS 3975 amended up to date.

4.04.06 The outer sheath shall be of special low smoke and very low Halogen content (Acid gas generation shall be less than 2% by weight) elastomeric HOFR compound comprising of synthetic rubber and shall generally conform to the type SE-3 of IS: 6380 latest revision.

4.04.07 The colour of outer sheath shall be black or any other natural colour agreed mutually between Owner and Contractor.

4.04.08 The minimum sizes of L.T. cable to be chosen are as below:
AL-16 mm^2 (3 core) & Cu – 2.5 mm^2 (3 core)

In power cables maximum conductor size to be used will be 300 sq. mm & 630 sq.mm for multi core and single core cables. In case of multi core cables not more than 3 runs to be used or otherwise single core cable to be used.

4.05.00 Cable Drums

Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof cover. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS: 10418.

5.00.00 TESTS

5.01.00 Type Tests:

5.01.01 The reports for the following type tests shall be submitted on one size each of LV Power cables :

S.No.	Type Tests	Remarks
a)	**For Conductor**	
1.	Annealing test	For copper conductor only.
2.	Tensile test	For aluminium conductor only.
3.	Wrapping test	For aluminium conductor only.
4.	Resistance test	
b)	**For Armour Wires/ Formed Wires**	
1.	Measurement of Dimensions	
2.	Tensile Test	
3.	Elongation test	
4.	Torsion test	For round wires only
5.	Winding test	For Formed wires only
6.	Resistance test	
7(a)	Zinc Coating test	For G.S. Formed wires /wires only.

7(b)	Wrapping test	For Al. Formed wires /wires
c)	**For XLPE insulation & PVC Sheath**	
1.	Test for thickness	
2.	Tensile strength & elongation tests before ageing and after ageing	
3.	Ageing in air oven	
4.	Loss of mass test	For PVC sheath only
5.	Hot deformation test	For PVC sheath only
6.	Heat shock test	For PVC sheath only
7.	Shrinkage test	
8.	Thermal stability test	For PVC sheath only
9.	Hot set test	For XLPE insulation only
10.	Water absorption test	For XLPE insulation only
11.	Oxygen index test	For outer sheath only
12.	Smoke density test	For outer sheath only
13.	Acid gas generation test	For outer sheath only
d)	For completed cables	
1.	Insulation resistance test (Volume resistivity method)	
2.	High voltage test	
3.	Flammability test as per clause “Flammability test”	
4.	Flammability test as per IEC - 332 Part-3 (Category -B)	

5.01.02 Flammability Test

(f.) This test shall generally be carried out as per IEEE 383. The cable installation to be tested shall consist of as many cables as are necessary to give atleast 10 kg of organic material per metre run.

(g.) The following cable installation shall be tested :

(1.) Installation with single / multi core cables in touching formation.

(h.) Size of cables, number of cables, number of layers and laying arrangements for each installation shall be subject to Owner's approval.

(i.) The size of the cables selected (measured by total cross sectional area of the conductor) shall have maximum organic material per sq. mm of total cross sectional area of all the conductors.

5.01.03 Acceptance Tests

Acceptance tests shall be carried out on each type and size of the cables on the cable drums selected at random as per following sampling plan:

S. No.	No. of drums in the lot	No. of drums to be taken as sample
1.	Upto 100	10% (Subject to minimum of 1 drum)
2.	101 to 300	13
3.	301 to 500	20
4.	Above 500	32

The following shall constitute acceptance tests :

1. Item No. 1 to 14, 16, 19, 20, 22, 23, 24, 25 of list of type tests specified in 9.03.01 of chapter 15.
2. Fire resistance test as per SS 4241475 (F3 category)
3. One length per size / lot for surface finish and length measurement
4. Lay length / sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires, Band marking.

5.01.04 Routine Tests

Routine tests shall be carried out as per relevant standard for each drum of cables of all types and sizes.

CHAPTER 18

EARTHING AND LIGHTNING PROTECTION

A. EARTHING SYSTEM

1.00.00 SCOPE

The Contractor shall provide all required material and carry out main earth grid, treated earth pits, raisers and inter connections, equipment earthing etc for the following areas and all areas/buildings/structures in both units including but not limited to:

a) 400 kV Switchyard (Outdoor and Indoor GIS)
b) Main Plant Building (TG building)
c) Boiler area, ESP, Chimney, NDCT & other electrical systems
d) FOPH
f) Coal / Ash Handling plant etc.
g) Sea Water PH, RO-DM Plant
h) All other miscellaneous buildings not mentioned herein.

For Transformer yard, separate earth grid shall be suitably formed and treated earth pits including raisers shall be provided for transformer neutral & body earthing, bus duct support structures and LAs.

Earthing system shall consist of earth grids and electrodes buried in soil in the plant area, embedded in concrete inside the buildings to which all the electrical equipment, metallic structures are connected to have earth continuity for safety reasons. The earthing system shall conform to IS 3043 and Indian Electricity Act/rules.

The Contractor shall furnish the detailed design, layout and calculations for Owner's approval. Contractor shall obtain all necessary statutory approvals for the system.

2.00.00 CODES AND STANDARDS

2.01.00 All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening

of bid. In case of conflict between this specification and those (IS codes, standards, etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards/ codes as applicable.

2.02.00 Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed below. In such a case, the Contractor shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

1.	IS:513	Cold rolled low carbon steel sheets and strips.
2.	IS:802	Code of practice for the use of Structural Steel in Overhead Transmission Line Towers.
3.	IS:1079	Hot Rolled carbon steel sheet & strips
4.	IS:1239	Mild steel tubes, tubular and other wrought steel fittings
5.	IS:1367 Part-13	Technical supply conditions for threaded Steel fasteners. (Hot dip galvanized coatings on threaded fasteners).
6.	IS:2309	Code of Practice for the protection of building and allied structures against lightning.
7.	IS:2629	Recommended practice for hot dip galvanising of iron & steel
8.	IS:2633	Method for testing uniformity of coating on zinc coated articles.
9.	IS:3043	Code of practice for Earthing
10.	IS:6745	Methods for determination of mass of zinc coating on zinc coated iron & steel articles.

11.	IS:9595	Metal – arc welding of carbon and carbon manganese steels - recommendations.
12.	IEEE:80	IEEE guide for safety in AC substation grounding
13.	IEEE:142	Grounding of Industrial & commercial power systems
14.		Indian Electricity Act.
15.		Indian Electricity Rules.

3.00.00 DESIGN CRITERIA

3.01.00 Fault Current & Duration

Earthing system network/earth mat shall be interconnected mesh of mild steel rods buried in ground in the plant. For earth mat design, the size of earthing conductor shall be calculated considering maximum fault current 56 kA for duration of 1 second and corrosion factor. The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.

3.02.00 Conductor Material

3.02.01 The earthing system conductors and accessories as proposed are to be as

(a) Conductors above ground level and in trenches: Galvanized steel
(b) Conductors buried in ground or embedded in concrete: Mild Steel
(c) Electrodes: GS Pipe / Rod

3.02.02 The contractor shall undertake the soil resistivity measurements at site and shall select suitable type of conductors.

3.02.03 The earth conductors shall be free from pitting, laminations, rust, scale and other electrical, mechanical defects.

3.03.00 Size of Conductors

3.03.01 Main Conductors

The minimum sizes of earthing conductors for various electrical equipments shall be as below:

Equipment		Earth conductor buried in earth	Earth conductor above ground level & in built-up trenches
a)	Main earth grid	40 mm dia.MS rod	65x8mm GS flat
b)	Switchyard	---	75x12 mm GS Flat and 50x6 mm GS flat
b)	11/3.3KV/415V Switchgear/equipment	---	65x8mm GS flat
c)	415 V MCC/ Distribution boards / Transformers	---	50x6mm GS flat
d)	LV Motors above 125 KW	---	50 x 6mm GS flat
	25 KW to 125 KW	---	25 x 6mm GS flat
	1KW to 25 KW	---	25 x 3mm GS flat
	Fractional HP LV Motors	---	8 SWG GS wire
e)	Control panel & control desk	---	25 x 3 mm GS flat
f)	Push button station / Junction Box	---	8 SWG GI wire
g)	Columns, structures, cable trays and busducts enclosures	---	50x6mm GS flat
h)	Crane, rails, rail tracks & other non-current carrying metal parts		25x6mm GS flat

3.03.02 Soil Treatment to Lower Resistivity

The soil resistivity study shall be carried out by the contractor.

In order to reduce the resistivity of the soil the earth pits shall be treated with high purity electrically conductive material having ultra low resistance value (typically, 0.001 ohm-m). The properties of the material shall be such that it does not require periodic re-watering or recharge of salt or earth enhancing compound during the life of the power plant. The material should be such that it does not reach chemicals into the adjacent soil or underground water channels and should be PH neutral. Earth enhancing material should permanently protect the encased metal components of the earthing systems. Earthing electrodes encased in high strength concrete mixed with the conductive material shall be preferred instead of electrode buried directly in the earth.

3.03.03 Rod Electrodes

Galvanized steel rod electrodes of suitable diameter and length shall be used as per the recommendation of IS-3043. For test pits electrodes shall be heavy duty type (Class – C) GI pipe of suitable diameter with perforations. For treated earth pits, GI pipe shall be provided as per IS 3043 including charcoal, salt etc. Necessary number of treated earth pits shall be provided for LAs, GTs, UTs, ST, UATs in the transformer yard and other UATs in coal and ash handling plants, ant UATs at raw water pump house and for all LT transformer Neutral & body earthing. Electrodes installed in the test pits will have disconnecting facilities.

3.03.04 Earthing of Electrical equipment on cranes and travelling machines:

Every electrical equipment shall have double earthing. A ring earthing system shall be provided within the crane/machine to which electrical equipment shall be connected at least at two places. The earth ring on the crane/machine shall be connected to the plant earthing system through gantry rails. Two sets of earth collector brushes shall be provided on each side of crane/machine to connect its earth ring to the gantry rails. Each end of each gantry rail shall be bonded to the plant earthing system. In addition, intermediate earthing bond shall also be provided on the rails at every 60 m in case of longer tracks. Flexible copper bonds shall be provided across any gap in the running

gantry rails. For mobile equipment with flexible cables, one separate copper conductor of adequate size shall be provided for earthing.

3.03.05 Equipment Earthing Leads

The size of the earthing leads shall be decided based on the type of equipment and structure to be earthed and shall be provided generally as per IS-3043.

4.00.00 EARTHING SYSTEM LAYOUT

4.01.00 General

Metallic frames of all current carrying equipment, supporting structures adjacent to current carrying conductors, structures in contact with switchyard earth, lightning protection system conductors and neutral points of various systems shall be connected to a single earthing system.

All the offsite areas shall be interconnected together by minimum two parallel conductors.

Crane rails, tracks, metal pipes and conduits shall be effectively earthed at two points. Steel RCC columns, metallic stairs, and rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing lead ensured by bonding the different sections of hand rails and metallic stairs.

For all other equipments, two earthing leads shall be used if rated voltage of equipment is above 250V. In case the rated voltage is 250 V or below, one earth lead can be used. Metallic structures adjacent to electrical equipment shall be earthed by one earthing lead.

Earthing conductors in outdoor areas shall be installed at a minimum depth of 600 mm.

All cable trays in the plant buildings as well as inside the trenches shall be connected to earth grid at an interval of about 10 m.

Portable tools, appliances and welding equipment shall be earthed by flexible insulated cable

4.02.00 Earthing Conductor Layout in Switchyard

Main earthing conductors shall be laid in the form of a grid. Spacing between conductors, number of parallel conductors, etc., shall be decided such that step and touch potential are within safe limits.

The maximum permissible step and touch potentials shall be calculated in accordance with the formula, given in IEEE-80.

Earthing conductors shall be provided around the outside edge of fence at a distance of approximately 6000 mm. This shall be connected to the switchyard earthing grid.

Every alternate post of the switchyard fence shall be connected to earthing grid by one GS flat and gates by flexible lead to the earthed post.

An earthing mat comprising closely spaced (about 150 mm) conductors shall be provided below the operating handles of disconnecting switches and breaker operating kiosk for the additional safety of the operating personnel.

Each of the earth leads of transformer neutral, lightning arrester shall be directly connected to two separate electrodes. Neutral points of HV transformer shall be earthed through NG resistors. The Contractor shall connect the NGR earthing point to earth electrodes by suitable earth conductors Lightning protection down conductor shall be directly connected to a separate earth electrode.

All earth electrodes in turn shall be connected to main earthing system. The earth grids of different areas of the plant shall be interconnected through, test pits to enable measurement of earth resistance for each area separately.

Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

Earth pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600 mm.

4.03.00 Earthing Conductors Inside Building

Main earthing conductors shall be buried in earth around the building. Minimum two taps-off from this earthing loop shall be taken inside the building and connected to the earthing grid embedded in the floor slab with approximately 50 mm concrete cover. The requirement of electrodes around the building shall be specified.

In case the building has more than one floor, each floor shall be provided with separate earth grid. These floor earthing grids shall be interconnected.

Each RCC / Steel column of the building shall be interconnected to the floor earthing grid in the ground floor.
Instrumentation system and computer system shall be provided with a dedicated earthing system suitable for the equipment. Separate electronic earthing for the PLC equipments, SAS panels and all other equipments wherever necessary shall also be provided

Earthing grids of all the buildings, outdoor yards shall be interconnected to form a single grid for the plant.
Earthing grid design shall be done in such a manner that the grid resistance is less than one ohm.

Suitable earth risers as approved by Owner shall be provided above finished floor/ground level, if the equipment is not available at the time of laying of main earth conductor.

5.00.00 EARTHING SYSTEM INSTALLATION

The spacing between two electrodes shall be at least equivalent to twice the length of the electrode.

Earthing conductors along their run on columns, walls, etc. shall be supported by suitable welding / cleating at interval of 1000mm and 750mm respectively. 8 SWG earth wire should be run along with lighting conduits and shall be earthed at both ends. The wire should be suitable clamped with conduit at equal interval at not more than 500 mm.

The earthing conductor crossing the road / track shall be laid in hume pipe or laid at a greater depth to avoid damage.

When earth conductor passes through floors, walls, etc., suitable pipe sleeves shall be provided and the same shall be sealed after installation.

The connection between earthing pads / terminal to the earth grid shall be made short and direct and shall be free from kinks & splices.

Cable trays, metal pipes / conduits, steel columns, etc., shall not be used as earth continuity conductors.

Street lighting poles, flood light poles & towers, their junction boxes shall be connected to the earthing conductor to be run along with supply cable. This earth conductor shall be in turn connected to earth grid at two extreme points.

Flexible earth conductors shall be provided at expansion joints for earthing the gates, operating handles, etc.

Equipment bolted connection after being checked and tested shall be painted with anti-corrosive paint / compound be welded. For rust protection, the welds shall be treated with zinc chromate primer and coated with zinc rich paint.

Metallic sheaths/screens, and armour of multi-core cables shall be earthed at both ends. Metallic Sheaths and armour of single core cables shall be earthed at switchgear end only unless otherwise instructed by the Owner.

All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

The contractor shall demonstrate the effectiveness of earthing system by measurement of earth resistance, step and touch potential at different locations. Earth resistance at earth terminations shall be measured in presence of Owner's representatives. All equipment required for testing shall be furnished by contractor.

Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections. Equipment bolted connections after being tested and checked shall be painted with anti corrosive paint/compound.

Connections between equipment earthing leads and between main earthing conductors shall be of welded type. For rust protection the welds should be treated with red lead compound and afterwards thickly coated with bitumen compound. All welded connections shall be made by electric arc welding. The overlapping of earthing conductor in welded joints should be 6 times diameter. Cleats should be provided at both sides to increase contact area. Angles/ cleats should be welded at the point of crossing of longitudinal and transverse earthing conductors.

Resistance of the joint shall not be more than the resistance of the equivalent length of conductors.

Back filling material to be placed over buried conductors shall be free from stones and harmful mixtures. Back filling shall be placed in layers of 150 mm. Trenches after laying earth rods should be closed with approved filling materials in layers and not with debris.

6.00.00 OTHER REQUIREMENTS OF EARTHING SYSTEM:

Life expectancy	40 Years
System Fault Level	56KA for one second
Min. Steel corrosion	0.12mm/year

Depth of burial of main earth conductor		600mm below grade level; where it crosses trenches, pipes, ducts, tunnels, rail tracks, etc., it shall be at least 300mm below them.
Conductor joints		By electric arc welding, with resistance of joint not more than that of the conductor.
Surface resistivity	- Gravel	: 3000 ohm-meter
	- Concrete	: 500 ohm-meter

B. LIGHTNING PROTECTION SYSTEM

Lightning protection system shall be in strict accordance with IS: 2309 and NFPA 78 as applicable.

7.00.00 CONDUCTOR MATERIALS

a) Lightning protection air termination, down conductors, test links for buildings: GS flat

b) Exposed lightning protection air termination on chimney top: lead coated copper

c) Earth conductors buried in ground/concrete: MS rod

8.00.00 LIGHTNING SYSTEM LAYOUT

8.00.01 Lightning conductors shall be connected through test link with earth electrode/earthing system

8.00.02 Suitable lightning protection shall be provided to protect

a) Main Power House building and other structure as per IS requirement.
b) Main transformers and other equipments.
c) 400 KV GIS switchyard & building
d) Chimney, Cooling Tower and CHP
e) Other off site buildings & structures as applicable.

8.01.00 Down Conductors

1. Down conductors shall be as short and straight as practicable and shall follow a direct path to earth electrode.

2. Each down conductor shall be provided with a test link at 1000 mm above ground level for testing but it shall be in accessible to interference. No connections other than the one direct to an earth electrode shall be made below a test point.

3. All joints in the down conductors shall be welded type.

4. Down conductors shall be cleated on outer side of building wall, at 750 mm interval or welded to outside building columns at 1000 mm interval.

5. Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor

fixing at an interval of 1500 mm.

6. All metallic structures within a vicinity of two meters of the conductors shall be bonded to conductors of lightning protection system.

7. Lightning conductors shall not pass through or run inside GI Conduits.

8. Testing link shall be made of galvanized steel of size 25x 6mm.

9. Pulser system for lightning shall not be accepted.

10. Hazardous areas handling inflammable/explosive materials and associated storage areas shall be protected by a system of aerial earths.

11. Lightning protection conductors/ air termination rods and circumferential band provided at the top position of chimney stack shall be lead coated in order to avoid melting by exposure to hot flue gases.

12. For tall buildings and structures, early streamer emission (ESE) type, air terminal system such as marketed by Heary Brothers (USA) or any other reputed make are preferred.

13. Horizontal air termination flats provided on top of boilers, main plant building, pump houses & other buildings shall be laid such that no part of the roof shall be more than 9 metres.

14. Conductors of lightning protection system shall not be connected with conductors of earthing system above ground level

15. Lightning protection shall have as few joint as possible and avoid sharp bends. Down conductors shall have as far as possible, no joint except at test point and end termination.

16. Termination at the metallic equipments on roof should be made by suitable nuts, bolts, pressure washer and bitumen washers with good electrical conductivity.

17. All lightning protection conductors shall be exposed to atmosphere unless specifically mentioned.

9.00.00 QUALITY ASSURANCE PROGRAMME

Contractor shall furnish detailed Quality Assurance Programme and Quality Plans for all materials and accessories to be supplied and installed under the scope of the specification as per General Technical Conditions of technical specification. The Quality Plans shall include all tests/ checks as per relevant National/International Standards and the requirements of this specification including tests listed in this section.

10.00.00 INSPECTION AND TESTING

1) Earth continuity checks.

2) Earth resistance of the complete system as well as sub-system.

3) The earthing and lightning conductors should be type tested as per IS 2629.Following minimum tests shall be conducted:

i. Freedom form defects
ii. Uniformity in thickness
iii. Mass of coating
iv. Adhesion tests

Any other applicable tests not mentioned in the specification but required

GENERAL TECHNICAL REQUIREMENTS
OF
LIGHTNING PROTECTION OF CHIMNEY

SPECIFICATION NO. PES-509-02A

1.0 GENERAL

1.1 This section includes the design, fabrication, supply, installation and testing of Lightning Protection system for the Chimney(s). The requirements of this specification shall be complied with in relation to the requirements set out in Data Sheet-A & Section-C.

1.2 The contractor's scope, besides material supply shall include complete installation of Lightning Protection System, protective coating application, and testing of the system. All materials, consumables, erection equipment etc. as required for the completion of installation and testing facilities shall be supplied.

2.0 CODES & STANDARDS

2.1 The latest revisions of the following codes & standards shall be applicable:

IS:2309 Code of practice for protection of buildings & allied structures against lightning.

IS:3043 Code of Practice for earthing

IS:4759 Hot-dipped galvanised coating on structural steel

IS:2629 Recommended practice for Hot-dipped galvanising for Iron & Steel.

IS:2633 Methods of Testing Uniformity of Coating on zinc-coated Articles.

IS:1731 Dimensions for Steel flats for structural & General Engineering Purposes.

IS:1752 Electroplated Coatings of Cadmium on Iron & Steel

Indian Electricity Rules, 1956,

Indian Electricity Act, 1960.

IS:4990(Part-I) Criteria for Design of Reinforced concrete Chimney.

3.0 DESIGN REQUIREMENTS

3.1 Lightning Protection system for the chimney shall consist of air-termination network comprising requisite number of vertical copper rods, 20mm in dia, projecting at least 1000mm above the top of the chimney and the flues, spaced uniformly along the top periphery of the outer shell of the Chimney and that of the flues. A ring of 75x6mm GI strip shall be laid along the top periphery of the flues and the Chimney, forming the

annular horizontal air terminations. The vertical air terminations shall be electrically connected (Brazed) to the horizontal air terminations, the vertical termination of the flues and those of the Chimney to the horizontal termination of the Chimney. The vertical terminations shall be spaced not more than 3m apart from each other.

3.2 The air terminations shall be secured to the top of Chimney top by an arrangement of substantially strong construction to withstand high wind pressure prevalent in the area commensurate with the height involved. All materials for the securing arrangement shall be of the same grade as the conductors and must be galvanised. The vertical air terminals at the top of the shell shall also be secured to the guard ring at the top of the shell.

3.3 A minimum of two numbers of equally spaced conductors, each consisting of 50x6mm GI strip, shall be brought down from their connecting points on the annular rings at the top of the Chimney/flues. The down-conductors originating at the top of the flues shall be brought down along the walls of the flues and electrically connected (welded) to the annular ring at the top of the outer shell of the Chimney. The down conductors (minimum two numbers) from the chimney top shall be brought down to the bottom of the Chimney all along the exterior Chimney wall.

3.4 A test link of copper black/phosphor bronze gunmetal bolted to the conductor for the purpose of isolation & testing shall be provided on each down conductor 1000mm above ground level.

3.5 Down conductors shall be cleated to the wall at an interval of 1500mm all along the length of the Chimney.

3.6 Down conductors near ground level shall be protected against mechanical injuries by means of wood-moulding or non-metallic cover. A removable cover of the same material shall be provided over the test- link for easy access.

3.7 The connection between the downconductor from the test link onwards upto an annular ring of galvanised steel running around the entire periphery of the chimney bottom shall be provided through risers which shall be of 40mm dia MS rods.

3.8 The risers shall be terminated on the annular ring of 40mm dia MS rod running around the periphery of the chimney buried 1 metre deep in the ground and clearing all foundation by at least 2 metres.

3.9 From the termination points of the downconductors on to this underground ring, mild steel rods shall terminate at test pits complete with test-links and electrodes.

3.10 The test pits at para 3.9 shall in turn be connected to the main earthmat of the power house through 40mm dia MS rod.

3.11 All joints, except for testing purposes, shall be welded type lap joints with an overlap of 100mm. The welding shall be complete around the joint and not tack welded. Electric arc welding shall be used for all joints.

3.12 After welding, two coats of anti-corrosive (red-oxide) paint followed by a coat of bituminous paint shall be applied to each joint.

3.13 The 40mm dia MS rods shall be protected against corrosion by applying a coat of barium chromate paint and two coats of bitumen below the test link.

3.14 The complete lightning protection system arrangement including air-terminations, conductors, connections, fittings etc. and materials located on the exterior within 10m from the top of the chimney shall have lead coating of 2.0mm thickness.

3.15 All exposed metal structures such as hand rails, platforms, ladders/stairs shall be connected to the downconductors through earthing band rings, of 50x6mm GI strip located 2000mm above each platform. Ladders and platforms shall be bonded together for electrical continuity. A strip of 25x3mm GI shall be used for connection between equipment and earthing band rings. Similarly, all lighting fixtures shall be earthed.

3.16 Temporary lightning protection system shall have to be provided and maintained during the construction of chimney or till final lightning protection system is installed by the contractor free of cost and in line with IS:4998(Part-I).

3.17 For general reference and guidance, Below Ground Earthing Typical Details drg.no. PE-DG-XXX-509-0004 & drg.no.PE-DG-XXX-509-003 may be used.

4.0 GALVANISING

4.1 All steel strips and materials requiring galvanisation shall be hot-dip galvanised according the IS:2629 & IS:4759. Galvanising shall be done at a place where galvanising and testing facilities conforming to the relevant Indian Standards exist. The galvanising shall be smooth, clean, uniform, continuous & free from acid spots. The thickness of zinc deposit at any spot shall not be less than 75 microns. The purchaser reserves the right to measure the thickness of zinc deposit and reject any component which shows thickness of zinc at any location less than 75 microns. Should the galvanising of the sample be found defective, the entire batch of the steel will have to be re-galvanised at the seller's cost.

4.2 All nuts, bolts and washers, wherever used, shall be cadmium coated or zinc passivated, the thickness of plating conforming to the relevant Indian Standards.

5.0 INSPECTION & TESTING

5.1 The following stages of manufacture/installation shall be stage inspected by purchaser or his duly authorised representative:

5.1.1 Inspection of all material such as vertical air terminals, steel strips, electrodes, test links including hardware items such as bolts, nuts etc.

5.1.2 Inspection of manufacturing processes such as shearing, punching, beinding, welding, galvanising, painting etc.

5.1.3 Inspection of installation procedures

The actual inspection will be carried out as per the agreed Quality Plan.

5.2 TESTING

5.2.1 The supplier shall perform all tests necessary to ensure that the material and workmanship conform to relevant standards and that such tests are adequate to

demonstrate that the equipment shall comply with the requirements of this specification.

5.2.2 The tolerance in dimensions shall be in accordance with appropriate Indian Standards.

5.2.3 Forged steel below 10mm thick is subject to Magnetic Particle Testing.

6.0 DRAWINGS, DATA & DOCUMENTS

6.1 Data sheet-A of this specification gives the details of materials to be used for the Lightning Protection system for Chimney.

6.2 The tenderer shall submit his design(s) and drawings for Direct stroke Lightning Protection System of Chimneys for purchaser's evaluation/scrutiny and approval.

6.3 The contractor shall furnish his design(s) and installation drawings for approval.

6.4 The contractor shall furnish the requisite number of prints & RTF's of all drawings as specified elsewhere in this specification.

6.5 The site modifications/deviations shall be marked on the latest revision of the drawings & submitted as 'As Built' drawings to the purchaser after completion of installation.

6.6 Tenderer shall submit all filled up schedules as per Volume-III.

6.7 The tenderer shall submit reports on Type tests & Special tests conducted on lightning protection materials & accessories.

7.0 COMPLETENESS

7.1 The offer for supply and erection shall be complete in all respects & shall include all materials, tools and appliances, whether specified or not, required for the completion of the job.

7.2 Supply/arrangements of all accessories and material etc. shall be the responsibility of the contractor.

SPECIFIC TECHNICAL REQUIREMENTS

MATERIALS & SIZES

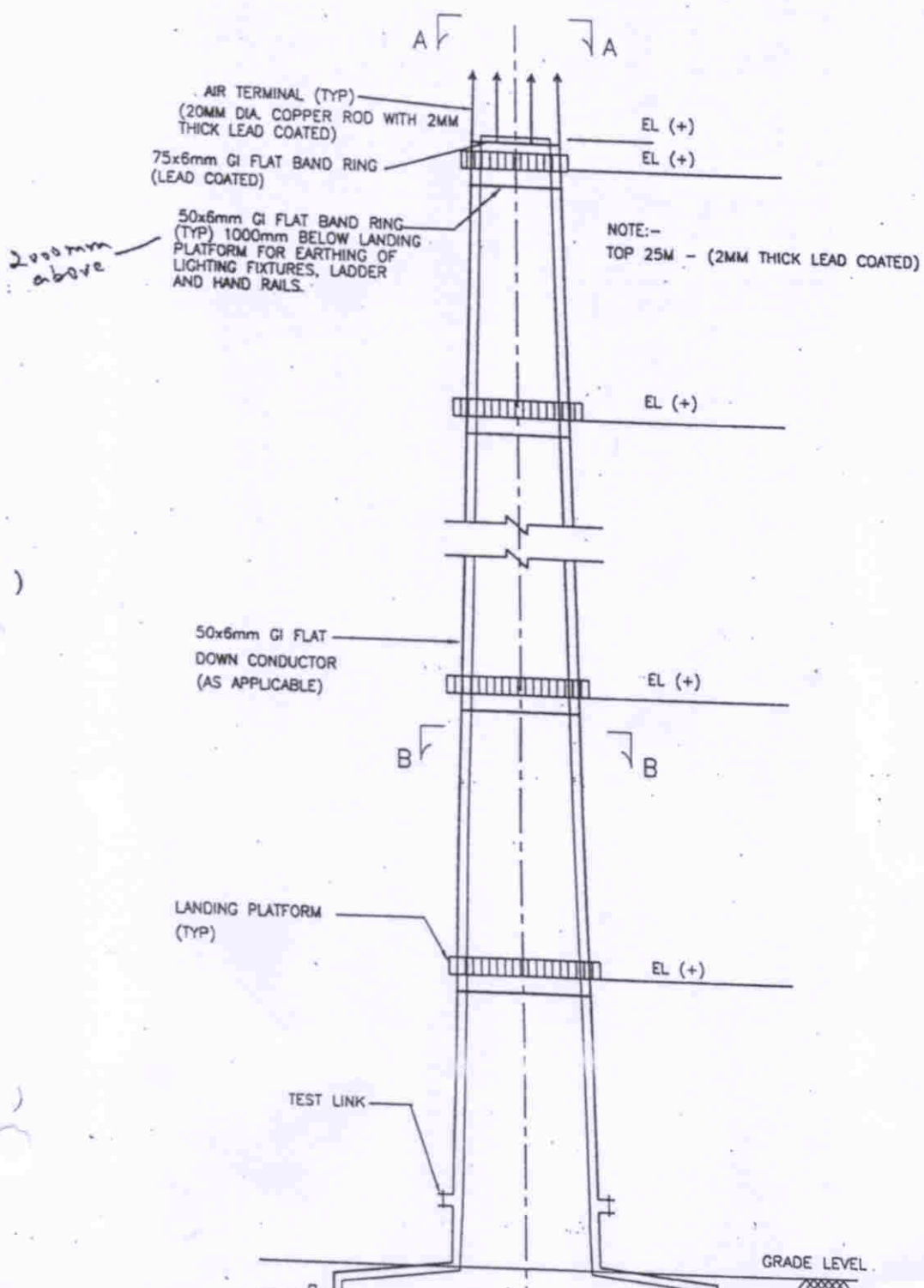
The following are the minimum sizes of material to be used for lightning protection system:

S.No.	Material	Minimum Size
1.	COPPER RODS (Lead Coated)(for vertical air Terminations projecting 1000mm above the Chimney/ flues)	20mm dia
2.	GI STRIP (for annular horizontal band ring at the top of the Chimney/flues)	75x6mm
3.	GI STRIP (for downconductor)	50x6mm
4.	GI STRIP (for earthing band ring each platform)	50x6mm
5.	MS ROD (for risers)	40mm dia
6.	TEST LINK	compatible with size at Sl.No.3 & 5 above
7.	MS ROD (for annular ring buried 1 metre in the ground around the chimney)	40mm dia
8.	MS ROD (for electrodes) with Test Pits	40mm dia
9.	MS ROD (for connection between test pit and customer's earthmat)	40mm dia
10.	GI STRIP/WIRE (for connection between equipment and earthing band rings)	25x3mm/As required

1.0 GUARANTEED TECHNICAL PARTICULARS:

The tenderer shall fill up and submit the following technical particulars:

1.01	Name of Manufacturer	:
1.02	Place and country of Manufacture	:
1.03	Standards applicable	:
	i/ For materials & sizes	:
	ii/ For galvanisation/Electroplated coating	:
	iii/ For testing uniformity of Galvanization	:
	iv/ For code of practice	:
	v/ For hexagonal bolts, nuts washers	:
	vi/ For welding	:
1.04	Thickness of galvanizing on steel	:
1.05	Thickness of Electriplated coatings	:
1.06	Thickness of Lend coating on copper	:
1.07	Materials and sizes offered	:
	i/ Below ground conductor	:
	ii/ Electrodes	:
	iii/ Risers	:
	iv/ Down Conductors	:
	v/ Air terminations (Vertical)	:
	vi/ Air termination (Horizontal)	:
	vii/ Test Pits	:
	viii/ Test Links	:
1.08	Whether all type test certificates furnished	
1.09	Whether all schedules of Vol.III filled up and submitted.	

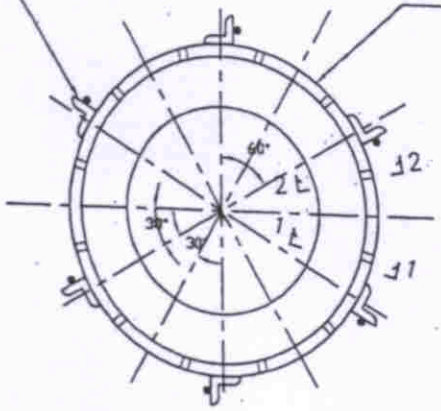


CHIMNEY (ELEVATION)

BHEL	[illegible]	LIGHTNING PROTN. OF CHIMN
	BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003
		SHEET 1 OF 4 REV. 00

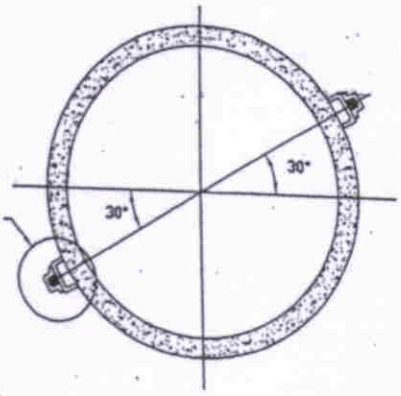
AIR TERMINAL (TYP)
(20MM DIA. COPPER
ROD WITH 2MM THICK
LEAD COATING)

75X6 G.I. FLAT BAND
RING-LEAD COATED
(HORIZONTAL AIR
TERMINATION)



SECTION A-A

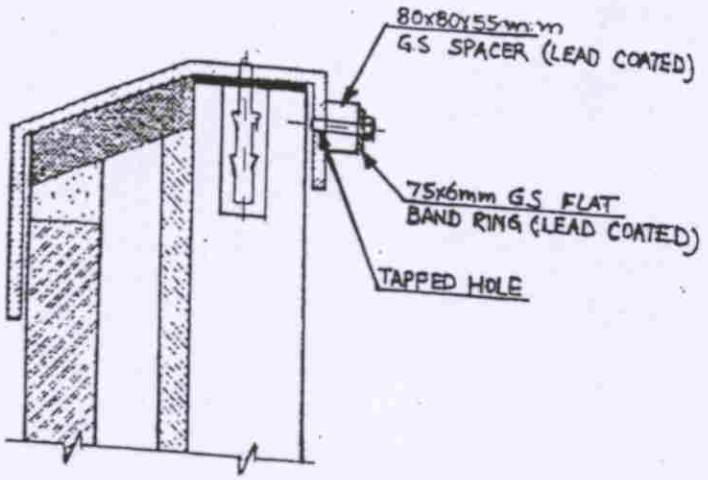
SEE DETAIL-'Y'



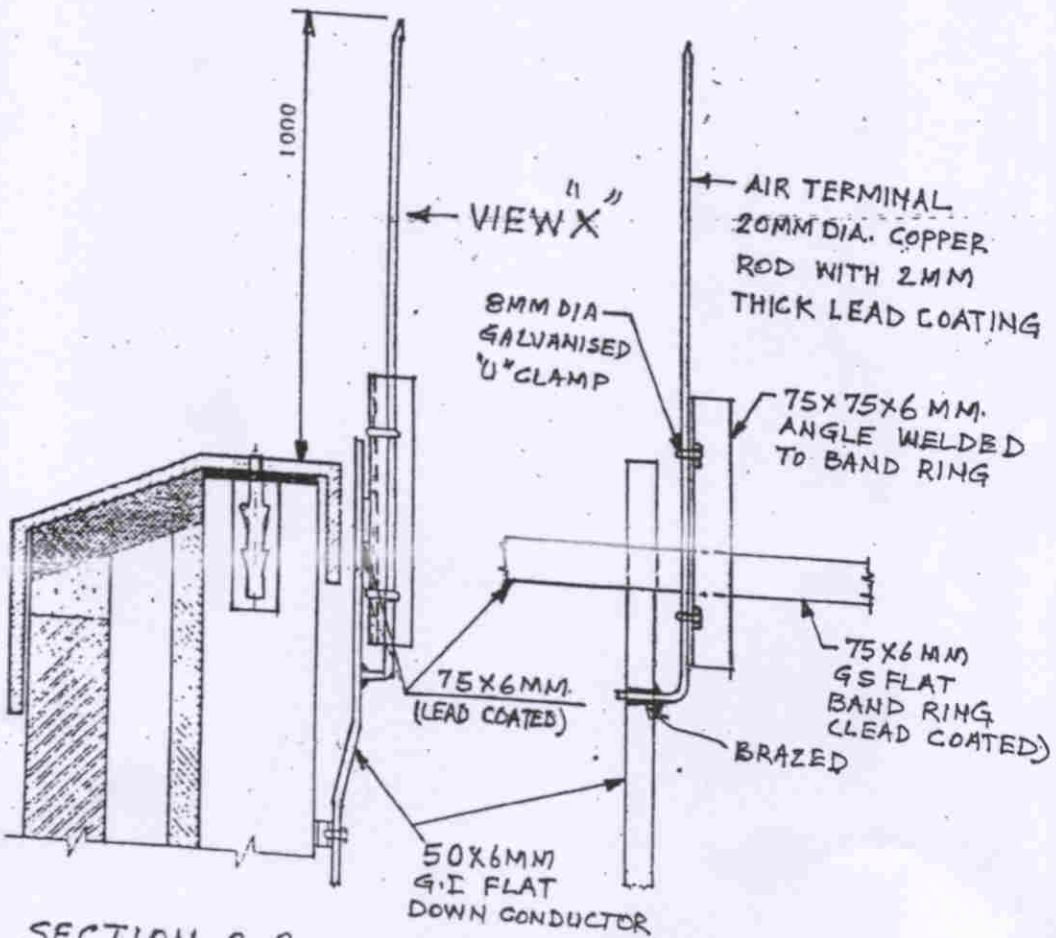
SECTION B-B

NOTE:-
TOP 25M OF CHIMNEY SHALL HAVE A LEAD COATING OF 2MM THICKNESS.

BHEL	BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003 SHEET 2 OF 4 REV. 00



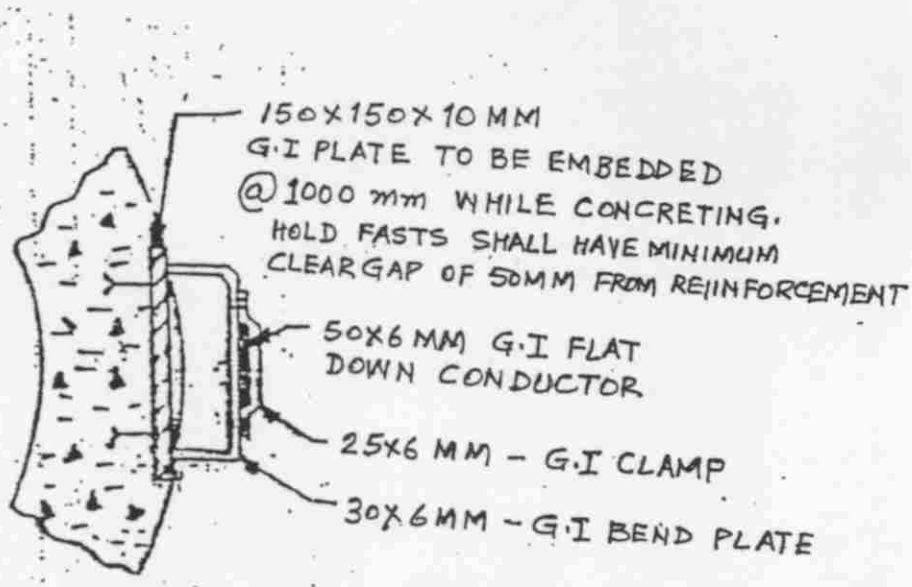
SECTION 1-1



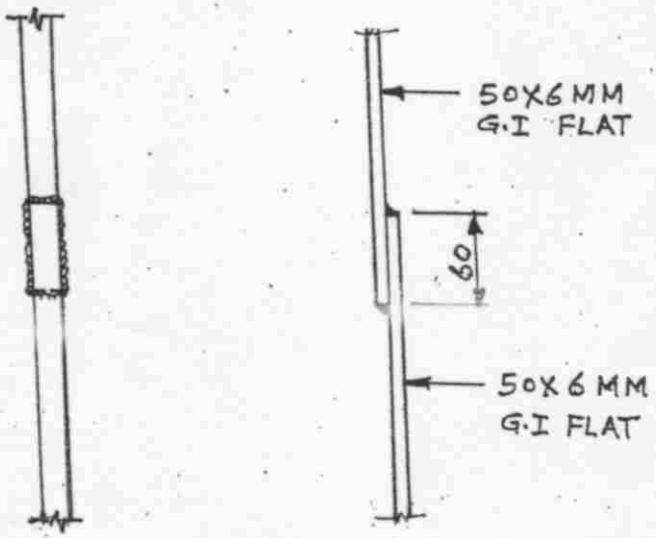
SECTION 2-2

VIEW- "X"

BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003	
	SHEET 3 OF 4	REV. 00



DETAIL-"Y"



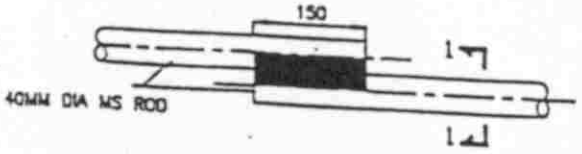
TYPICAL WELDED JOINT

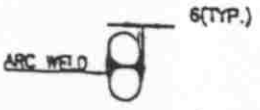
BHEL		
BHARAT HEAVY ELECTRICALS LIMITED PROJECT ENGINEERING MANAGEMENT NEW DELHI	DRG. No. PE-DG-XXX-509-0003	
	SHEET 4 OF 4	REV. 00

BELOW GROUND EARTHING
TYPICAL DETAILS

DRG. NO. PE-DG-~~XXX~~-509-0004

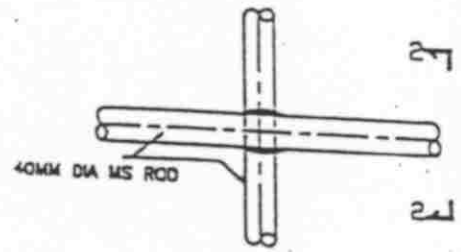
LAP JOINT

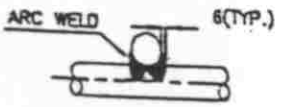




SECTION 1-1

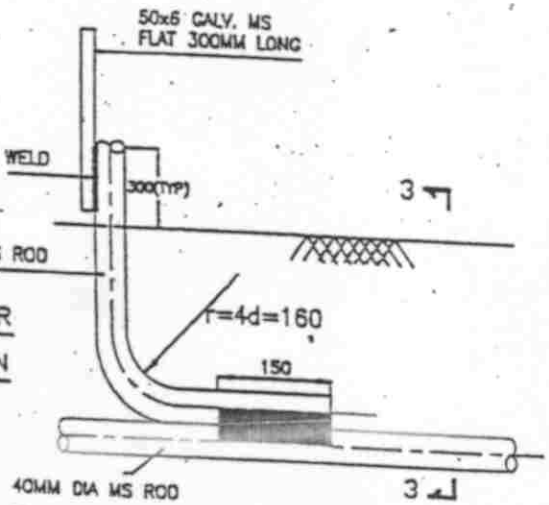
CROSS JOINT

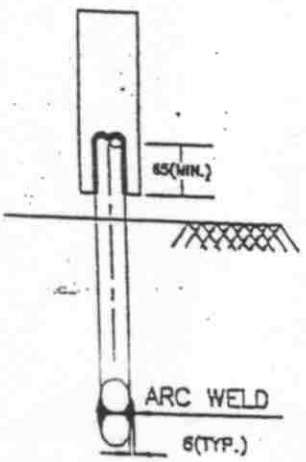




SECTION 2-2

LAP JOINT FOR RISER/COLUMN EARTHING





SECTION 3-3

WELDED JOINTS

NOTES :-

ALL DIMENSIONS ARE IN MM.

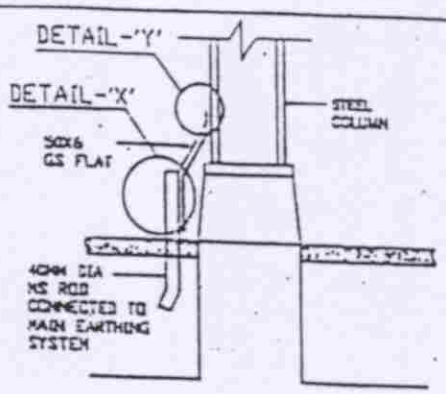
BHEL

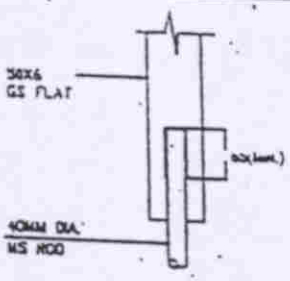
BELOW GROUND EARTHING TYPICAL DETAILS

BHEL DRAWING No.

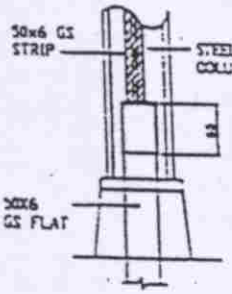
PE-DG-XXX-509-0004

SHEET 2 OF 8



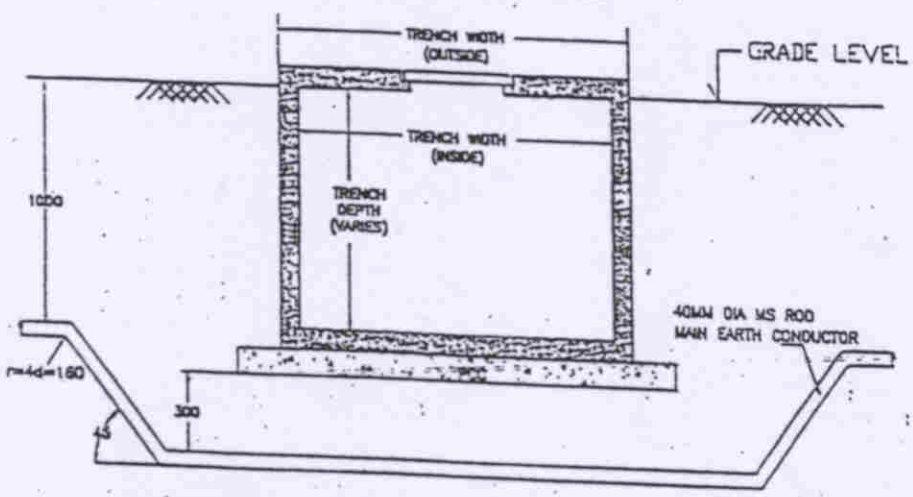


DETAIL-'X'

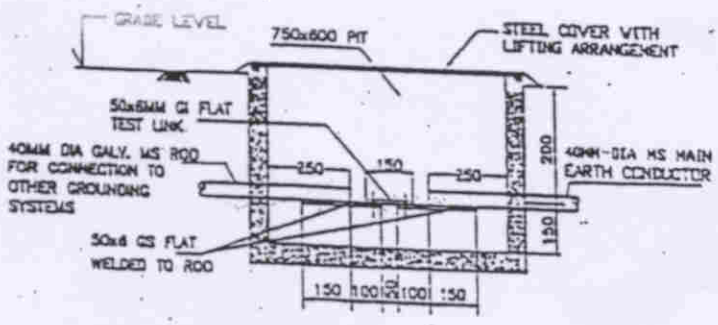


DETAIL-'Y'

COLUMN EARTHING



TRENCH CROSSING



Concrete cover

TEST-LINK

(PROVIDED FOR CONNECTION BETWEEN VARIOUS GROUNDING SYSTEMS)

NOTES :-

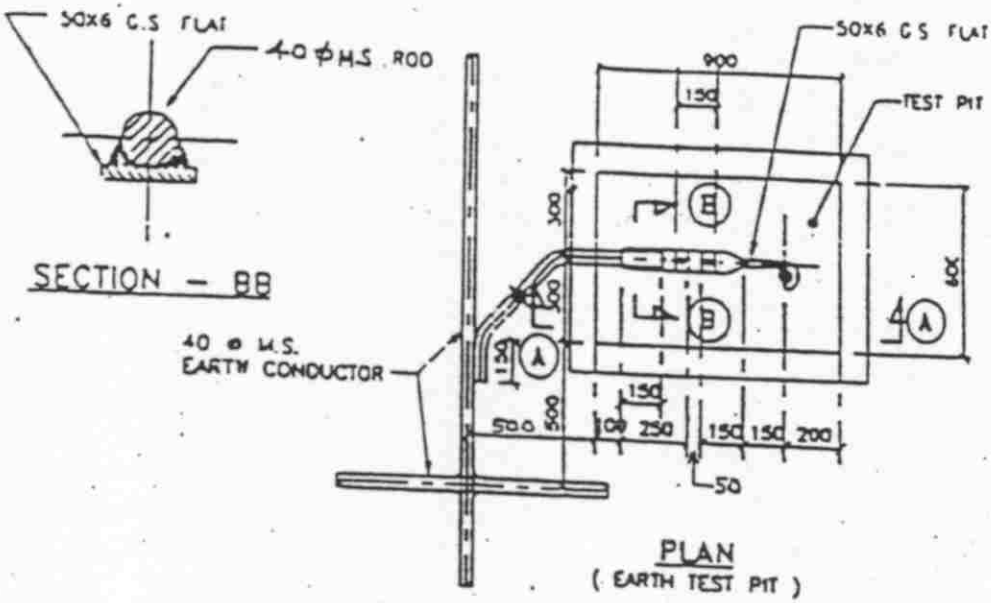
ALL DIMENSIONS ARE IN MM.

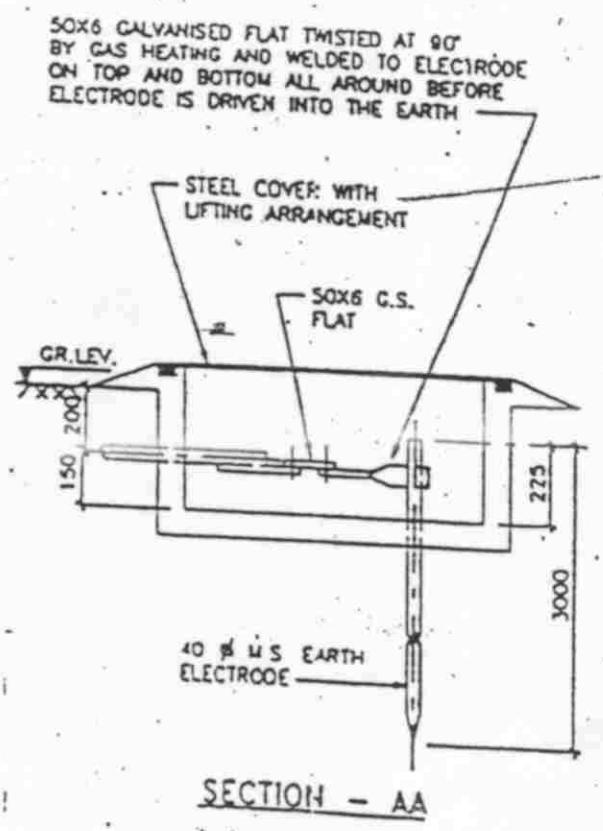
BHEL DRAWING No.

PE-DG-XXX-503-0004

BELOW GROUND EARTHING TYPICAL DETAILS

SHEET 3 OF 8





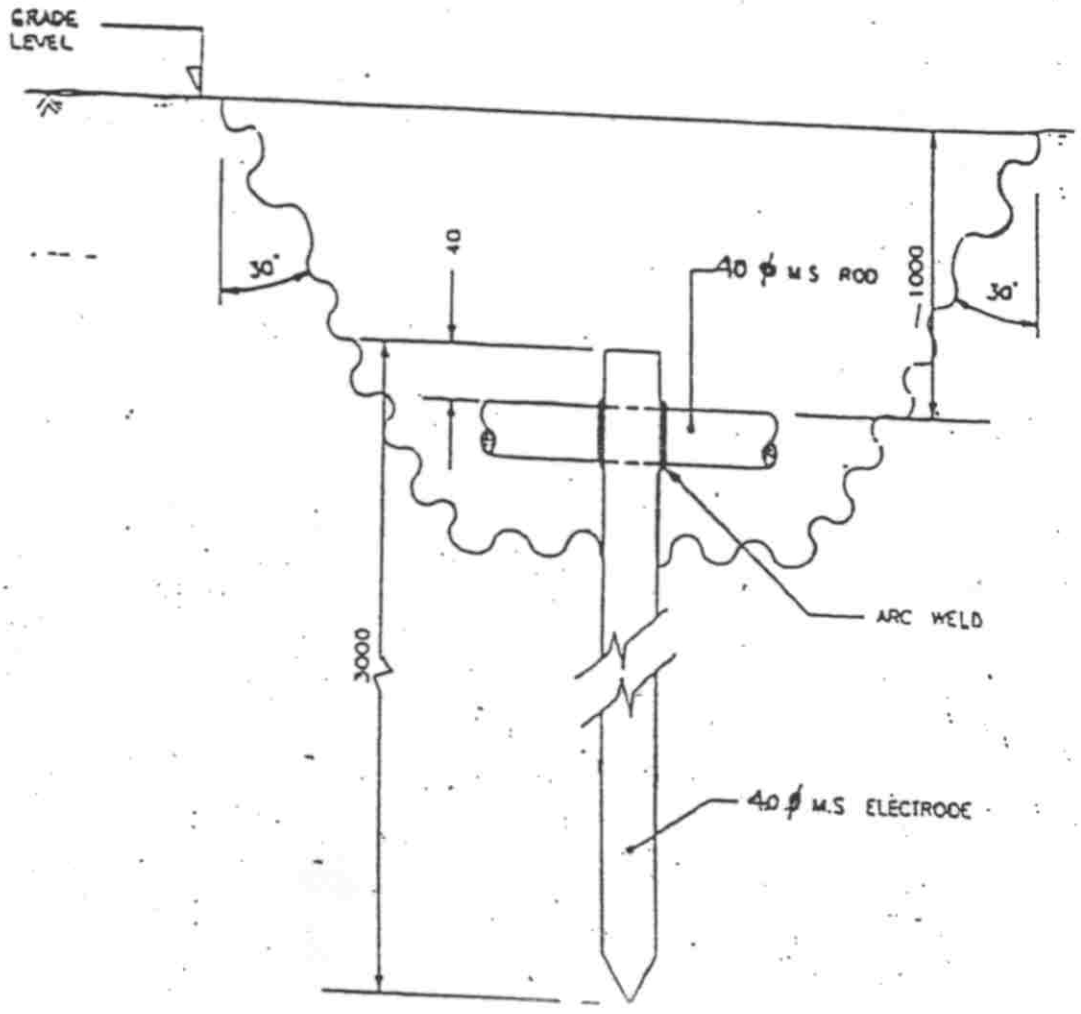
NOTE: ALL DIMENSIONS ARE IN MM.

BHEL

BELOW GROUND EARTHING TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-XXX-509-0004



GROUND ELECTRODE

NOTE:-

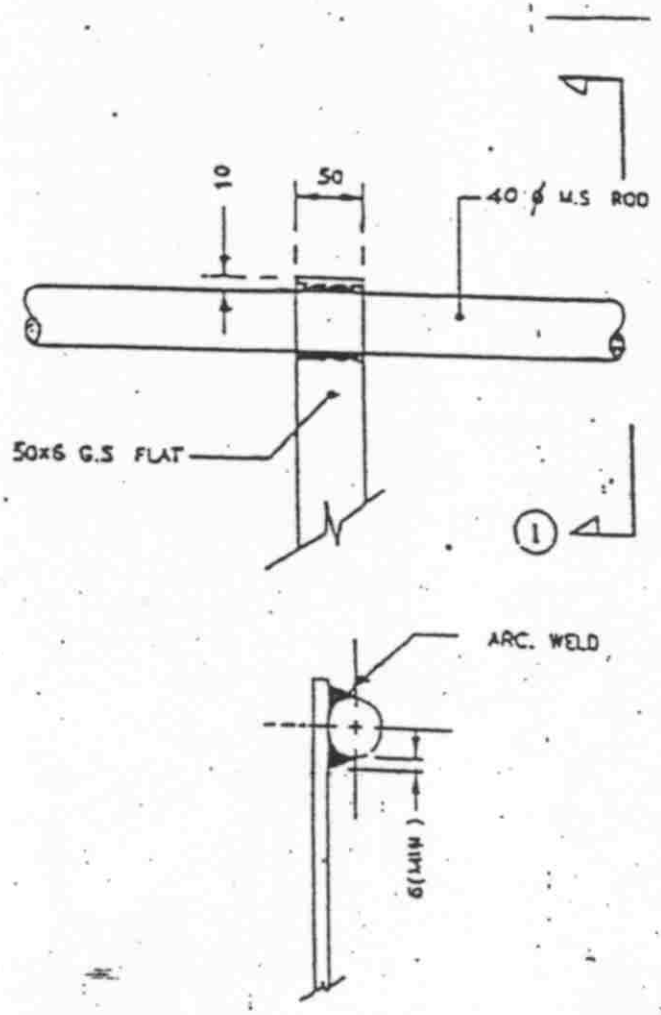
1. ALL DIMENSIONS ARE IN MM.

BELOW GROUND EARTHING
TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-XXX509-0004

SHEET 5 OF 8



SECTION – (1)

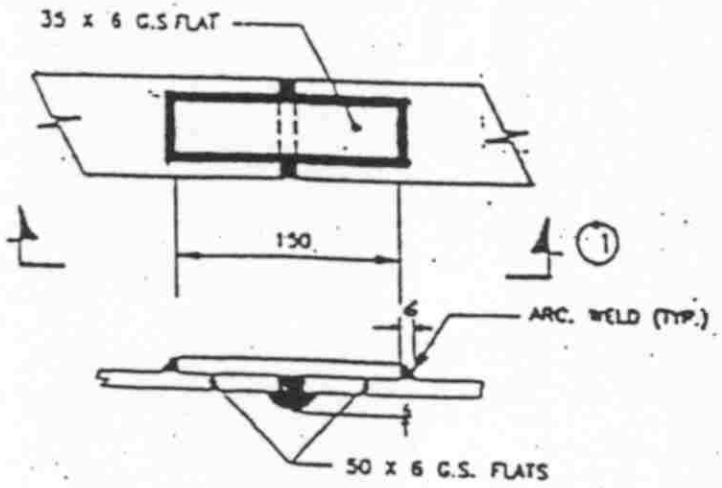
CROSS JOINT
BETWEEN M.S. ROD & G.S FLAT

NOTE:-
1. ALL DIMENSIONS ARE IN MM.

BELOW GROUND EARTHING
TYPICAL DETAILS

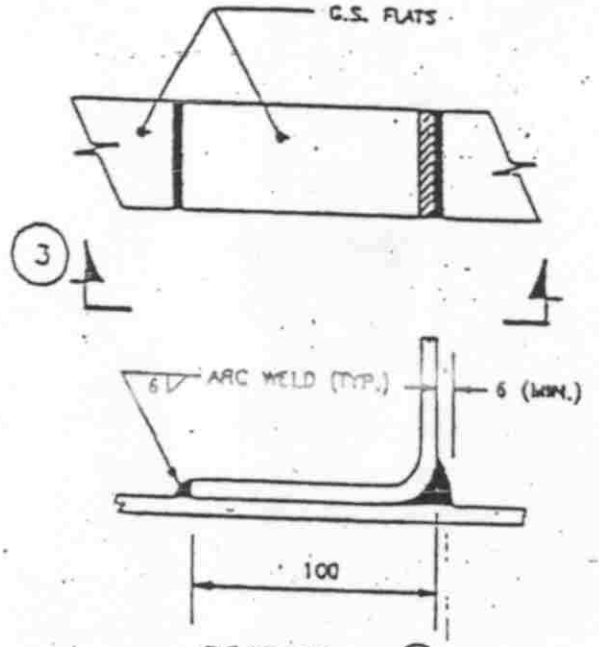
BHEL DRAWING No.
PE-DG-XXX509-0004

SHEET 6 OF 8



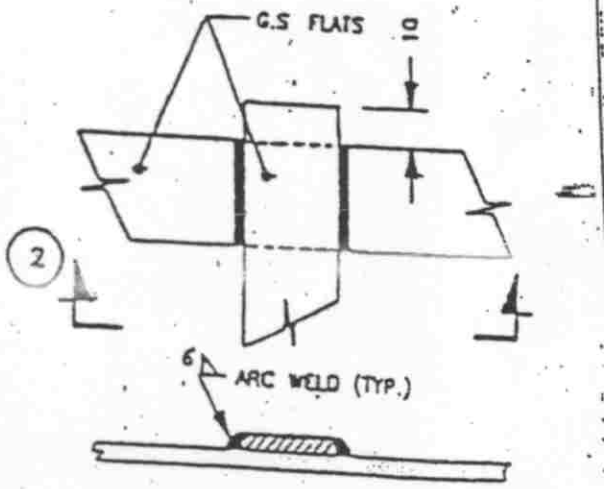
SECTION – (1)

LAP JOINT
BETWEEN G. S. FLATS



SECTION – (3)

ANGULAR JOINT
BETWEEN G. S. FLATS



SECTION – (2)

CROSS JOINT
BETWEEN G. S. FLATS

BHEL

BELOW GROUND EARTHING TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-~~XXX~~-509-0004

NOTES:-

1. WELDING OF GALVANISED FLAT/MS RODS SHALL BE CARRIED OUT AS FOLLOWS:
   a) CLEANING OF WELD AREA WITH WIRE BRUSH.
   b) REMOVAL OF GALVANISATION COATING IN THE WELD AREA.
   c) WELDING OF CONDUCTORS AS PER DETAILS SHOWN IN THIS DRAWING BY ELECTRIC ARC WELDING PROCESS USING LOW HYDROGEN CONTENT WELDING ELECTRODES.
   d) NATURAL COOLING OF WELDED JOINT.
2. EARTH CONDUCTOR SHALL BE ROUTED BELOW ROADS/ TRENCHES WITH MINIMUM CLEARANCE OF 300MM.
3. CIVIL DETAILS OF EARTH PITS/ TEST PITS ARE INDICATIVE. ACTUAL DETAILS SHALL BE SHOWN IN CIVIL DRAWINGS.
4. MINIMUM DEPTH OF BURIAL OF EARTH CONDUCTOR SHALL BE 1000 MM.

NOTES :-
ALL DIMENSIONS ARE IN MM.

BHEL PUS PIM

BELOW GROUND EARTHING TYPICAL DETAILS

BHEL DRAWING No.

PE-DG-XXX-509-0004

SHEET 8 OF 8

GENERAL TECHNICAL REQUIREMENTS

OF

CHIMNEY LIGHTING

SPECIFICATION NO. PES-558-03 REV-01

1.0 **GENERAL**

1.1 This specification covers the following :

- Engineering of lighting system including the associated power distribution system for chimney.
- Design, manufacture, supply, storage at site, testing of all necessary equipment such as lighting luminaries, lamps, wires, conduits, wiring accessories and any other equipment and material as would be found necessary for the satisfactory execution/ completion of the job.
- Erection, testing and commissioning of the lighting system for chimney.
- Temporary warning lights shall be provided during the course of work for heights above 45m free of cost.

2.0 **CODES & STANDARDS**

2.1 Unless otherwise specified, the following codes & standards are applicable. In all cases latest revision of codes shall be referred to.

Indian Standards	Title
IS 418	Tungsten flament general service electric lamps.
IS 732	Code of practice for electric wiring installation (system voltage not exceeding 650 V)
IS 5133 (Part-I)	Boxes for enclosure of electrical accessories steel & cast iron boxes.
IS 9537	Hot dip galvanised conduit.
IS 1913	General Safety requirements for electric lighting fitting.
IS 1947	Specification for flood lights.
IS 9900	High pressure mercury Yapour Lamp.
IS 3043	Code of practice for earthing.
IS 9974	High pressure sodium vapour Lamps.

IS 3528 Water proof electric lighting fitting.

IS 694 PVC insulated cables for working voltages up to & including 1100 V.

Indian Electricity Rules -1956.
International Civil Aviation Code.

3.0 DESIGN REQUIREMENTS

3.1 Lighting luminaries

3.1.1 Twin obstruction luminaire for aviation lighting shall be used having aluminium alloy casting body with separate galleries to take two specially designed red prismatic glass domes to give a symmetrical light distribution with maximum intensity 10 degrees above horizontal. Two porcelain Bayonet caplamp holders for 100 watt incandescent lamps shall be provided. Approved weather proof paint shall be provided.

3.1.2 Alternatively Neon lamp type Luminaire shall also be quoted.

3.1.3 The obstruction lights shall be fixed lights, red in colour, having an intensity sufficient to ensure conspiquity considering the intensity of adjacent lights and general level of illumination against which they would normally be viewed. In no case, the intensity shall be less than 10 candles of red lights.

3.1.4 Flood light shall be outdoor type consisting of light weight die cast aluminium alloy housing, heat resistant and toughened glass cover with synthetic rubber gasket, reflector and mounting bracket. The luminaries shall be suitable for 1x250 W High pressure Mercury Vapour lamp (HPMV) with suitable lamp holder, ballast, power factor improvement capacitor, mounting box for accessories and connector block & fuses duly pra-wired.

3.1.5 Alternatively flood lights with 150 W High Pressure sodium vapaur lamp (HPSV) HPSV lamp shall be provided with external igniters and rapid restart facility.

3.2 Arrangement of lights

3.2.1 The number and arrangement of lights at each platform to be provided shall be such that the obstruction is indicated from every angle in azimuth. Number of obstruction luminaire at each platform shall not be less than four.

3.2.2 The lights shall be placed between 1.5 metres and 3 metres below the top of chimney.

3.2.3 When the top of the chimney is more than 45metres above the level of the surrounding ground, intermiate lights shall be provided for each additional 45metres or fraction thereof.

3.2.4 Four (4) Nos. flood lights shall be provided at the lowest platform of chimney for illuminating the surrounding of chimney.

3.3 **Power Distribution Scheme**

3.3.1 Lighting system load shall be supplied from A.C. Emergency lighting board. From the outgoing of A.C. ELDB, PVC armoured cable of suitable size shall emanate for feeding supply to lighting panel for chimney.

3.3.2 The contractor shall install lighting panel to be supplied by the purchaser.

3.3.4 A.C. ELDB shall be supplied & erected by the purchaser. Inter-connecting power cable between A.C. ELDB and lighting panel shall be supplied and installed by the purchaser. However, necessary provision shall be made by the chimney vendor in his civil works near the chimney for installation of above cable.

3.4 **Method of wiring**

3.4.1 From A.C. ELDB to lighting panel for chimney 650/1100 V grade, PVC insulated, PVC sheathed, armoured cable of aluminium conductor shall be installed. From lighting panel further distribution to lighting luminaries shall be done with 650 V/1100V grade, Single core ,stranded copper conductor, PVC insulated, unsheathed wires of minimum 4mm sq in conduits fixed on the chimney wall.

3.4.2 Each circuit from lighting panel shall be taken in a separate conduit.

3.4.3 The minimum acceptable copper conductor size for connecting lighting fixtures shall be 4 sq.mm. or more depending upon the voltage drop consideration.

3.4.4 Minimum conductor size shall be such that the voltage drop to the farthest lighting point shall not exceed 2.5% of 240 V.

3.4.5 The aviation obstruction lights/flood lights shall be balanced on all the three phases to the extent possible.

3.5. **Conduits**

3.5.1 Conduits (Heavy gauge) & junction boxes, shall be hot dip galvanised type as per relevant IS. No conduit less than 20mm diameter shall be used. Junction boxes/pull boxes shall be made from 1.6mm thick galvanised sheet steel and shall incorporate terminal block for termination of incoming and outgoing cables. Junction boxes to be used outdoor shall be weather proof type with gasket conforming to degree of protection IP 55.

3.5.2 Conduit accessories/ fittings shall be as per relevant IS.

3.6 **Earthing**

A separate G.I. wire of 14 SWG shall be used for earthing the lighting fittings, lighting panels as per IE Rules & IS 3403. The contractor shall connect this earthing system to main earthing mat provided by the purchaser . Main earthing mat shall be located near the chimney.

3.7 For other general reqts. of Lighting design, refer to (w enclosed "Lighting Notes & Details" (Dg No. PE-DG-XXX-558-0004).

4.0 **TESTING & INSPECTION**

4.1 Standard quality plan (QP) for lighting system is enclosed in VOL III. Bidder to confirm compliance to this quality plan by signing every page of it.

4.2 All equipment shall comply with the type and routine tests as prescribed in the relevant standards. Certificates of type tests shall be furnished with the tender. The vendor shall furnish certified test reports for all routine tests before the equipment is dispatched.

4.3 Test at Site: The vendor, in the presence of the customer shall subject the installation to the following tests.

a) Insulation resistance test.

b) Testing of earth continuity path connections.

c) Complete operational tests on the whole of the installation.

4.4 Field quality plan (FQP) for quality checks to be observed at site during erection, testing & commissioning shall also be furnished by vendor alongwith offer as per standard BHEL format.

5.0 SPARE PARTS

Recommended list of spares for commissioning and for operation and maintenance of the lighting system for a period specified in data sheet -A shall be furnished. The vendor shall furnish separate price and list of the same. Unit rates shall also be furnished in addition to total price.

6.0 GUARANTEED PERFORMANCE REQUIREMENTS

The vendor shall guarantee satisfactory performance of equipment supplied under all conditions & requirement as laid down by this specification.

7.0 DRAWINGS & DATA

7.1 Drawings & data to be furnished with the offer

a) Filled in Data Sheet B.

b) Technical leaflets of luminaires offered.

7.2 Drawings & data to be furnished after award of contract

a) Design calculation for luminaries.

b) Design calculation for selection of lighting wires.

c) Lighting Layout plan showing lighting fixtures, conduit routing, conduit Size, cable size etc.

d) Fixing and mounting details of luminaires, conduits, junction boxes etc.

e) Test certificates for all equipment .

f) General arrangement drawing of equipment supplied.

g) Manufacturer catalogues/literature.

h) Field quality plan

i) As built drawings

8.0 OPERATION AND MAINTENANCE MANUAL

Operation and maintenance manual shall contain the followings :

a) Technical Data Sheet.

b) Instruction for maintenance for various lighting equipment.

FORM No. PEM - 0000-0

	TITLE	SPECIFICATION NO. PE
BHEL	DATA SHEET A CHIMNEY LIGHTING	VOLUME II B SECTION A REV. NO. 0 DATE SHEET 1 OF 1

1.0	**Details of Supply System**		
	a) Rated voltage	:	415 V ± 10%.
	b) Rated frequency	:	50 Hz ± 5%
	c) Combined voltage and frequency variation	:	10% (Absolute)
	d) System fault level at rated voltage	:	50 kA for 0.25 sec.
	e) LV System grounding	:	Solidly
	f) Design ambient temp.	:	50°C
2.0	Type of conduit mounting	:	Surface Mounting
3.0	Type of obstruction light	:	i) GEC ZA 750(L) NEON ii) High intensity flashing white light having intensity > 200 candles & flashing freq. 40-60/min.
4.0	Type of Flood light	:	→ 250 W HPSV lamps
5.0	Source for power	:	Normal AC & Emergency AC
6.0	Junction boxes	:	Weather-proof, Galvanised steel
7.0	Main earthing mat details	:	MS Rod 40 mm dia
8.0	No. of years for which O&M spares required	:	3 years

	TITLE	SPECIFICATION NO.
BHEL	DATA SHEET - B CHIMNEY LIGHTING	VOLUME III
		SHEET 1 OF 2

FORM No. PEM - 6019 B-0

INSTRUCTIONS FOR BHEL

1. In the ... 'SPECIFICATION NO.' the specification number for th... ject shall be entered by DE b... e issue for an enquiry. The standard specification number sha... not be entered.

1.0 **CONDUIT**

a) Make :

b) Size :

c) Material :

d) Applicable Standard :

2.0 Applicable Standard for Conduit accessories and fittings :

3.0 **JUNCTION BOX**
(for each type & size)

a) Make :

b) Type :

c) Material :

d) Degree of protection of enclosure :

e) Applicable Standard

4.0 **LIGHTING WIRES**

a) Make :

b) Type :

c) Conductor material :

d) Size :

e) Voltage grade :

f) Applicable Standard :

Name of Bidder / Vendor				Project
Revision Number	0	1	2	3
Signature of Bidder / Vendor / Authorised Representative				
Date				

	TITLE	DATA SHEET - B CHIMNEY LIGHTING	SPECIFICATION NO. VOLUME III SHEET 2 OF 2

5.0 **LUMINARIES**

a) Make :

b) Type :

c) Type of lamp holder :

d) Applicable Standard :

6.0 **LAMPS**

a) Make :

b) Type :

c) Wattage :

d) Nominal lamp voltage :

e) Light output :

f) Applicable Standard :

Name of Bidder / Vendor				Project	
Revision Number	0	1	2	3	
Signature of Bidder / Vendor / Authorised Representative					BIDDER'S SEAL
Date					

FORM No. PEM - 6019 B-0

1. In the DE below, "SPECIFICATION NO." the specification number for the enquiry. The standard specification number shall not be entered.

FOR BHEL

1.0 **CONDUIT**
(for each type & size)

a) Make :

b) Type :

c) Size :

d) Applicable Standard :

2.0 **JUNCTION BOX**
(for each type & size)

a) Make :

b) Material :

c) Size :

d) Degree of protection of enclosure :

e) Applicable Standard :

3.0 **LIGHTING WIRES**

a) Make :

b) Type :

c) Voltage grade :

d) Applicable Standard :

e) Continuous current rating at design ambient :

f) Conductor

i. Material :

Form No. PEM-60188-0

...shall be entered by ... be entered.

...SPECIFICATION NO ... the specification number for ...ue for an enquiry. The standard specification number

FOR BHEL

Form No. PEM - 6018B-0

ii. Nominal cross sectional area :

iii. No. & Diameter: of wires

g) **Insulation**

i. Composition of insulation :

ii. Thickness of insulation :

iii. Tolerance on thickness of insulation :

h) Colour scheme for identification of wires :

4.0 **LUMINARIES**
(for each type)

a) Make :

b) Type :

c) Type of lamp holder :

d) Capacitor rating :

e) Weight of luminaires :

f) Applicable Standards :

5.0 **LAMPS**

a) Make :

b) Type :

c) Wattage :

Name of Bidder / Vendor				Project
Revision Number	0	1	2	3
Signature of Bidder / Vendor / Authorised Representative				
Date				

BIDDER'S SEAL

	TITLE	SPECIFICATION NO.
BHEL	DATA SHEET - C CHIMNEY LIGHTING	VOLUME II B PART D SHEET 3 OF 3

Form No. PEM - 60188-0

d) Nominal lamp voltage :

e) Light output (lumen) :

f) Life of lamp :

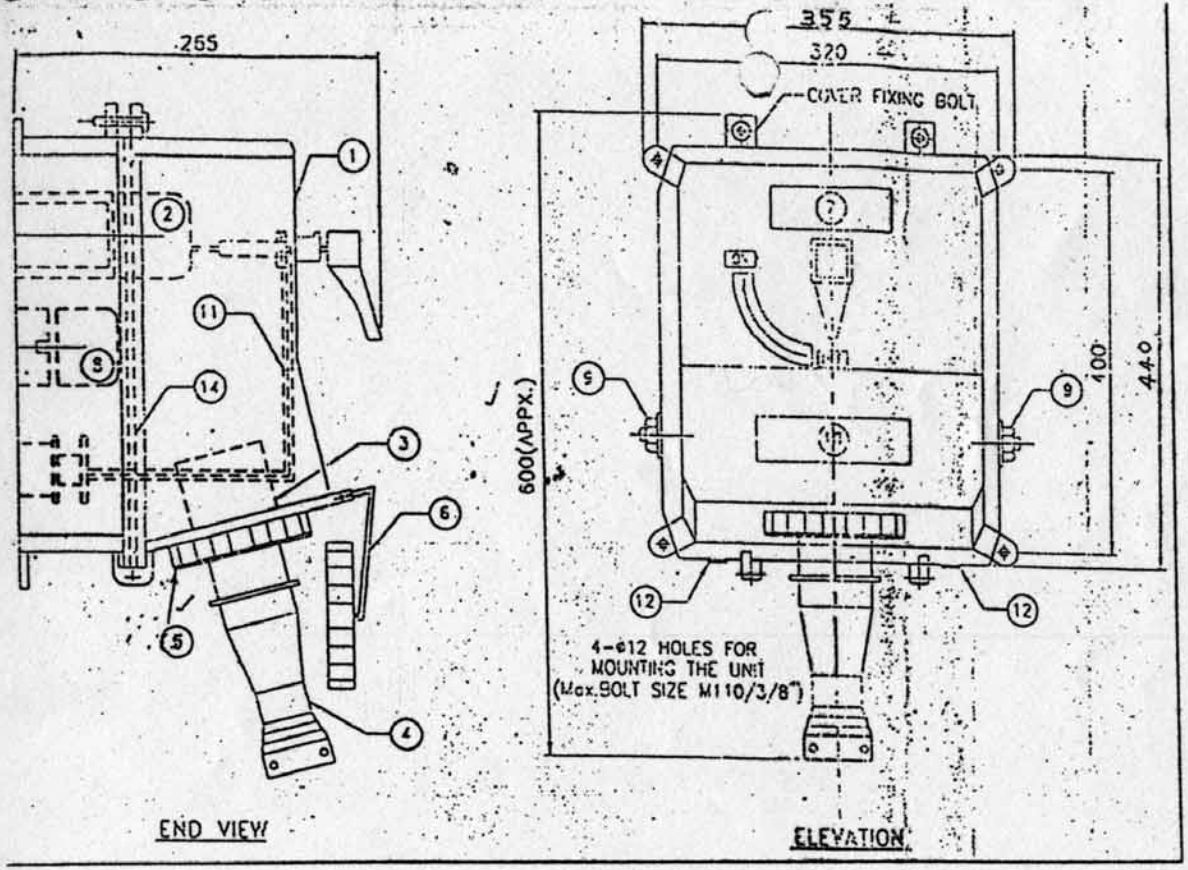
g) Applicable Standard :

...ct shall be entered by
...e entered.

...olumn 'SPECIFICATION NO.' the specification number for
...sue for an enquiry. The standard specification number

INSTRUCTIONS
FOR BHEL

Name of Bidder / Vendor				Project
Revision Number	0	1	2	3
Signature of Bidder / Vendor / Authorised Representative				

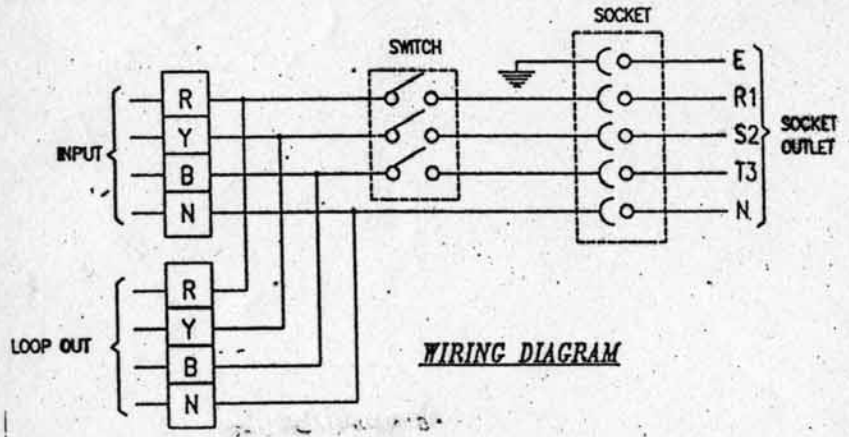


SPECIFICATION

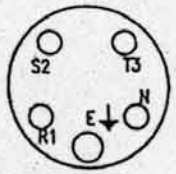
1] ALUMINIUM ALLOY HOUSING (MIN THICKNESS 3mm)
2] GE POWER CONTROL TP ON/OFF SWITCH DOUBLE BREAK TYPE SP02, AC23 CATEGORY CONFORMING TO IS-13947-3
3] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH SOCKET
4] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH PLUG
5] PLUG RING
6] SPRING LOADED COVER FOR SOCKET OUTLET
7] NAME PLATE
8] 4 WAY STUD TYPE TERMINAL BLOCK 2 Nos. FOR LOOP IN LOOP OUT, ARRAGEMENT TO TERMINATE 3.5Cx50 sq.mm STUD TYPE BEST & CROMPTON MAKE
9] ELECTROPLATED EARTHING TERMINAL 2 Nos. COMPLETE WITH 6mm BOLT,NUT & WASHER SUITABLE FOR 14 SWG. GI. EARTHING CONDUCTOR
10] CAUTION STACKER
11] MECHANICAL INTERLOCKING ARRANGEMENT
12] DETACHABLE GLAND PLATE O TAKE 2 Nos. GLAND SUITABLE FOR 3.5x70 sq.mM. CABLES.

NOTES

1] ALL DIMENSION ARE IM MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 2.5 sq.mm. CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN NOT BE MADE 'ON' UNLESS PLUG IS INSERTED
PLUG CAN NOT BE WITHDRAWN UNLESS SWITCH IS IN OFF POSITION
6] UNIT IS MANUFACTURE BY "BEST & CROMPTON"
7] SUITABLE CABLE GRIP SHALL BE PROVIDED



WIRING DIAGRAM



SHOWING TERMINAL POSITION

COLOUR CODED SLEVE WILL BE PROVIDED ON BOTH ENDS ON COPPER FLEXIBLE
R PHASE – RED COLOUR
Y PHASE – YELLOW COLOUR
B PHASE – BLUE COLOUR
NEATRAL – BLACK COLOUR

CHIMNEY LIGHTING SPECIFICATION

REV	DATE	DESCRIPTION
01		
02		

1230-001-29PE-PVE-B-073

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT
NEW DELHI

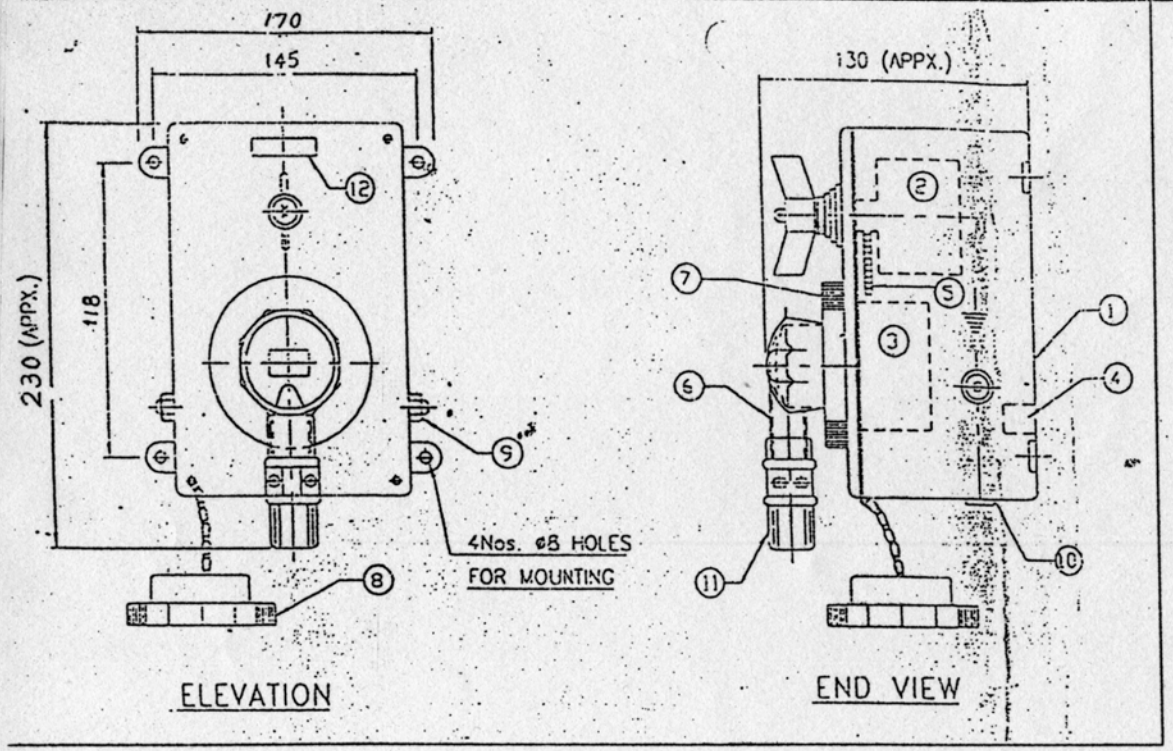
bajaj electricals limited MUMBAI
Engineering & Projects Division.

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	JS	AP	30.06.03	PE-V0-200-558-E073

TITLE GENERAL ARRANGEMENT DWG FOR 63 A FULLY INTERLOCKED SWITCHED PLUG 63 AMPS 415 VOLTS [TYPE RC]

DWG. NO. EPBU-03-PS005-04-073 REV 0

SHT. 1 OF 1



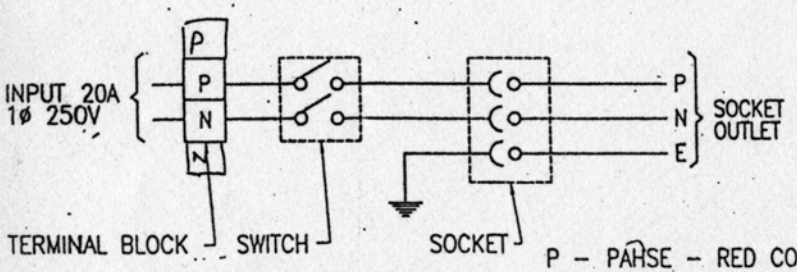
SPECIFICATION

1] ALUMINIUM ALLOY ENCLOSURE 3mm THICK
2] 25A, 250V, DOUBLE POLE/ OFF ROTARY SWITCH AC 23 CATEGORY IS-4064 – RECOM MAKE
3] ALUMINIUM ALLOY METAL CLAD SOCKET UNIT "BEST & CROMPTON" MAKE
4] BAKELITE STUD TYPE 2 WAY TERMINAL BLOCK TO TERMINATE 2Cx4 sq.mm CABLE
5] MECHANICAL INTERLOCKING SYSTEM
6] DIE CAST ALUMINIUM ALLOY METAL CLAD PLUG AND SOCKET OF 20A, 240V, 3 PIN (P+N+E), 3rd PIN GROUNDED
7] THREADED PLUG LOCKING RING
8] SOCKET COVER WITH CHAIN FOR SOCKET OUTLET
9] EARTHING TERMINAL 2 Nos. – M6 SIZE
10] CABLE ENTRY 25mm DIA – 2Nos.
11] PVC CABLE GRIP
12] NAME PLATE

NOTES

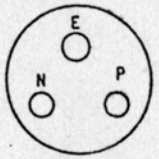
1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE OF ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 4 sq.mm. COPPER CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWDER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN NOT BE MADE 'ON' ONLY WHEN PLUG IS FULLY ENGAGED WITH SOCKET. PLUG CAN NOT BE WITH DRAWN WHEN SWITCH IS ON
6] 2 Nos. CABLE ENTRY AT BOTTOM

CHIMNEY LIGHTING SPECIFICATION.



WIRING DIAGRAM
(FOR SINGLE PHASE UNIT)

P – PHASE – RED COLOUR
N – NEUTRAL – BLACK COLOUR
E – GREEN COLOUR.



VIEW ON SOCKET
PLUG REMOVED

REV	DATE	DESCRIPTION
01		
02		

1230-001-29PE-PVC-B-070

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT

bajaj electricals limited MUMBAI
Engineering & Projects Division

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	IS	AP	30.05.03	PE-V0-200-558-E070

TITLE GENERAL ARRANGEMENT DWG FOR FULLY INTERLOCKED SWITCHED PLUG 20 AMPS, 250 VOLTS [TYPE RA]

DWG. NO. EPBU-03-PS005-04-070 REV 0

SHT. 1 OF 1

LIGHTING NOTES AND DETAILS

SPECIFICATION NO. PES-558-0004

LIGHTING NOTES

1.0 These lighting notes and details shall be read and construed in conjunction with the lighting specifications and drawings

2.0 Contractor shall develop final conduit/cable routings based on fixture location and other site conditions.

3.0 Unless otherwise shown, the mounting heights of lighting fixtures and accessories shall generally be as follows.

3.a. Lighting fixture in general areas of powerhouse, miscl. Pump house etc.

3.a.i.	Low bay type	: 3000 mm to bottom.
3.a.ii.	Medium bay type	: bet 3500 mm to 8000 mm to bottom.
3.a.iii.	High bay type	: above 8000mm to bottom.

3.b. Bracket lights over door opening : 300 mm bot of fixture above opening.

3.c. Receptacles

3.c.i.	In control room office	: 450 mm floor to center.
3.c.ii.	Elsewhere	: 900 mm floor to center.

3.d. Local switches : 1500 mm floor to center

3.e. Lighting panels : 1800 mm floor to top

4.0 All outdoor illumination fixtures unless it fed from photocell/tank-switch controlled lighting panel shall be provided with outdoor type local switches.

5.0 Separate neutral wire shall be provided for each circuit. Wiring throughout the installation shall be such that there is no break in the neutral wire in the form of switch or fuse.

5. SEPARATE NEUTRAL WIRE SHALL BE PROVIDED FOR EACH CIRCUIT. WIRING THROUGHOUT THE INSTALLATION SHALL BE SUCH THAT THERE IS NO BREAK IN THE NEUTRAL WIRE IN THE FORM OF SWITCH OR FUSE.

6. ALL EXPOSED CONDUIT RUNS IN BATTERY ROOM, CHEMICAL FEED STATION AREA, WATER TREATMENT BUILDING ETC. SHALL BE SUITABLY PAINTED WITH ACID/ ALKALI PROOF PAINTS.

7. THE ENTIRE METALLIC CONDUIT SYSTEM SHALL BE ELECTRICALLY CONTINUOUS AND THOROUGHLY GROUNDED.

8. LIGHTING FIXTURES SHALL NOT BE SUSPENDED DIRECTLY FROM JUNCTION BOX IN THE MAIN CONDUIT RUN.

9. AC AND DC CIRCUITS SHALL NOT BE RUN IN THE SAME CONDUIT.

10. RECEPTACLES SUB-CIRCUITS SHALL BE KEPT SEPARATE AND DISTINCT FROM LIGHTING AND FAN SUB-CIRCUITS.

11. WIRES/CABLES SHALL BE SPLICED ONLY AT JUNCTION BOXES WITH RING-TONGUE LUGS OR APPROVED EQUAL.

12. FOR CABLE/WIRE NUMBERING, PVC SLEEVE WITH CABLE/WIRE TAG NUMBER OF DIFFERENT COLOUR CODE SHALL BE USED.

13. IN OUTDOOR AREAS, MAIN RUNS FROM LIGHTING PANELS SHALL BE BY MEANS OF AIVY CABLES, LAID IN TRENCHES OR DIRECTLY BURIED IN GROUND WITH PROPER PROTECTION AS PER DETAILS SHOWN.

14. WHEN BURIED CABLES CROSS ROAD/RAILWAY TRACK, ADDITIONAL PROTECTION TO BE PROVIDED IN FORM OF HUME/C.I. PIPE.

15. FLAME PROOF INSTALLATIONS SHALL BE CARRIED OUT WITH FLAME-PROOF C.I. CONDUITS AND FLAME-PROOF ACCESSORIES AND JUNCTION BOXES.

16. UNLESS OTHERWISE NOTED, THE SIZE OF CABLES, WIRES, CONDUITS, JUNCTION BOXES SHALL BE AS BELOW :-

A) C A B L E S

FROM STATION AUXILIARY SYSTEM TO MAIN LIGHTING DISTRIBUTION BOARDS : AL [redacted]PVC FRLS *

i) FROM MAIN LIGHTING DISTRIBUTION BOARDS TO 415 V NORMAL A.C. LIGHTING PANELS : AL [redacted]PVC FRLS *

ii) FROM EMERGENCY MAIN LIGHTING DIST. BOARDS (EMLDB) TO 415 V EMERGENCY A.C. LIGHTING PANELS : AL [redacted]PVC FRLS *

iii) FROM MAIN LIGHTING DIST. BOARDS (MLDB) TO 415 V AC/220 V DC EMERGENCY LIGHTING DISTRIBUTION BOARDS (DCELDB) : AL [redacted]PVC FRLS *

iv) FROM 220 V MAIN DC DISTRIBUTION BOARDS TO 415 V AC/220 V DC EMERGENCY LIGHTING DISTRIBUTION BOARD (DC ELDB) : AL [redacted]PVC FRLS *

v) FROM MCC/PMCC/DB TO RC, RD RECEPTACLES : AL HRPVC FRLS *

vi) FROM 415 V NORMAL AC STREET AREA LIGHTING PANEL TO STREET LIGHTING POLE JUNCTION BOX : AYWY *

* SIZES OF CABLES TO BE DECIDED BY THE BIDDER.

B) WIRES

i) FROM LIGHTING PANELS TO JUNCTION BOXES : 1C, 4 MM^2 Cu

ii) FROM JUNCTION BOXES TO LIGHTING FIXTURES : 1C, 2.5 MM^2 Cu.

iii) FROM JUNCTION BOXES TO FLOOD LIGHT FIXTURES : 2 x 2.5 MM^2, 1C, Cu

iv) FROM LIGHTING PANELS TO 240 V AC 5/15A, 1 PHASE RECEPTACLES & 24 V AC SUPPLY MODULES TYPE M4 : 1C, 4 MM^2 Cu

v) FROM 24 V AC SUPPLY MODULES TO 24 V AC, 5A RECEPTACLES : 1C, 4 MM^2 Cu

C) CONDUITS

CABLE SIZE	CONDUIT SIZE 20-MM	25 MM	32MM	40MM	50 MM	
i) 10 MM^2 AL	-	2	5	7	8	MAXIMUM NO. OF CONDUCTORS ADMISSIBLE FOR CONDUIT
ii) 2.5 MM^2 CU	3	5	9	-	-	

D) JUNCTION BOXES

CONDUIT SIZE (MM)	JUNCTION BOX SIZE (MM) 4-WAY	3-WAY	STRAIGHT THROUGH	90°
i) 20 / 25	150x150x100	150x100x100	88 ϕ	88 ϕ
ii) 32 / 40	254x200x127	254x200x127	150x150x100	-
iii) 50	254x200x127	254x200x127	254x200x127	-

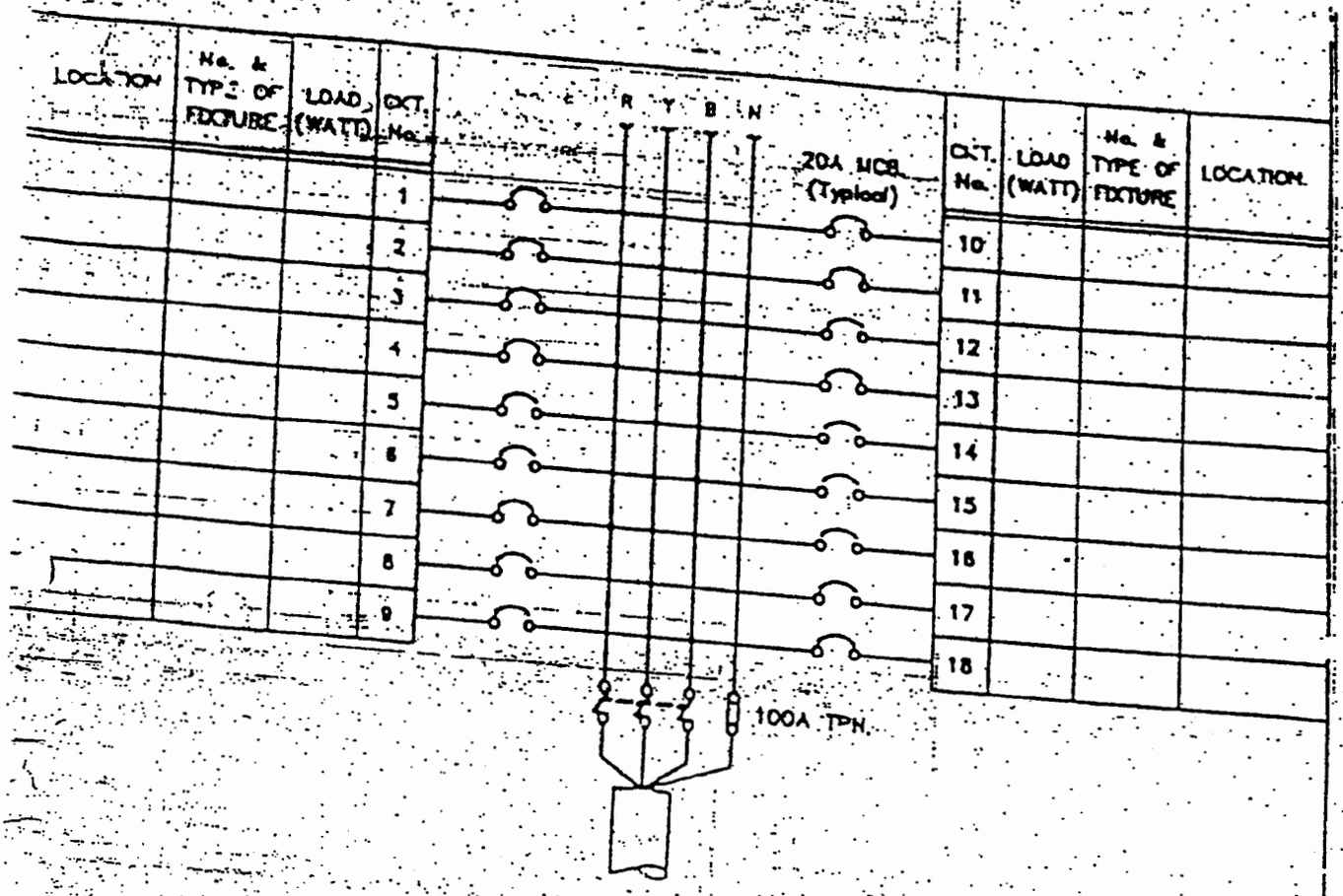
17. ALL LIGHTING PANELS/DISTRIBUTION BOARDS, JUNCTION BOXES, RECEPTACLES, FIXTURES, CONDUITS, ETC. SHALL BE GROUNDED IN COMPLIANCE WITH THE PROVISION OF I.E. RULE AND AS DETAILED BELOW :-

i)	LIGHTING PANELS	: 35 x 6 MM G.S. FLATS
ii)	DISTRIBUTION BOARDS	: 50 x 6 MM G.S. FLATS
iii)	FIXTURES, RECEPTACLES, SWITCHES, CONDUITS, JUNCTION BOXES ETC.	: 16 SWG G.I. WIRE
iv)	STREET LIGHT POLES & TOWERS FOR FLOOD LIGHTING	: 50 x 6 MM G.S. FLATS

18. A CONTINUOUS GROUND CONDUCTOR OF 12 SWG G.I. WIRE SHALL RUN ALONG EACH CONDUIT RUN AND BONDED TO IT EVERY 600 MM.

19. THE ELECTRICAL INSTALLATION WORK SHALL MEET THE REQUIREMENTS OF INDIAN ELECTRICITY RULES, RELEVANT IS CIDES OF PRACTICE & SAFETY CODES, ALL AS AMENDED UPTO DATE. IN ADITION, OTHER RULES OR REGULATIONS, AS APPLICABLE TO THE WORK SHALL BE FOLLOWED. IN CASE OF ANY DISCREPANCY, THE MORE RESTRICTIVE RULE SHALL BE BINDING.

20. TYPICAL DETAILS OF LIGHTING FIXTURES, OTHER LIGHTING SYSTEM COMPONENTS AND THEIR MOUNTING ARRANGEMENT AS SHOWN IN DRAWING NO. E [illegible] SHEET 6 TO [illegible] ARE FOR GENERAL GUIDANCE ONLY. THE CONTRACTOR HAS TO DESIGN THE SAME FULFILLING THE REQUIREMENT OF THE SPECIFICATION.



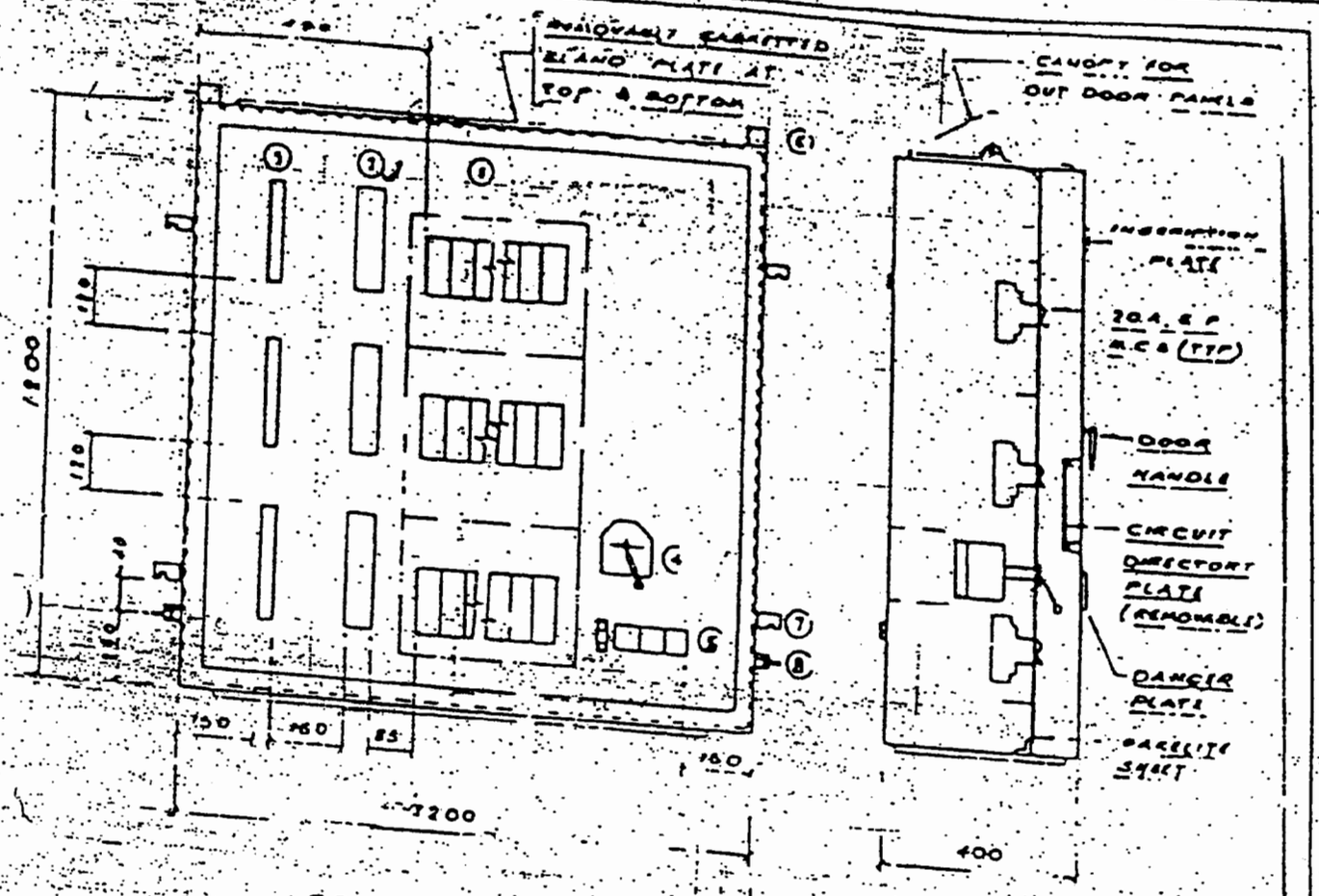
LIGHTING NOTES & DETAILS

SLD OF 415V LTG PANEL

DRG. No.
PE-DG-[illegible]-558-0004

REV. No.
0

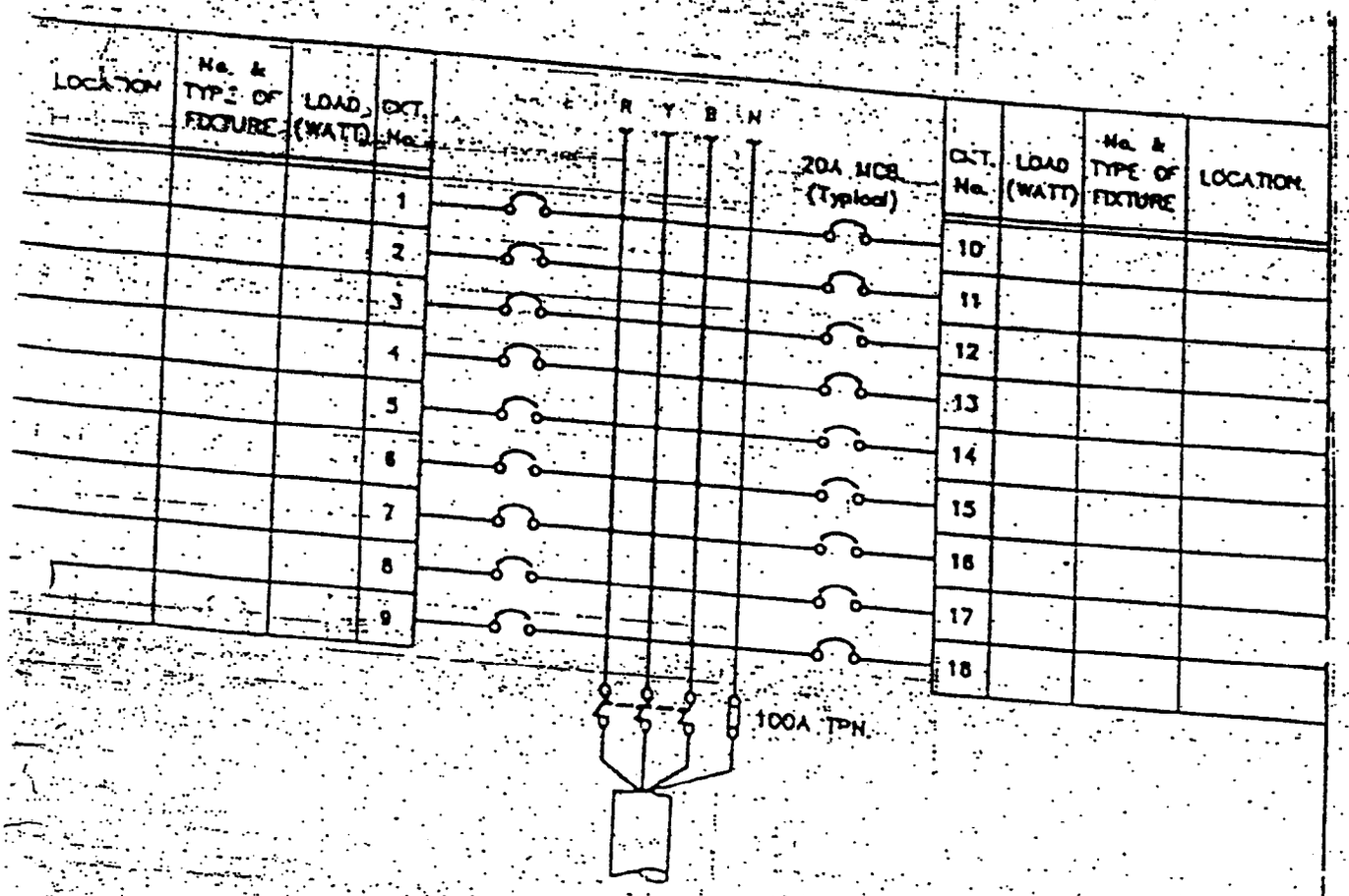
SHEET 7 OF 15



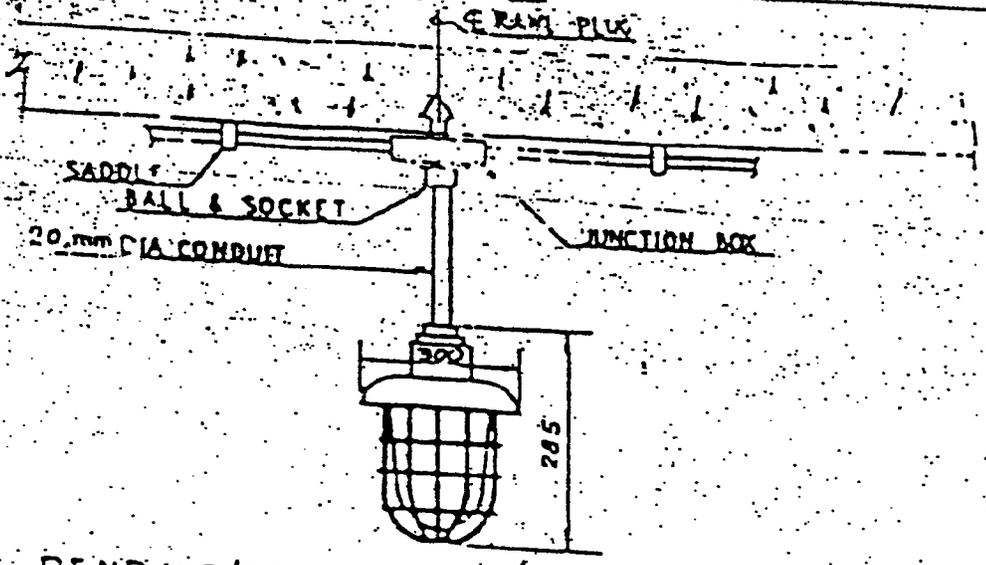
LEGEND

- ○ MINIATURE CKT BKR.
- ① PHASE TERMINALS STUD
- ① NEUTRAL BUS WITH NUT, BOLT & WASHER
- ④ ISOLATOR
- ⑤ TERMINAL BLOCK
- ⑥ LIFTING LUG
- ⑦ FIXING LUG
- ⑧ EARTHING STUD WITH NUTS

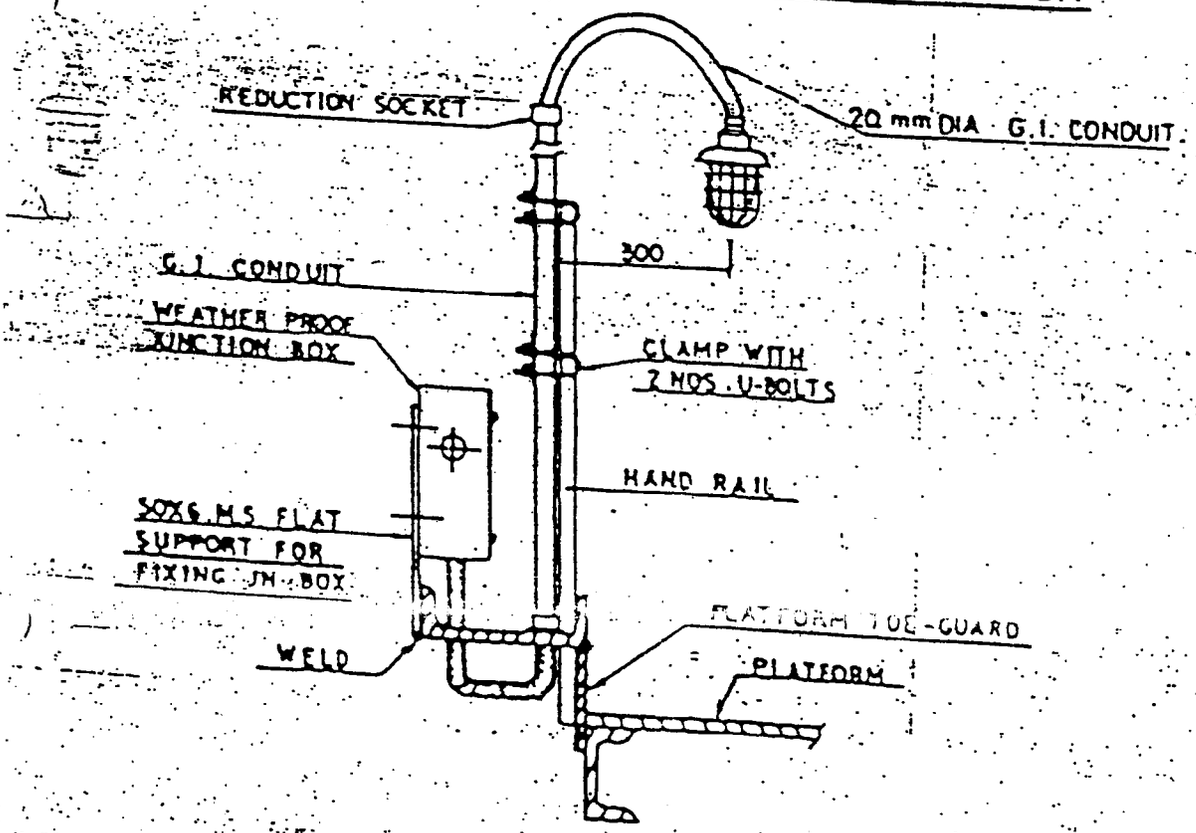
LIGHTING NOTES & DETAILS G.A. OF LIGHTING PANEL	DRG. No. PE-DG-XXX-558-0004
	REV. No. 0
	SHEET 6 OF 15



WIPRO PPT offin	LIGHTING NOTES & DETAILS SLD OF 415V LTG PANEL	DRG. No. PE-DG-XXX-558-0004 REV. No. 0 SHEET 7 OF 15

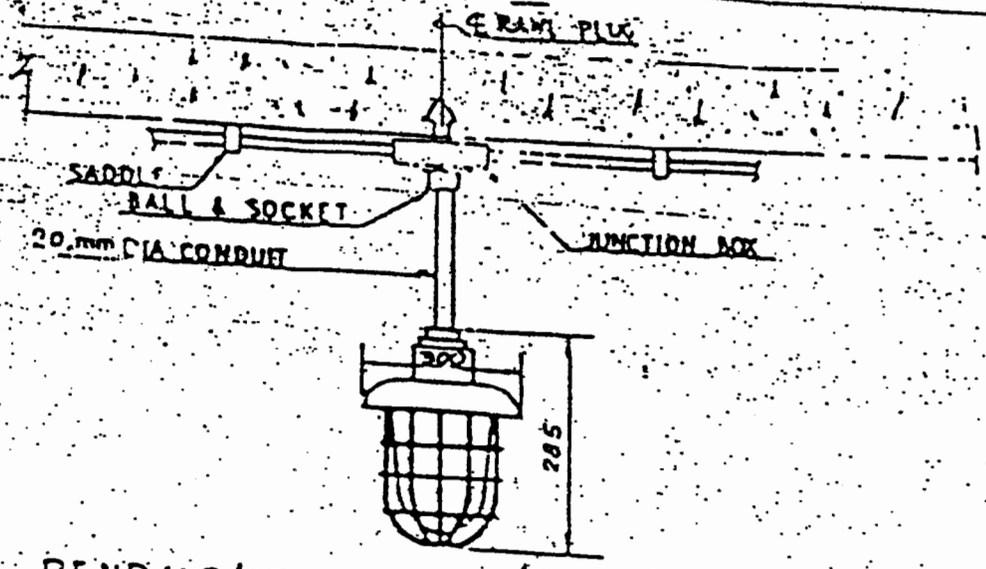


PENDANT/CEILING MOUNTING : TYPE-CA

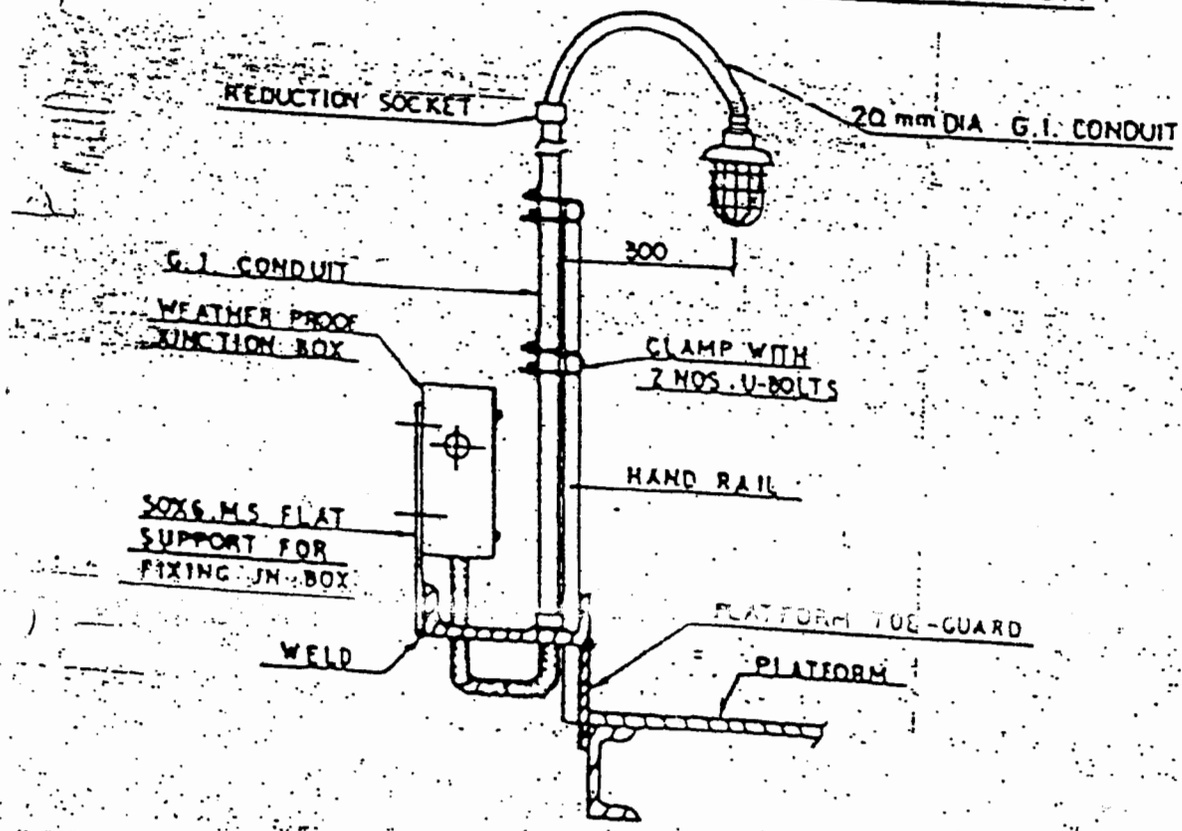


PLATFORM MOUNTING : TYPE-CB

	LIGHTING NOTES & DETAILS FIXTURE MOUNTING ON DECK & STAIRS	DRG. No. PE-DG-XXX558-0004
		REV. No. 0
		SHEET 8 OF 15



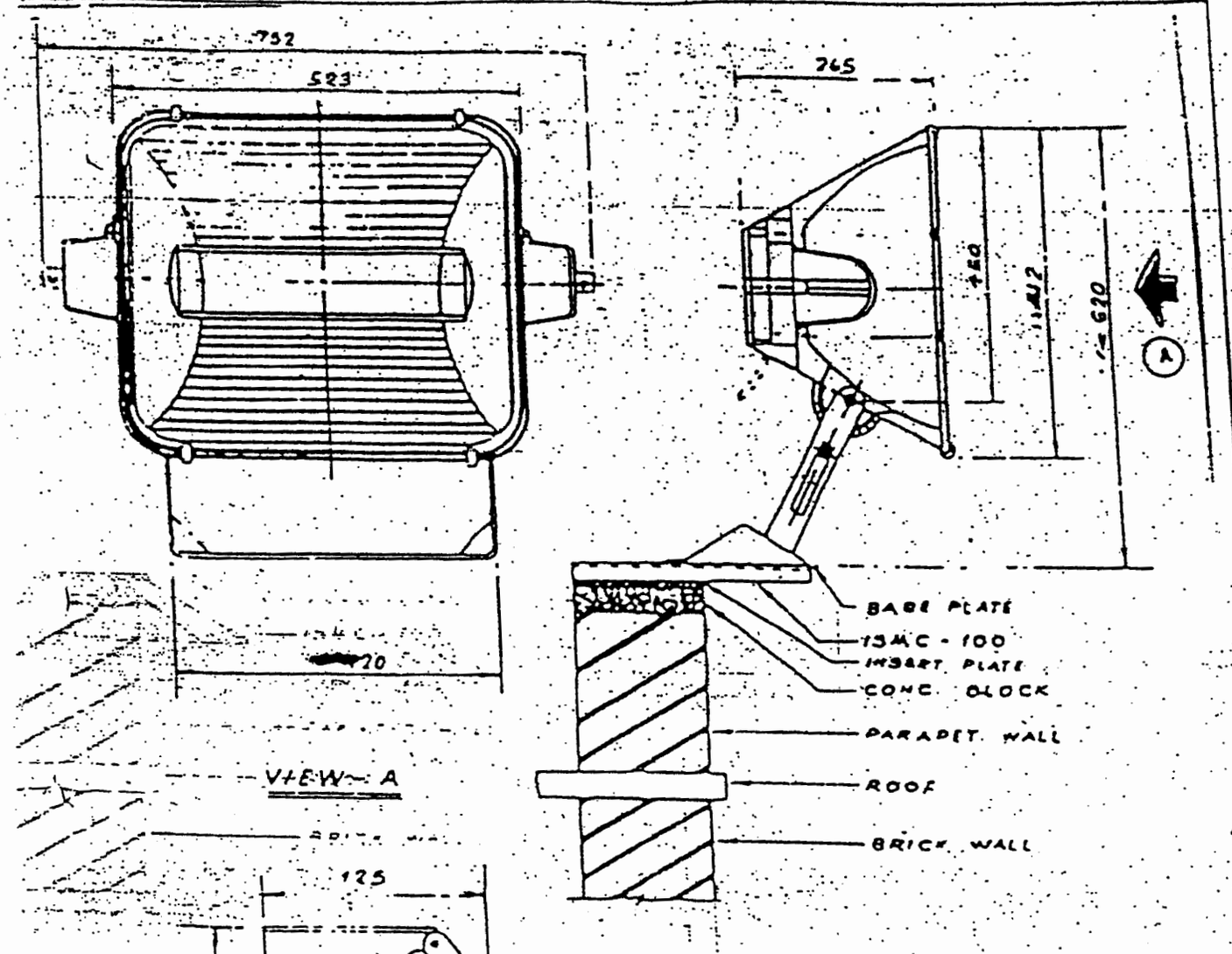
PENDANT/CEILING MOUNTING : TYPE-CA



PLATFORM MOUNTING : TYPE-CB

	LIGHTING NOTES & DETAILS FIXTURE MOUNTING ON DECK & STAIRS	DRG. No. PE-DG-XXX-558-0004 REV. No. 0 SHEET 8 OF 15

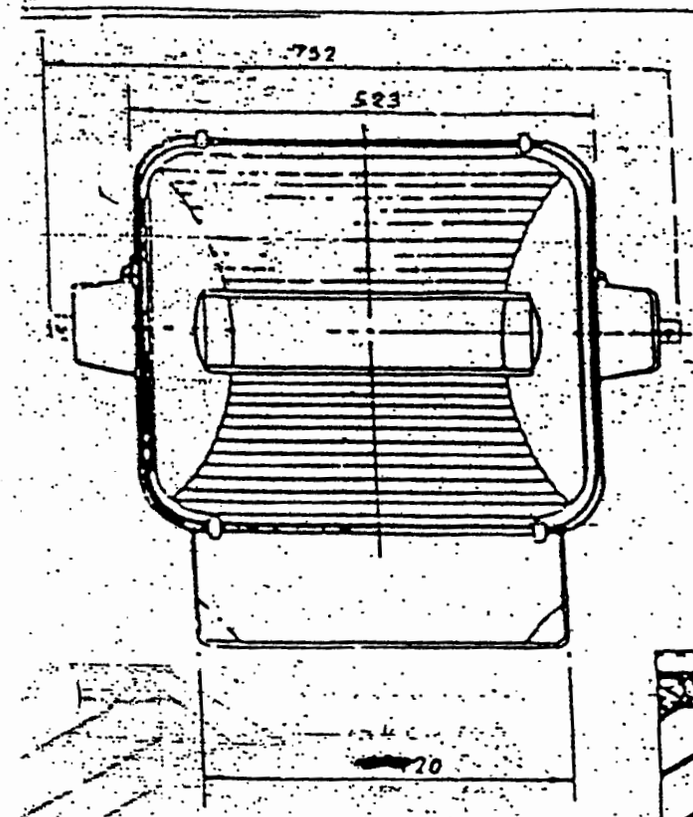
56

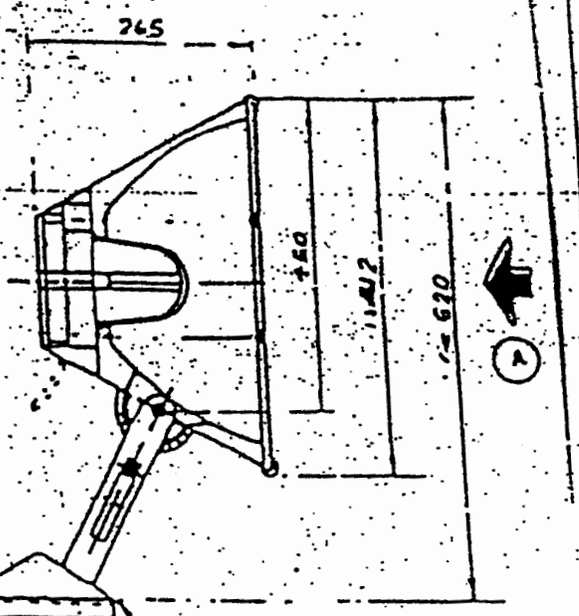


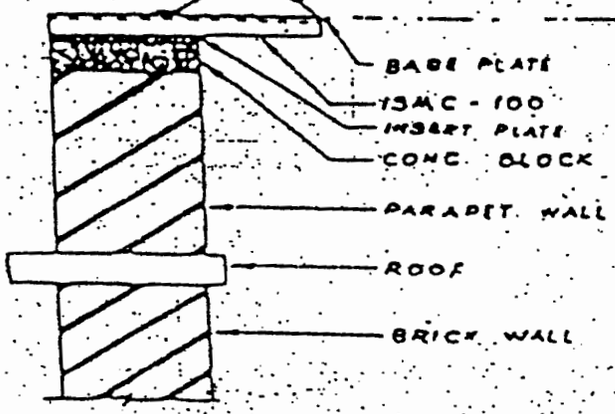
TYPICAL MOUNTING ARRANGEMENT OF FLOOD LIGHT FIXTURE ON THE ROOF

BASE PLATE

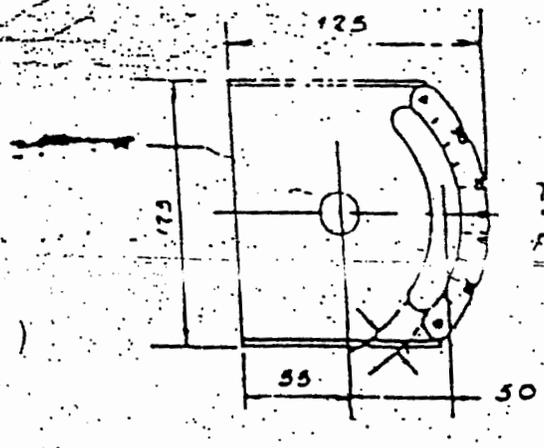
LIGHTING NOTES & DETAILS MOUNTING OF FLOOD LIGHT FIXTURE	DRG. No. PE-DG-~~XXX~~-558-0004 REV. No. 0 SHEET 9 OF 15





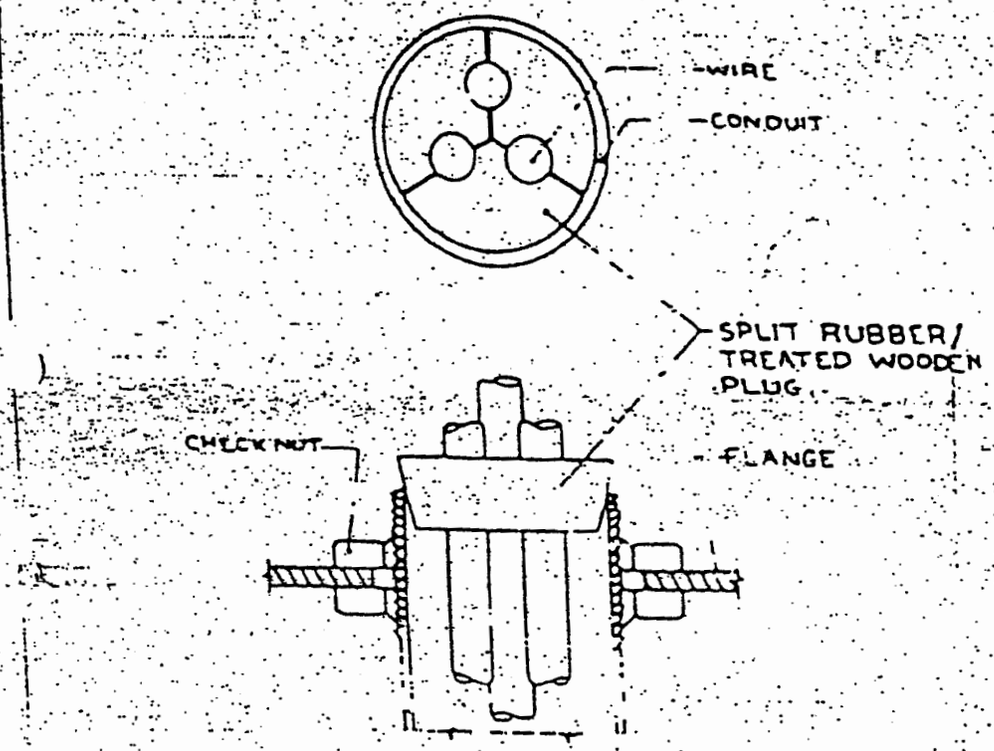


TYPICAL MOUNTING ARRANGEMENT OF FLOOD LIGHT FIXTURE ON THE ROOF



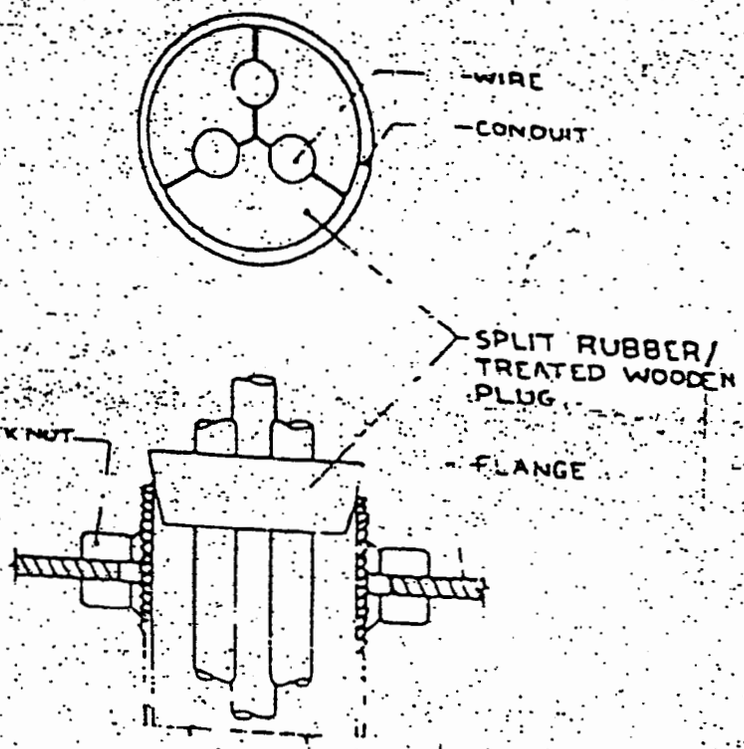
BASE PLATE

बी एच ई एल	LIGHTING NOTES & DETAILS MOUNTING OF FLOOD LIGHT FIXTURE
	DRG. No. PE-DG-XXX-558-0004
	REV. No. 0
	SHEET 9 OF 15

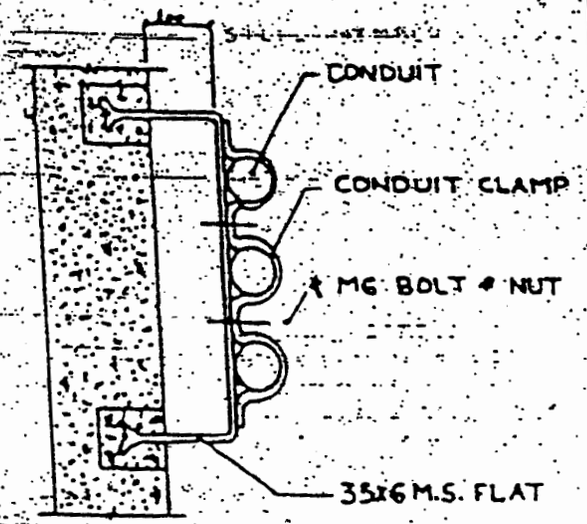


CLAMPING OF WIRES
IN CONDUIT VERTICAL RUN

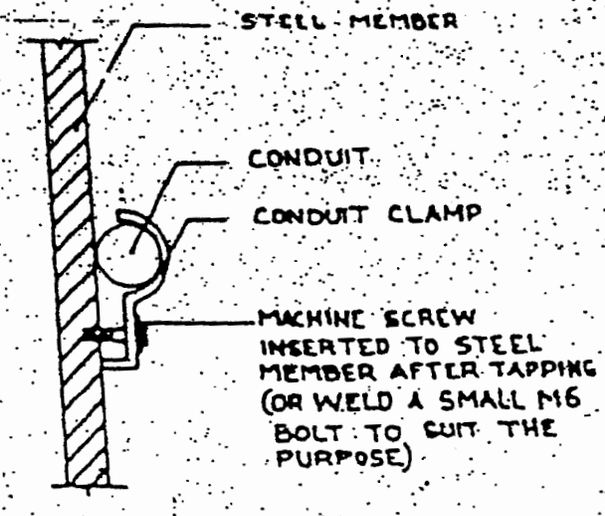
ओएनजीसी	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-~~XXX~~-558-0004
		REV. No. 0
		SHEET 10 OF 15



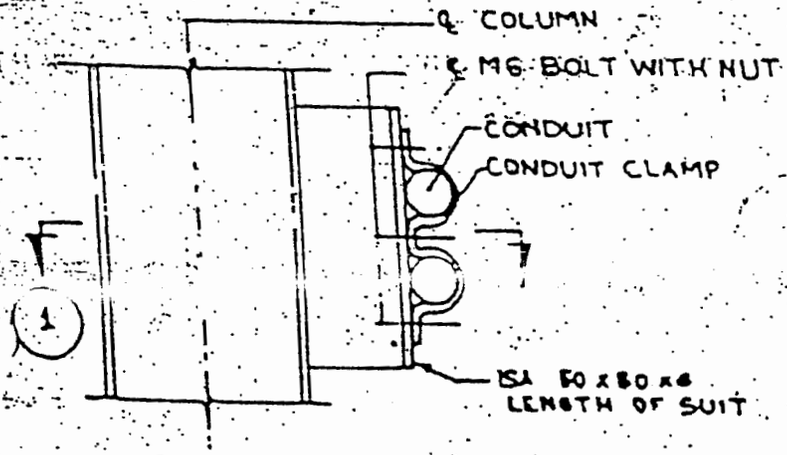
CLAMPING OF WIRES IN CONDUIT VERTICAL RUN



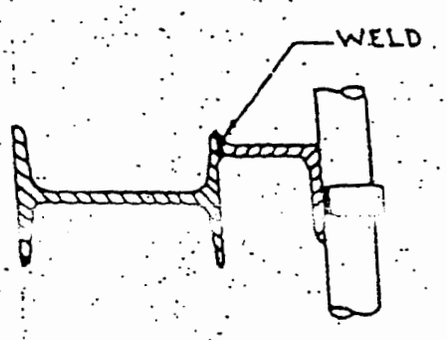
GROUP OF CONDUITS RUN ON CONCRETE SURFACE



SINGLE CONDUIT RUN ON STEEL MEMBER



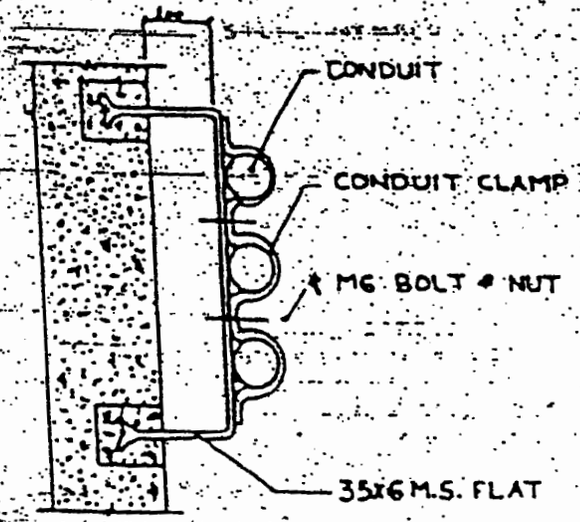
ELEVATION



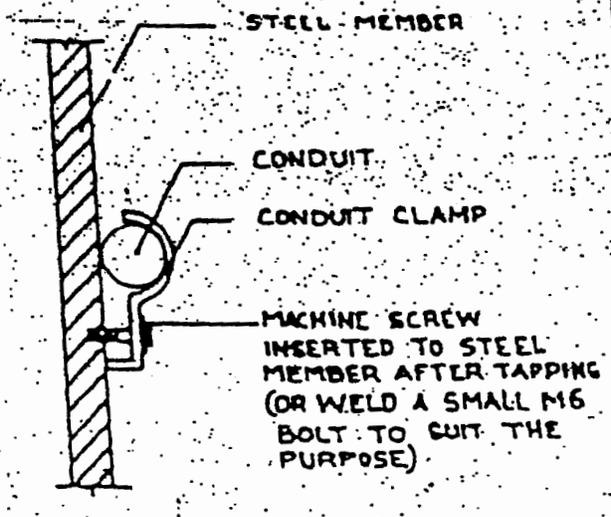
SECTION — (1)

GROUP OF CONDUIT RUN ON STEEL MEMBER ARRANGEMENT-A

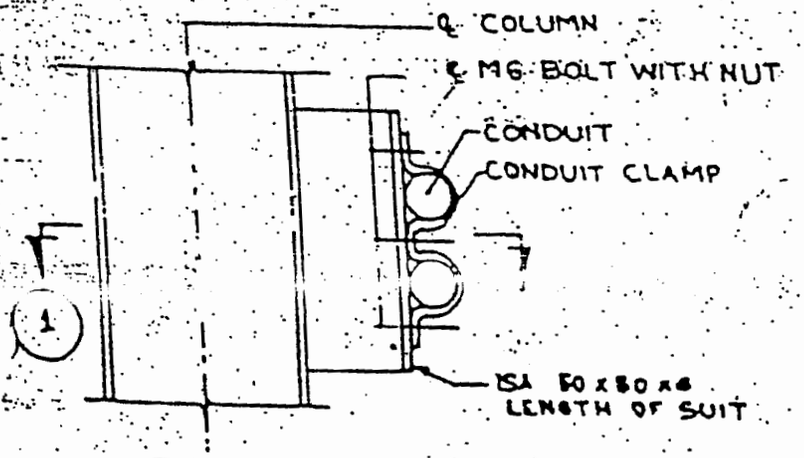
	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-~~XXX~~-558-0004
		REV. No. 11 OF 15



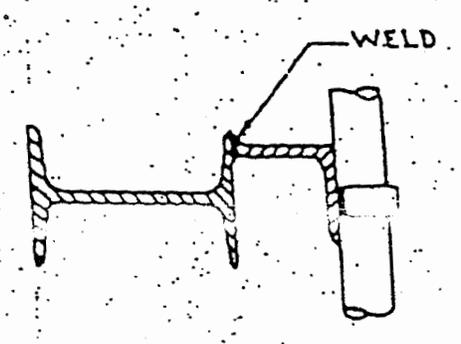
GROUP OF CONDUITS RUN ON CONCRETE SURFACE



SINGLE CONDUIT RUN ON STEEL MEMBER



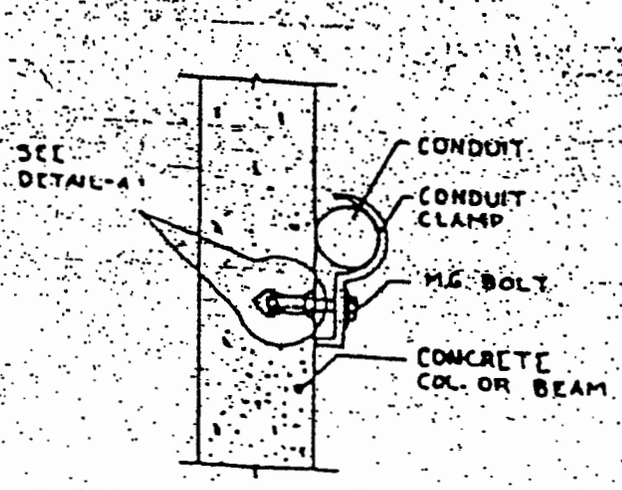
ELEVATION



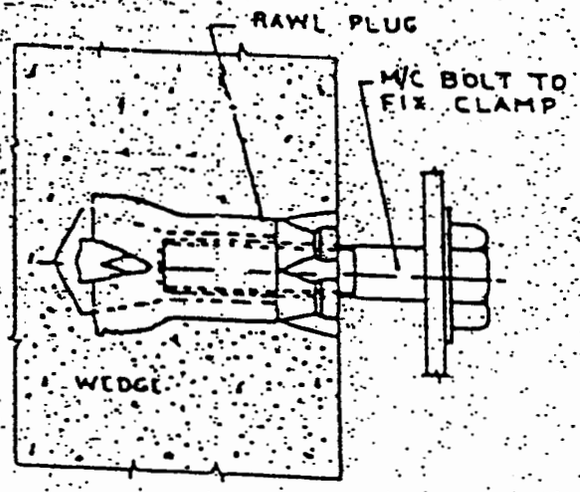
SECTION — (1)

GROUP OF CONDUIT RUN ON STEEL MEMBER ARRANGEMENT-A

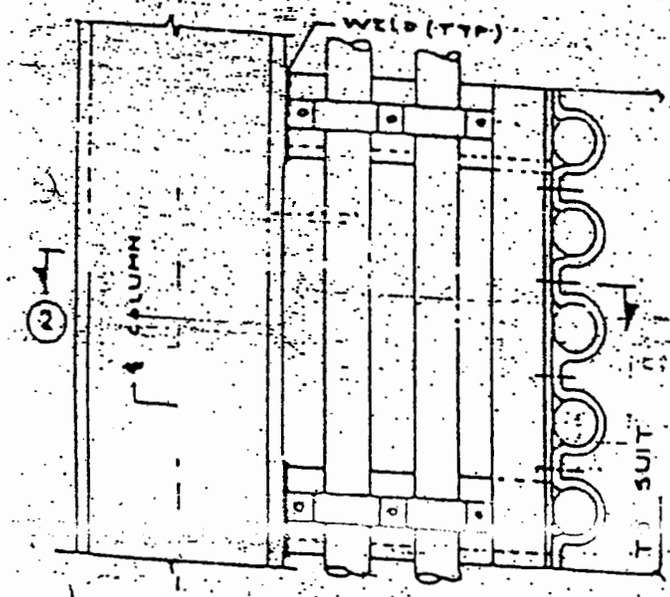
	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-~~XXX~~-558-0004
		REV. No. 11 OF 15



SINGLE CONDUIT RUN ON CONCRETE SURFACE

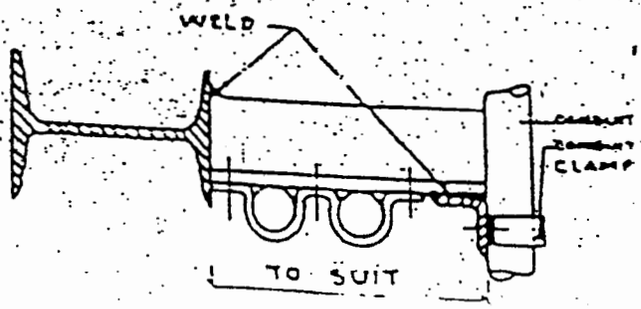


DETAIL - A



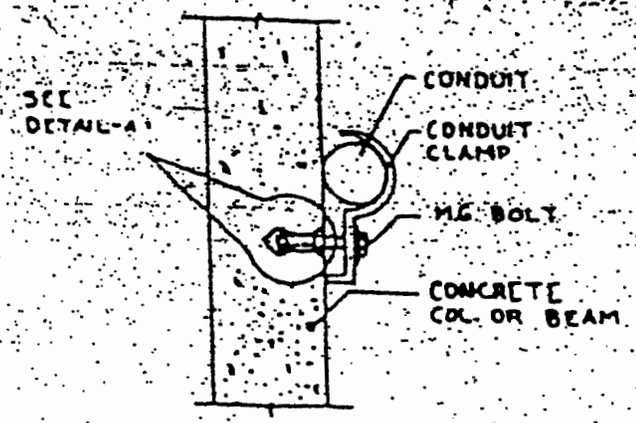
ELEVATION

GROUP OF CONDUIT RUN ON STEEL MEMBER ARRANGEMENT-B

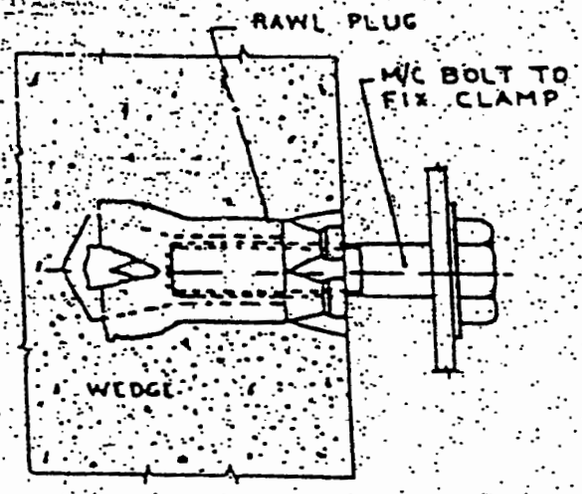


SECTION - ②

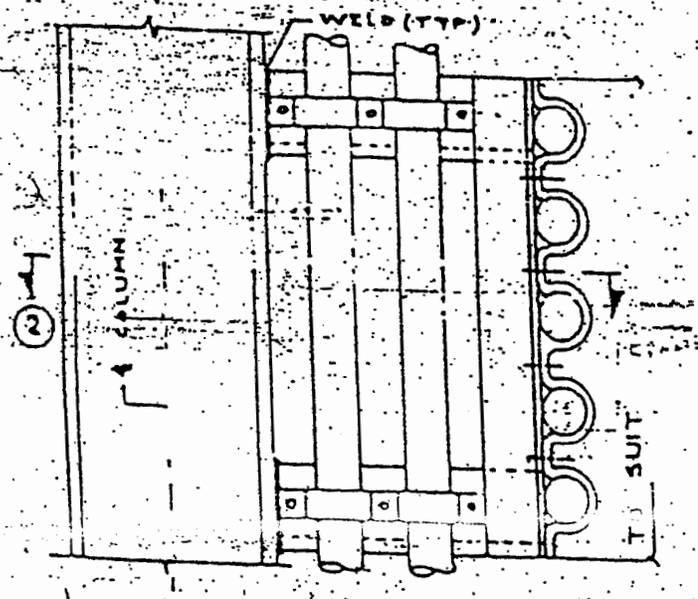
LIGHTING NOTES & DETAILS	DRG. No. PE-DG-XXX-558-0004	
	REV. No. 0	
	SHEET 12	OF 15



SINGLE CONDUIT RUN ON CONCRETE SURFACE

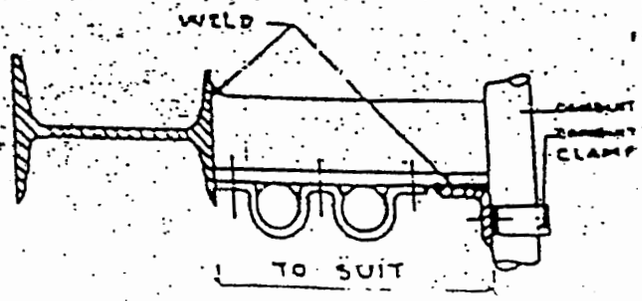


DETAIL - A



ELEVATION

GROUP OF CONDUIT RUN ON STELL MEMBER ARRANGEMENT-B



SECTION-(2)

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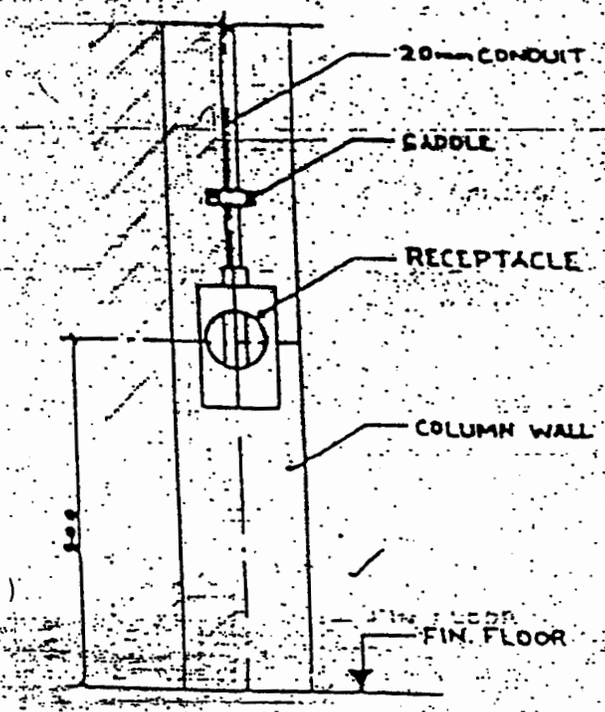
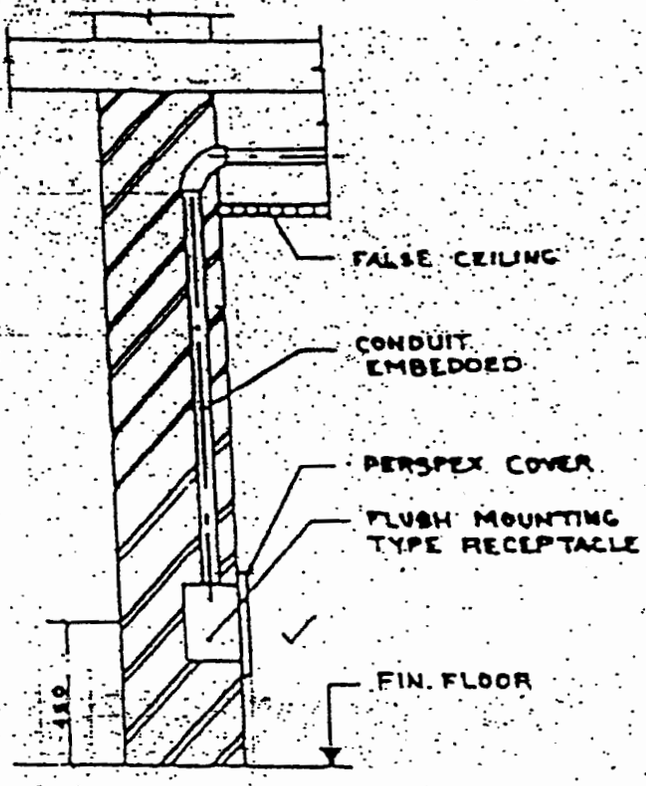
LIGHTING NOTES & DETAILS	REV. No. 0
	SHEET 12 OF 15



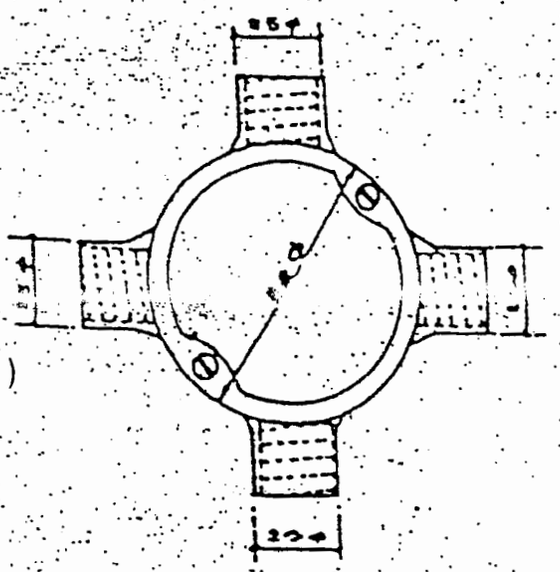
RECEPTACLE – TYPE 'RB'

(STRUCTURE MOUNTING)



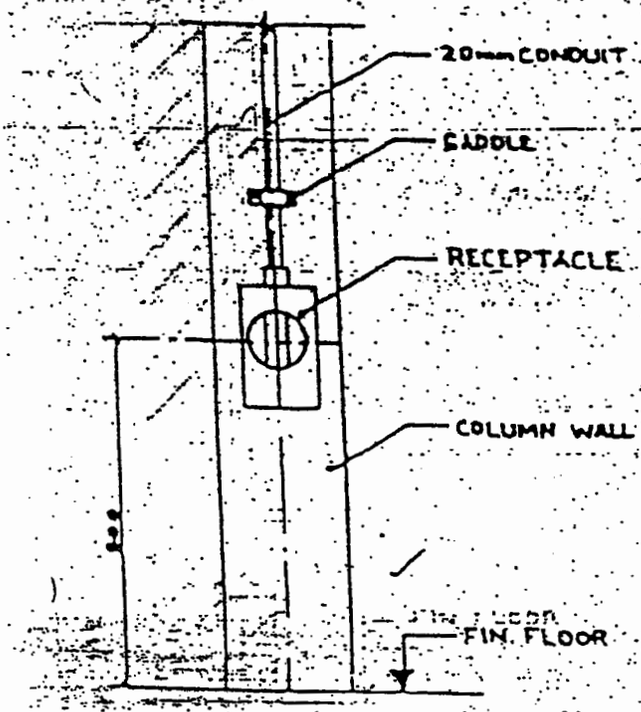
RECEPTACLE – TYPE 'RA'

(WALL MOUNTING)



JUNCTION BOX ROUND (TYP.)

	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-~~XXX~~558-0004
		REV. No. 0
		SHEET 13 OF 15



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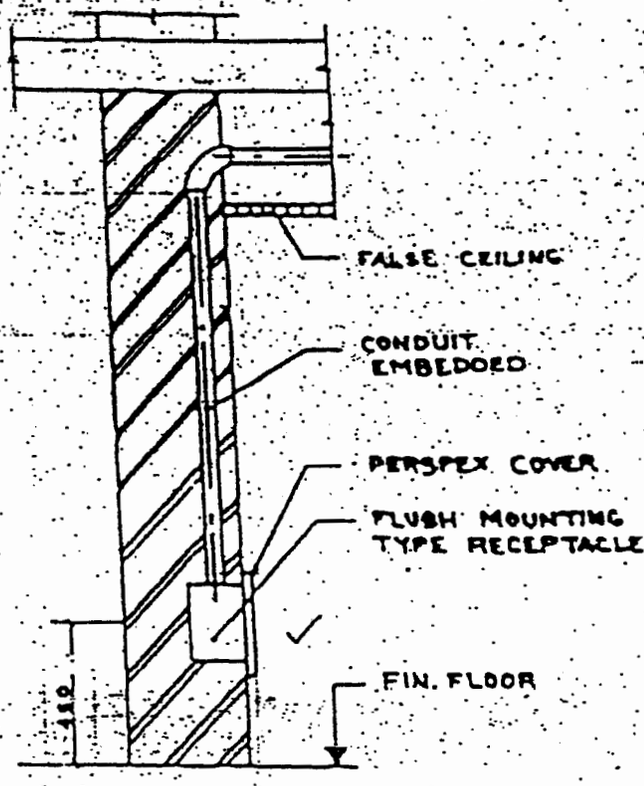
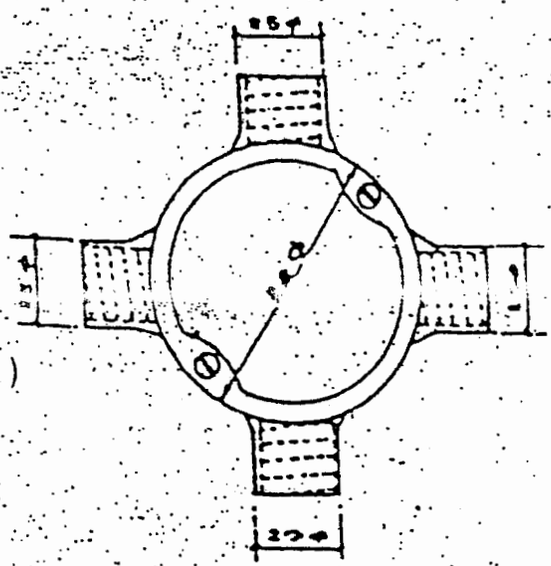
(STRUCTURE MOUNTING)



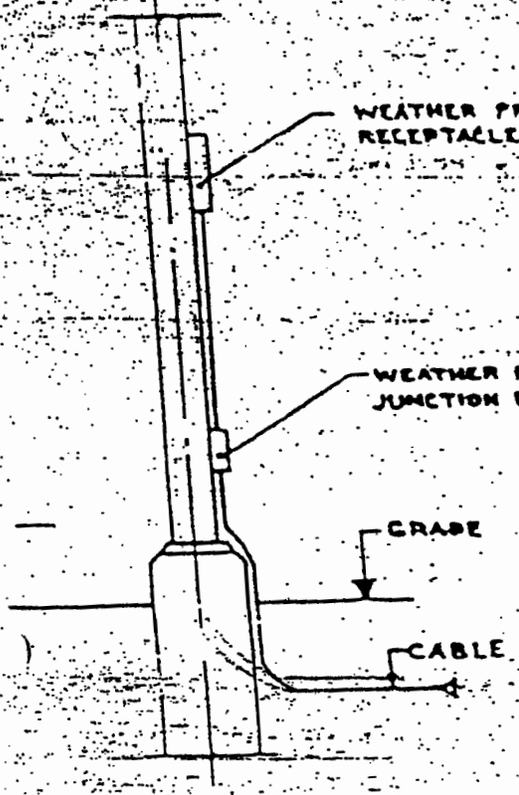
RECEPTACLE – TYPE 'RA'

(WALL MOUNTING)

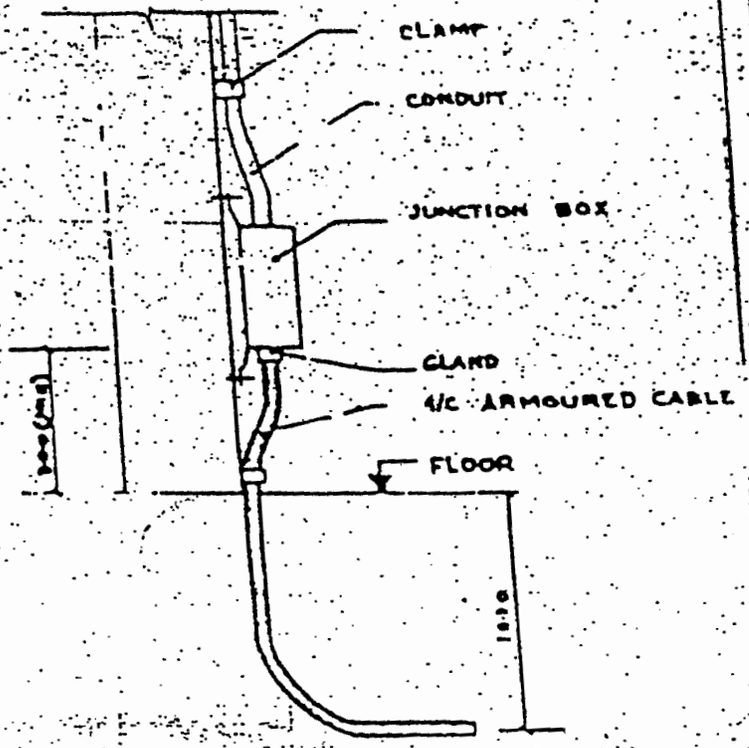


JUNCTION BOX ROUND (TYP.)

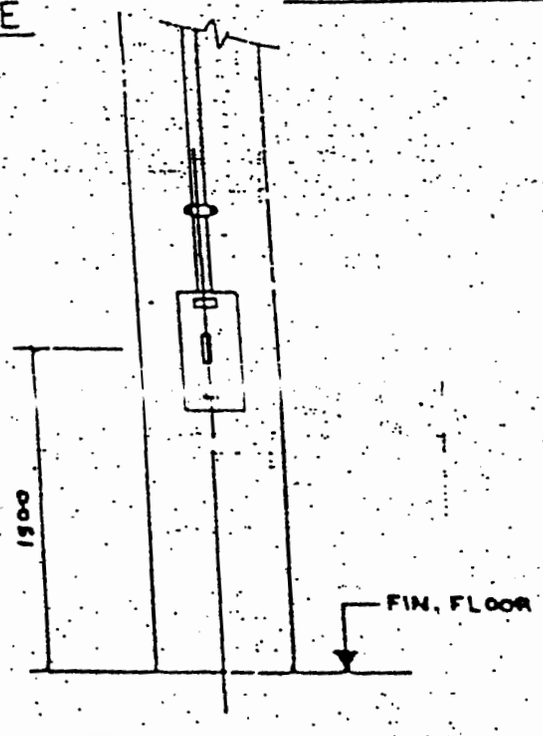
MPUS HT	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-~~XXX~~558-0004
		REV. No. 0
		SHEET 13 OF 15



OUTDOOR RECEPTACLE

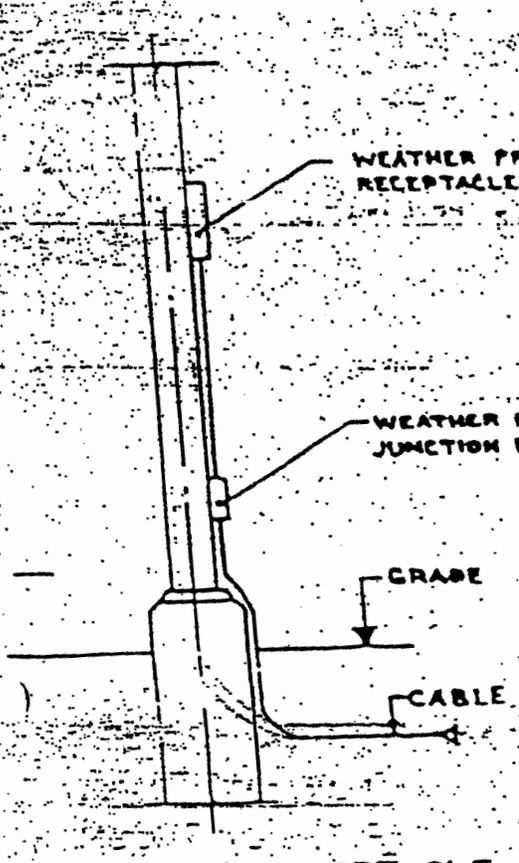


JUNCTION BOX
MOUNTING (TYP.)

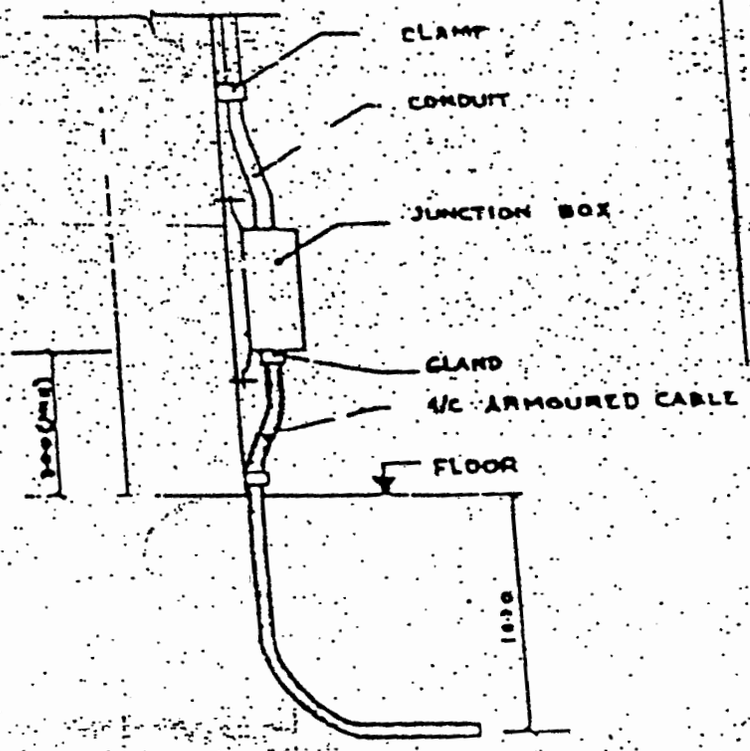


SWITCH ON COLUMN

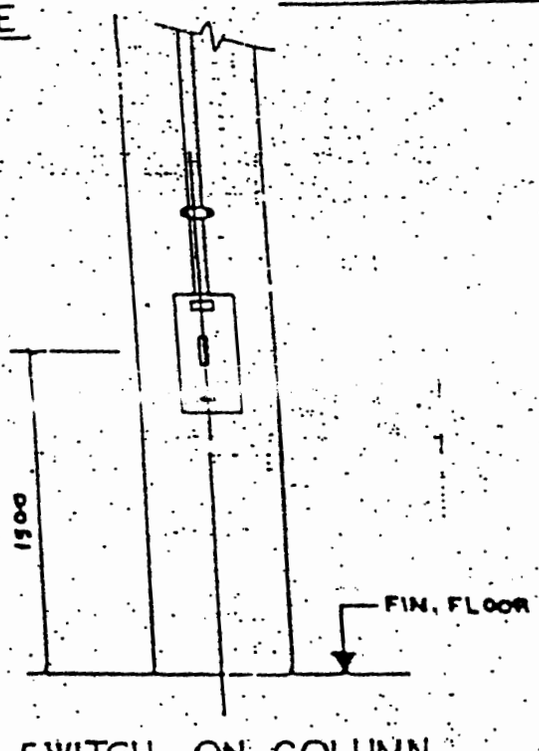
	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-~~XXX~~558-0004
		REV. No. 0
		SHEET 14 OF 15



OUTDOOR RECEPTACLE

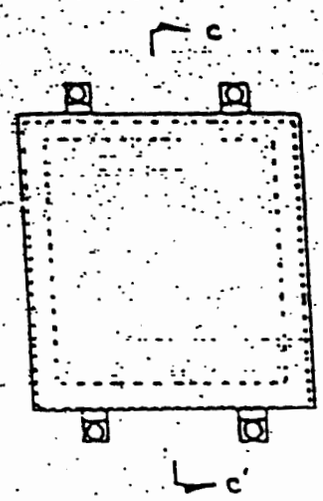


JUNCTION BOX
MOUNTING (TYP)

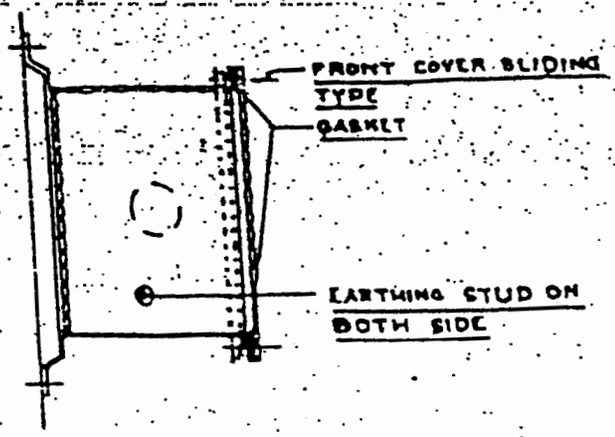


SWITCH ON COLUMN

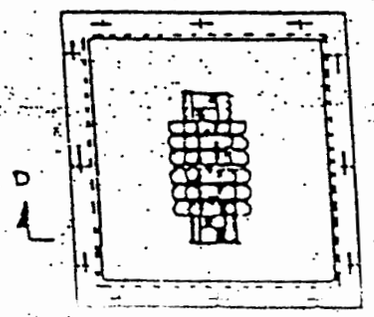
TATA PROJECTS LTD	LIGHTING NOTES & DETAILS	DRG. No. PE-DG-~~XXX~~558-0004
		REV. No. 0
		SHEET 14 OF 15



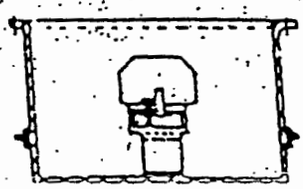
TYP. FIXING DETAIL OF JUNCTION BOX



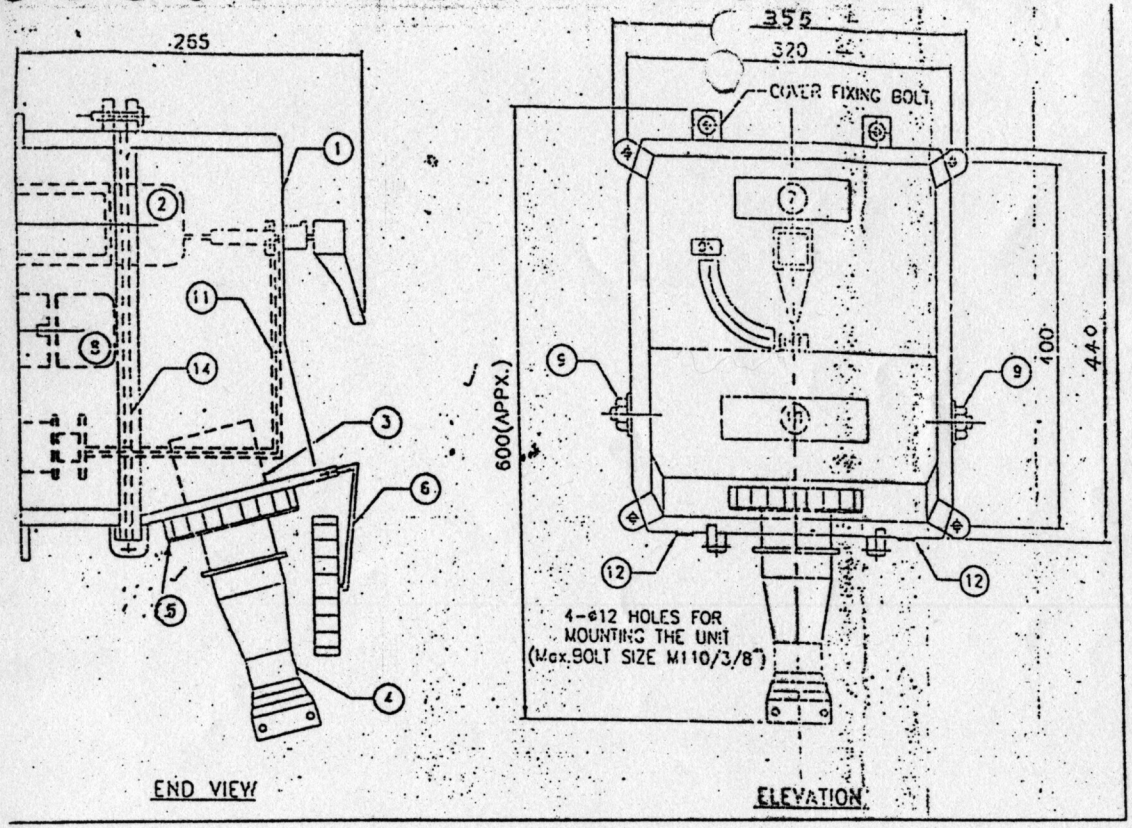
SECTION: C-C'



JUNCTION BOX (TYP.) FRONT VIEW



SECTION: D-D'

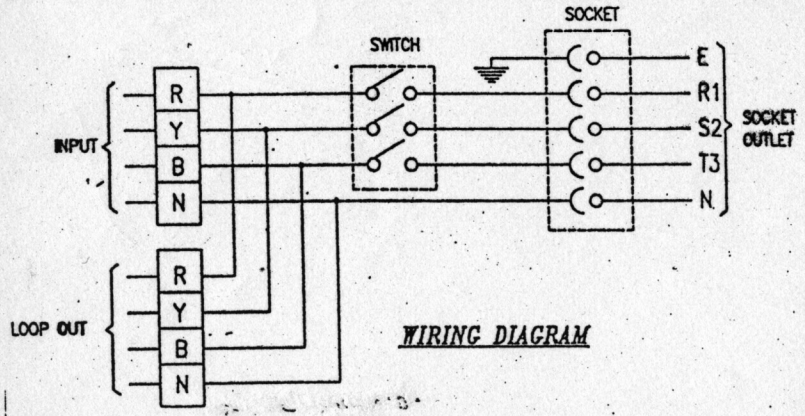


SPECIFICATION

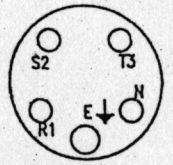
1] ALUMINIUM ALLOY HOUSING (MIN THICKNESS 3mm)
2] GE POWER CONTROL TP ON/OFF SWITCH DOUBLE BREAK TYPE SP02, AC23 CATEGORY CONFORMING TO IS-13947-3
3] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH SOCKET
4] BEST & CROMPTON MAKE-63A, 415V, 5 PIN TRIPLE POLE, NEUTRAL & EARTH PLUG
5] PLUG RING
6] SPRING LOADED COVER FOR SOCKET OUTLET
7] NAME PLATE
8] 4 WAY STUD TYPE TERMINAL BLOCK 2 Nos. FOR LOOP IN LOOP OUT, ARRAGEMENT TO TERMINATE 3.5Cx50 sq.mm STUD TYPE BEST & CROMPTON MAKE
9] ELECTROPLATED EARTHING TERMINAL 2 Nos. COMPLETE WITH 6mm BOLT,NUT & WASHER SUITABLE FOR 14 SWG. GI. EARTHING CONDUCTOR
10] CAUTION STACKER
11] MECHANICAL INTERLOCKING ARRANGEMENT
12] DETACHABLE GLAND PLATE O TAKE 2 Nos. GLAND SUITABLE FOR 3.5x70 sq.mM. CABLES.

NOTES

1] ALL DIMENSION ARE IM MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 16/25 sq.mm. CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN NOT BE MADE 'ON' UNLESS PLUG IS INSERTED
PLUG CAN NOT BE WITHDRAWN UNLESS SWITCH IS IN OFF POSITION
6] UNIT IS MANUFACTURE BY "BEST & CROMPTON"
7] SUITABLE CABLE GRIP SHALL BE PROVIDED



WIRING DIAGRAM



SHOWING TERMINAL POSITION

COLOUR CODED SLEVE WILL BE PROVIDED ON BOTH ENDS ON COPPER FLEIBLE
R PHASE – RED COLOUR
Y PHASE – YELLOW COLOUR
B PHASE – BLUE COLOUR
NEATRAL – BLACK COLOUR

CHIMNEY LIGHTING SPECIFICATION

REV	DATE	DESCRIPTION
01		
02		

1230-001-29PE-PVE-B-073

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT
NEW DELHI

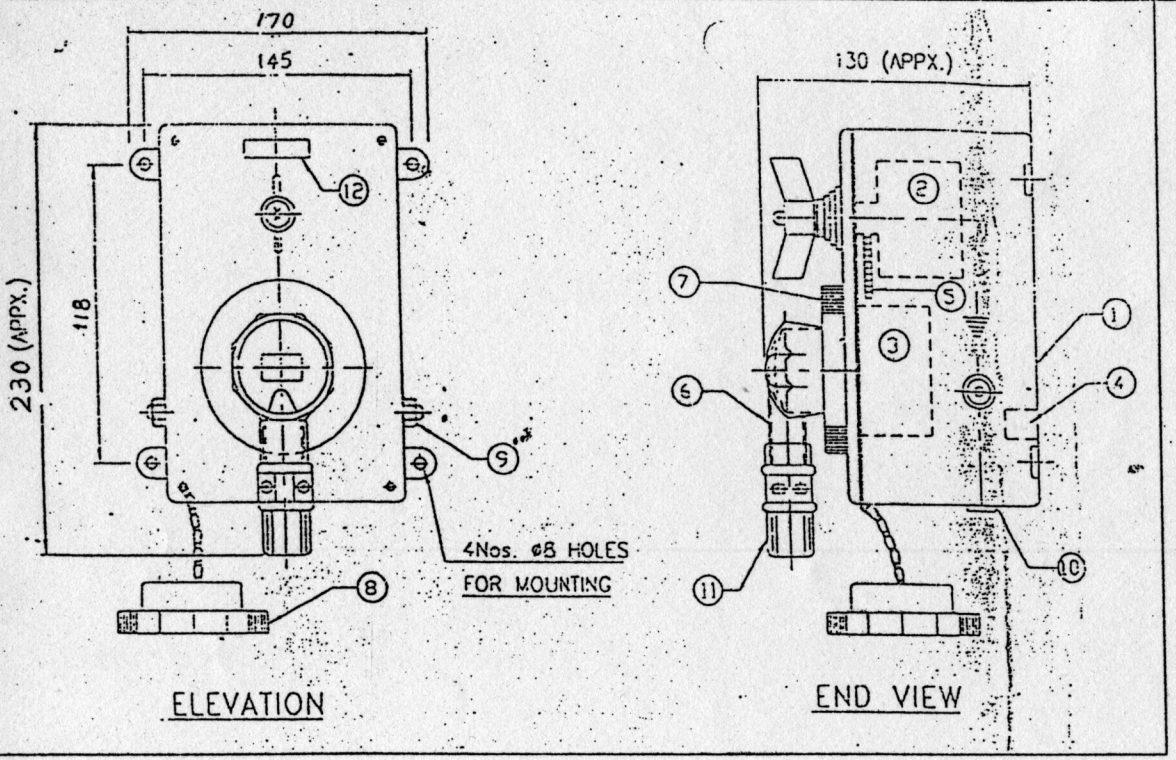
bajaj electricals limited MUMBAI
Engineering & Projects Division.

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBM	JS	AP	30.06.03	PE-V0-200-558-E073

TITLE GENERAL ARRANGEMENT DWG FOR 63 A FULLY INTERLOCKED SWITCHED PLUG 63 AMPS 415 VOLTS [TYPE RC]

DWG. NO. EPBU-03-PS005-04-073 REV. 0

SHT. 1 OF 1



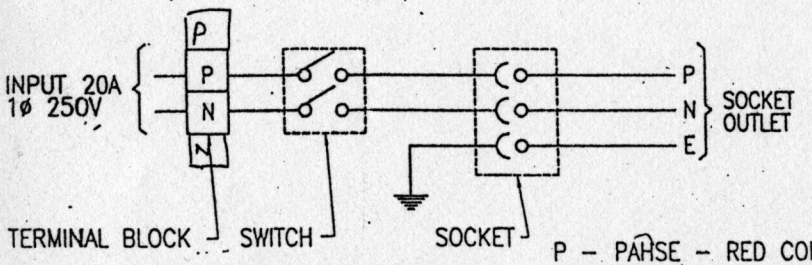
SPECIFICATION

1] ALUMINIUM ALLOY ENCLOSURE 3mm THICK
2] 25A, 250V, DOUBLE POLE/ OFF ROTARY SWITCH AC 23 CATEGORY IS-4064 – RECOM MAKE
3] ALUMINIUM ALLOY METAL CLAD SOCKET UNIT "BEST & CROMPTON" MAKE
4] BAKELITE STUD TYPE 2 WAY TERMINAL BLOCK TO TERMINATE 2Cx4 sq.mm CABLE
5] MECHANICAL INTERLOCKING SYSTEM
6] DIE CAST ALUMINIUM ALLOY METAL CLAD PLUG AND SOCKET OF 20A, 240V, 3 PIN (P+N+E), 3rd PIN GROUNDED
7] THREADED PLUG LOCKING RING
8] SOCKET COVER WITH CHAIN FOR SOCKET OUTLET
9] EARTHING TERMINAL 2 Nos. – M6 SIZE
10] CABLE ENTRY 25mm DIA – 2Nos.
11] PVC CABLE GRIP
12] NAME PLATE

NOTES

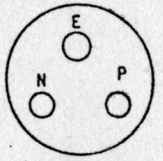
1] ALL DIMENSION ARE IN MM UNLESS OTHERWISE SPECIFIED SUBJECT TO TOLERANCE OF ±5mm
2] EACH UNIT PROVIDED WITH INTERNAL WIRING SIZE 4 sq.mm. COPPER CABLE
3] THE ENCLOSURE IS PAINTED WITH SHADE GREY RAL 9002 – POWDER COATING
4] THE UNIT ARE SUITABLE FOR OUTDOOR USE, IP-55 AS PER IS-13947
5] SWITCH CAN ~~NOT~~ BE MADE 'ON' ONLY WHEN PLUG IS FULLY ENGAGED WITH SOCKET. PLUG CAN NOT BE WITH DRAWN WHEN SWITCH IS ON
6] 2 Nos. CABLE ENTRY AT BOTTOM

CHIMNEY LIGHTING SPECIFICATION.



WIRING DIAGRAM
(FOR SINGLE PHASE UNIT)

P – PHASE – RED COLOUR
N – NEUTRAL – BLACK COLOUR
E – GREEN COLOUR.



VIEW ON SOCKET PLUG REMOVED

1230-061-298E-PVG-B-070

REV	DATE	DESCRIPTION
01		
02		

NATIONAL THERMAL POWER CORPORATION LTD.
RIHAND 2X500MW THERMAL POWER PROJECT STAGE-II

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR, PROJECT ENGINEERING MANAGEMENT

bajaj electricals limited MUMBAI
Engineering & Projects Division

DRN	CHKD	APPD	DATE	BHEL DWG. No
KBU	IS	AP	30.06.03	PE-V0-200-558-E070

TITLE GENERAL ARRANGEMENT DWG FOR FULLY INTERLOCKED SWITCHED PLUG 20 AMPS, 250 VOLTS [TYPE RA]

DWG. NO. EPBU-03-PS005-04-070

REV 0

SHT. 1 OF 1

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–558–00–Q–001/01	SPECIFICATION TITLE
	SHEET 1 OF 3	SYSTEM	ITEM ILLUMINATION	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
1.0	CABLES & WIRES	1. SURFACE DEFECTS	MA	VISUAL	SAMPLE	BHEL SPEC., IS:694, IS:1554	BHEL SPEC., IS:694, IS:1554	INSPN. REPORT & TEST REPORT FROM MANUFACTURER	3/2	2	1	TO BE PROCURED FROM APPROVED SOURCE
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	–DO–	–DO–	–DO–	3/2	2	1	
		3. TYPE TESTS	CR	ELEC. TESTS	ONE/TYPE & SIZE	BHEL SPEC., IS:694, IS:1554	BHEL SPEC., IS:694, IS:1554	TEST CERT.	3	2	1	
		4.ACCEP–TANCE TESTS	MA	–DO–	SAMPLING	–DO–	–DO–	–DO–	3	2	1	
		5. ROUTINE TESTS	MA	–DO–	100%	–DO–	–DO–	–DO–	3	–	2,1	
		6. FRLS PROPS.	CR	FRLS TESTS	SAMPLES	BHEL SPEC.	BHEL SPEC.	–DO–	3	2	1	
2.0	JUNCTION BOXES, LIGHTING PANELS AND DISTRIBUTION BOARDS											
2.1	JUNCTION BOXES	1.DIMENSIONS	MA	MEASUREMENTS	100%	BHEL DRG.	BHEL DRG.	INSP. REPORT	3	–	2	COMPONENTS TO BE OF APPROVED MAKE.
		2.PAINT SHADE/ THICKNESS	MA	VISUAL / MEAS.	SAMPLE	BHEL SPEC./DRG.	BHELSPEC./DRG.	–DO–	3	–	2	
		3.HV / IR / HV	MA	ELECT. TESTS	100%	2KV AC FOR 1 MINUTE	2KV AC FOR 1 MINUTE	–DO–	3	–	2	
		4.DEGREE OF PROTECTION	MA	TESTS	1/SIZE	IS:2147	IS:2147	TEST CERT.	–	–	2,1	
		5.SPECIAL TESTS IF ANY, EXPLOSION PROOF ETC.	MA	–DO–	–DO–	IS:2148	IS:2148	–DO–	–	–	2,1	
2.2	LIGHTING PANELS AND LIGHTING DISTRIBUTION BOARDS	1. DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DRG.	BHEL DRG.	INSPT. REPORT	3	2,1	–	COMPONENTS TO BE OF APPROVED MAKE.

BHEL	PARTICULARS	BIDDER / VENDOR
	NAME	
	SIGNATURE	

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–558–00–Q–001/01	SPECIFICATION TITLE
	SHEET 2 OF 3	SYSTEM	ITEM ILLUMINATION	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10	10	10	11
		2. PAINT SHADE/ THICKNESS	MA	VISUAL/ MEASUREMENT	–DO–	BHEL SPEC./DRG.	BHEL SPEC./DRG.	INSPT. REPORT	3	2,1	–	
		3.DEGREE OF PROTECTION (INCLUDING EXPLOSION PROOF IF ANY)	MA	TESTS	1/SIZE	BHEL SPEC./ RELEVANT IS	BHEL SPEC./ RELEVANT IS	TEST CERTF.	–	–	2,1	
		4.PERFORMANCE TESTS	MA	ELEC.	100%	BHEL SPEC.	BHEL SPEC.	INSPT. REPORT	3	2,1	–	BHEL SHALL WITNESS ON RANDOM ONE SAMPLE, THOUGH EACH ITEM SHALL BE CHECKED BY THE MANUFACTURER.
		5.HV/IR/HV	MA	ELEC.	100%	2.5 KV AC FOR 1 MINUTE	2.5 KV AC FOR 1 MINUTE	–DO–	3	2,1	–	–DO–
		6. TEMP. RISE TEST (FOR COM–PLETE ASSEMBL–ED LDB)	MA	ELEC.	1/RATING	BHEL SPEC.	BHEL SPEC.	–DO–	3	2	1	
3.0	TUNGSTEN FILAMENT LAMPS, TUBULAR FLUORESCENT LAMPS, H.P. MERCURY VAPOUR LAMPS,SODIUM VAPOUR LAMPS,BALLASTS, LUMINAIRES	1. – ACCEPTANCE TESTS	MA	TESTS	SAMPLE	BHEL SPEC./ RELEVANT IS	BHEL SPEC./ RELEVANT IS	TEST CERTF.	3,2	–	1	

BHEL	PARTICULARS	BIDDER / VENDOR
	NAME	
	SIGNATURE	

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–558–00–Q–001/01	SPECIFICATION TITLE
	SHEET OF 3	SYSTEM	ITEM ILLUMINATION	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
4.0	CONDUITS	1. MATERIAL	MA	VISUAL, MECH. AND CHEMICAL	AS PER SPEC./ IS : 9537	IS:9537	IS:9537	INSPT. REPORT	3	2	1	
		2. DIMENSIONS	MA	MEASUREMENT	AS PER SPEC./ IS : 9537	IS:9537	IS:9537	–DO–	3	2	1	
		3. OTHER TESTS	MA	TESTS	AS PER SPEC./ IS:9537,	AS PER SPEC./ IS:9537,	IS:9537,	–DO–	3	2	1	
5.0	ELECTRIC POLES											
5.1	MATERIAL	1. CHEMICAL COMP.	MA	CHEM. ANALYSIS	SAMPLE	IS:2713, IS:228 & IS:1894	IS:2713 IS:228 & IS:1894	–DO–	3/2	–	2,1	
		2. PHYSICAL PROP.	MA	PHYS. TESTS	–DO–	–DO–	–DO–	–DO–	3/2	–	2,1	
5.2	FINAL INSPECTION	1. WORK–MANSHIP & FINISH	MA	VISUAL & MEAS.	SAMPLES	BHEL DRG./IS:2713	BHEL DRG./IS:2713	–DO–	3/2	2,1	–	
		2. DIMENSIONS	MA	–DO–	–DO–	–DO–	–DO–	–DO–	3/2	2,1	–	
		3. WEIGHT	MA	–DO–	–DO–	–DO–	–DO–	–DO–	3/2	2,1	–	
		4. TESTS AS PER IS:2713	MA	–DO–	–DO–	IS:2713	IS:2713	–DO–	3/2	2,1	–	

NOTE : IN CASE TYPE TEST CERTIFICATE FOR DEGREE OFPROTECTION /EXPLOSION PROOFNESS FROM INDEPENDENT LAB. IS NOT AVAILABLE, THE ITEM SHALL BE TESTED AT AN INDEPENDENT LAB.

BHEL	PARTICULARS	BIDDER / VENDOR
	NAME	
	SIGNATURE	

1.00.00 **CODES AND STANDARDS** IS:1554, IS:7098, IEC:502, IS:6380, IS:9968

2.00.00 **TYPE** All cable shall be Flame retardent low smoke type

3.00.00 **RATING** As per requirement specified in General Electrical Requirements.

4.00.00 **OPERATIONAL REQUIREMENTS**

All cables shall be suitable for high ambient, high humid tropical Indian climatic conditions. All cables shall be designed to withstand the mechanical, electrical and thermal stresses under the foreseen steady state and transient/fault conditions, and shall be suitable for the proposed method of installation.

5.00.00 **DESIGN AND CONSTRUCTIONAL FEATURES**

5.01.00 Parameters of the cables are as follows :

Particulars	Power cables		Control cables	Trailing cables
	XLPE	PVC		
a) Conductor				
i) Material	Stranded Aluminium		Stranded plain annealed copper	Tinned copper of class 5 of IS:8130
ii) Size	As required, but Min. 6 sq.mm size.		As required, but min. 1.5 sq.mm. size.	As required, but min. 1.5 sq.mm. size.
iii) Shape	Circular/ sector shaped. Circular only for HT cables	Circular/ sector shaped		
b) Main Insulation				
i) Material	XLPE	PVC	PVC	Heat resistant elastomeric compound based on Ethylene Propyline Rubber (EPR)

Particulars	Power cables (XLPE)	Power cables (PVC)	Control cables	Trailing cables
ii) Continuous withstand temperature (deg.C)	90	70	70	90
iii) Short circuit withstand temperature (deg.C)	250	160	160	250
iv) Colour identification	As per relevant codes and standards			
c) Inner Sheath	All armoured and multicore unarmoured cables have distinct extruded inner sheath			
i) Material	PVC	PVC	PVC	Heat resistant elastomeric compound.
ii) Colour	Black	Black	Black	Black
d) Armour, wherever provided				
i) Material	Aluminium wire for single core cable and GS wire/flat for multi-core cables as per relevant IS. Minimum Coverage of 90%		GS wire/flat as per relevant IS. Min. coverage of 90%.	Nylon cord reinforcemenet
ii) Breaking load of joint	95% of normal armour		95% of normal armour	
e) Outer sheath	All power & control cable shall have extruded outer sheath.			
i) Material (Polyethelene based halogen free material not acceptable)	PVC	PVC	PVC	Heat resistant, oil resistant & flame retardant heavy duty elastomeric compound

Particulars		Power cables		Control cables	Trailing cables
		XLPE	PVC		
ii)	Colour	Black	Black	Grey	Black
iii)	Marking	- Cable size & voltage grade (by embossing) - Word "FRLS" @ 5m (by embossing) - Sequential marking @1m		Same as for Power Cables	Same as for Power Cables

f)	FRLS properties on outer sheath	Oxygen Index : Acid gas generation: Smoke density rating:	Min. 29 (As per ASTMD 2863) Max. 20% (As per IEC754-I) 60% (As per ASTMD 2843)
g)	Flamability test on all types of cables	As per Swedish chimney test F3 as per SEN 4241475 As per IEC 332 Part-3 (Category B)	

5.01.02 **HT cables**

For HT cables conductor screen and insulation screen shall be of extruded semi-conducting compound and shall be applied alongwith XLPE insulation in a single operation by triple extrusion process. Method of curing for 11kV/6.6kV cables shall be "Dry curing/gas curing/steam curing" whereas for 33KV cables it shall be "Dry/Gas curing". 11kV/6.6kV cables shall be provided with copper metallic screen suitable for carrying allowable earth fault current for 2 secs. All other voltage grade HT cables shall be provided with copper metallic screen suitable for carrying earth fault current as per E0. For single core armoured cables, the armouring shall constitute the metallic part of screening.

5.01.03 LT Cables of size 150 sq.mm. and above shall be with XLPE insulation.

5.01.04 **Core identification**

For cables having more than five (5) cores, each core shall be identified by number marking. However, for cables upto five (5) cores, the same shall be by colour as per IS.

5.01.05 **Armouring**

Cables buried direct in ground and cables in switchyard shall be armoured.

Clause No.	POWER AND CONTROL CABLES		
		..... (Bidder's Name)	
	POWER AND CONTROL CABLES (Use separate sheet for each type and size of cables)		
1.00.00	Make	.....	.....
1.02.00	Country of Manufacturer	.....	.....
1.03.00	Type & designation	.....	.....
1.04.00	Applicable standard	.....	.....
1.05.00	Cable size & no. of cores	.....	.....
1.06.00	Rated voltage	.....	.....
1.07.00	Catalogue attached as Annexure No.	.....	.....
1.08.00	Continuous current rating for max. conductor temperature	.....	.....
	a) When laid in air at an ambient temperature of 50 deg. C	.....	.....
	b) When buried in soil having thermal resistivity of 150 deg.C cm/n at a depth of 1000 mm at ground ambient temperature of 40 deg. C	.....	.....
1.09.00	Short circuit withstand capacity and duration for	.....	.....
	a) Conductor	.....	.....
	b) Screen	.....	.....
	c) Armour	.....	.....
1.10.00	Conductor	.....	.....
	a) Material	.....	.....
	b) Nominal cross section area in sq. mm	.....	.....

Clause No.	POWER AND CONTROL CABLES		
		..... (Bidder's Name)	
	c) Shape of conductor	.....	.....
	d) DC resistance at 20°C	.....	.....
1.11.00	Insulation		
	a) Material	.....	.....
	b) Nominal thickness (in mm)	.....	.....
	c) Type of curing (for XLPE)	.....	.....
1.12.00	Metallic screen (wherever applicable)		
	a) Material	.....	.....
	b) Type	.....	.....
	c) Rating KA, Sec		
1.13.00	Material & Type of Inner sheath	.....	.....
1.14.00	Armour material & shape	.....	.....
1.15.00	Outer sheath material & type	.....	.....
1.16.00	Over all dia of cable (in mm)	.....	.....
1.17.00	Guaranteed value of minimum oxygen index of outer sheath	.....	.....
1.18.00	Maximum acid-gas generation by weight (%) of outer sheath	.....	.....
1.19.00	Smoke Density rating of outer sheath	.....	.....

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 1 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
1.0	RAW MATERIAL											
1.1	PVC COMPOUND (FOR INSULATION- AND SHEATH)	1. PHYSICAL PRO- PERTIES	MA	PHYS TESTS	SAM- PLE	IS:5831/ BHEL SPEC- IFICATION	IS:5831/ BHEL SPEC IFICATION	LOG BOOK /TEST CERT	3/2	-	2	
		2. ELEC. PROPER- TIES	MA	ELEC TEST	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3.MAKE & TYPE	MA	VISUAL	100 %	PLANT STD.	PLANT STD.	DO	2	-	-	
1.2	GALVANIZED STEEL WIRE / STRIP	1. PHY. AND ELEC PROPERTIES	MA	PHY. ELEC.TESTS	SAM-* PLE	IS:3975, BHEL SPEC	IS:3975 BHEL SPEC	-DO-	3/2	-	2	* SAMPLE FROM EACH BATCH / LOT
		2. DIMENSION	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3. GALVANIZAT- ION QUALITY	MA	GALV. TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
1.3	COPPER / ALUMINIUM RODS / WIRES	1. PHYSICAL PROERTIES.	MA	PHY.TESTS	-DO-	IS:613 IS:5484 IS:8130 AND BHEL SPEC.	IS:613 IS:5484 IS:8130 AND BHEL SPEC.	-DO-	3/2	-	2	
		2.CHEM COMPOS- ITION & PURITY	MA	CHEM ANALYSIS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		3. ELECTRICAL PROPERTIES	MA	ELECTRICAL TESTS	-DO-	-DO-	-DO-	-DO-	3/2	-	2	
		4. DIMENSION	MA	MEASURMENT	-DO-	-DO-	-DO-	-DO-	3/2	-	2	

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 2 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
2.0	IN PROCESS											
2.1	WIRE DRAWING, TINNING AND ANNEALING	1. PHYSICAL, ELECT. FINISH & DIMEN.	CR	PHY. & ELECT-TESTS VISUAL, MEAS.	SAMPLE	BHEL SPEC., IS-8130	BHEL SPEC., IS-8130	LOG BOOK	2	-	1	
		2. CHEMICAL TEST FOR TINNING	CR	CHEMICAL TEST	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.2	STRANDING OF WIRES	1. NO. OF WIRES	MA	COUNTING	SAMPLE	VENDORS/ BHEL SPEC. & APPD. DATA SHEET & RELEVANT IS	VENDORS/ BHEL SPEC. & APPD. DATA SHEET & RELEVANT IS	LOG BOOK	2	-	-	
		2 SEQUENCE,LAY LENGTH AND DIRECTION	MA	VISUAL, MEAS	-DO-	-DO-	-DO-	-DO-	2	-	-	
		3. SURFACE FINISH	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. DIMENSION	MA	MEASURE-MENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.3	CORE - INSULATION (NO REPAIR PERMITTED)	1 SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM BULGING, BURNT PARTICLES LUMPS, CUTS & SCRATCHES	-DO-	2	-	1	
		2. INSULATION THICKNESS	CR	MEASUREMENT	SAMPLE	APPD.DATA SHT. IS : 1554	APPD.DATA SHT. IS : 1554	-DO-	2	-	-	

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 3 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3. CONCENTRI-CITY. #	CR	MEASUREMENT	SAMPLE	MFR. STD. ./APPD. DATA SHEET.	MFR. STD. /APPD. DATA SHEET.	-DO-	2	-	1	# TO BE CHECKED AT STARTING & FINISH END OF EXTRUDED LENGTH
		4. DIA OVER INS-ULATION	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		5. SPARK TEST OR WATER IMMERSION TEST	CR	ELECTRICAL	100%	MFR. STD.	MFR. STD.	-DO-	2	-	1	
		6. CORE IDENTIF-ICATION.	MA	VISUAL	100%	IS:1554	IS:1554	-DO-	2	-	-	
2.4	CORE - LAYING	1.DIA OVER LAID UP CORE	MA	MEASUREMENT	SAMPLE	-DO-	-DO-	-DO-	2	-	-	
		2.SEQUENCE OF LAY, LAY LENGTH & DIRECTION UP CORE	MA	VISUAL & MEAS.	SAMPLE	MFR. STD/ RELEVANT IS	MFR. STD/ RELEVANT IS	LOG BOOK	2	-	-	
2.5	INNER SHEATH EXTRUSION	1. SURFACE FINISH	MA	VISUAL	100%	–	FREE FROM BULGING,BURNT PARTICLES, LUMPS CUTS & SCRATCHES	-DO-	2	-	-	
		2. SHEATH THICKNESS	MA	MEASUREMENT	SAMPLE	IS:5831 & DATA SHEET IS-1554	IS:5831 & DATA SHEET IS-1554	-DO-	2	-	-	
		3. DIA OVER INN-ER SHEATH	MA	-DO-	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.6	ARMOURING	1. NO. OF WIRES/ STRIPS	MA	COUNTING	AT THE START OF THE PROCESS	BHEL SPEC./ APPD.DATA SH. IS:3975 & IS:1554	BHEL SPEC./ APPD.DATA SH. IS:3975 & IS:1554	-DO-	2	-	-	
		2. LAY DIRECTION	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	-	-	

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 4 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11
		3. LAY LENGTH	MA	VISUAL, MEAS.	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. COVERAGE	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
		5. DIA OVER - ARMOURING	MA	MEASUREMENT	-DO-	-DO-	-DO-	-DO-	2	-	-	
2.7	OUTER SHEATH EXTRUSION	1. SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM BUL-GING, BURNT PA-RTICLES, LUMPS CUTS & SCRATC-HES.	LOG BOOK	2	-	-	
		2. SHEATH THICK-NESS	MA	MEASUREMENT	SAMPLE	IS:5831 & IS-1554 DATA SHEET	IS:5831 & IS-1554 DATA SHEET	-DO-	2	-	-	
		3.DIA OVER OUT-ER SHEATH	MA	-DO-	-DO-	-DO-	-DO-	-DO-	2	-	-	
		4. MARKING	MA	VISUAL	100%	IS:1554 & BHEL SPEC.	IS:1554 & BHEL SPEC.	TEST REPORT	2	-	-	SEQUENTIAL MARKING SHALL BE DONE BY PRINTING.
2.8	FINISHED CABLE	1. ROUTINE TEST	CR	ELEC. & MEAS.	100%	IS:1554 & BHEL SPEC.	IS:1554 & BHEL SPEC.	TEST REPORT	2	-	1	
		2.TYPE AND FRLS TESTS	CR	ELEC. PHY & MEAS	SAMPLE *	-DO-/APPD. DATA SHEET.	-DO-/APPD.DATA SHEET.	-DO-	2	-	1	*ONE DRUM / SIZE / LOT
3.0	FINAL INSPECTION	1. FINISH & LENGTH	MA	VISUAL	(SEE REMARK)	BHEL SPEC. IS: 1554	FREE FROM BULGING,BURNT PARTICLES LUMPS CUTS & SCRATC-HES.	-DO-	2	1	-	ONE DRUM EACH FOR POWER AND CONTROL CABLES IN A LOT

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 5 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		2. DIMENSION	MA	MEASUREMENT	AS PER IS	APPD.DATA SHEET. IS:1554 IS:10810	APPD.DATA SHEET. IS:1554 IS:10810	-DO-	2	1	-	
		3. ARMOURING-COVERAGE NO.OF WIRES /STRIPS	MA	VISUAL & MEAS.	AS PER IS	-DO-	-DO-	-DO-	2	1	-	
		4.MARKING/COL-OUR CODING	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	2	1	-	
		5 ACCEPTANCE TESTS	CR	PHY. & ELECT. TESTS	-D0-	-DO-	-DO-	-DO-	2	1		
		6. TYPE & FRLS TESTS	CR	MEASUREMENT	(SEE REMARK)	BHEL SPEC. , APPD. DATA SHEET	BHEL SPEC. APPD. DATA SHEET	-DO-	2	1	-	TYPE TEST SHELL BE WITNESSED ON ONE SAMPLE PER TYPE (POWER / CONTROL) OF EVERY LOT.

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

FORM No. PEM 6041–0

	QUALITY PLAN	CUSTOMER	PROJECT TITLE	SPECIFICATION NUMBER
		BIDDER / VENDOR	QUALITY PLAN NUMBER PED–507–00–Q–002 / 02	SPECIFICATION TITLE
	SHEET 6 OF 6	SYSTEM	ITEM PVC POWER & CONTROL CABLE	SECTION VOLUME III

S. NO.	COMPONENT / OPERATION	CHARACTE–RISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
									P	W	V	
1	2	3	4	5	6	7	8	9	10			11

NOTES:
A) JOINTS IN WIRES SHALL BE AS PERMITTED BY IS/BHEL SPECIFICATION. VENDOR TO CERTIFY THE SAME
B) NO REPAIR OF CORE INSULATION FERMITTED.
C) CABLE ENDS SHALL BE SEALED AS PER BHEL SPECIFICATION.
D) PURCHASER SHALL HAVE RIGHT TO WITNESS THE SPARK TEST AT CORE STAGE.
E) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDOR'S Q.C. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER.
F) FILLERS / DUMMY CORES ETC. SHALL BE AS PER BHEL SPECIFICATION.
G) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS SAMPLES, THE SAME SHALL BE AS PER VENDOR'S SAMPLING PLAN.
H) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER BHEL SPECIFICATION.

LEGEND :– P – PERFORMER : W–WITNESSER : V – VERIFYER:
1–BHEL/BHEL'S CUSTOMER : 2– VENDOR : 3–SUB VENDOR

BHEL	PARTICULARS	BIDDER / VENDOR	
	NAME		
	SIGNATURE		
	DATE		BIDDER'S / VENDOR'S COMPANY SEAL

	TITLE	SPECIFICATION NO. PES-506-05
		VOLUME II B
		SECTION D
		REV NO. 0 DATE 11.02.2002
		SHEET 1 OF 1

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GENERAL TECHNICAL REQUIREMENTS
OF
415 V AC DISTRIBUTION BOARD

SPECIFICATION NO. PES-506-05

(7 SHEETS)

1.0 SCOPE

This specification covers the design, manufacture, assembly, testing, packing & despatch of AC Distribution Boards complete in all respect with all components, fittings & accessories for efficient and trouble free operation.

2.0 STANDARDS

Major standards which shall be followed are listed below. Other applicable standards for any component, if not covered in the listed standards, shall also be followed.

IS:375	Marking& arrangement for swgr. busbars, main connections & aux. Wiring
IS:4064	Air-break switches, disconnectors switch-disconnectors & fuse combination units
IS:2147	Degree of protection provided by enclosures
IS:8623	Factory built assemblies of switchgear & controlgear

3.0 CONSTRUCTIONAL FEATURES

3.1 GENERAL REQUIREMENTS

ACDBs shall be of single front contruction having a continuous line-up of vertical sections housing switch-fuse modules only. ACDBs shall have duplicate incomers and a bus-section.In-cubicle rating of incomer and bus-section switches shall be identical to the associated busbar rating.Outgoing feeders shall be such so as to ensure uniform loading on each section DB.

ACDBs shall be indoor, air insulated, metal-clad and fixed type suitable for floor mounting.It shall conform to the degree of protection IP:54. Panels shall be fabricated from minimum 2mm thick CRCA sheet steel.

DB shall be front wired and front connected. They shall be fully compartmentalised with metal insulating partitions between compartments. Working height shall be limited between 450mm and 1800mm from floor level.

All instruments, switches etc. mounted on the front face of the panels shall be of flush type.

Each panel shall be provided with internal illumination lamp operated by door switch, space heater and switchfuse unit and plug socket with switch for hand lamp.

DBs shall be supplied with base frame made out of structural steel sections along with all necessary mounting hardware required for bolting/welding the base frames to the foundation.

3.2 BUSBARS & CONNECTIONS

Busbars shall be sized to carry continuously the total running load of the ACDB plus a 20% margin. The minimum clearance in air between phases and between phases and

earth for entire run of horizontal and vertical busbars shall be 25mm. Horizontal and vertical busbars and bus connections shall be of high conductivity copper/ aluminium alloy. Maximum temperature shall be limited to 90 deg C.

3.3 PANEL WIRING

All panels shall be fully wired at the factory to ensure proper functioning of all control, protection and interlock schemes. All wiring for external connection shall be brought to terminal blocks and numbered.

Panel wiring shall be carried out with flexible heat resistant 650V grade, PVC insulated stranded copper wire of minimum 2.5sq.mm cross-section.

Solderless compression /clamp type connection shall be used for wire terminals. Wiring shall be continuous between terminals without splicing. Each wire shall be identified at both ends with permanent markers having wire numbers as per approved wiring drawings.

Terminal blocks shall be box clamp type with marking strip. Not more than two wires shall be connected to one terminal. Spare terminals equal in number to 20% of active terminals shall be furnished.

3.4 GROUNDING

A copper ground bus, sized to carry maximum short circuit current shall run along the entire length of panel structure and shall have terminal connection at each end for connection to station ground grid (50x6 mm GI flat).

3.5 NAME PLATE

Name plates of approved design shall be furnished on each panel and for each instrument or device mounted on panel.

The material shall be lanucoid or approved equal 3mm thick with white letters on black background.

Name plates shall be held by self tapping screws. Name plates size shall be minimum 20x75mm for instruments devices and 40x50mm for panels.

4.0 SWITCHGEAR COMPONENTS

4.1 SWITCHES

Switches shall be triple/double pole air break type.

The switch shall have a quick-make, quick-break mechanism operated by a suitable external handle, complete with position indicator. This handle shall have provision for padlocking in ON & OFF position.

The compartment door shall be interlocked mechanically with the switch such that the door cannot be opened unless the switch is in OFF position . Means shall be provided for releasing the interlock at any time.

Switches shall be capable of withstanding the through fault current of back up fuse.

Wherever two incoming switches and one bus-section switch are provided for an assembly, these shall be mechanically/key interlocked to ensure that only two out of three can be closed at a time.

4.2 FUSES

Fuses shall be HRC, preferably link type with a minimum interrupting capacity equal to short circuit current of the LV system.

Fuses shall be furnished complete with fuse bases and fittings of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

The fuse on incoming feeder wherever provided shall be chosen to provide discrimination with outgoing feeder fuses.

4.3 METERS & METER SELECTOR SWITCHES

All indicating instruments (96x96mm) shall be switchboard types with 250deg. Scale, antiglare glass and accuracy class of ±2% full scale. Each meter shall have zero adjuster on the front.

Meter selector switches shall be maintained contact, stay-put type with knob handle. Voltmeter selector switches shall be four position type.

5.0 PAINTING

All metal surface shall be cleaned, phosphated and given two coats of rust-resistant primer followed by two coats of synthetic enamel paint in light grey shade (IS:5 shade 631).

6.0 TESTS

Each panel shall be completely assembled, wired, adjusted and tested at the factory prior to shipment. The test shall include wiring continuity tests, insulation tests and functional tests to ensure satisfactory operation and control of individual equipment.

	TITLE	SPECIFICATION NO.
BHEL	415 V AC DISTRIBUTION BOARD (DATA SHEET – A)	VOLUME II B SECTION D REV NO. DATE SHEET 1 OF 1

1.0	GENERAL		
1.1	Type	:	Fixed Type
1.2	Service	:	Indoor
1.3	Enclosure	:	IP-54
2.0	SYSTEM		
2.1	Voltage	:	415 V±10%
2.2	Phase	:	3
2.3	Frequency	:	50Hz±5%
2.4	System	:	Solidly grounded
3.0	RATED CURRENT AT 50 DEG.C		
31.	Busbar	:	to be decided by tenderer
3.2	Switches	:	to be decided by tenderer
4.0	SHORT CIRCUIT RATING		
4.1	Interrupting	:	50kA
4.2	Short time for 1sec.	:	50kA
5.0	INSULATION LEVEL	:	2.5kV for 1min

	TITLE	SPECIFICATION NO.
	415 V AC DISTRIBUTION BOARD	VOLUME II B
		SECTION D
	DATA SHEET C/B	REV NO. DATE
		SHEET 1 OF 3

1.0 EQUIPMENT

1.1 Make :

1.2 Type :

1.3 Reference Standard :

1.4 Construction

a/ Degree of protection :

b/ Sheet metal thickness (mm):

c/ Floor channel sills vibration damping pads & kick plate furnished

1.5 Whether all equipment are flush: Mounted

1.6 Name plate

a/ Material :

b/ Thickness :

c/ Size for

-Equipment :

-Panels :

1.7 Internal illumination

a/ Volt :

b/ Watt :

c/ Door switch controlled :

1.8 Space Heater :

a/ Volt :

b/ Watt :

c/ Thermostat controlled :

1.9 Plug Socket :

a/ Type :

b/ Rating :

1.10 Type & rating of isolating Switch-fuse units for incoming AC supply

1.11 Internal Wiring :

a/ Wire type :

b/ Voltage grade :

c/ Conductor material :

d/ Conductor size for :

-Current control circuit :

-Voltage circuit :

1.12 Terminal Block

a/ Make :

b/ Type :

c/ 20% spare terminals furnished

1.13 Ground Bus

a/ Material

b/ Size

1.14 Painting

a/ Type of finish

b/ Colour shade

2.0 SWITCHES

2.1 Make

2.2 Type

2.3 Reference standard

2.4 Breaking current at 415V AC

3.0 FUSE

3.1 Make

3.2 Type

3.3	Reference standard
3.4	Rupturing capacity (kA rms)
3.5	Cont. current at 50deg.C ambient and within cubicle (Amp.)
3.6	Cut-off currents (kA peak)
3.7	Whether fuse characteristics furnished
4.0	METER SELECTOR SWITCH
4.1	Make
4.2	Type
4.3	Reference standard
4.4	Contact rating
	a/ Make & continuous (Amp.)
	b/ Break inductive (Amp.)
5.0	INDICATING INSTRUMENT
5.1	Make
5.2	Type
5.3	Reference Standard
5.4	Type of movement
5.5	Accuracy class
5.6	Scale in degrees
5.7	VA barden

GENERAL TECHNICAL REQUIREMENTS

OF

LIGHTING DISTRIBUTION BOARD
&
LIGHTING PANEL

SPECIFICATION NO. PES-559-01A

1.0 SCOPE

This specification covers the design, manufacture, assembly, testing, packing & despatch, installation & commissioning of AC Lighting Distribution Boards complete in all respect with all components, fittings & accessories for efficient and trouble free operation.

2.0 STANDARDS

Unless specified otherwise, the latest revisions of standards, codes and other applicable statutory rules and regulations specified in Annexure-I of Data Sheet A are applicable and shall be referred to.

3.0 Light Distribution Boards (LDBs)

3.1 General Requirements

3.1.1 LDBs shall be totally enclosed, modular in construction, indoor type and suitable for electrical system data as specified in Data Sheet A. The LDB shall be free standing type suitable for installation on cable trenches / floor.

3.1.2 LDBs shall be constructed from CRCA sheet and structural sections. Sheet thickness for load bearing members shall be 2.0 mm and that for non-load bearing members shall be 1.6 mm, unless specified otherwise in Data Sheet A. The design and construction of LDBs shall ensure adequate rigidity.

3.1.3 Vertical cable chambers / alleys of adequate width but not less than 250 mm shall be provided for incoming / outgoing cables of each panel.

3.1.4 LDBs shall have only one operational front. Door shall be provided at the front of each module to give full access to all the components.

3.1.5 LDBs shall consist of dust and vermin proof cubicles without the use of louvers (except the transformer compartment, where applicable).

3.1.6 Good quality synthetic rubber / neoprene gaskets shall be put around the door, cover edges and cutout edges for pushbutton, lamps etc. for protection against dust. The door when closed, shall compress the gasket uniformly.

3.1.7 Cutout edges for instruments, relays etc. shall have sufficient overlap surface to minimize the dust entry. The arrangement for the front mounting of switch handles shall render the LDB reasonably dust free such that the normal operations are not affected.

3.1.8 Degree of protection for completed LDBs (Distribution Board) shall be IP:52 unless mentioned otherwise in Data Sheet A.

3.1.9 The LDBs shall be designed to prevent contact with live parts both within the modules and in the cable alley.

3.1.10 The ratings of all components shown in the enclosed drawings are indicative only. The bidder shall be responsible to check and coordinate the MCB characteristic with back up fuses etc. provided. Any change in size / ratings of components required for final arrangement may be complied with and provided by the vendor at no extra cost.

3.1.11 All equipment shall be constructed of non-hygroscopic and non-inflammable materials.

3.1.12 All components mounted in the LDBs shall be accessible and shall not impede access to wiring or terminals. All faults except busbar fault which may occur within any individual unit shall be confined within that unit only and shall not cause shutdown of any section of the board other than the affected unit itself. Maintenance and inspection shall be possible in any individual unit without affecting other units.

3.1.13 Incoming unit shall comprise of either switch-fuse / composite fuse-switch unit or MCCB as per scheme / Data Sheet A. Outgoing units shall be a switch-fuse / composite fuse-switch unit / MCB.

3.1.14 The rated continuous current of the equipment and components shall be as given in the schemes. These ratings shall be obtained with the components mounted in their housing as in service without exceeding the permissible temperature rise.

3.1.15 Interlock between compartment door and modules shall be provided such that the door cannot be opened without switching off the power supply to the module.

3.1.16 Defeat interlock shall be provided for the units comprising of switch or moulded case circuit breaker as a means of isolation device, such that it is possible to open the door with device ON. It shall not be possible to close the door till the interlock has been reinstated.

3.1.17 Each LDB shall be fitted with base frame made of angle or channel.

3.1.18 All fixing nuts and bolts together with grounding bolts shall be provided.

3.1.19 Lifting lugs shall be provided for each shipping section of LDB. Removal of such lugs or hooks shall leave no opening in the LDB.

3.2 LDBs with transformers (Additional Features)

3.2.1 The lighting distribution board shall be arranged in two adjacent but separate compartments, one compartment for the lighting transformer and the other for the incoming & outgoing feeders etc.

3.2.2 The transformer shall be mounted on the base channel and it shall be possible to easily remove the transformer from the cubicle after opening the door. Necessary portable ramp made of mild steel shall be supplied along with each LDB.

3.2.3 Independent gasketted hinged door with operating handle shall be provided for access to transformer & its taps. Operating handle shall have built-in key locking arrangement.

3.2.4 Suitable ventilation arrangement for the transformer compartment to dissipate the heat of the transformer shall be provided. The arrangement shall be in the form of louvers and the same shall be provided with galvanized wire mesh with dust catchers on the inside.

3.2.5 The degree of protection for transformer compartment shall be IP:42 unless mentioned otherwise in Data Sheet A.

3.2.6 Connections between transformer secondary terminals and the busbars shall be made by using PVC insulated flexible copper cables or busbars.

3.2.7 Warning plate shall be provided on transformer enclosure. The inscription of warning plate shall be as given below:

- DO NOT OPEN DOORS WHEN ENERGISED

- KEEP TAPS AT SAME POSITION FOR ALL PHASES

3.2.8 Transformer enclosure shall be provided with a danger plate.

3.3 Lighting Transformer

3.3.1 Lighting transformer, where specified shall form an integral part of lighting distribution board.

3.3.2 Lighting transformer shall be dry type, natural air cooled and suitable for mounting inside the lighting distribution board. Transformer shall be non-encapsulated type, unless specified otherwise in Data Sheet A.

3.3.3 Rating of transformer shall be 50 kVA as per type of LDB.

3.3.4 Voltage rating shall be given in Data Sheet A.

3.3.5 Percentage impedance shall be 3% for 50kVA and 4% for 100 kVA transformers, unless specified otherwise in Data Sheet A.

3.3.6 Off circuit tap changers/links shall be provided for $\pm$ 5% in steps of 2.5%.

3.3.7 Transformer winding insulation shall be class “F” or better.

3.3.8 Transformer shall be of vector group Dynl.

3.3.9 Winding shall be of copper material maximum winding temperature at full load and under site conditions shall not exceed 120 Deg. C.

3.3.10 Transformer shall be suitable for cable connections on the primary side and flexible cable or busbar connectin on the secondary side.

3.3.11 The secondary neutral of the transformer shall be brought out for getting a grounded 4 wire supply system.

3.3.12 The transformer neutral shall be brought outside the LDB for earthing. The neutral busbar shall be insulated from the LDB enclosure.

3.3.13 Transformer shall be provided with the rollers, pulling holes, lifting lugs, jacking positions etc.

3.4 Busbars, Connections and Joints

3.4.1 Busbars shall be made of aluminium grade E 91E or high conductivity copper (ETC), Busbar material shall generally be aluminium unless mentioned otherwise in Data Sheet A.

3.4.2 Busbars shall be supported on non-hygroscopic and non-inflammable insulators of material such as glass reinforced moulded plastic material, epoxy cast resin etc. Separate supports shall be provided for each phase of the busbars, Insulation level of neutral busbar shall be same as that of phase busbars.

3.4.3 Busbars shall be contained in a separate vermin-proof compartment within the LDB and shall have bolted sheet steel covers for providing suitable access.

3.4.4 Busbar clearances in the air shall be as per applicable standard for 500V, 3 phase system.

3.4.5 Temperature of busbars, droppers and connections shall not exceed 90 Deg. C for an ambient of 50 Deg. C while carrying maximum continuous current.

3.4.6 The busbar, busbar connections and supports shall have sufficient strength to withstand thermal and electromechanical stresses produced by the specified short circuit level of the system.

3.4.7 Busbars (including neutral busbar) shall be capable of carrying the short-time current specified in Data Sheet A. The duration of short-time current shall be 1 sec unless mentioned otherwise in Data Sheet A. For the specified current and duration, there shall be no damage to the equipment.

3.4.8 The neutral bus shall be rated same as phase bus.

3.4.9 Main busbars and connections shall be prominently marked and displaced for standard sequence counting from rear to front top to bottom, or left to right as viewed from the switching device operating mechanism side.

3.4.10 Busbars and connections shall be provided with colour coded PVD sleeves. All live parts shall be properly shrouded with insulating material.

3.4.11 Earth busbar shall be provided separately. Material of earth busbar shall be GI unless mentioned otherwise in Data Sheet A.

3.4.12 Busbar Joints

a) Busbar and tap off joints shall be bolted type.

b) Busbars shall be thoroughly cleaned before jointing. Suitable contact greae shall be applied to remove oxide film just before jointing.

c) For copper busbars, the connecting portion shall be tinned or silver plated.

3.5 Wiring and Terminals

3.5.1 All internal wiring for connections to remote equipment shall be brought to terminal boards. Spare contacts of devices shall also be wired upto terminal board as per schemes. Wires shall not be jointed or teed-off except at terminal points.

3.5.2 Wiring shall be made by 1000 volt grade three / seven strand PVC insulated copper wire having a cross-sectional area of not less that 1.5 sq.mm. All connections from CT leads upto instruments, terminals shall be made by copper wires of minimum 2.5 sq.mm. size.

3.5.3 All wiring shall be made with the Colour Codes specified below:

a) 3 phase AC Connections

Phase 1 (R)	Red
Phase 2 (Y)	Yellow
Phase 1 (B)	Blue
Neutral	Black

b) 1 phase AC Connections

Phase	Red/ Yellow / Blue (as per associated circuit)
Neutral	Black

c) DC Connections

Positive	While
Negative	Grey

d) Earth Connection Green

3.5.4 Where wiring passes from one compartment to another, the aperture shall be 'Bushed' to prevent damage to wires against sheet metal edges. Bushes may comprise of good quality rubber/ PVC grommets.

3.5.5 Every wire end shall be fitted with numbered ferrules of white or yellow colour having glossy finish with identification number engraved in black, Ferrules shall be made of moisture and oil resisting insulating material. Ferrules shall be or interlocked type or tight fitting type. Ferrules shall be so fitted that they will not get detached, when the wire is removed from the terminal.

3.5.6 System of marking of wiring shall be as per applicable standard.

3.5.7 All wires used internally shall have crimped on tinned copper lugs for terminations.

3.5.8 Terminal boards shall be stud type with insulating barriers of adequate height.

3.5.9 Terminal boards shall have separate terminals for incoming and outgoing wires with not more than two wires connected to any one terminal.

3.5.10 Terminal boards shall be mounted vertically or in the horizontal rows and properly spaced to have clean wiring arrangement, adequate access for putting ferrules, making terminations etc. It shall be possible to read the ferrule numbers when the wiring is complete. Where terminals may be live when the equipment is isolated from the main supply, these shall be clearly marked near the terminal boards.

3.6 Controls

The controls shall be provided as per purchaser's requirements covered in the specification and control schemes.

3.7 Switch Fuse Units

3.7.1 These units shall preferably comprise of switches having integral fuses, called composite units. Alternatively, combination units of separate switch and fuse may also be acceptable.

3.7.2 These units shall be provided for general purpose i.e. incoming or outgoing units.

3.7.3 The units shall be of the air break air insulated type and designed to ensure safety to operating personnel.

3.7.4 Composite units shall have integral fuses i.e. fuse carrier with fuse link (fuse link forming the moving contact). The design shall ensure that the moving contact is not live when switch is open i.e. in OFF position, so as to facilitate removal of fuse.

3.7.5 The switch shall be capable making and carrying the system prospective fault current, but limited in magnitude and duration by the cut off characteristics of the largest HRC fuse link that may be fitted to that unit.

3.7.6 The fixed contact shall be so shrouded that maintenance of the unit can be carried out in safety with the busbars live.

3.7.7 Where one isolating switch is used as the incoming device, the incoming side fixed contacts shall be shrouded to ensure that maintenance can be carried out with the remote fuse and switch closed.

3.7.8 Composite switch-fuse or the combination of switch and fuse shall meet the requirements of its components as follows:

3.7.9 Isolating Switch

a) Switches shall be air-break, quick make, quick break heavy duty type conforming to applicable standard.

b) All switches shall have visible ON / OFF position indication and shall be padlockable in any (ON /OFF) position.

c) Switches shall be door interlocked such that it shall not be possible to gain access to inside the unit unless the isolating switch is in OFF position.

d) The switches shall be suitable for independent manual operation.

e) The switch contacts shall be of silver alloy or silver plated copper and springs of non corrosive material.

f) Inter-phase barriers shall be provided to prevent possibilities of phase to phase fault in the switch. The switch shall also be shrouded from all sides to prevent access to live parts on the switch after opening the unit door. The barriers and shrouding shall extend upto the height of switch to fully enclose both side terminals of the device. The arrangement shall permit easy maintenance.

3.7.10 High Rupturing Capacity (HRC) Fuses

a) The fuse serving as the short-circuit protective device in isolating fuse-switch units shall be of HRC cartridge, current limiting and plug-in non-deteriorating type.

b) The fuse carriers shall be easily withdrawable for replacement of fuse, Insulated fuse pullers shall be provided where fuses are not mounted in insulating carriers to remove and replace fuses in live conditions.

c) Fuses shall preferably be fitted with a device to indicate operation (i.e. when the fuse has blown).

d) Live terminals of fuse bases shall be shrouded to prevent contact with personnel where fuse links are not mounted in carriers and are directly plugged into the fuse base. Inter-phase barriers extending throughout the length of the fuse base shall be provided to prevent inter-phase short circuit. They shall be shrouded from all sides to prevent accidental contact.

e) Fuse carriers and bases shall be of good quality moulded insulating material. Porcelain fuse bases and carriers will not be accepted.

3.8 Cable Terminations

3.8.1 All cable, either incoming or outgoing to the LDB, shall be terminated in a cable chamber. For each panel, there shall be a cable chamber on the side. The door of cable chamber should open or be locked with the help of a tool. Unless stated otherwise in Data Sheet A, all cables shall enter from the bottom.

3.8.2 Removable undrilled gland plates of sheet steel shall be provided in the cable chamber for entry of cables. Minimum thickness of gland plate shall be 3mm. The gland plate shall be of adequate size for connecting requisite number of cable glands for power and control cables.

3.8.3 Heavy duty bolt-on termination tinned copper lugs of compression type shall be used in for power cable termination.

3.8.4 For supporting and clamping of cable cores at regular interval in cable alleys, suitable slotted angle upto the respective terminal blocks shall be provided.

3.8.5 The supply of tinned copper cable lugs for power cables from part the supply of equipment.

3.9 Earthing

3.9.1 An earth busbar of adequate size of galvanized MS shall be provided at the bottom for the entire length of the LDB.

3.9.2 Every metal part other than those forming parts of an electrical circuit shall connected to the earth bus by means of high conductivity copper wire of size not less than 2.5 sq. mm cross-sectional area.

3.9.3 Doors shall have a flexible copper wire for earth connection to fixed unit.

3.9.4 Each LDB shall be fitted with two earthing studs located in accessible position on sides for connection of internal earth busbar to the external earthing connection.

3.9.5 Earth busbar shall be brought outside LDB for making external connections.

3.10 Type of LDBs

The LDBs shall be of following type:

a) LDB-H (n) - AC LDB with 100 kVA transformer

b) LDB-F (n) - AC LDB with 50 kVA transformer

c) LDB-N (n) - AC LDB with no transformer

d) LDB-D (n) - DC LDB

NOTE: (n) indicates number of outgoing feeders.

3.10.1 AC LDBs (LDB-H, LDB-F, LDB-N)

Each LDB shall comprise of the following and comply with the enclosed single line diagrams:

a) One lighting transformer (LDB-H & LDB-F)
LIGHTING SYSTEM

b) One incomer of TP / TPN switch-fuse unit or MCCB / MCCB with neutral link as per Data Sheet A. It shall be provided on the primary side of transformer for LDB type LDB-H & LDB-F.

c) Set of busbars with 3 phase and neutral.

d) TPN switchfuse units for each outgoing circuit.

e) Three indicating lamps with fuses for indicating bus supply ON.

f) CT operated ammeter with selector switch.

g) VT operated voltmeter with selector switch.

h) Power & control terminals, earth-stud, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.

3.10.2 DC LDBs (LDB-D)

Each LDB shall comprise of the following and comply with the enclosed single line diagrams:;

a) One incomer of two pole switch-fuse unit.

b) Two pole DC contactor on the incoming circuit for changeover to DC in case of AC normal supply failure.

c) One under voltage relay of suitable range, if specified in Data Sheet A.

d) One ON delay timer.

e) One test push button.

f) Set of busbars for positive and negative.

g) Two pole switch-fuse units / MCB for outgoing feeders.

h) Two indicating lamps with fuses for indicating but supply ON.

i) Power & control terminals, earth busbar, designation labels, internal wiring, power cable lugs, glands etc. shall be provided to complete the LDB in all respects.

4.0 LIGHTING PANELS (LPs)

4.1 General Requirements of Lighting Panels

4.1.1. LPs shall be totally enclosed, suitable for electrical system data as specified ind Data Sheet A.

4.1.2 Panels shall be suitable for indoor / outdoor application as per Data Sheet A and BOQ. Outdoor panels shall have a sloping canopy.

4.1.3 LPs shall be constructed from CRCA sheet. Sheet thickness shall be 2.0mm, unless mentioned otherwise in Data Sheet A. The construction of LPs shall ensure adequate rigidity.

4.1.4 All components of the LP shall be fully mounted inside the panel, LPs shall have only one operational front. Door shall be provided to give full access to all the components. Door shall have padlocking arrangement.

4.1.5 LPs shall consist of dust and vermin proof cubicles without the use of louvers.

4.16 Good quality synthetic rubber / neoprene gaskets shall be put around the door. The door when closed, shall compress the gasket uniformity.

4.17 Unless mentioned otherwise in Data Sheet A, degree of protection for completed LPs shall be IP:52 for indoor LPs and IP:55 (with weather-proof protection & canopy) for outdoor LPs.

4.1.8 The LPs shall be designed to prevent contact with live parts when the front door is open.

4.1.9 All busbars (phase, neutral, positive, negative as applicable) within a panel shall be of the same size.

4.1.10 All control wiring inside the panels shall be carried out with 1100 V grade, PVC insulated flexible copper wire of 2.5 sq.mm size.

4.1.11 The rated continuous current of the equipment and components

4.1.12 Each LP shall be fitted with MS. Mounting brackets.

4.1.13 Panel shall be suitable for top / bottom cable / conduit entires. However, outdoor LPs shall have bottom cable / conduit entry. Removable undrilled undrilled gland plate of sheet steel shall be provided for entry of cables. Minimum thickness of gland plate shall be 3 mm. The gland plate shall be of adequate size having knock-outs for requisite number cable connections. Gland plate shall be provided with gasket.

4.1.14 The lighting panel shall be complete with copper busbars, and shall incorporate switch fuse or MCB on the incoming side, single pole miniature circuit breakers (MCBs) for AC outgoing circuits and double pole MCBs for DC outgoing circuits. Number of outgoing circuits shall be as per BOQ.

4.1.15 Each lighting panel shall be fitting with two GI earth studs located in accessible position on the outside of the panel on opposite sides.

4.1.16 All metal parts of the panel except current carrying parts shall be bonded together electrically to the earthing stud.

4.1.17 Each panel shall be fitted with phase barriers of fireproof insulating material in such a manner that it is not readily possible for personnel to touch the phase busbars.

Insulating sheet shall be fitted around the MCBs such that only the surface and toggle of the MCBs are available on the front.

4.1.18 The supply of cable lugs for power and control cable connections forms part the supply of equipment.

4.1.19 Each panel shall be provided with a circuit directory plate with inscriptions neatly typed and laminated fitted on the inside of door.

4.2 Type of Lighting Panels

a)	LP-A (n)	-	AC	Lighting Panel
b)	LP-D (n)	-	DC	Lighting Panel
c)	LP-F (n)	-	Fancy	Lighting Panel (Decorative)
d)	LP-V (n)	-	Aviation	Lighting Panel

NOTE: (n) indicates number of outgoing circuits.

4.3 AC Lighting Panel (LP-A)

4.3.1 LPs shall be provided with TPN switch as incomer.

4.3.2 Requisite number of single pole MCBs shall be provided for outgoing circuits.

4.3.3 Separate neutral shall be available at terminal block for each outgoing circuit.

4.3.4 Construction of AC Normal and AC Emergency panels shall be same.

4.4 DC Lighting Panels (LP-D)

4.4.1 LPs shall be provided with double pole switch as incomer.

4.4.2 Requisite number of double pole MCBs shall be provided for outgoing circuits.

4.5 Decorative Type Lighting Panels (LP-F)

4.5.1 Decorative lighting panels shall be designed for use in areas like administrative building, service building, canteen, residential premises etc.

4.5.2 Thickness of sheet steel shall be as per manufacturer’s practice.

4.5.3 LPs shall be of tone colour with elegant finish.

4.5.4 LPs shall be provided with TPN switch as incomer and requisite number of MCBs shall be provided for outgoing circuits.

4.5.5 LPs shall be suitable for either surface or flush mounting as per Data Sheet A and BOQ. Flush mounted panels shall have the collared door suitable for matching with the wall.

4.5.6 Lighting Panels may be provided with transparent acrylic cover for operation of MCBs, if asked for in Data Sheet A.

4.5.7 LPs shall be provided with knockouts on the top, bottom and sides.

4.6 Aviation Lighting Panel (LP_V)

4.6.1 Aviation Lighting Panels shall be provided for feeding power supply to Aviation obstruction luminaries.

4.6.2 Each Aviation Lighting Panel shall comprise of the following:

a) One TPN door interlocked switch-use unit. Interlock defeat feature shall also be provided.

b) Three pole AC Contactor

c) 00-24 hrs timer and a photo-electric switch for automatic switching of contactor

d) Three phase & neutral busbars

e) Single pole or three pole MCBs for each outgoing circuit as per Data Sheet A

f) Two lamps for bus supply ON & OFF indications

g) Complete wiring arrangement as per control scheme.

h) Auto-Manual selector switch

i) ON push button

j) OFF push button

k) Photo switch

4.6.3 Switching ON and switching OFF shall be through both 00-24 hrs timer and light sensor in automatic mode.

4.6.4 One number light sensor in weather proof enclosure having IP:55 degree of protection shall be supplied loose along with each SLP.

4.6.5 Internal power wiring shall be done with PVC insulated Cu wire of suitable size. All control wiring inside the panel shall be carried out with 1100 V grade, PVC insulated flexible copper wires.

5.0 Guaranteed Performance Requirements

5.1 The vendor shall guarantee satisfactory performance of the equipment under all conditions and requirement as laid down by this specification.

5.2 For the general requirements of performance guarantees refer to other parts of the specification.

6.0 PAINTING

(All metal surface shall be cleaned, phosphated and given two coats of rust-resistant primer followed by two coats of synthetic enamel paint in light grey shade (IS:5 shade 631).

7.0 TESTS

Each panel shall be completely assembled, wired, adjusted and tested at the factory prior to shipment. The test shall include wiring continuity tests, insulation tests and functional tests to ensure satisfactory operation and control of individual equipment.

1.0 SYSTEM DESIGN DATA

1.1	Design Ambient	:	50 Deg.C
1.2	Relative humidity	:	
	a) Average	:	As per project synopsis
	b) Maximum	:	-do-

1.3 Details of Operating parameters

a)	AC Supply			
	i.	Rated voltage	:	415 V
	ii.	Rated frequency	:	50 Hz
	iii.	Voltage variation (Permissible)	:	± 10 %
	iv.	Frequency variation (Premissible)	:	± 5 %
	v.	Combined voltage & Frequency variation (sum of absolutes permissible)	:	10%
	vi.	System fault level At rated voltage	:	50 kA for 0.25 sec.
	vii.	System grounding	:	Solidly
b)	DC Supply			Not applicable
	i.	Rated voltage	:	V
	ii.	Voltage variation (Permissible)	:	%
	iii.	System fault level at rated voltage	:	
c)	AC Emergency luminaries as per percentage of total luminaries		:	Not applicable %

2.0	APPLICABLE STANDARDS	:	As per Annexure I

3.0	LIGHTING DISTRIBUTION BOARDS			
3.1	Sheet thickness	:	2.0	mm
3.2	Degree of protection	:		
	a) Main panel	:	IP 54	
	b) Transformer cubicle	:	IP 33	
3.3	Type of Incomer	:	Switch-Fuse	
3.4	Type of Outgoing Feeders	:	Switch-Fuse	
3.5	Voltage rating of transformer	:	415 V	
3.6	Whether transformer is encapsulated:		No	
3.7	Transformer impedance			
	a) 100 kVA	:	-	%
	b) 50 kVA	:	4.0	%
3.8	Bus bar material	:	Aluminium	
3.9	Earth busbar material	:	GI (50X6 mm)	
3.10	Cable entry	:	Bottom	
3.11	Whether under voltage relay required in DC LDB	:	Not applicable	
4.0	LIGHTING PANEL			
4.1	Application	:	Both Indoor & outdoor	
4.2	Sheet thickness	:	2.0	mm
4.3	Degree of protection			
	a) Indoor	:	IP : 54	
	b) Outdoor	:	IP : 55 (weather-proof protection with canopy)	
4.4	Type of Incomer	:	Switch-Fuse	
4.5	No. of poles for Aviation lighting panel MCBs	:	1 / 3	

4.6	Type of mounting of decorative lighting panel	:	Not applicable		
4.7	Whether decorative lighting panel required with acrylic panel	:	Not applicable		
5.0	LABELING	:	As per specification		
6.0	PAINTING	:			
6.1	Shade (as per IS:5)				
				Interior	Exterior
	a) LDBs	:		Glossy white	631 of IS:5
	b) LPs	:		-do-	-do-
6.2	FINISH				
	a) Interior	:		Semi-glossy	
	b) Exterior	:		Semi-glossy	
6.3	Paint thickness (min.)	:	50 microns		
7.0	MAKE OF COMPONENTS	:	Shall be subject to BHEL approval		

	TITLE	SPECIFICATION NO.
BHEL	LIGHTING DISTRIBUTION BOARD & LIGHTING PANEL (DATA SHEET – B)	VOLUME II B
		SECTION D
		REV NO. / DATE
		SHEET 1 OF 4

1.0 SYSTEM DESIGN DATA

1.1 Design Ambient : °C

1.2 Details of Operating parameters

a) AC Supply

i. Rated voltage : V

ii. Rated frequency : Hz

iii. Voltage variation (Permissible) : %

iv. Frequency variation (Permissible) : %

v. Combined voltage & frequency variation (sum of absolutes permissible) : %

vi. System fault level at rated voltage :

b) DC Supply

i. Rated voltage : V

ii. Voltage variation (Permissible) : %

iii. System fault level at rated voltage :

2.0 APPLICABLE STANDARDS : As per Annexure I

3.0 Lighting Distribution Boards

3.1 Sheet thickness : mm

3.2 Degree of protection

a) Main panel :

b) Transformer cubicle :

3.3	Type of Incomer	:	[ ] MCCB [ ] Switch-Fuse
3.4	Type of Outgoing Feeders	:	[ ] Switch-Fuse [ ] MCB
3.5	Bus bar material	:	[ ] Aluminium [ ] Copper
3.6	Cable entry	:	[ ] Bottom [ ] Top
3.7	Whether under voltage relay required in DC LDB	:	[ ] Yes [ ] No
3.8	Range of time delay relay	:	
3.9	Whether hinged door with locking facility provided	:	[ ] Yes [ ] No
3.10	Whether earth busbar provided	:	[ ] Yes [ ] No
3.11	Earth busbar material	:	[ ] GI [ ] Copper
3.12	Fault current and duration	:	kA
3.13	Lighting Transformer		
a)	kVA Rating(s)	:	50 100
b)	Type of cooling	:	
c)	Rated current		
i.	Primary	:	Amp.
ii.	Secondary	:	Amp.
d)	Rated voltage		
i.	Primary	:	Volts
ii.	Secondary	:	Volts
e)	Rated frequency	:	Hz
f)	No. of phases	:	
g)	Temperature rise above ambient in winding by resistance	:	^{o}C

h)	Vector Group	:		
i)	Tap changer			
	i. Type	:		
	ii. Range	:		
	iii. No. of taps	:		
	iv. Voltage of each tap	:		
j)	Type of ventilation arrangement provided for transformer enclosure	:		
k)	Iron loss at 50 Hz and 100% rated voltage	:		kW
l)	Regulation at full load and at 75 ^{o}C and 0.8 p.f. lagging	:		
m)	Copper loss at rated load and 75 ^{o}C	:		kW
n)	Impedance at rated current, frequency and at 75 ^{o}C	:		
o)	Winding conductor material	:		
p)	Whether transformer is encapsulated	:	[ ] Yes [ ] No	
q)	Insulation class	:		
r)	Weight	:		kg

4.0	Lighting Panel		
4.1	Application	:	[ ] Indoor [ ] Outdoor [ ] Both
4.2	Sheet thickness	:	mm
4.3	Degree of protection		
	a) Indoor	:	IP :

	b) Outdoor	:	IP :
4.4	Type of Incomer	:	[ ] Switch-Fuse [ ] MCB
4.5	MCB type for street lighting panel.	:	[ ] 1 pole [ ] 3 pole
4.6	Busbar material	:	
4.7	Whether hinged door with with locking facility provided	:	[ ] Yes [ ] No
4.8	Whether earthing studs provided	:	[ ] Yes [ ] No

5.0 LABELING

	Requirement of specification complied with	:	[ ] Yes [ ] No

6.0 PAINTING

6.1 Shade (as per IS:5)

			Interior	Exterior
	a) LDBs	:		
	b) LPs	:		

6.2 Finish

	a) Interior	:	[ ] Matt [ ] Semi-glossy
	b) Exterior	:	[ ] Semi-glossy [ ] Full-glossy

6.3 Paint thickness (min.) : microns

7.0 O&M SPARES

7.1	Duration for which O&M spares considered	:	years

	TITLE	SPECIFICATION NO.
	LIGHTING DISTRIBUTION BOARD & LIGHTING PANEL (DATA SHEET – C)	VOLUME II B
		SECTION D
		REV NO. / DATE
		SHEET 1 OF 5

1.0 SYSTEM DESIGN DATA

1.1 Design Ambient : °C

1.2 Details of Operating parameters

a) AC Supply

i. Rated voltage : V

ii. Rated frequency : Hz

iii. Voltage variation (Permissible) : %

iv. Frequency variation (Permissible) : %

v. Combined voltage & frequency variation (sum of absolutes permissible) : %

vi. System fault level at rated voltage :

b) DC Supply

i. Rated voltage : V

ii. Voltage variation (Permissible) : %

iii. System fault level at rated voltage :

2.0 APPLICABLE STANDARDS : As per Annexure I

3.0 LIGHTING DISTRIBUTION BOARDS

3.1 Sheet thickness : mm

3.2 Degree of protection

a) Main panel :

b) Transformer cubicle :

3.3 Type of Incomer : [ ] MCCB

			[ ] Switch-Fuse
3.4	Type of Outgoing Feeders	:	[ ] Switch-Fuse [ ] MCB
3.5	Bus bar material	:	[ ] Aluminium [ ] Copper
3.6	Cable entry	:	[ ] Bottom [ ] Top
3.7	Whether under voltage relay required in DC LDB	:	[ ] Yes [ ] No
3.8	Range of time delay relay	:	
3.9	Whether hinged door with locking facility provided	:	[ ] Yes [ ] No
3.10	Whether earth busbar provided	:	[ ] Yes [ ] No
3.11	Earth busbar material	:	[ ] GI [ ] Copper
3.12	Fault current and duration	:	kA
3.13	Lighting Transformer		
a)	kVA Rating(s)	:	50 100
b)	Type of cooling	:	
c)	Rated current		
i.	Primary	:	Amp.
ii.	Secondary	:	Amp.
d)	Rated voltage		
i.	Primary	:	Volts
ii.	Secondary	:	Volts
e)	Rated frequency	:	Hz
f)	No. of phases	:	
g)	Temperature rise above ambient in winding by resistance	:	^{o}C
h)	Vector Group	:	

i) Tap changer

i. Type :

ii. Range :

iii. No. of taps :

iv. Voltage of each tap :

j) Type of ventilation arrangement provided for transformer enclosure :

k) Iron loss at 50 Hz and 100% rated voltage : kW

l) Regulation at full load and at 75 ^{o}C and 0.8 p.f. lagging :

m) Copper loss at rated load and 75 ^{o}C : kW

n) Impedance at rated current, frequency and at 75 ^{o}C :

o) Winding conductor material :

p) Whether transformer is encapsulated : [ ] Yes [ ] No

q) Insulation class :

r) Weight : kg

4.0 LIGHTING PANEL

4.1 Application : [ ] Indoor [ ] Outdoor [ ] Both

4.2 Sheet thickness : mm

4.3 Degree of protection

a) Indoor : IP :

b) Outdoor : IP :

4.4	Type of Incomer	:	[ ] Switch-Fuse [ ] MCB
4.5	MCB type for street lighting panel.	:	[ ] 1 pole [ ] 3 pole
4.6	Busbar material	:	
4.7	Whether hinged door with with locking facility provided	:	[ ] Yes [ ] No
4.8	Whether earthing studs provided	:	[ ] Yes [ ] No

5.0 LABELING

Requirement of specification complied with	:	[ ] Yes [ ] No

6.0 PAINTING

6.1 Shade (as per IS:5)

		Interior	Exterior
a)	LDBs	:	
b)	LPs	:	

6.2 FINISH

a)	Interior	:	[ ] Matt [ ] Semi-glossy
b)	Exterior	:	[ ] Semi-glossy [ ] Full-glossy

6.3 Paint thickness (min.) : microns

7.0 MAKE

EQUIPMENT	MAKE	TYPE DESIGNATION OF MANUFACTURER
7.1 LDBs		
a) AC		
b) DC		

7.2 LPs

a) AC

b) DC

c) Decorative

d) Street Lighting

8.0 QUANTITY VARIATION (Limited to the value of the contract)

a) Till the "Engineering" is complete : %

b) Till the "Erection" is complete : %

9.0 O&M SPARES

9.1 Duration for which O&M spares considered : years

10.0 DOCUMENTATION

Whether following enclosed :

a) General Arrangement drawings of all types of LDBs : [ ] Yes [ ] No

b) General Arrangement drawing of Lighting Transformer : [ ] Yes [ ] No

c) Bar chart of activities of manufacture, testing, inspection and dispatch : [ ] Yes [ ] No

The above documents shall be submitted in the form of Annexure- A to Annexure - C in the exact order listed above along with this Data Sheet C duly filled up.

	TITLE	SPECIFICATION NO.	
BHEL	LIGHTNING PROTECTION OF CHIMNEY (SUPPLY & INSTALLATION)	VOLUME	II B
		SECTION	D
	DATA SHEET – C (TO BE SUBMITTED BY SUCCESSFUL BIDDER)	REV NO.	DATE
		SHEET 1 OF 1	

1.0 Name of manufacturer :

2.0 Place & country of manufacture :

3.0 Standards applicable :

- i/ For materials & sizes :
- ii/ For galvanisation/Electroplated coating :
- iii/ For testing uniformity of Galvanization :
- iv/ For code of practice :
- v/ For temporary lightning protection during construction :

4.0 Thickness of galvanizing on steel (microns) :

5.0 Thickness of Electroplated coatings (microns) :

6.0 Thickness of Lead coating on copper (mm) :

7.0 Materials and sizes offered :

- i/ Below ground annular ring conductor :
- ii/ Electrodes :
- iii/ Below ground interconnection conductor :
- iv/ Down Conductors :
- v/ Vertical air terminations :
- vi/ Horizontal air termination :
- vii/ Test Pit :
- viii/ Earthing band ring (above landing platform) :
- ix/ Test Link :
- x/ Conductor for equipment earthing :

ANNEXURE-I

LIST OF APPLICABLE STANDARDS

Illumination

1.	Code of practice for interior illumination	[ ] IS 3646 [ ]
2.	Code of practice for industrial lighting	[ ] IS 6665 [ ]
3.	Code of practice for design of electrical street lighting installations	[ ] IS 1944 [ ]

Luminaires

4.	General and safety requirement for electric lighting fittings	[ ] IS 1913 [ ]
5.	Luminaires	[ ] IS 10322 [ ]
6.	Industrial lighting fittings with metal reflector	[ ] IS 1777 [ ]
7.	Industrial lighting fittings with plastic reflectors	[ ] IS 3287 [ ]
8.	Decorative lighting outfits	[ ] IS 5077 [ ]
9.	Water proof electric lighting fittings	[ ] IS 3528 [ ]
10.	Water tight electric lighting fittings	[ ] IS 3553 [ ]
11.	Dust proof electric lighting fittings	[ ] IS 4012 [ ]
12.	Dust tight electric lighting fittings	[ ] IS 4013 [ ]
13.	Flameproof electric ltg. fittings well glass & bulk head types	[ ] IS 2206 [ ]
14.	Electric lighting fittings for division 2 areas	[ ] IS 8224 [ ]

Lamps

15.	Electric lamps, tungsten filament general service	[ ] IS 418 [ ]
16.	Tubular fluorescent lamps for general lighting service	[ ] IS 2418 [ ]
17.	High pressure mercury vapour lamps	[ ] IS 9900 [ ]
18.	High pressure sodium vapour lamps	[ ] IS 9974 [ ]

Luminaire Components

19.	Ballast for fluorescent lamps for switch start circuits	[ ] IS 1534 [ ]
20.	Ballast for high pressure mercury vapour lamps	[ ] IS 6616 [ ]
21.	Capacitors for electric discharge lamps (fluorescent and MV)	[ ] IS 1569 [ ]
22.	Bi-pin lamp holders for tubular fluorescent lamps	[ ] IS 3223 [ ]
23.	Methods of measurment of lamp cap temp. rise	[ ] IS 8913 [ ]
24.	Starters for fluorescent lamps	[ ] IS 2215 [ ]
25.	Holders for starters for tubular fluorescent lamps	[ ] IS 3324 [ ]
26.	Cast acrylic sheets for use in luminaires	[ ] IS 7569 [ ]

Assembled Equipment and Components

27.	General requirements for swgr. and control gear for voltage not exceeding 1000 V AC or 1200 V DC	[ ] IS 4237 [ ]
28.	Code of practice for selection, installation & maintenance of switchegear & control gear	[ ] IS 10118 [ ]
29.	Flame proof enclosures for electrical apparatus	[ ] IS 2148 [ ]

30.	Classification of hazardous areas for electrical installations	[ ] IS 5572 [ ]
31.	Degree of protection provided by enclosures for LV switchgear & control gear	[ ] IS 2147 [ ]
32.	Dry type transformers	[ ] IS 11171 [ ]
33.	Air break switches, disconnector etc. and fuse combinations units	[ ] IS 4064 [ ]
34.	Miniature air break circuit breaker for voltages not exceeding 1000 V	[ ] IS 8828 [ ]
35.	Low voltage Fuses	[ ] IS 9224 [ ]
36.	Contactors for voltags not exceeding 1000 V AC or 1200V DC	[ ] IS 2959 [ ]
37.	Indicator lamps (visual)	[ ] IS 1901 [ ]

Poles, Sockets and Other Miscellaneous

38.	Tubular steel poles for over head power lines	[ ] IS 2713 [ ]
39.	Three pin plugs and sockets	[ ] IS 1293 [ ]
40.	Switch socket outlets (non-interlocking)	[ ] IS 4615 [ ]
41.	Interlocking switch socket outlet	[ ] IS 4160 [ ]
42.	Structural steel (Standard quality)	[ ] IS 226 [ ]
43.	Danger notice plates	[ ] IS 2551 [ ]
44.	Boxes for enclosure of electric accessories steel & cast iron boxes	[ ] IS 5133 [ ]
45.	Code of practice for general construction in steel	[ ] IS 800 [ ]

46.	Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes	[ ] IS 5082 [ ]
47.	Code of practice for phosphating of iron and steel	[ ] IS 6005 [ ]
48.	Colour for ready mixed paints & enamels	[ ] IS 5 [ ]
49.	Recommended practice for hot dip galvanising of iron & steel	[ ] IS 2629 [ ]
50.	Method of testing uniformity of coating on zinc coated articles	[ ] IS 2603 [ ]

Annexure C to Corrigendum 6 dated September 03, 2021 to Tender Specification BHEL PSSR SCT 1979

2X660 MW Ennore SEZ SUPERCRITICAL TPS Approved vendor list against the clarification Sno : 10			
Sl. No.	**Package Name**	**Vendor Name**	**Remarks**
ELECTRICAL PACKAGES			
1	ABOVE GROUND EARTHING MATERIALS	INDIA ELECTRICALS SYNDICATE	Submit cedentials
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Approved
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	Approved
		Associated Power Structures Pvt. Ltd.	Submit cedentials
		PASSIVE INFRA PROJECTS PVT. LTD.	Submit cedentials
		INDUSTRIAL PERFORATION (I) PVT.LTD.	Approved
		PATNY SYSTEMS (P) LTD	Submit cedentials
		RUKMANI ELECTRICAL & COMPONENTS PVT LTD	Approved
		UNITECH FABRICATORS and ENGINEERS PVT LTD	Approved
		RABI ENGINEERING WORKS PVT. LTD.	Approved
		JAMNA METAL COMPANY	Approved
2	CABLE TERM.& JOINT KITS	HARI CONSOLIDATED PVT.LTD.,NEW DELHI	Submit cedentials

		3M Electro and Communication India P.Ltd	Approved
		RAYCHEM RPG PRIVATE LIMITED	Approved
		YAMUNA POWER and INFRASTRUCTURE LTD	Approved
3	CABLE TRAY SUPPORT SYSTEM - BOLTABLE	PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Approved
		STEELITE ENGINEERING LTD.	Submit cedentials
		INDUSTRIAL PERFORATION (I) PVT.LTD.	Approved
		RATANS PROJECTS AND ENGINEERING CO. PVT. LTD.	Submit cedentials
		AM-TECH ENGG.SERVICES	Approved
4	CABLE TRAYS & ACC.	RUKMANI ELECTRICAL & COMPONENTS PVT LTD	Approved
		EROS METAL WORKS PVT. LTD	Submit cedentials
		RABI ENGINEERING WORKS PVT. LTD.	Approved
		PATNY SYSTEMS (P) LTD	Submit cedentials
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	Approved
		UNITECH FABRICATORS and ENGINEERS PVT LTD	Approved
		PASSIVE INFRA PROJECTS PVT. LTD.	Submit cedentials

		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	Submit cedentials
		INDIANA GRATINGS PVT. LTD.	Submit cedentials
		Maheshwari Electrical Mfrs. Pvt. Ltd.,	Submit cedentials
		INDUSTRIAL PERFORATION (I) PVT.LTD.	Approved
		INDIA ELECTRICALS SYNDICATE	Submit cedentials
		JAMNA METAL COMPANY	Approved
		PENTAX FERRO INCORPORATE	Submit cedentials
		PARMAR METALS PVT.LTD.	Submit cedentials
5	DC BATTERY CHARGER	DUBAS ENGG PVT LTD	Approved
		HBL POWER SYSTEMS LTD	Approved
		STATCON POWER CONTROLS LTD	Approved
		CHLORIDE POWER SYSTEMS & SOLUTIONS LIMITED	Approved
		JEMA ENERGY	Submit cedentials
		MASS-TECH CONTROLS PVT.LTD.	Submit cedentials
		CHHABI ELECTRICALS PVT.LTD.	Approved

		AMARA RAJA POWER SYSTEMS LIMITED	Approved
6	DC Ni Cd BATTERIES	AMCO SAFT INDIA LTD	Approved
		HOPPECKE BATTERIEN GMBH & CO.KG,	Approved
		AMARA RAJA POWER SYSTEMS LIMITED	Approved
		EXIDE INDUSTRIES LTD	Approved
		HBL POWER SYSTEMS LTD	Approved
7	ELECTRIC LAB EQUIPMENT	PCI LIMITED	Approved
		SCIENTIFIC MES-TECHNIK PVT.LTD.	Approved
		THE MOTWANE MANUFACTURING CO.PVT.LTD.	Approved
		Applied Techno Products Pvt. Ltd.,	Approved
		TECHNOLOGY PRODUCTS	Approved
		TTL Technologies Pvt. Ltd.	Approved
		THE TINSLEY GROUP LTD.	Approved
		HIOKI E.E. CORPORATION	Approved
		Pinkcity Electronics Pvt. Ltd.	Submit cedentials

		JOST's ENGG. CO. LTD.	Approved
8	FIRE SEALING SYSTEM	LLOYD INSULATIONS (INDIA) LIMITED	Approved
		MULTI KILFIRE PVT LTD	Approved
		VIJAY SYSTEMS ENGINEERS PVT LTD	Approved
		SIGNUM FIRE PROTECTION (INDIA) PVT LTD	Submit cedentials
		HILTI INDIA PRIVATE LIMITED	Approved
9	GENERATOR CIRCUIT BREAKER	ALSTOM GRID SAS	Approved
		ABB SWITZERLAND LTD.,	Approved
10	HT XPLE CABLES	POLYCAB WIRES PVT. LTD.	Approved
		RAVIN CABLES LIMITED	Approved
		TORRENT CABLES LTD.	Approved
		PARAMOUNT COMMUNICATIONS LTD.	Approved
		KEC INTERNATIONAL LIMITED	Approved
		KEI INDUSTRIES LTD.	Approved
		GEMSCAB INDUSTRIES LTD.	Submit cedentials

		SRIRAM CABLES PVT. LTD.	Submit cedentials
		CRYSTAL CABLE INDUSTRIES LTD.	Submit cedentials
		UNIVERSAL CABLES LTD.	Approved
		Havells India Limited	Approved
		Diamond Power Infrastructure Ltd	Not approved
		NICCO CORPORATION LTD.	Submit cedentials
		KRISHNA ELECTRICAL INDUSTRIES LTD.	Not approved
		APAR INDUSTRIES LIMITED,	Approved
		CABLE CORPORATION OF INDIA LTD.	Approved
11	LT PVC CONTROL CABLE	PARAMOUNT COMMUNICATIONS LTD.	Approved
		UNIVERSAL CABLES LTD.	Approved
		CRYSTAL CABLE INDUSTRIES LTD.	Submit cedentials
		KEC INTERNATIONAL LIMITED	Approved
		TORRENT CABLES LTD.	Approved
		Incom Cables (P) Ltd.,	Submit cedentials

Advance Cable Technologies (P) Ltd.	Submit cedentials
GOVIND CABLE INDUSTRIES	Not approved
KEI INDUSTRIES LTD.	Approved
Scot Innovation Wires and Cables Pvt. Ltd.	Submit cedentials
RAVIN CABLES LIMITED	Approved
ELKAY TELELINKS LTD.	Approved
Sam Cables & Conductors (P) Ltd.,	Submit cedentials
DELTON CABLES LTD.	Approved
GEMSCAB INDUSTRIES LTD.	Submit cedentials
SPECIAL CABLES PVT. LTD.	Submit cedentials
NICCO CORPORATION LTD.	Submit cedentials
POLYCAB WIRES PVT. LTD.	Approved
Havells India Limited	Approved
CMI LTD.	Submit cedentials
APAR INDUSTRIES LIMITED,	Approved

		KRISHNA ELECTRICAL INDUSTRIES LTD.	Not approved
		Diamond Power Infrastructure Ltd	Not approved
		CORDS CABLE INDUSTRIES LTD.	Approved
		SPM POWER & TELECOM PVT. LTD,	Submit cedentials
		GUPTA POWER INFRASTRUCTURE LIMITED,	Approved
		THERMO CABLES LTD.	Approved
		SUYOG ELECTRICALS LTD.	Approved
		MANSFIELD CABLES COMPANY LTD.	Approved
12	LT XLPE FIRE SURVIVAL CABLES	CORDS CABLE INDUSTRIES LTD.	Approved
		APAR INDUSTRIES LIMITED,	Approved
		KEI INDUSTRIES LTD.	Approved
		POLYCAB WIRES PVT. LTD.	Approved
13	LT XLPE POWER CABLE	KEI INDUSTRIES LTD.	Approved
		POLYCAB WIRES PVT. LTD.	Approved
		HAVELLS INDIA LTD.	Approved

KRISHNA ELECTRICAL INDUSTRIES LTD.	Not approved
KEC INTERNATIONAL LIMITED	Approved
Scot Innovation Wires and Cables Pvt. Ltd.	Submit cedentials
PARAMOUNT COMMUNICATIONS LTD.	Approved
SPECIAL CABLES PVT. LTD.	Submit cedentials
RAVIN CABLES LIMITED	Approved
APAR INDUSTRIES LIMITED,	Approved
MANSFIELD CABLES COMPANY LTD.	Approved
CORDS CABLE INDUSTRIES LTD.	Approved
TORRENT CABLES LTD.	Approved
Diamond Power Infrastructure Ltd	Not approved
SRIRAM CABLES PVT. LTD.	Submit cedentials
SUYOG ELECTRICALS LTD.	Approved
THERMO CABLES LTD.	Approved
GEMSCAB INDUSTRIES LTD.	Submit cedentials

		GUPTA POWER INFRASTRUCTURE LIMITED,	Approved
		Govind Cable Industries,	Submit cedentials
		CRYSTAL CABLE INDUSTRIES LTD.	Submit cedentials
14	MS ROD FOR BELOW GROUND EARTHING	STEEL AUTHORITY OF INDIA LTD.	Approved
		RASHTRIYA ISPAT NIGAM LIMITED	Approved
15	NEUTRAL GROUNDING RESISTOR	S.R.NARKHEDE ENGG.PVT.LTD.	Submit cedentials
		RSI SWITCHGEAR PVT. LTD.	Approved
		LACHHMAN ELECTRONICS	Approved
		RESITECH ELECTRICALS PVT.LTD.	Approved
		AMP CONTROL EQUIPMENTS PVT. LTD.	Approved
16	OIL FILLED SERVICE TRANSFORMER	ESENNAR TRANSFORMERS (P) LTD.	Submit cedentials
		DANISH PRIVATE LIMITED	Submit cedentials
		SOUTHERN POWER EQUIPMENT COMPANY PVT. LTD.	Submit cedentials
		Tesla Transformers Ltd.,	Approved
		KANOHAR ELECTRICALS LTD.	Submit cedentials

		EMCO LIMITED	Approved
		MARSONS LIMITED	Submit cedentials
		UNIVERSAL POWER TRANSFORMERS PVT. LTD.,	Submit cedentials
		SCHNEIDER ELECTRIC INFRASTRUCTURE LIMITED	Approved
		TECHNICAL ASSOCIATES LTD.,	Submit cedentials
		KRYFS Power Components Ltd. ,	Submit cedentials
		VOLTAMP TRANSFORMERS LTD.	Approved
		TRANSFORMERS and RECTIFIERS (INDIA) LTD.	Approved
17	PA SYSTEM	Hi-Tech audio Systems Pvt. Ltd	Approved
		KARTHIK ENGRS. and CONSULTANTS PVT. LTD.	Approved
		CHASHMITA ENGINEERS PVT. LTD.	Approved
		BYTE COMMUNICATIONS PVT.LTD.	Submit cedentials
		INDUSTRONIC INDUSTRIE-ELECTRONIC GmbH & CO KG	Submit cedentials
		POWER SYSTEMS	Approved
18	SCREENED CONTROL CABLES	THERMO CABLES LTD.	Approved

	CABLES	PARAMOUNT COMMUNICATIONS LTD.	Approved
		KEI INDUSTRIES LTD.	Approved
		ELKAY TELELINKS LTD.	Approved
		POLYCAB WIRES PVT. LTD.	Approved
		MANSFIELD CABLES COMPANY LTD.	Approved
		NICCO CORPORATION LTD.	Approved
		SUYOG ELECTRICALS LTD.	Approved
		DELTON CABLES LTD.	Approved
		CMI LTD.	Submit cedentials
		SPECIAL CABLES PVT. LTD.	Submit cedentials
		TC COMMUNICATION PVT. LTD.	Submit cedentials
		CORDS CABLE INDUSTRIES LTD.	Approved
19	STATION LIGHTING SYSTEM	BAJAJ ELECTRICALS LTD.	Approved
		M/s.Crompton	Approved
			Approved

		SPACEAGE SWITCHGEARS LTD.	Submit cedentials
		TECHNO ELECTRIC and ENGG. CO. LTD.	Submit cedentials
		MIKA ENGINEERS,	Not approved
		AVAIDS TECHNOVATORS PVT. LTD.	Approved
20	TREFOIL CLAMPS	SUMIP COMPOSITES PVT.LTD.	Submit cedentials
		ELECTROMAC INDUSTRIES	Submit cedentials
		AJMERA INDUSTRIAL & ENGINEERING WORKS	Approved
		MOULDED FIBREGLASS PRODUCTS	Approved