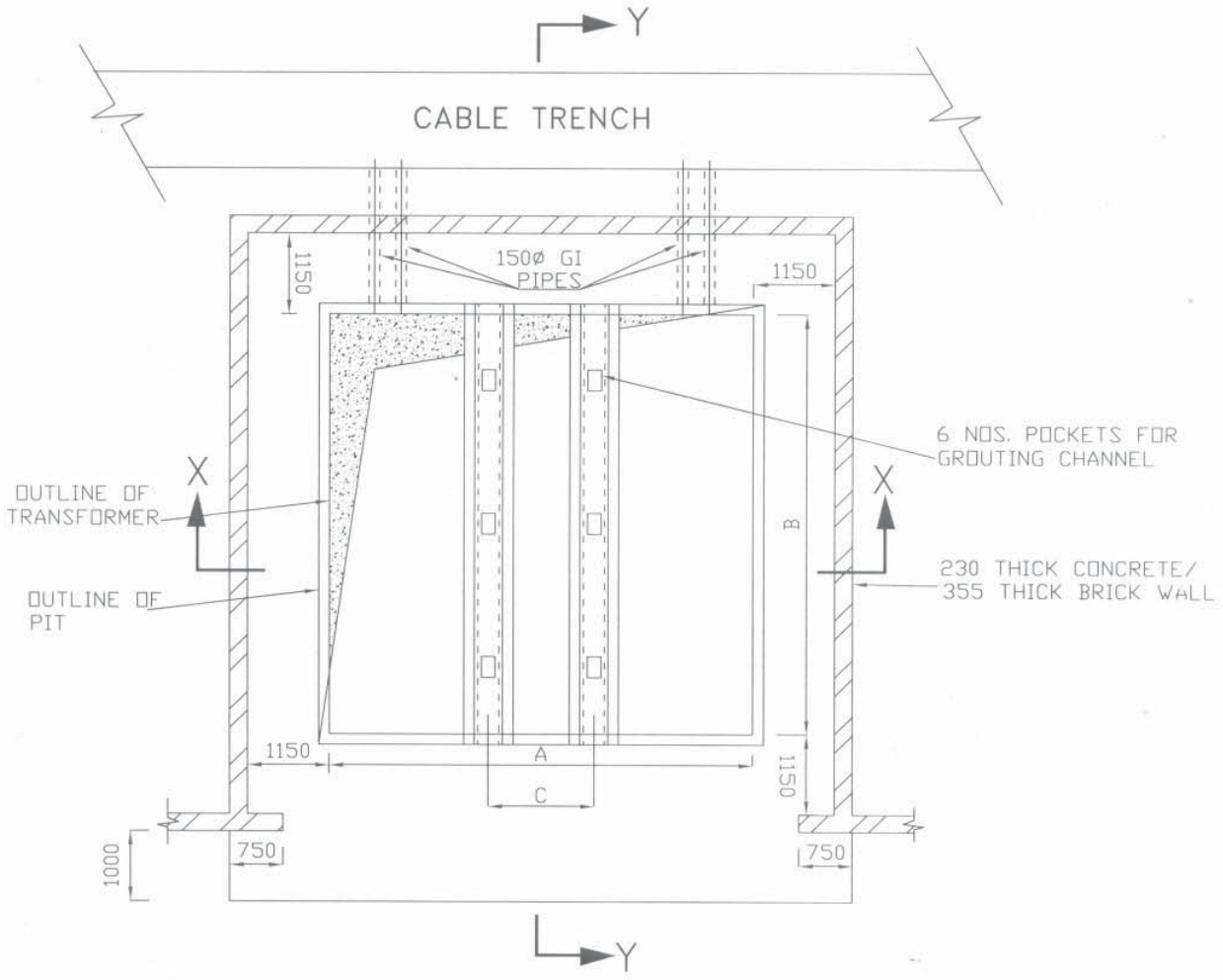
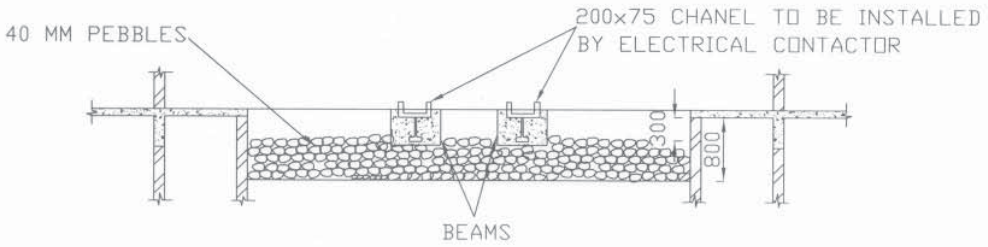
FOUNDATION DETAIL OF 11/.433 KV TRANSFORMER	PC183 PDS: E113	0
	DOCUMENT NO.	REV
	SHEET 1 OF 1	

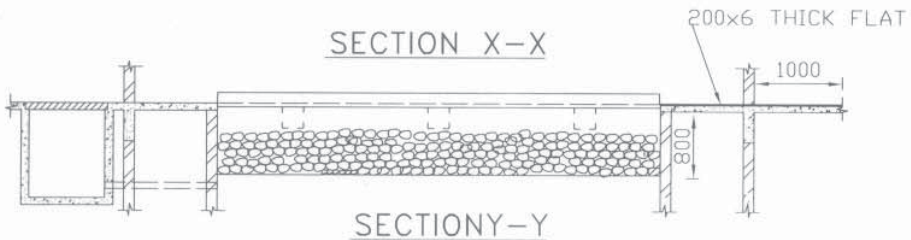


PLAN

TYPICAL DETAIL OF 11/.433KV T/F



SECTION X–X

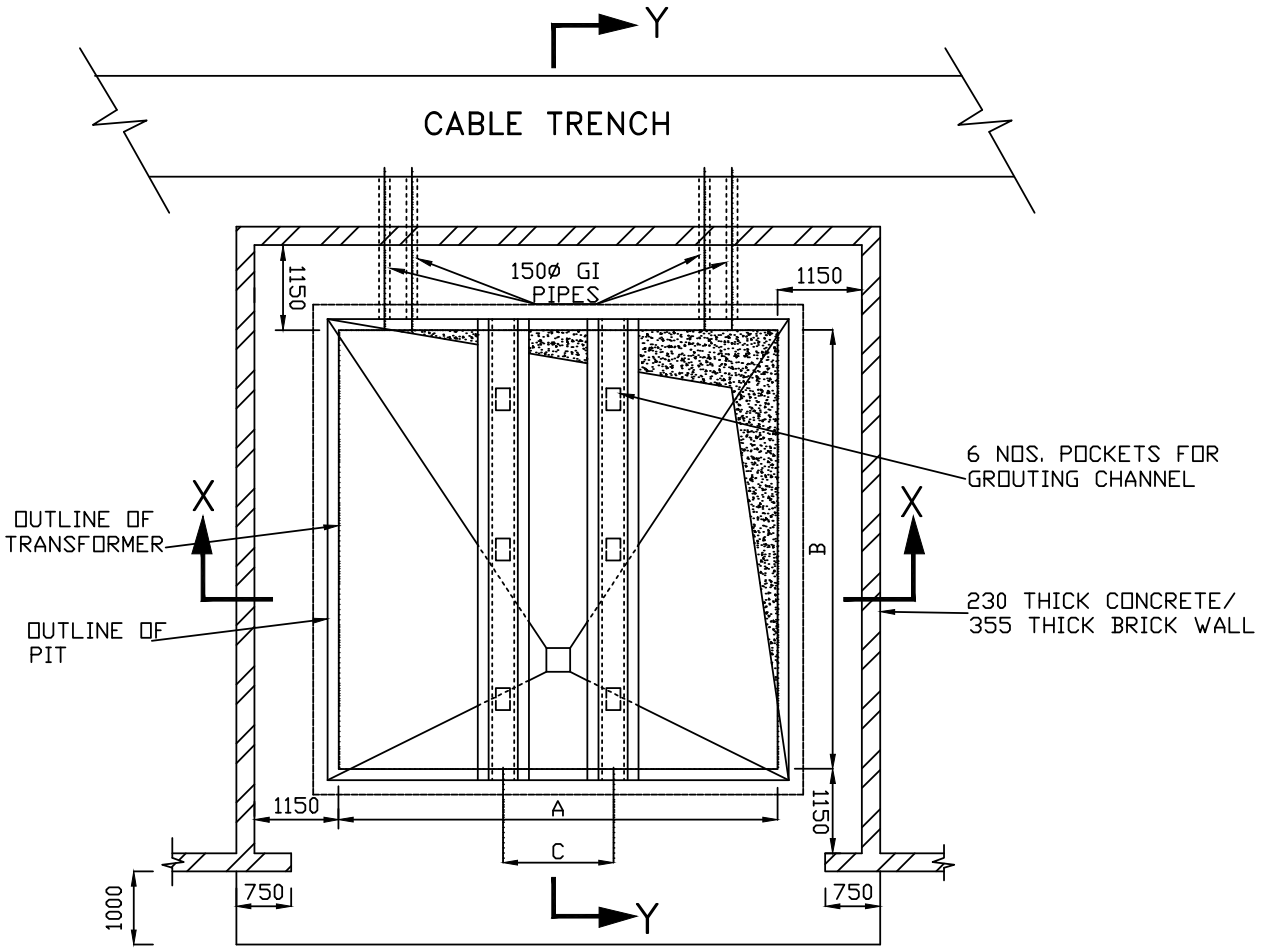


SECTIONY–Y

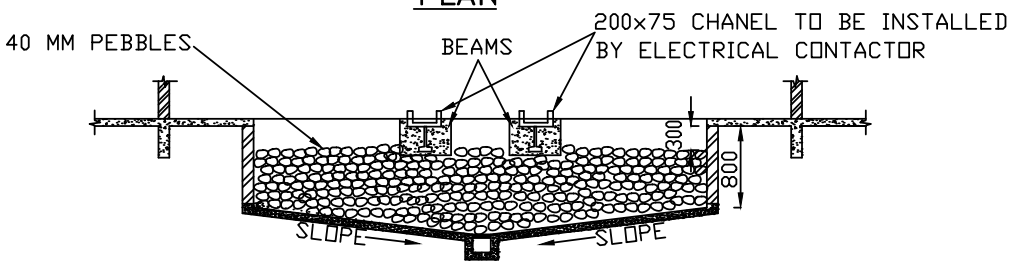
NOTE :

TRANSFORMERS RATED ABOVE 10MVA SHALL BE MOUNTED ON 200MM x 8MM THICK PLATES.

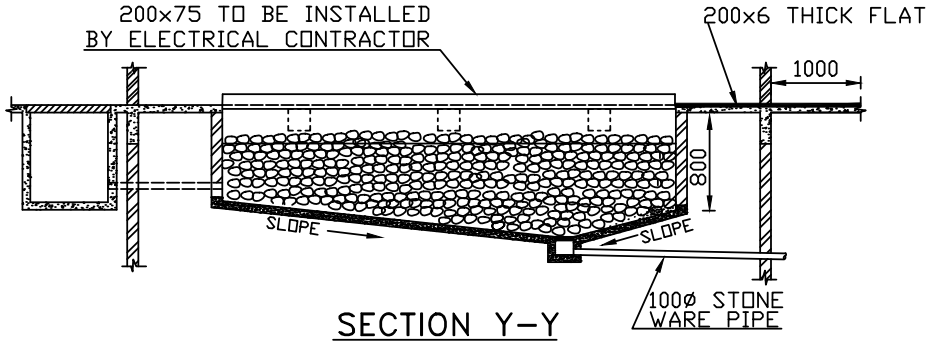
पी डी आई एल PDIL	FOUNDATION DETAIL OF 11/3.45 KV TRANSFORMER	PC183-PDS:E 114	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



PLAN



SECTION X-X

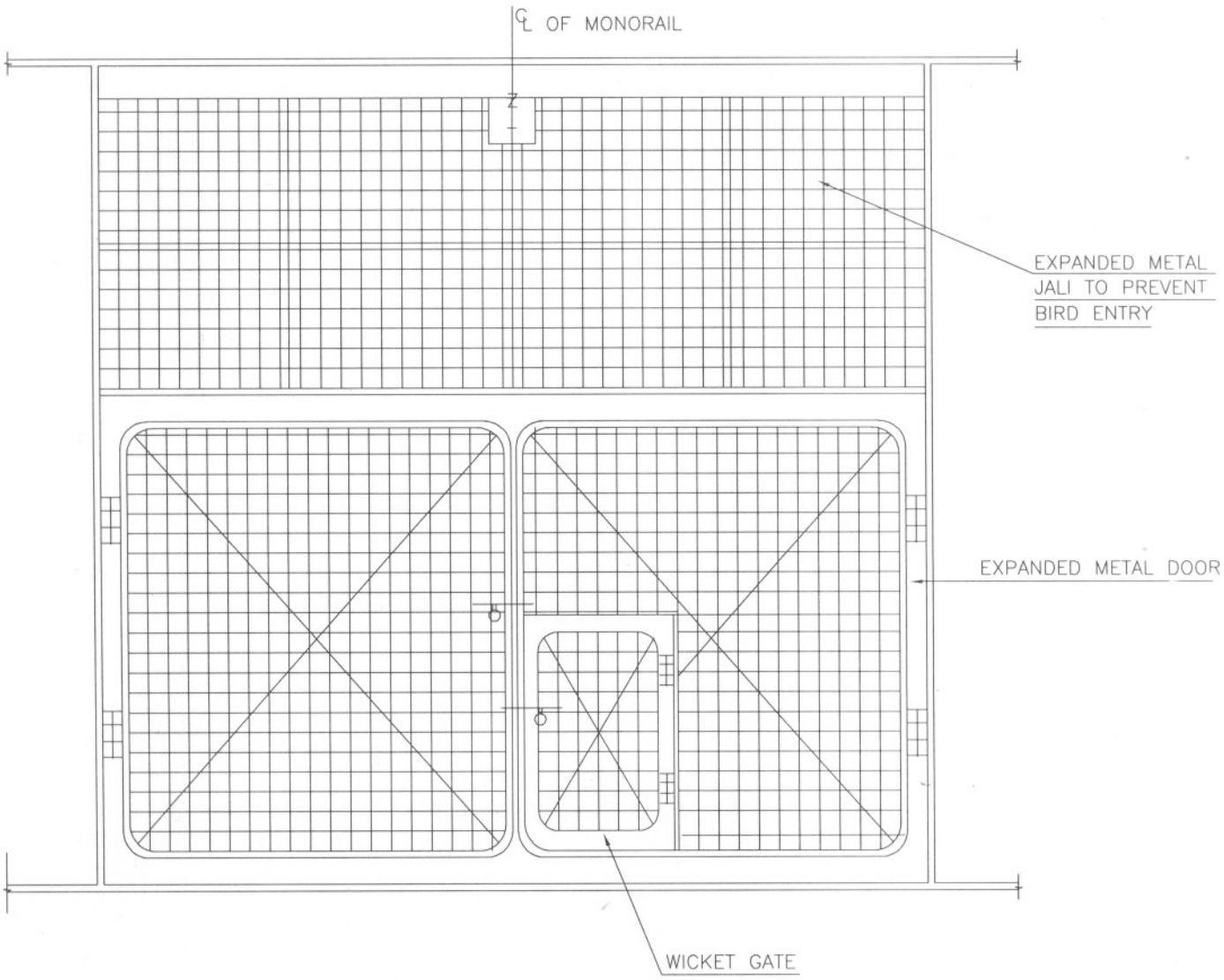


SECTION Y-Y

NOTE :

TRANSFORMERS RATED ABOVE 10MVA SHALL BE MOUNTED ON 200MM x 8MM THICK PLATES.

PDIL	TYPICAL DETAILS OF TRANSFORMER ROOM DOOR	PC183 E 115	0
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



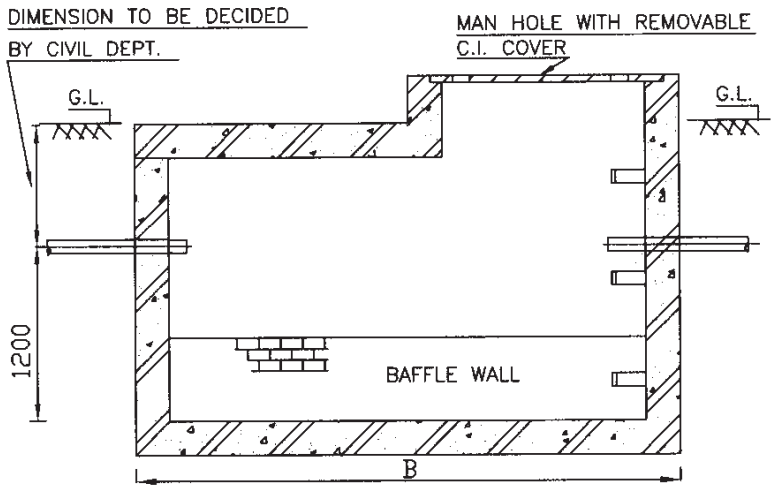
NOTE :–

1. THIS STANDARD IS INDICATIVE ONLY, THE EXACT DIMENSIONS SHALL BE DECIDED AS PER TRANSFORMER SIZE & SUB–STATION LAYOUT.

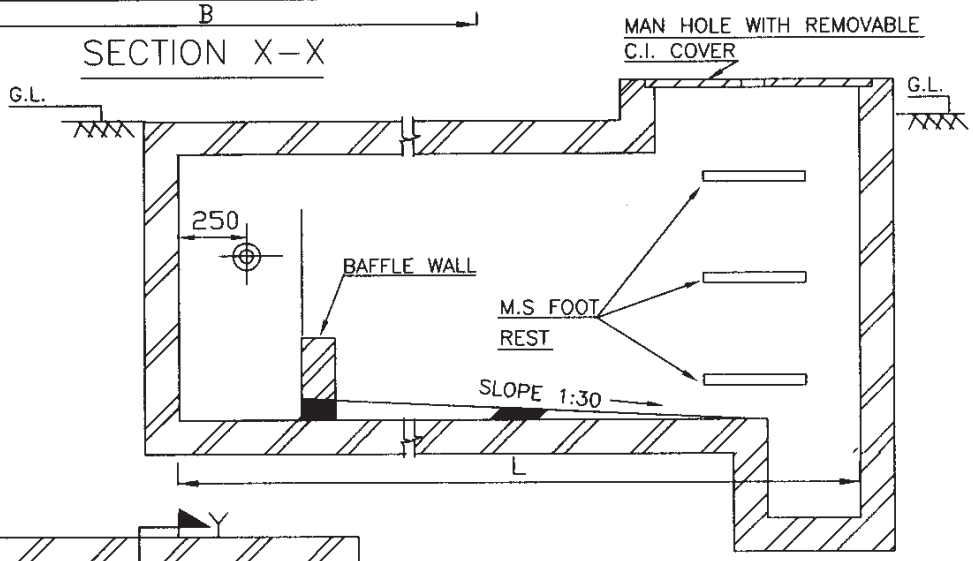
2. TRANSFORMER GATE HEIGHT SHALL BE 250MM MORE THAN THE TRANSFORMER HEIGHT AND SHALL BE OPENABLE OUTSIDE.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
0	20.01.07	01.02.07	ISSUED FOR IMPLEMENTATION	RUNDA/AV	SC	BB

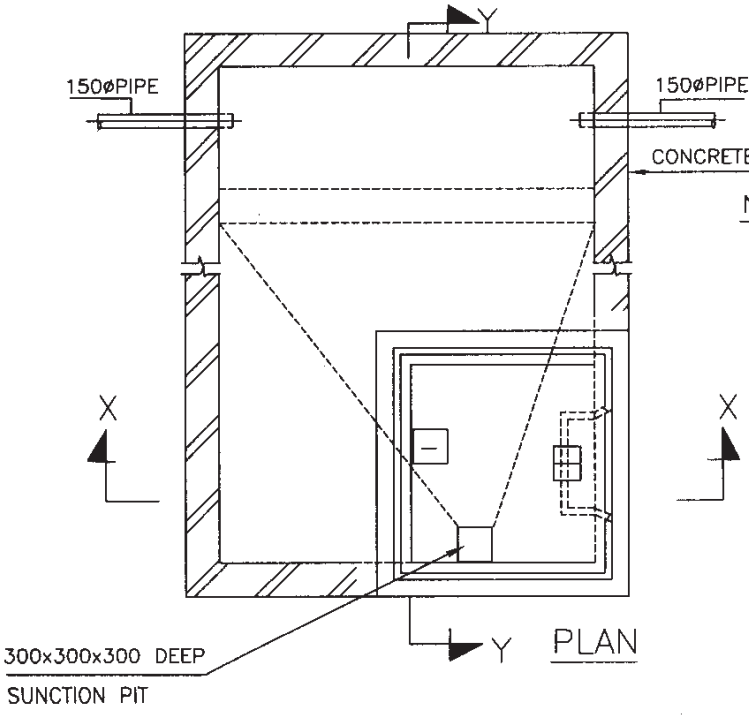
PDIL	SUMP PIT FOR TRANSFORMER OIL	PC183 PDS: E116	1
		DOCUMENT NO.	REV
		SHEET 1 OF 1	



SECTION X–X



SECTION Y–Y

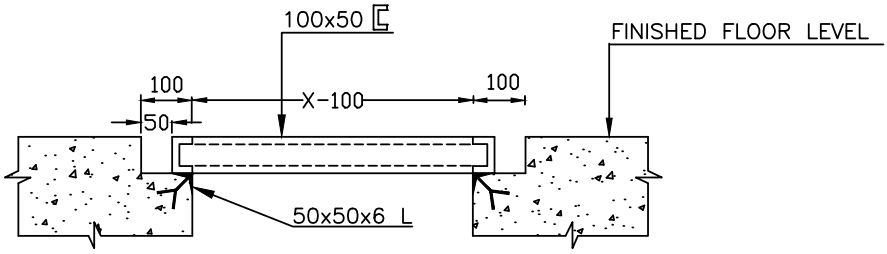


NOTES:–

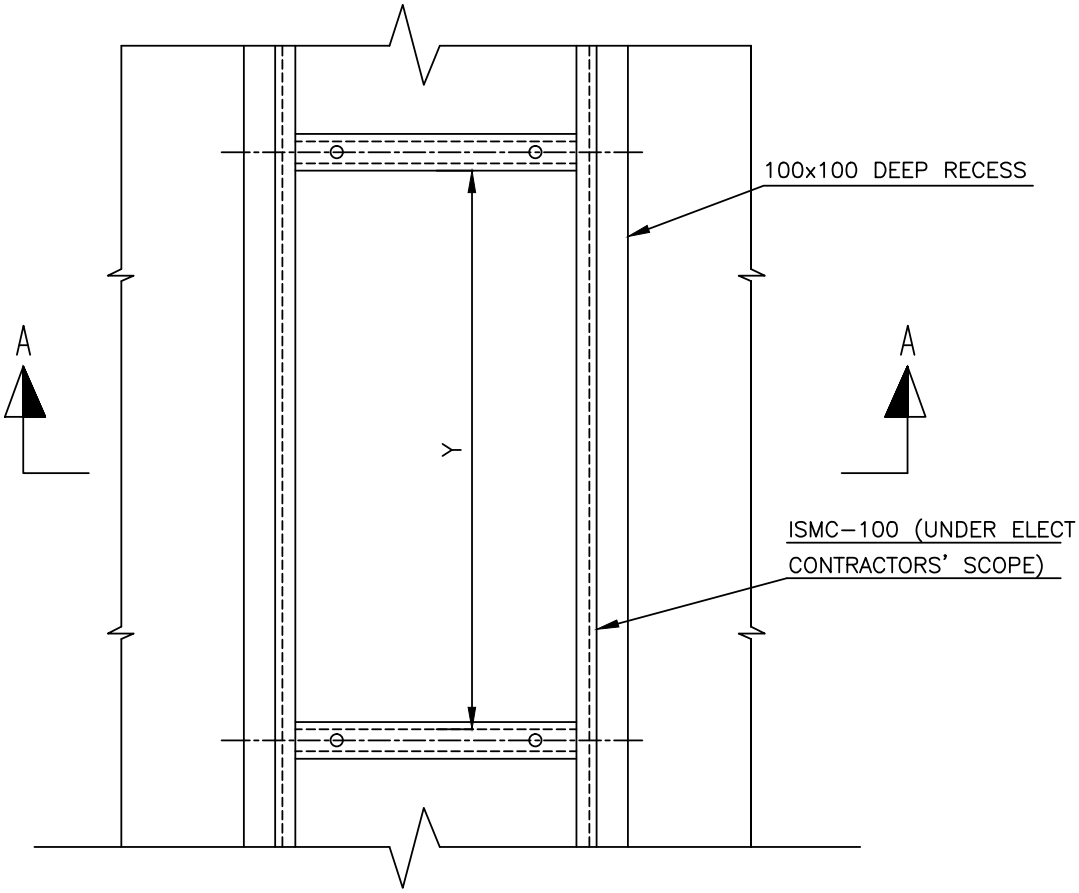
1. DIMENSION 'L' AND 'B' SHALL BE DECIDED BASED ON OIL VOLUME OF HIGHEST RATED TRANSFORMER.
2. ALL DIMENSIONS ARE IN mm

SL. No.	OIL CAPACITY	L	B
6	2000	1.5	1.5
5	3000	1.5	2
4	5000	2.5	2
3	7000	3.0	2.5
2	8000	3.5	2.5
1	10000	4.0	2.5

पी डी आई एल PDIL	TYPICAL FOUNDATION ARRANGEMENT FOR PANELS IN SUB-STATION	PC183-PDS:E 119	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION–A A



PLAN

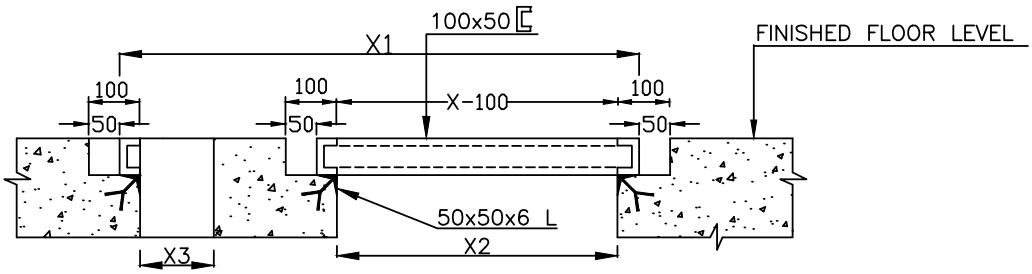
X– DEPTH OF PANEL

Y– LENGTH OF TWO PANELS

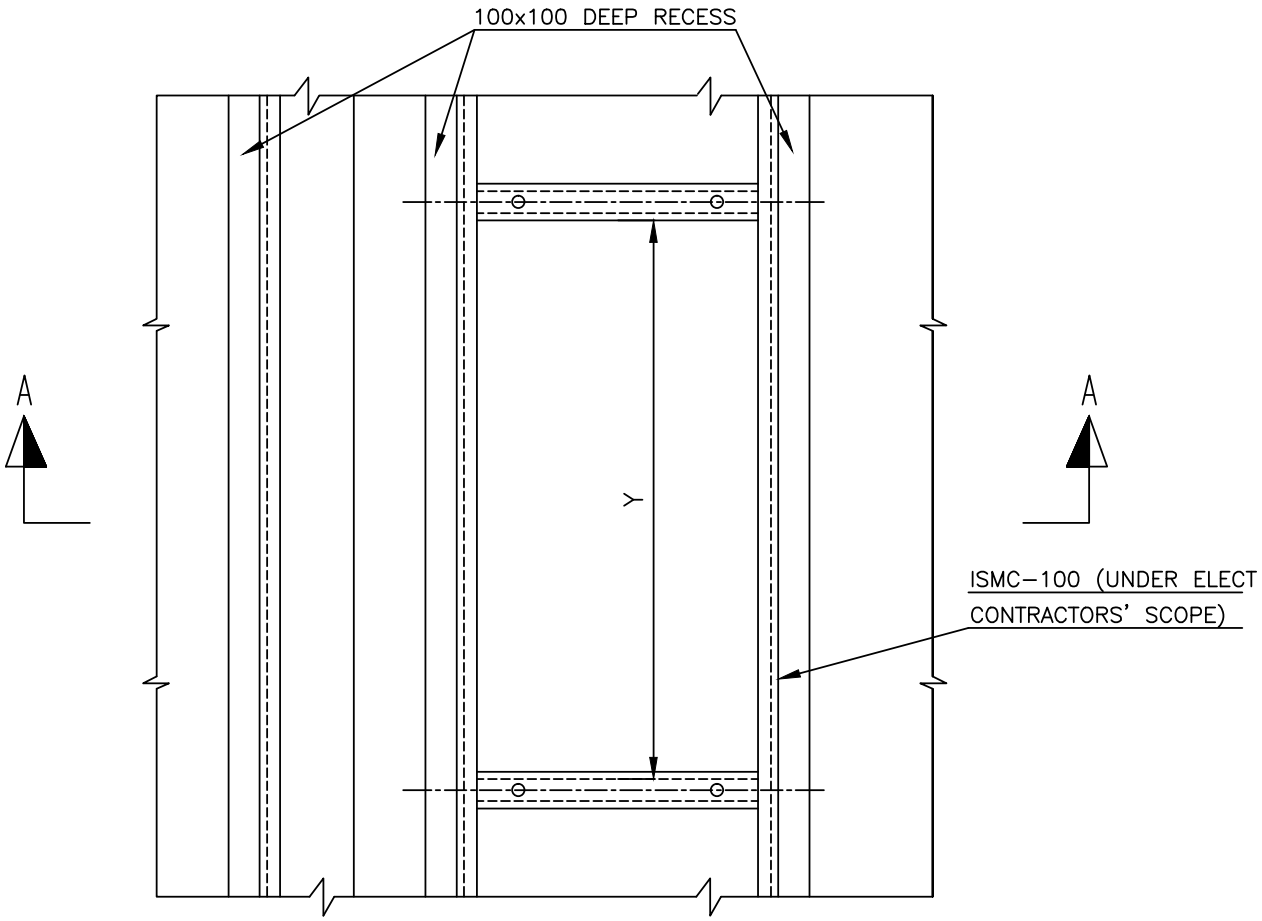
NOTES:–

1. THIS ARRANGEMENT SHALL BE APPLICABLE FOR M.C.C., DISTRIBUTION BOARDS, CONTROL PANELS ETC.
2. PANELS AFTER ERECTION SHALL BE TAG WELDED TO FOUNDATION CHANNELS

पी डी आई एल PDIL	TYPICAL FOUNDATION DETAILS FOR HT/LT CIRCUIT BREAKER PANELS	PC183-PDS:E 120	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION–A A



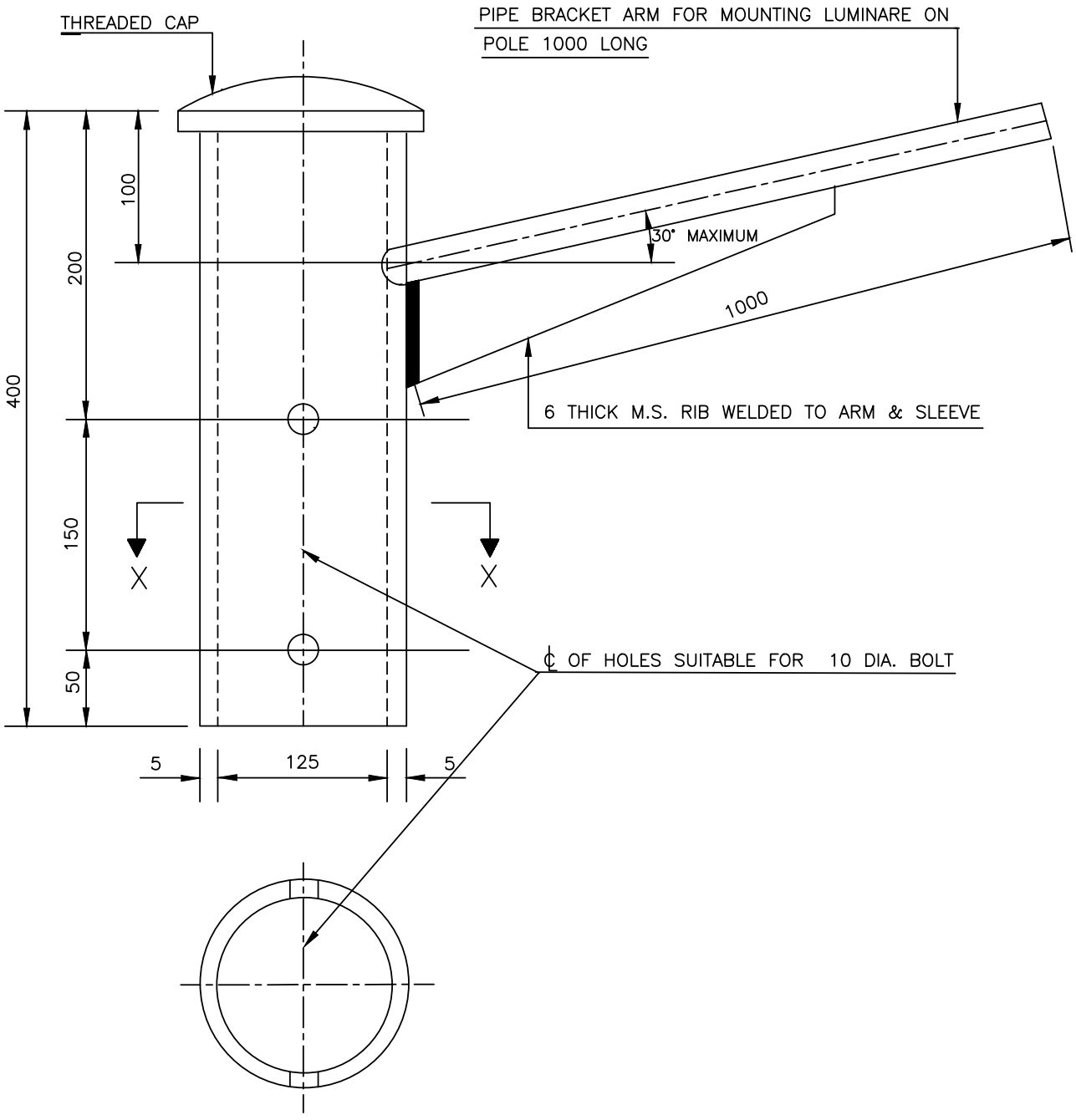
PLAN

X1 = DEPTH OF PANEL
X2 = FOOR OPENING
X3 = FOOR OPENING
Y = LENGTH OF PANEL

NOTES:–

1. PANELS AFTER ERECTION SHALL BE BOLTED TO FOUNDATION CHANNELS
2. POWER & CONTROL CABLES SHALL ENTER THROUGH OPENING X2
3. DEPENDING UPON THE FINAL DATA FROM THE VENDOR, ONLY TWO CHANNELS MAY BE NECESSARY IN WHICH CASE THE 3RD. RECESS SHALL BE FILLED AT SITE.

पी डी आई एल PDIL	DETAILS OF BRACKET ARM FOR STREET LIGHTING POLE	PC183–PDS:E 207	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

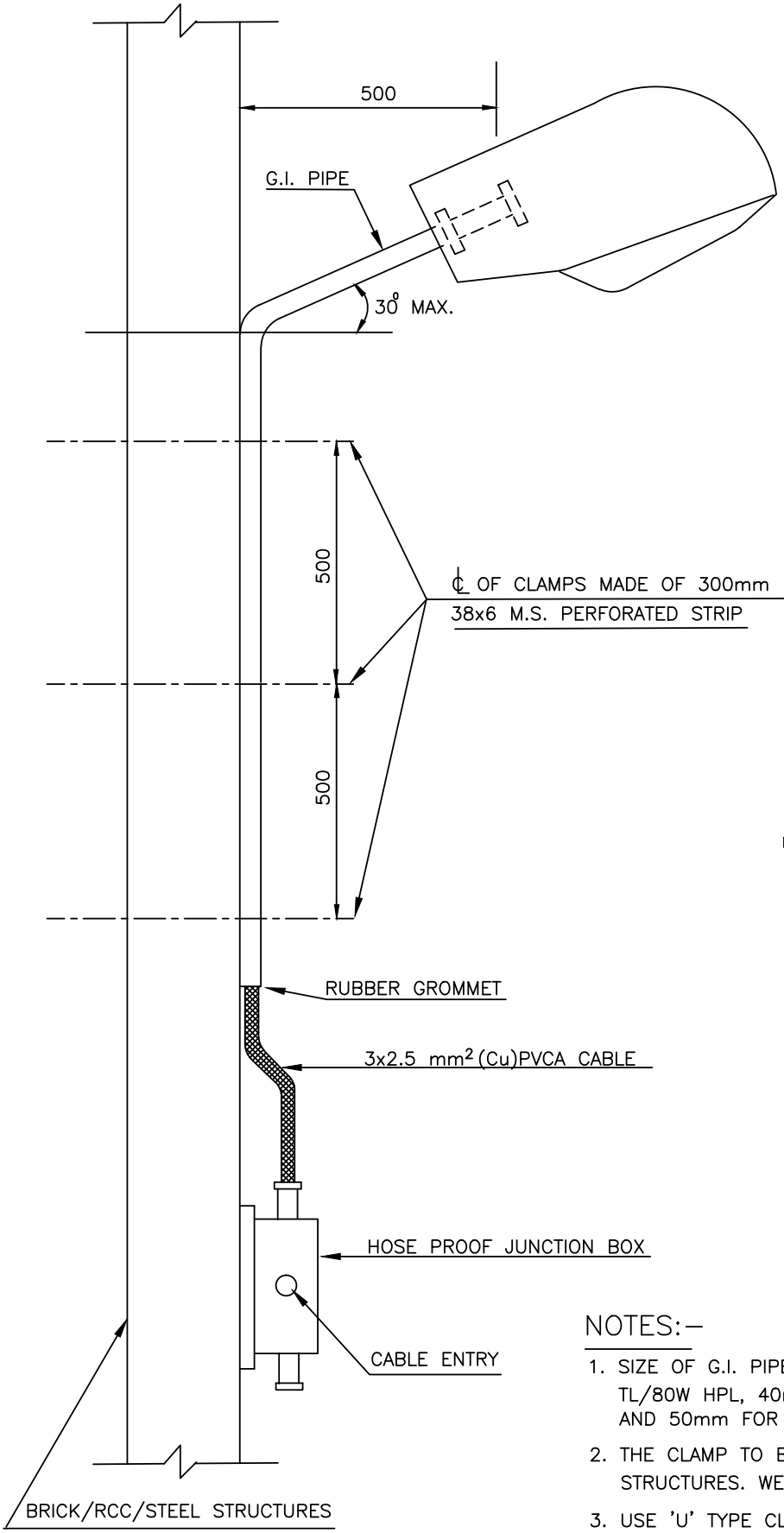


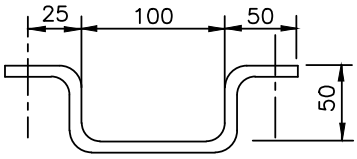
SECTION – XX

NOTES:–

1. SIZE OF PIPE SHALL BE 30mm FOR TL/80W HPL FIXTURES, 40mm FOR 70W SON/125W HPL FIXTURES AND 50mm FOR 150W SON/250W HPL FIXTURES.
2. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	INSTALLATION ARRANGEMENT AREA LIGHTING FIXTURES	PC183-PDS:E 208	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



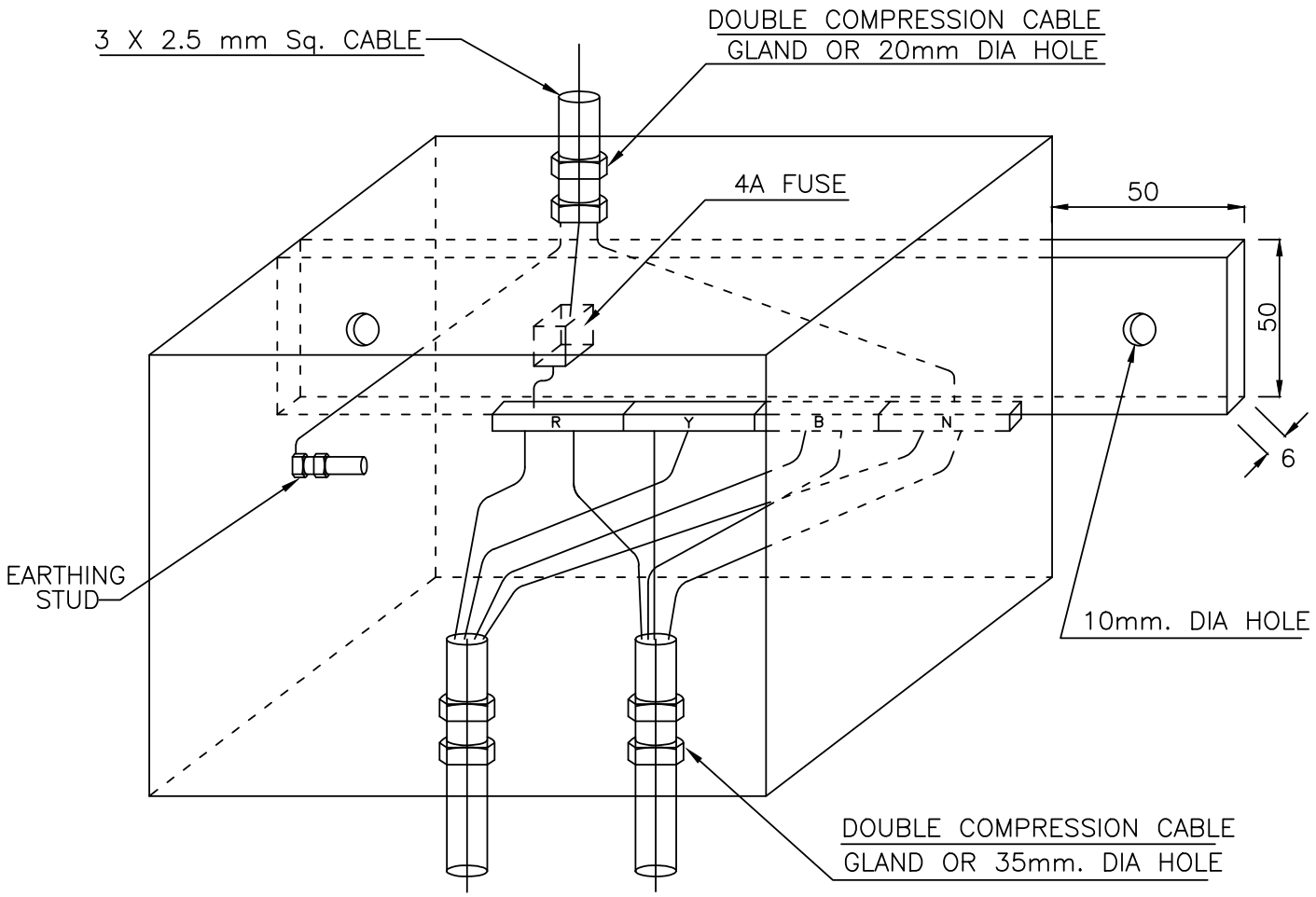


DETAILS OF CLAMP

NOTES:–

1. SIZE OF G.I. PIPE SHALL BE 30mm FOR TL/80W HPL, 40mm FOR 70W SON/125W HPL AND 50mm FOR 150W SON//250W HPL FIXTURES.
2. THE CLAMP TO BE GROUTED IN BRICK WALL/RCC STRUCTURES. WELDED TO STEEL STRUCTURES.
3. USE 'U' TYPE CLAMPS FOR RAILING.
4. ALL DIMENSIONS ARE IN mm.

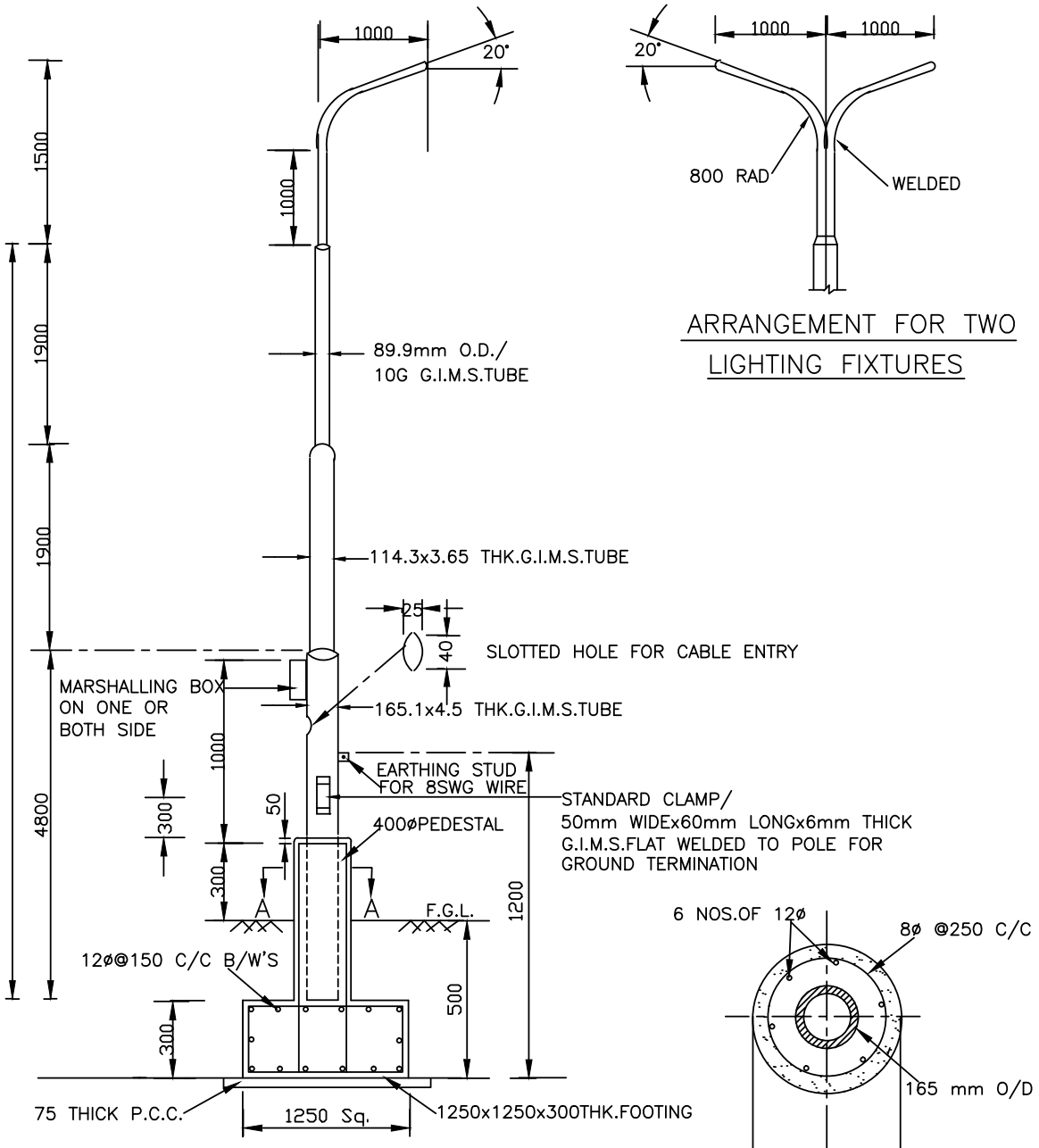
पी डी आई एल PDIL	JUNCTION BOX FOR STREET LIGHTING POLE	PC183–PDS:E 210	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



NOTE:–

1. THE MINIMUM INTERNAL DIMENSION OF THE J.B. SHALL BE 152 X 152 X 152.
2. THE FRONT DOOR SHALL BE HINGED & LOCKABLE TYPE.
3. THE CONNECTION OF FUSE TO THE PHASE 'R' IS TYPICAL ONE THE EXACT PHASE TO WHICH CONNECTION SHALL BE MADE SHALL BE DECIDED AT SITE.
4. FOR HAZARDOUS AREA'S THESE JUNCTION BOXES SHALL BE INCREASED SAFETY TYPE AND THE FUSE NEED NOT BE PROVIDED.
5. FOR POLE MOUNTED JUNCTION BOXED THE CABLE GLAND SHALL BE SIDE MOUNTED.
6. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	TYPICAL STREET LIGHTING POLE	PC183-PDS:E 213	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

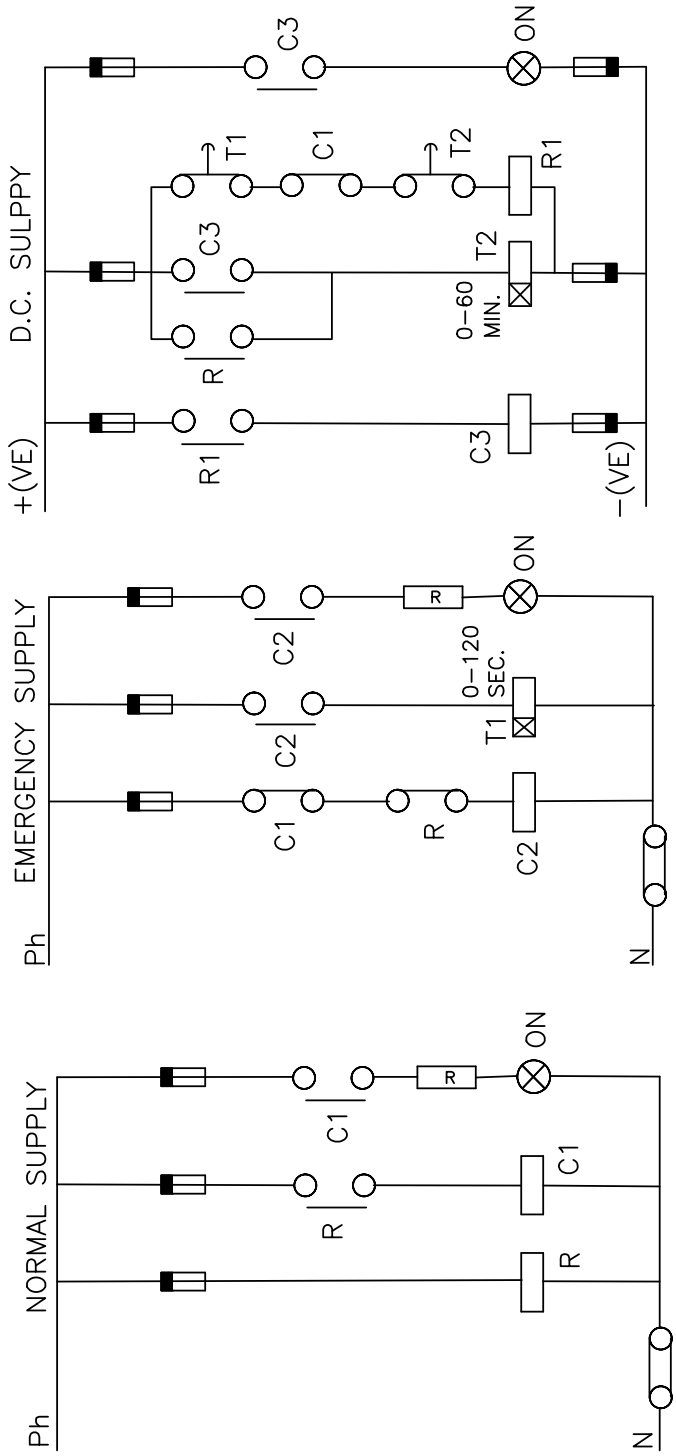


NOTE :–

1. CONCRETING AND APPROVED MOUNTING HARDWARE FOR LIGHTING FIXTURES ARE INCLUDING IN SCOPE OF SUPPLY.
2. CONCRETE FOUNDATION OF GRADE M15 SHALL BE PROVIDED.

ALL DIMENSIONS ARE IN mm.

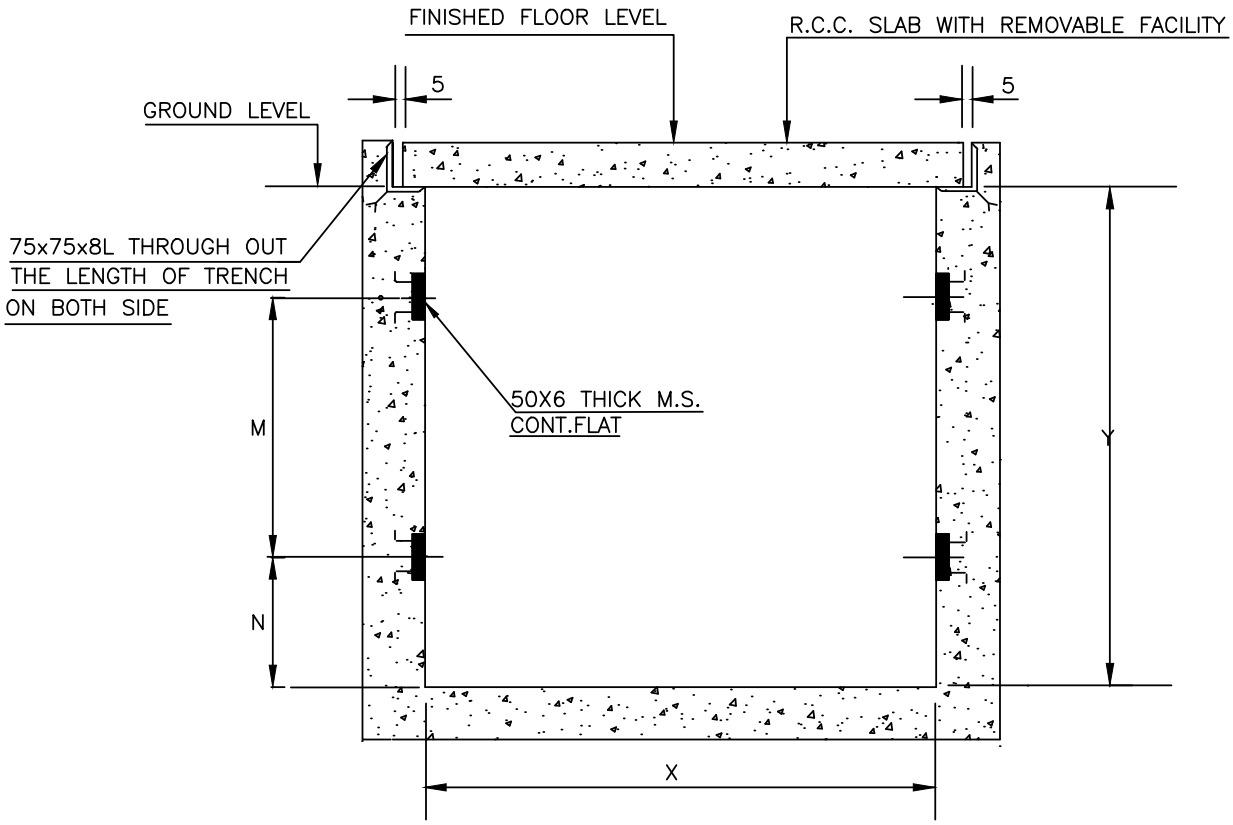
पी डी आई एल PDIL	SCHEMATIC DIAGRAM PANIC LIGHT	PC183-PDS:E 464	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



NOTE:-

CONTACTORS C1,C2 AND C3 CONTROLS THE LIGHTING FEEDERS FOR NORMAL,EMERGENCY AND D.C. SUPPLY RESPECTIVELY.

पी डी आई एल PDIL	DETAILS OF CONCRETE CABLE TRENCH	PC183-PDS:E 510	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



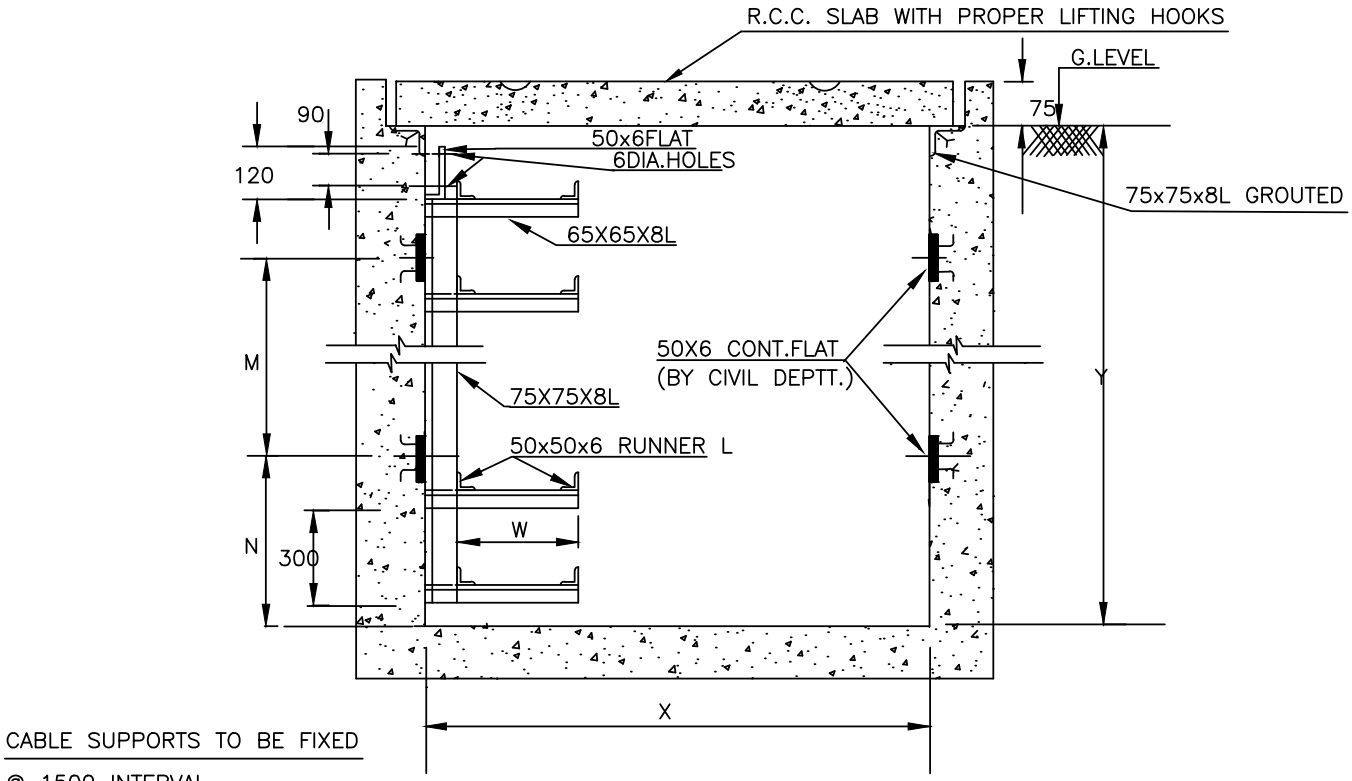
SECTION OF TRENCH

DESIGN TYPE	X	Y	N	M
5T 350DS.	1400	1500	400	650
4T 350DS.	1400	1200	250	650
3T 350DS.	1400	900	250	300
5T 350SS.	1000	1500	400	650
4T 350SS.	1000	1200	250	650
3T 350SS.	1000	900	250	300
5T 250DS.	1200	1500	400	650
4T 250DS.	1200	1200	250	650
3T 250DS.	1200	900	250	300
5T 250SS.	900	1500	400	650
4T 250SS.	900	1200	250	650
3T 250SS.	900	900	250	300

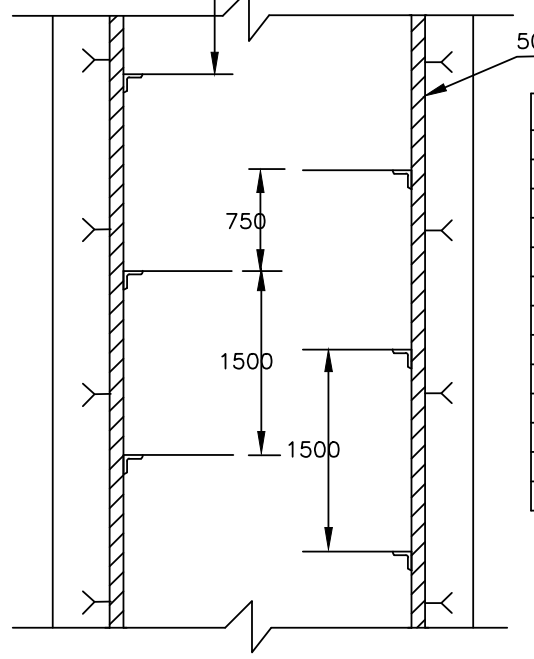
NOTES:–

1. THE TOP OF TRENCH SHALL MATCH THE FLOOR LEVEL IN PLANT AREA.
2. IN INDOORS INSTEAD OF RCC SLAB,20mm.THICK Al. EXTRUDED PLANK OR 10mm.THICK M.S.CHEQUERED PLATE SHALL BE USED AS PER PDS:E 507.
3. PROPER SLOPE TO BE GIVEN IN THE TRENCH FOR NATURAL DRAINAGE.
4. SS–SINGLE SIDE CABLE SUPPORTS.
5. DS–DOUBLE SIDE CABLE SUPPORTS.
6. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	CABLE RACK ARRANGEMENT IN TRENCHES	PC183-PDS:E 511	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION OF TRENCH

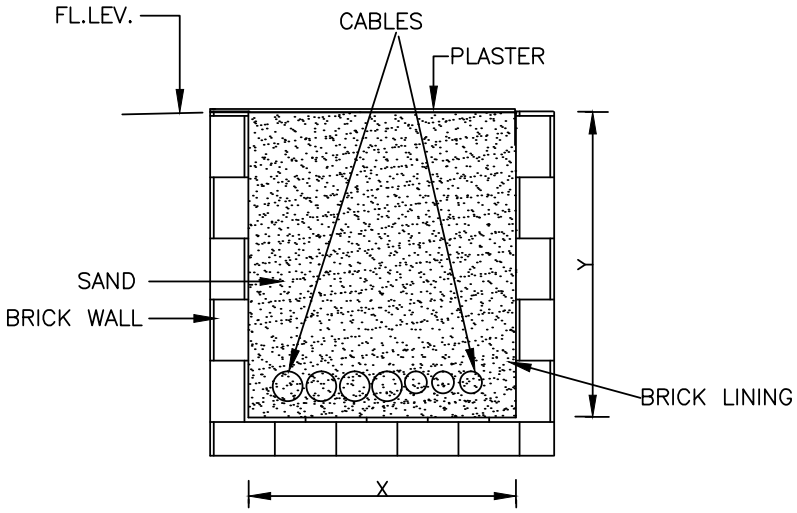


TYPICAL PLAN OF TRENCH

DESIGN TYPE	X	Y	N	M	W
5T-350-DS.	1400	1500	400	650	350
4T-350-DS.	1400	1200	250	650	350
3T-350-DS.	1400	900	250	300	350
5T-350-SS.	1000	1500	400	650	350
4T-350-SS.	1000	1200	250	650	350
3T-350-SS.	1000	900	250	300	350
5T-250-DS.	1200	1500	400	650	250
4T-250-DS.	1200	1200	250	650	250
3T-250-DS.	1200	900	250	300	250
5T-250-SS.	900	1500	400	650	250
4T-250-SS.	900	1200	250	650	250
3T-250-SS.	900	900	250	300	250

NOTES:-
1. SS-SINGLE SIDE CABLE SUPPORT.
2. DS-DOUBLE SIDE CABLE SUPPORT.
3. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF CABLES BURRIED IN SLITS	PC183–PDS:E 516	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



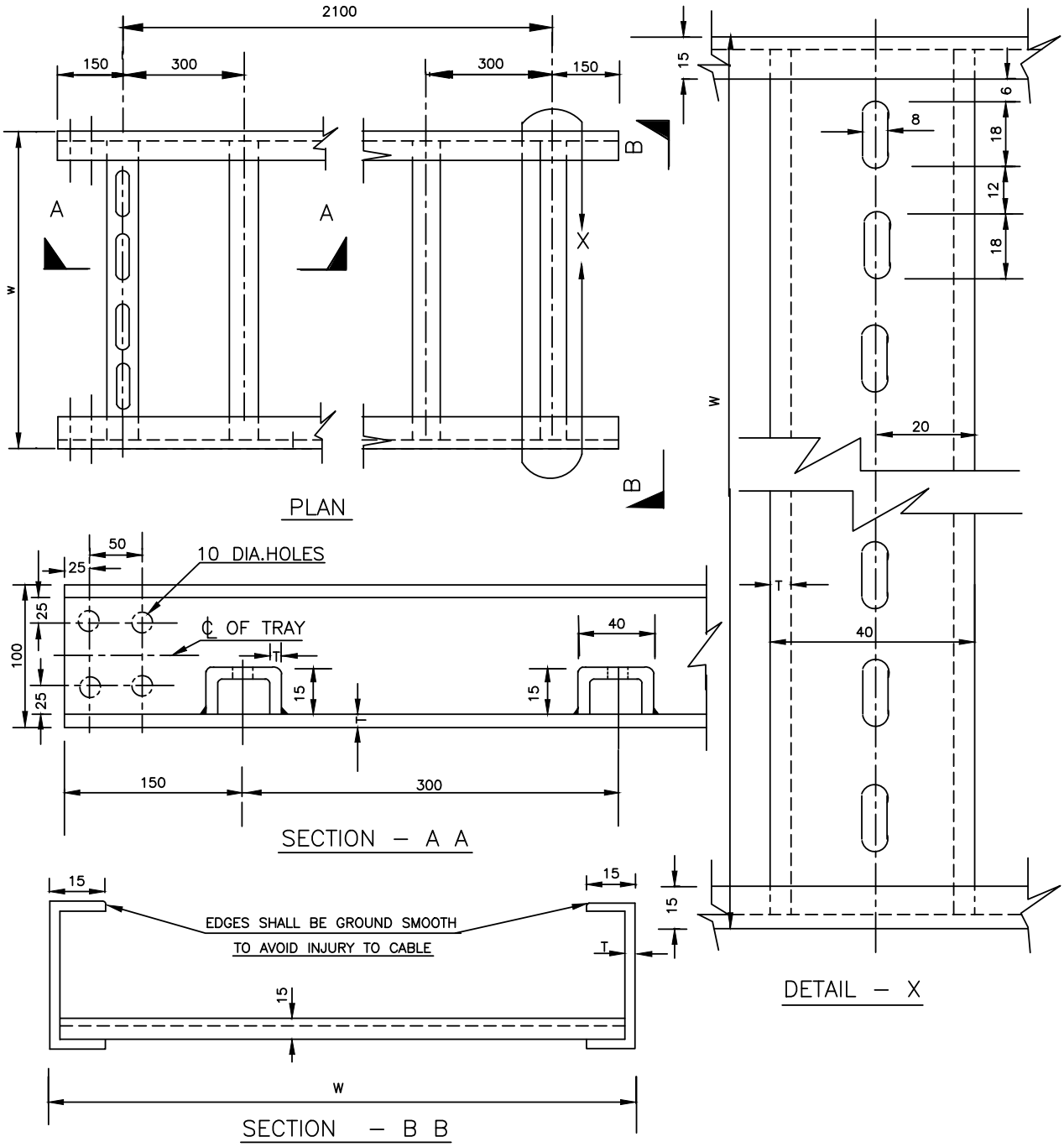
SECTION OF SLIT

DESIGN TYPE	X	Y
S 300	300	300
S 200	200	200

NOTE:–

1. CABLE SLITS SHALL BE FILLED WITH SAND AND PROPERELY PLASTERED WITH LEAN CONCRETE AFTER LAYING OF CABLES.
2. WHEREVER CABLES ARE COMING OUT OF THE SLIT, SUITABLE MECH.PROTECTION TO BE PROVIDED.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY STRAIGHT RUN	PC183–PDS:E 530	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

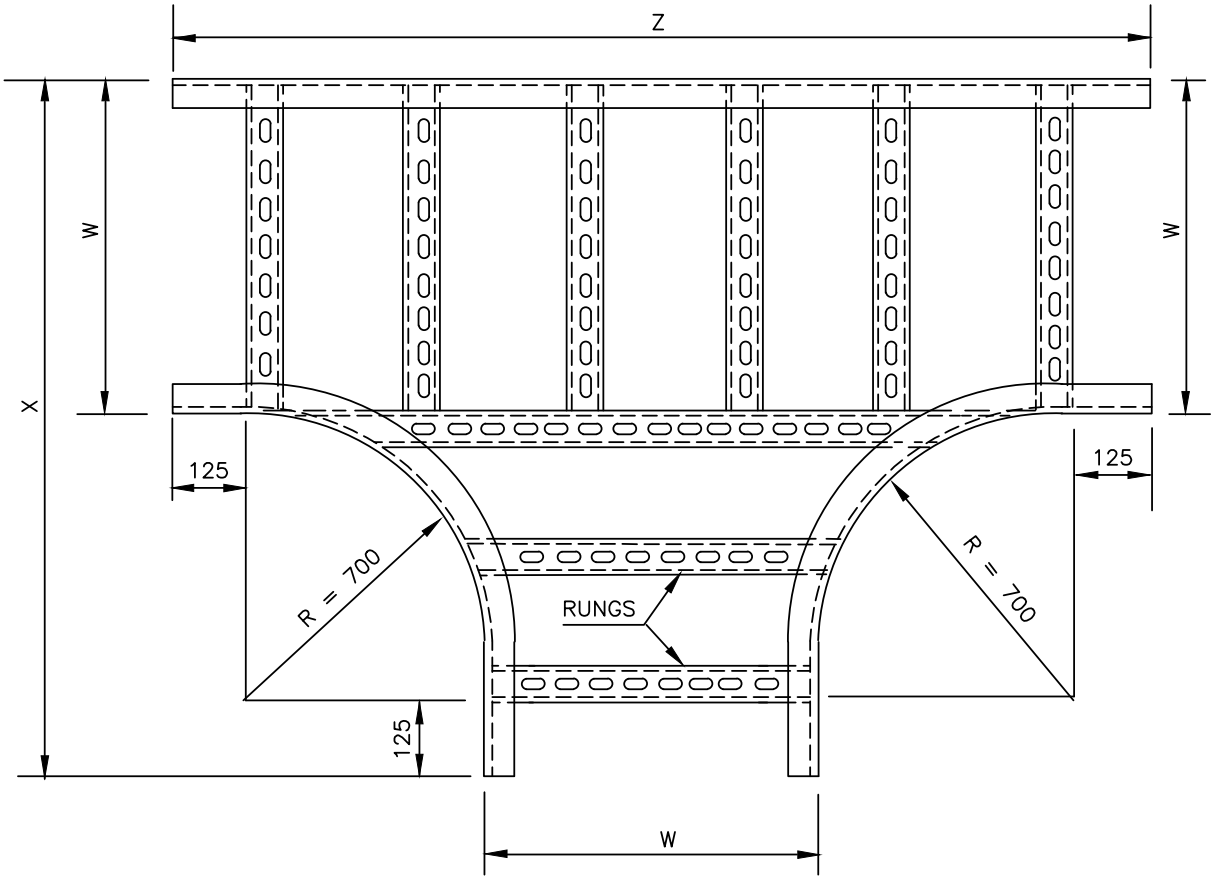


DESIGN TYPE (WIDTH)	MAX.SUPPORTING SPAN		WEIGHT/METER APPROX. IN Kg.	
	G. I.	A. L	G. I.	A. L
SR 900	2000	2000	10.5	3.6
SR 600	2000	2000	8.9	3.05
SR 450	2000	2000	8.0	2.75
SR 300	2000	2000	7.6	2.6
SR 150	2000	2000	6.8	2.33

NOTE:–

THICKNESS " T " SHALL BE 3mm FOR G.I AND 4mm.FOR AL.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY HORIZONTAL TEE	PC183–PDS:E 531	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



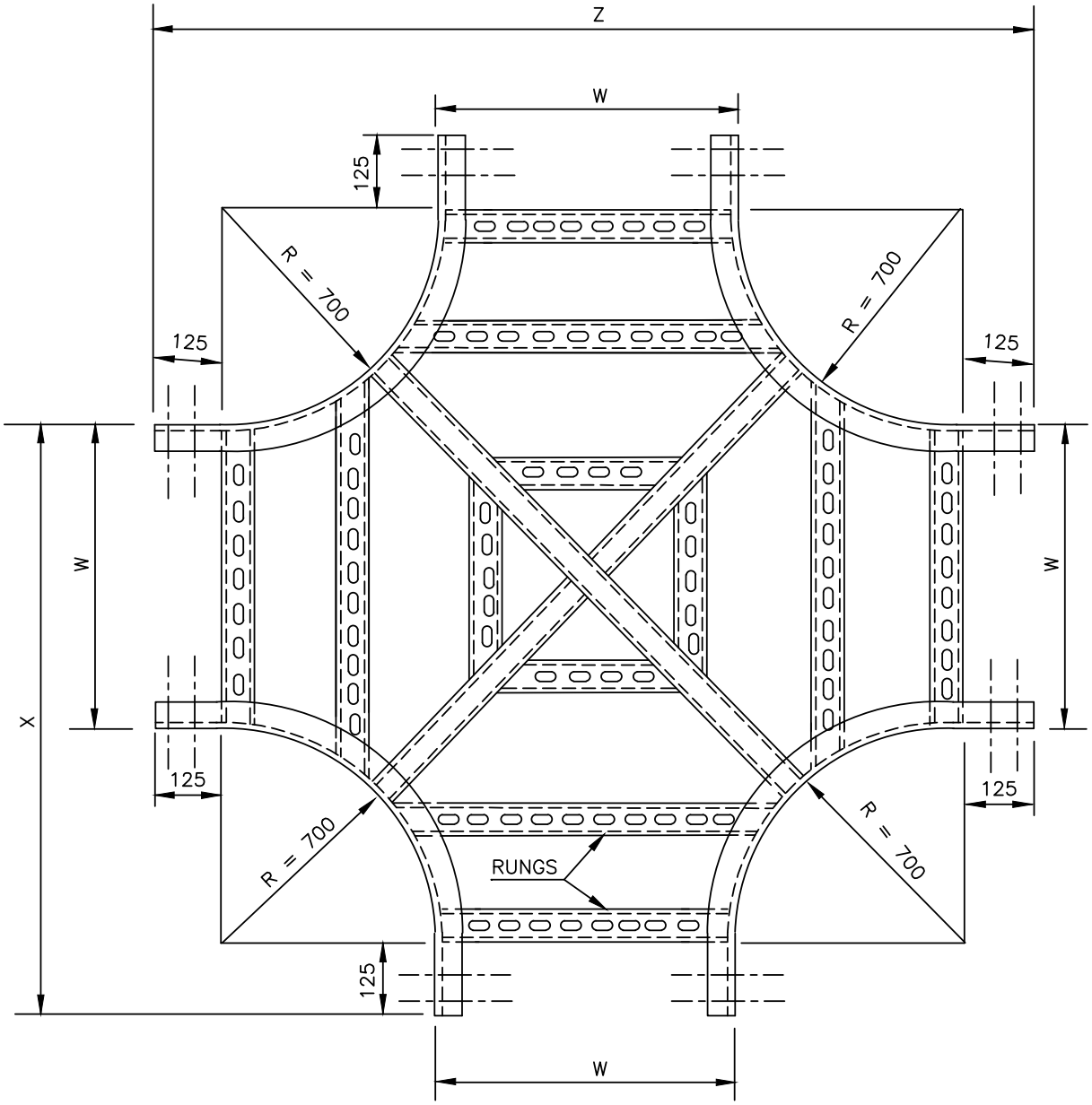
PLAN

DESIGN TYPE	W	X=R+W+125	Z=2R+W+250
HT 900	900	1725	2550
HT 600	600	1425	2250
HT 450	450	1275	2100
HT 300	300	1125	1950

NOTES :–

1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

PDIL	PRE–FABRICATED CABLE TRAY HORIZONTAL CROSS	PC183–PDS:E 532	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



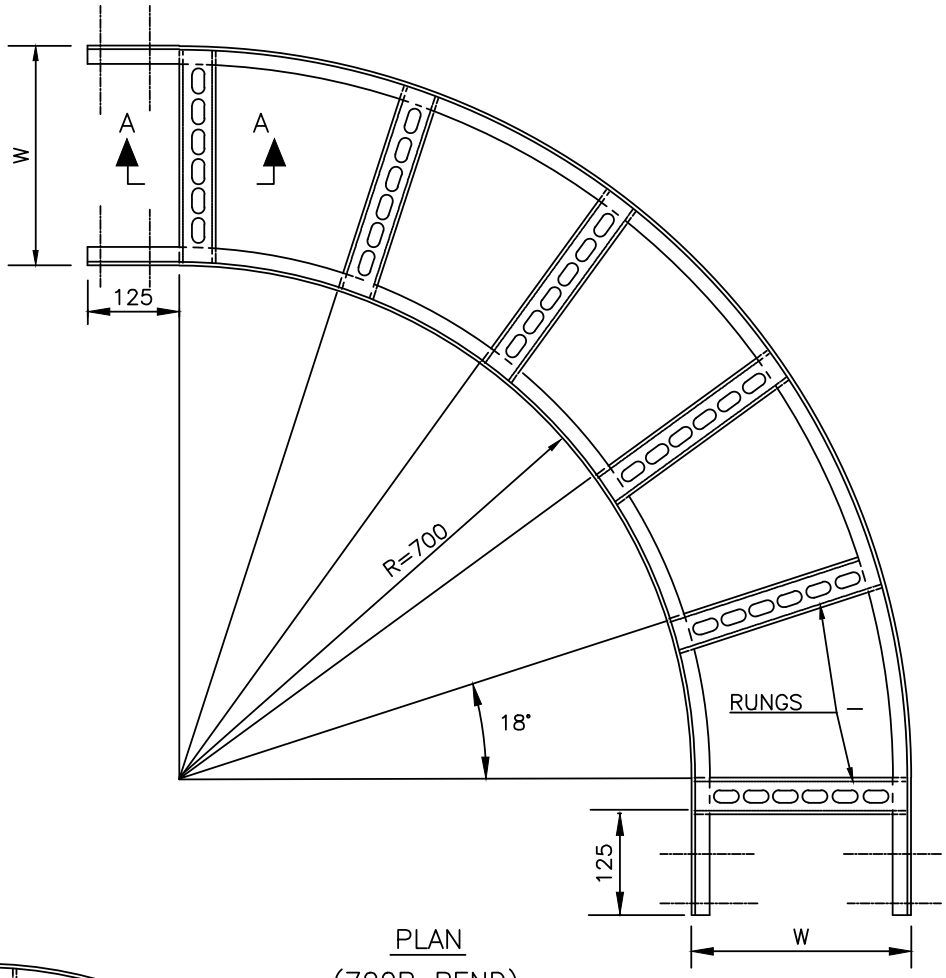
PLAN

DESIGN TYPE	W	X=R+W+125	Z=2R+W+250
HC 900	900	1725	2550
HC 600	600	1425	2250
HC 450	450	1275	2100
HC 300	300	1125	1950

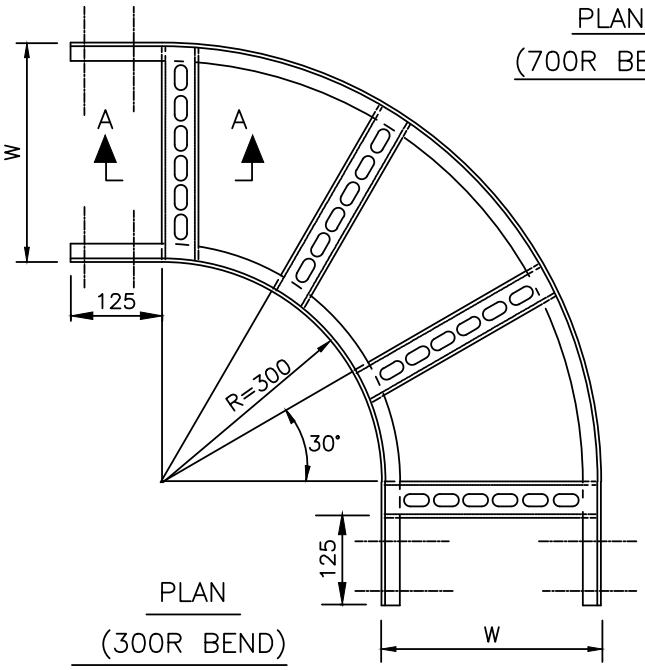
NOTES :–

1. DISTANCE BETWEEN TWO RUNGS SHOULD BE APPROX. 300mm.
2. ALL DIMENSIONS ARE IN mm.

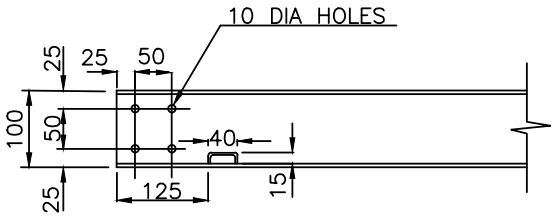
पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY 90° HORIZONTAL BENDS	PC183 –PDS:E 533	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



PLAN
(700R BEND)



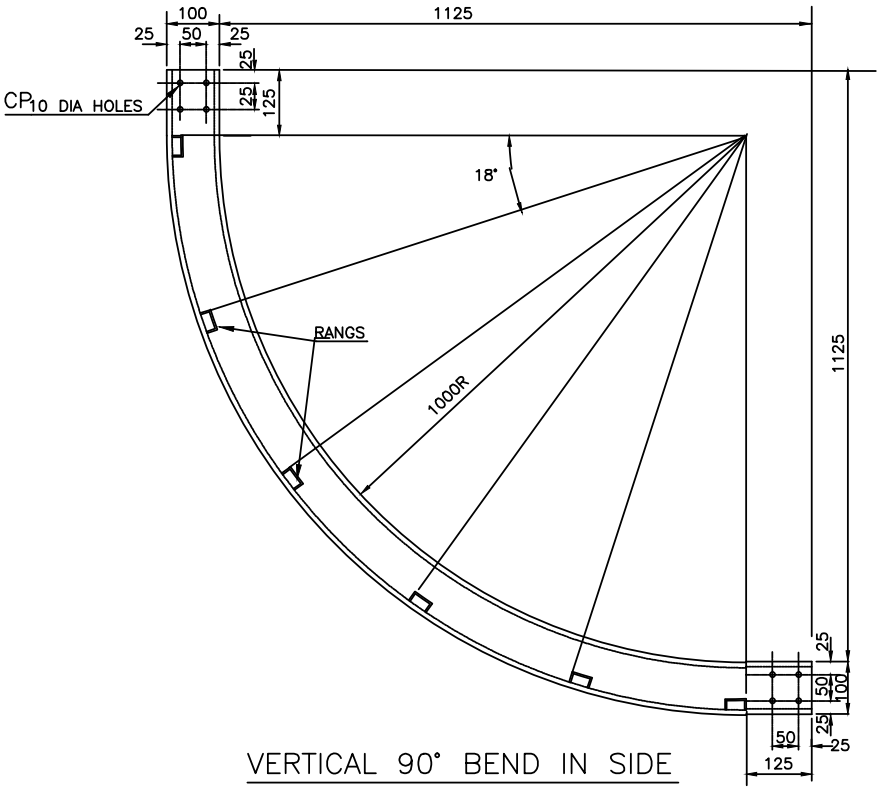
PLAN
(300R BEND)



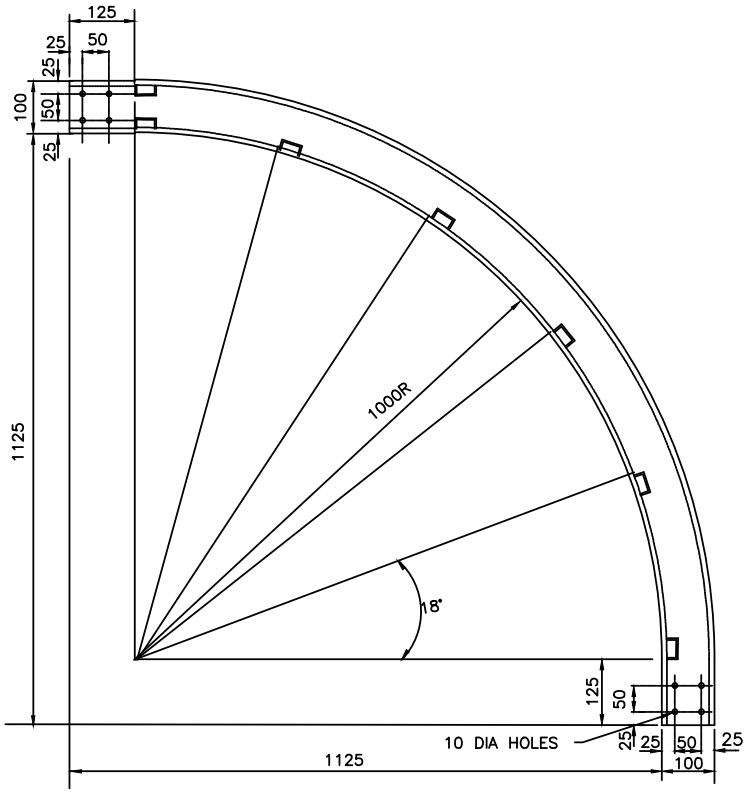
SECTION A–A

ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY 90° VERTICAL BEND BENDING RADIUS 1000 mm	PC183–PDS:E 534	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



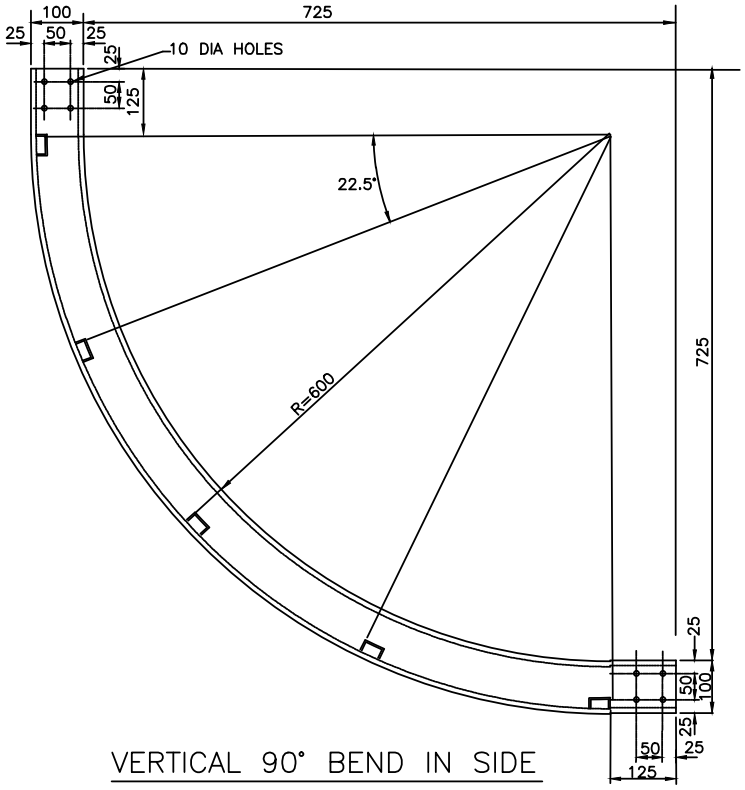
VERTICAL 90° BEND IN SIDE



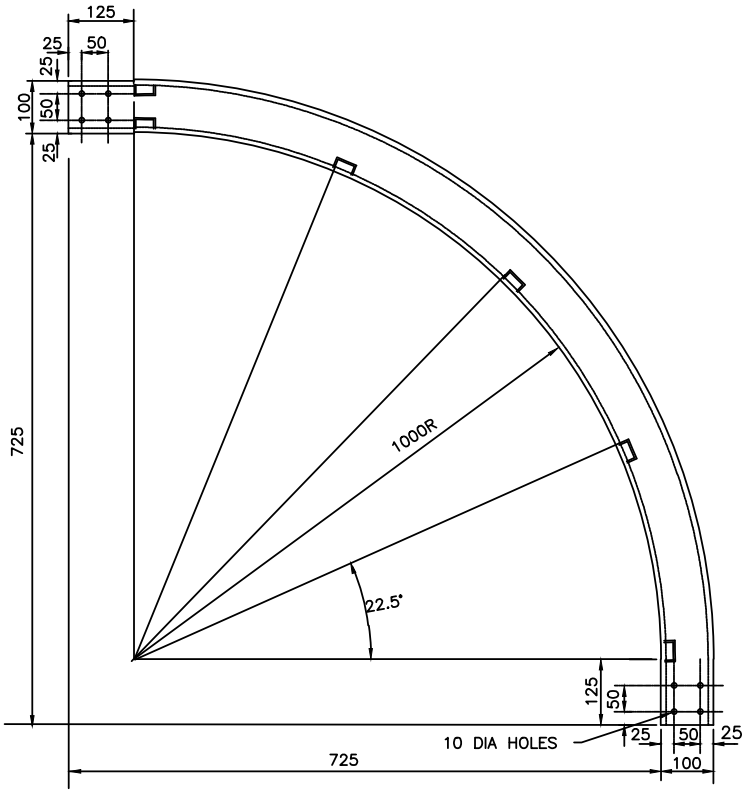
VERTICAL 90° BEND OUT SIDE

DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY 90° VERTICAL BENDS BENDING RADIUS 600 mm	PC183–PDS:E 535	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



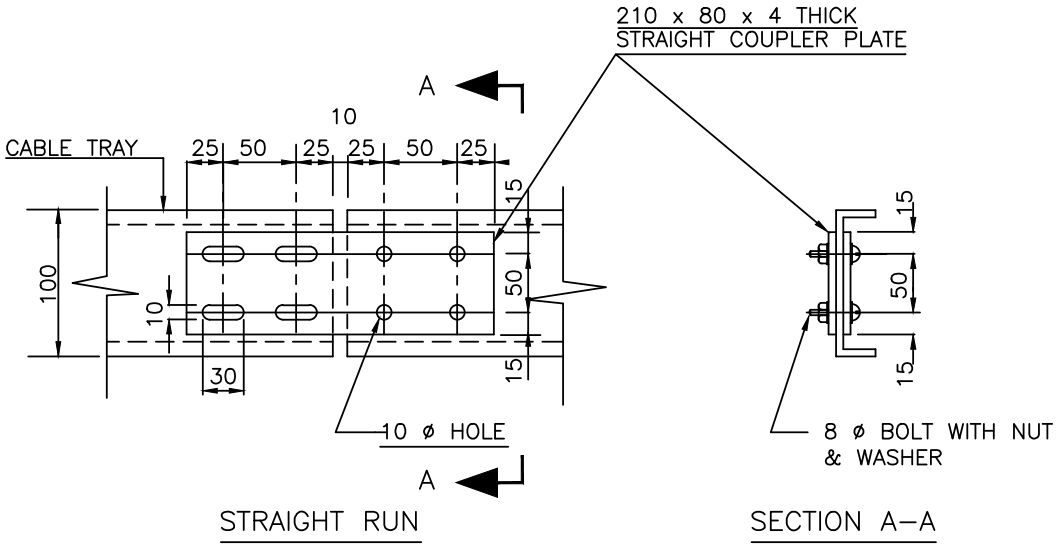
VERTICAL 90° BEND IN SIDE



VERTICAL 90° BEND OUT SIDE

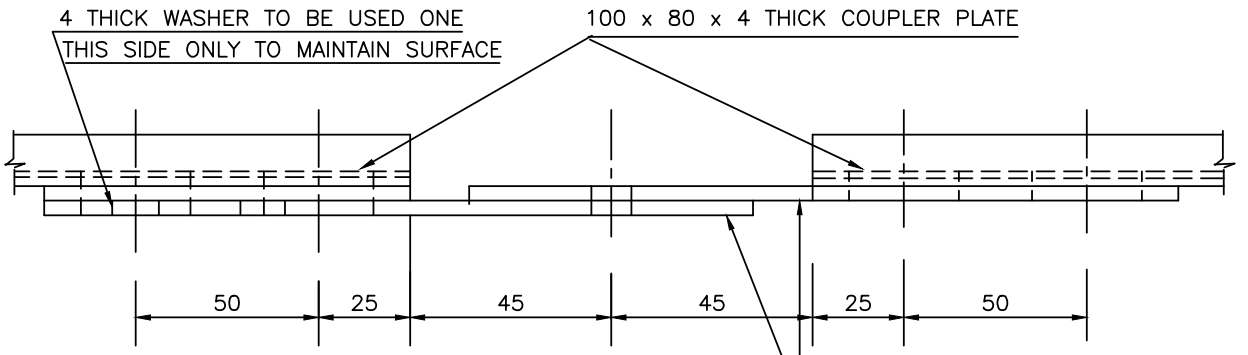
ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY COUPLING ARRANGEMENT	PC183-PDS:E 536	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

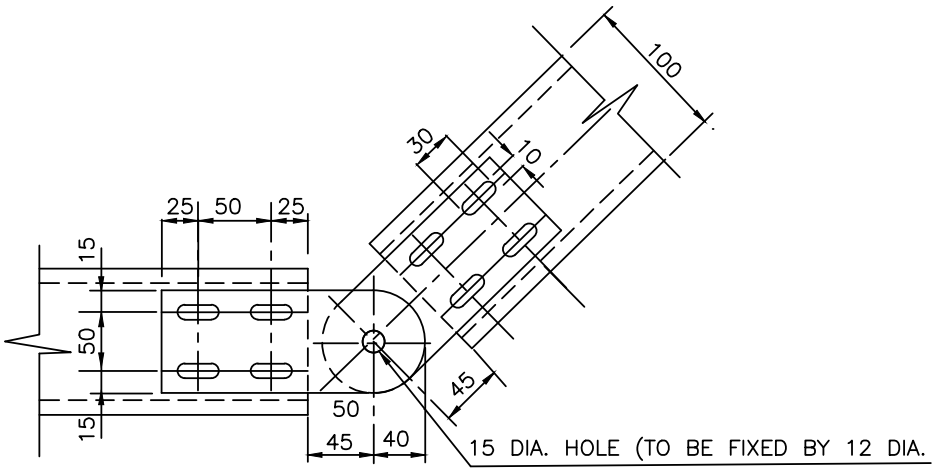


STRAIGHT RUN

SECTION A–A



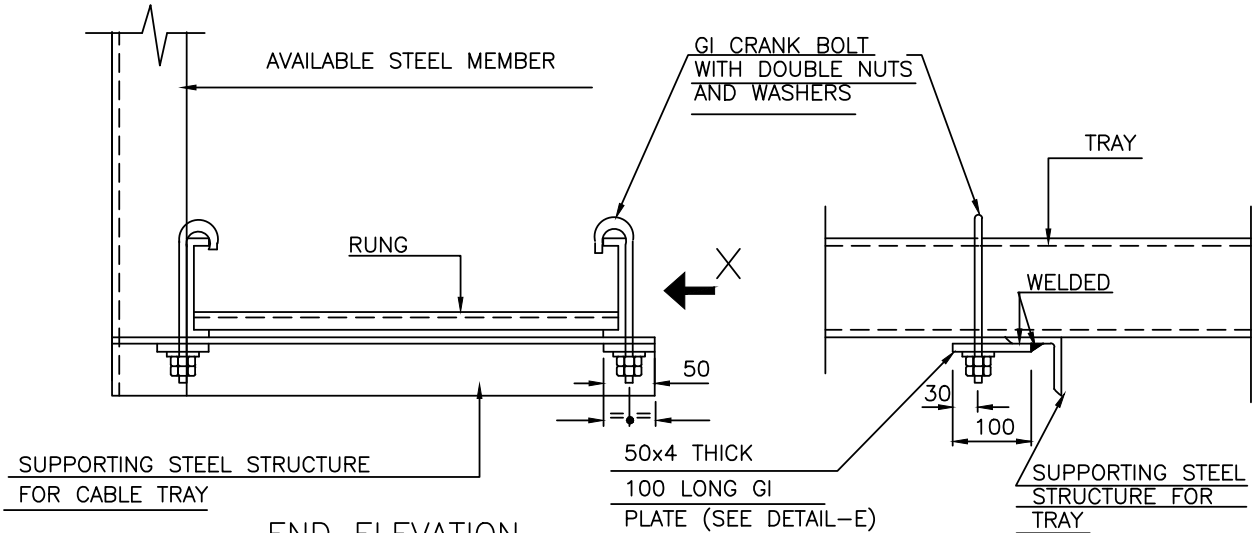
PLAN
(VIEW FORM B–B)



ELEVATION
(ADJUSTABLE BEND)

ALL DIMENSIONS ARE IN mm.

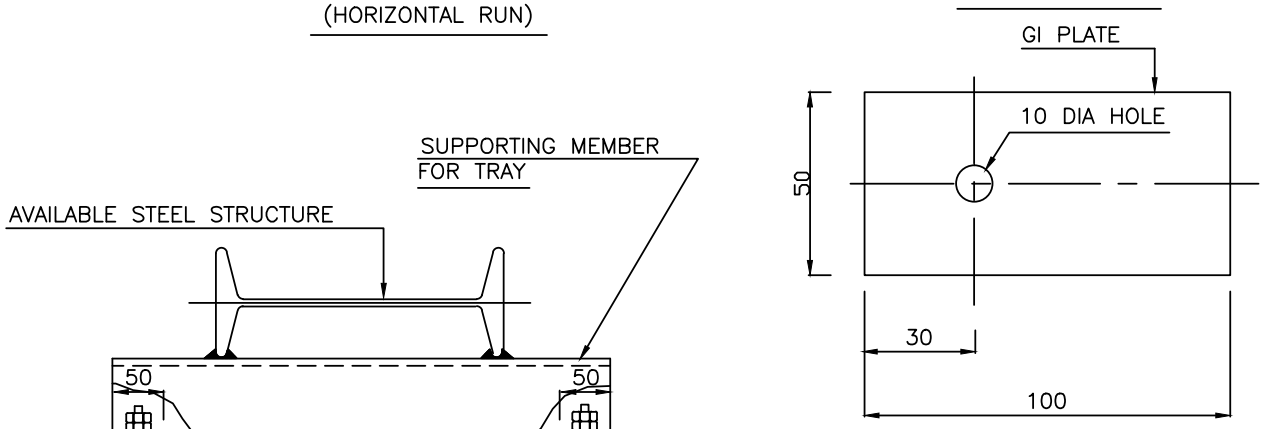
PDIL	PRE–FABRICATED CABLE TRAY FIXING ARRANGEMENT	PC183-PDS:E 537	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



END ELEVATION

(HORIZONTAL RUN)

VIEW AT –X

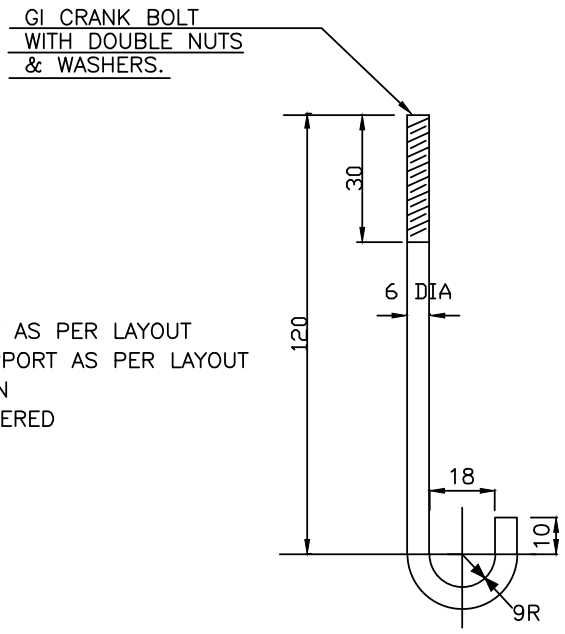


PLAN

DETAIL–E

PLAN

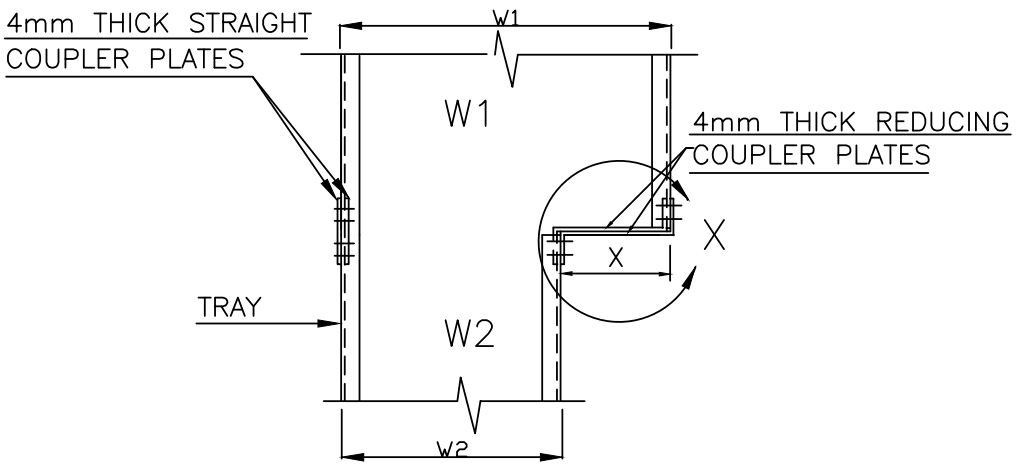
VERTICAL RUN (RISER)



NOTES:–

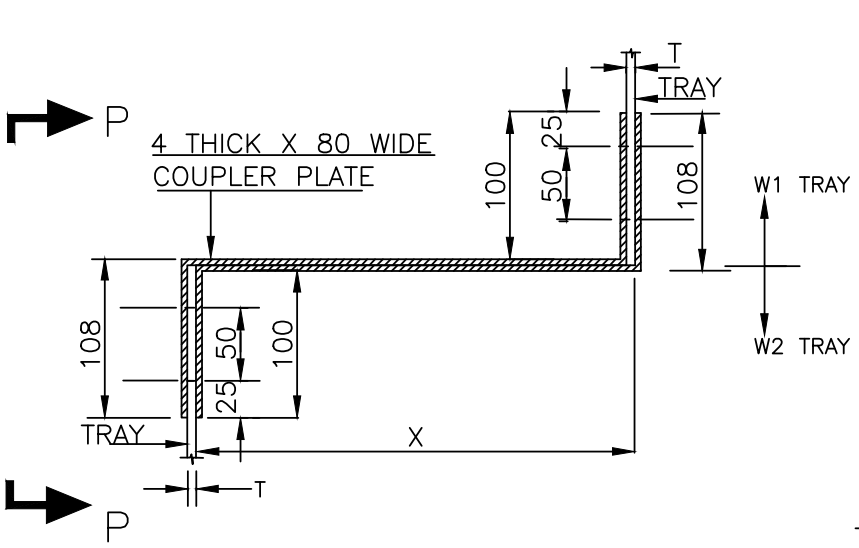
1. HORIZONTAL RUN TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
2. VERTICAL RUN/ RISER TO BE CLAMPED WITH EVERY SUPPORT AS PER LAYOUT
3. EACH CRANK HOOK SHALL BE SUPPLIED WITH ONE PLAIN WASHER, ONE SPRING WASHER AND TWO DOUBLE CHAMFERED HEX NUTS. THESE SHAL BE GALVANISED ITEMS.
4. ALL DIMENSIONS ARE IN mm.

पी डी आई एल PDIL	PRE–FABRICATED CABLE TRAY REDUCING COUPLER PLATE	PC183–PDS:E 538	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



PLAN

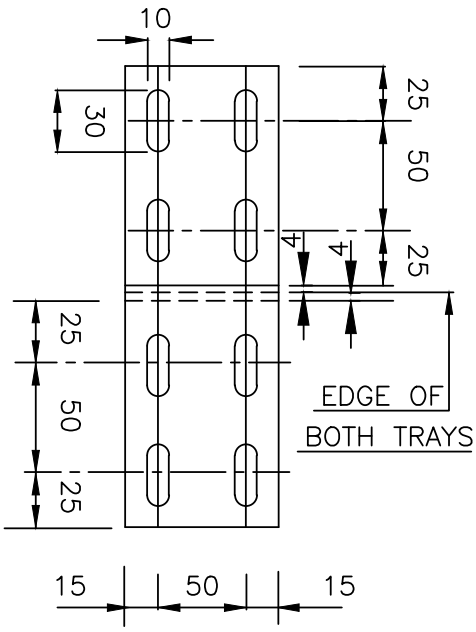
(REDUCING TRAY JOINT)



DETAIL– X

DETAIL OF REDUCING

COUPLER PLATE (4 THICK)



VIEW – P–P

ALL DIMENSIONS ARE IN mm.

SL. NO.	W1	W2	X
1	900	600 450 300	300 450 600
2	600	450 300	150 300
3	450	300 150	150 300

PDIL	GENERAL NOTES ON EARTHING AND LIGHTNING PROTECTION	PDSE: 601	0
		DOCUMENT NO.	REV
		SHEET 1 OF 2	

A. GENERAL

1. EARTHING AND LIGHTNING PROTECTION SHALL BE CARRIED OUT IN ACCORDANCE WITH IS : 3043 AND IS : 2309 RESPECTIVELY AND SHALL ALSO CONFORM TO THE REQUIREMENTS OF INDIAN ELECTRICITY RULES.
2. THESE NOTES SHALL BE READ IN CONJUCTION WITH EARTHING & LIGHTNING PROTECTION LAYOUT DRGS. AND RELEVENT EARTHING STANDARDS (PDS:E)
3. THE SIZE OF EARTH CONDUCTORS & SYMBOLS SHOWN IN THE LAYOUT DRGS. SHALL AS PER PDSE: 602
4. AS FAR AS POSSIBLE, THE EARTH CONDUCTORS SHALL BE TAKEN ALONG POWER & CONTROL CABLE ROUTES.
5. EARTHING CONDUCTORS BURIED UNDER THE GROUND SHALL BE LAID ATLEAST 500 MM BELOW THE GROUND LEVEL UNLESS REQUIRED OTHERWISE, e.g FOR CROSSING ANY UNDER GROUND PIPE OR TRENCH ETC. WHERE THE EARTHING CONDUCTORS SHALL RUN AT A MINIMUM DEPTH 300 MM BELOW THE BOTTOM OF THE PIPE/TRENCH.
6. BARE ALUMINIUM CONDUCTORS SHALL NOT BE BURIED DIRECTLY UNDER THE GROUND.
7. TAPPING FROM THE UNDER GROUND EARTH GRID SHALL BE TAKEN ONLY FROM EARTH PIT OR A PIT WITHOUT ELECTRODE PROVIDED FOR THIS PURPOSE.
8. JOINTING OF UNDERGROUND EARTHING STRIPS SHALL BE AVOIDED TO THE EXTENT POSSIBLE. HOWEVER, IF JOINTING IS TO BE DONE DUE TO UNAVOIDABLE REASONS, THIS SHALL BE DONE BY ELECTRIC ARC WELDING.
9. TERMINAL JOINTING & CLAMPING ARRANGEMENT SHALL BE AS SHOWN IN PDSE:603. ALL WELDED OR BOLTED JOINTS SHALL BE PAINTED WITH EPOXY RESIN PAINT OR BITUMINOUS PAINT.
10. EARTH BUSES, AS PER CONVENIENCE, SHALL BE PROVIDED IN PLANTS FOR EARTHING GROUPS OF EQUIPMENT TO EARTHING GRID. THESE EARTH BUSES, SHALL BE AS SHOWN IN PDSE: 615.
11. DETAILS OF EARTH PIT CONNECTIONS & ACCESSORIES FOR EARTH ELECTRODES SHALL BE AS SHOWN IN PDSE :604, 605 , 610 AND 611.
12. EARTH PITS FOR EQUIPMENT EARTHING, SYSTEM NEUTRAL EARTHING & LIGHTNING PROTECTION SHALL BE SEPARATE. HOWEVER, THESE PITS SHALL BE INTERCONNECTED.
13. SPACING BETWEEN TWO EARTH PITS SHALL NOT BE LESS THAN 10 M & THESE MAY BE LOCATED ABOUT 4M AWAY FROM THE BUILDING / STRUCTURE.
14. TYPICAL ARRANGEMENT OF NEUTRAL & EQUIPMENT EARTHING SHALL BE AS SHOWN IN PDSE: 617.

B. SYSTEM NEUTRAL EARTHING

1. THE NEUTRALS OF H.T & L.T SYSTEMS SHALL BE EARTHED BY USING 2 NOS. 150 SQ. MM ALUMINIUM CABLE OF RESPECTIVE VOLTAGE GRADE. EACH EARTH CONNECTION SHALL BE TERMINATED ON SEPERATE EARTH PITS. HOWEVER, FOR ECONOMY REASONS, 2 EARTH CONNECTIONS OF 2 DIFFERENT EQUIPMENT CAN BE TERMINATED ON THE SAME EARTH PIT AS SHOWN IN PDSE: 617.
2. THE NEUTRAL OF H.T. SYSTEM SHALL BE CONNECTED TO EARTH PIT AS ABOVE THROUGH THE NEUTRAL EARTHING RESISTOR (N.E.R.) AS REQUIRED, WHERE AS THE NEUTRAL OF L.T. SYSTEM SHALL BE SOLIDLY EARTHED THROUGH RESPECTIVE L.T. SWITCH BOARD.
3. FOR D.C. SYSTEM, POSITIVE POLE SHALL BE EARTHED THROUGH HIGH IMPEDANCE IN BATTERY CHARGER.

C. ELECTRICAL EQUIPMENT EARTHING

1. ALL EQUIPMENT RATED ABOVE 250V SHALL HAVE TWO EXTERNAL EARTH CONNECTIONS & THOSE RATED 250V & BELOW SHALL HAVE ONE EXTERNAL EARTH CONNECTION.

   FLAME PROOF EQUIPMENT, IN ADDITION, SHALL HAVE ONE INTERNAL EARTH CONNECTION THROUGH ADDITIONAL CORE OF POWER / CONTROL CABLE.

REV	REV.DATE	EFF.DATE	PURPOSE	PREPD	REVWD	APPD
0	03.01.07	15.01.07	ISSUED FOR IMPLEMENTATION	NKR	AV	BB

2. EARTHING CONNECTION TO INDIVIDUAL EQUIPMENT SHALL BE TAPPED ONLY FROM THE EARTHING GRID / RING OR EARTH BUS EXCEPT FOR EQUIPMENT RATED 250V & BELOW, FOR WHICH THE CONNECTION MAY BE TAKEN FROM THE NEAR BY EARTH CONDUCTOR OF A LARGER EQUIPMENT OR FROM THE BODY OF THE LARGER EQPT.
3. EARTHING ARRANGEMENT OF MOTOR AND ASSOCIATED LOCAL CONTROL STATION SHALL BE AS SHOWN IN PDSE: 608.
4. EARTHING ARRANGEMENT OF RAILS SHALL BE AS SHOWN IN PDSE: 609 WITH BOTH ENDS EARTHED.
5. CABLES RACKS/RISERS/TRAYS SHALL BE ELECTRICALLY CONTINUOUS BY BONDING THE JOINTS BETWEEN THE RUNNER MEMBERS OF THE ADJACENT SECTIONS. THE CABLE RACKS SHALL BE CONNECTED TO THE EARTHING GRID AT SUITABLE INTERVALS.
6. EARTHING ARRANGEMENT OF LIGHTING FIXTURES & PLUG SOCKETS RATED 250V AND BELOW SHALL NOT BE SHOWN IN THE EARTHING LAYOUT DRGS. HOWEVER, PLUG SOCKETS SHALL BE EARTHED BY 10 SWG SIZE G.I./AL. CONDUCTOR TAKEN FROM THE NEAREST EARTHING GRID/CONDUCTOR AND LIGHTING FIXTURES SHALL BE PROVIDED EARTHING THROUGH CABLE ARMOURS.
7. IN SWITCH YARD AND GENERATING STATIONS SUITABLE EARTHING MAT SHALL BE PROVIDED TO REDUCE THE VALUE OF STEP/TOUCH POTENTIAL TO PERMISSIBLE VALUE.
8. SWITCH YARD FENCE SHALL BE CONNECTED TO EARTH AT A REGULAR INTERVAL, NOT EXCEEDING 10 M.

D. STATIC EARTHING

1. ALL PROCESS EQUIPMENT WHICH ARE LIKELY TO GET STATICALLY CHARGED, e.g. STORAGE TANKS, HIGH PRESSURE & MIDIUM PRESSURE VESSELS/PIPES, HIGH PRESSURE COMPRESSORS. HIGH PRESSURE STEAM EJECTORS ETC. SHALL BE EARTHED AGAINST STATIC CHARGE ACCUMULATION.
2. EARTHING ARRANGEMENT ACROSS PIPE JOINTS/VALVES SHALL BE AS SHOWN IN PDSE: 612
3. DETAILS OF EARTHING OF VESSELS SHALL BE AS SHOWN IN PDSE: 613.
4. MOBILE EQUIPMENT, REQUIRING EARTHING AGAINST STATIC CHARGE, SHALL BE TEMPORARILY EARTHED AS SHOWN IN PDSE: 608.
5. PIPE TRESTLE CARRYING PIPES WITH HYDRO CARBONS SHALL BE CONNECTED TO EARTH GRID AT REGULAR INTERVALS, NOT EXCEEDING 25 M.
6. WHEREVER PROCESS EQUIPMENT ARE MOUNTED ON STEEL STRUCTURE, THE BASE OF THE STRUCTURES SHALL BE EARTHED INSTEAD OF EARTHING THE INDIVIDUAL EQUIPMENT.

E. LIGHTNING PROTECTION

1. FIXING ARRANGEMENT ON AIR TERMINATION AND ROOF/DOWN CONDUCTOR FOR LIGHTNING PROTECTION SYSTEM SHALL BE AS SHOWN IN PDSE: 614.
2. FOR LIGHTNING PROTECTION OF TALL STEEL STRUCTURES/VESSELS/TANKS, DOWN CONDUCTOR SHALL BE TAKEN FROM THE BASE AND CONNECTED TO EARTH PITS. AIR TERMINATION ROD SHALL NOT BE REQUIRED.
3. LIFT SHAFT SHALL NOT BE USED FOR FIXING THE DOWN CONDUCTOR.
4. IN CASE EARTH PITS FOR CONNECTING THE DOWN CONDUCTORS ARE NOT AVAILABLE IN THE BEGINNING OF FABRICATION/ERECTION OF SUCH STRUCTURES/VESSELS / TANKS. THEIR BASES SHALL TEMPORARILY BE CONNECTED TO NEAR BY STEEL COLUMN. ELECTRICAL CONTINUITY OF THE STRUCTURES, HOWEVER, SHALL BE CHECKED AND ENSURED.
5. FOR ALL HIGH RISE CONCRETE STRUCTURES, TEMPORARY LIGHNING PROTECTION NEED BE PROVIDED DURING CONSTRUCTION AND MAINTAINED TILL PERMANENT LIGHTNING PROTECTION IS INSTALLED. FOR THIS PURPOSE THE VERTICAL REINFORCEMENT, PROJECTING OVER EACH LIFT, SHALL BE CONNECTED TO EARTH PITS BY MEANS OF 2 NOS. FLEXIBLE COPPER CONDUCTOR CABLES. EACH OF THE FLEXIBLE CABLE SHALL BE OF 95 Sq. mm SIZE HAVING ONE END PERMANENTLY CONNECTED TO EARTH PIT AND OTHER END PROVIDED WITH A CLAMP FOR CONNECTING TO THE EXPOSED REINFORCEMENT.

SL. No.	EQUIPMENT TO BE EARTHED	FAULT LEVEL (MVA)	G.I.STRIPS/WIRES			ALUMINIUM					REMARKS
			MIN.SIZE (mm^2)	SIZE TO BE USED (mm^2)	SYMBOL	MIN.SIZE (mm^2)	STRIPS/WIRES SIZE TO BE USED (mm^2)	STRIPS/WIRES SYMBOL	1.1kv PVC SINGLE CORE CABLE SIZE (mm^2)	1.1kv PVC SINGLE CORE CABLE SYMBOL	
1A.	FOR PLANTS HAVING SWITCHYARDS/ GENERATING STATION										
I.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	750 AT 11KV	706	2-50x8	2 (2)	491	2-38.1x6.35=484	2 (12)	500	21	AS PER CLAUSE 17.3.2 OF IS:3043
II.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	500 AT 11KV 300 AT 6.6KV 150 AT 3.3KV	471	60x8	1	328	50.8x6.35=323	11	400	22	-DO-
III.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	250 AT 6.6KV 125 AT 3.3KV	392	50x8	2	272	50.8x6.35=323	11	300	23	-DO-
IV.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	350 AT 11KV 200 AT 6.6KV 100 AT 3.3KV	330 314 314	50x8	2	229 218 218	38.1x6.35=242	12	240	24	-DO-
V.	SWITCH YARD EQUIPMENT,GENERATORS,H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	250 AT 11KV 150 AT 6.6KV 75 AT 3.3KV	235	50x6	3	163	31.75x4.78=152	13	185	25	-DO-
1B	FOR PLANTS WITHOUT SW.YARD/GENERATING STN. H.T.SWITCH BOARDS,TRANSFORMERS,MAIN EARTHING GRID, CONNECTION FROM EARTH BUS TO EARTHING GRID.	ANY FAULT LEVEL AT ANY VOLTAGE	210	50x6	3	120	38.1x3.18=121	14	120	27	AS PER CLAUSE 12.3.2 OF IS:3043
1C	ALL M.V.SWITCH BOARDS		210	50x6	3	120	38.1x3.18=121	14	120	27	AS PER CLAUSE 12.3.2 OF IS:3043
2	H.V. MOTORS		210	50x6	3	120	38.1x3.18=121	14	120	27	-DO-
3	TRANSFOMER NEUTRALS		-	-	-	120	-		150	26	-
4	M.V. MOTORS RATED 75KW & ABOVE		210	50x6	3	120	38.1x3.18=121	14	120	27	AS PER CLAUSE 12.3.2 OF IS:3043
5	M.V. MOTORS ABOVE 30KW &LESS THAN 75KW		175	35x6	4	93	31.75x3.18=101	15	95	28	-DO-

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EARTHING CONDUCTOR DETAILS

PC183-PDS:E 602

DOCUMENT NO.

REV. 0

SHEET 1 OF 2

SL. No.	EQUIPMENT TO BE EARTHED	FAULT LEVEL (MVA)	G.I.STRIPS/WIRES			ALUMINIUM					REMARKS
			MIN.SIZE (mm^2)	SIZE TO BE USED (mm^2)	SYMBOL	MIN.SIZE (mm^2)	STRIPS/WIRES		1.1kv PVC SINGLE CORE CABLE		
							SIZE TO BE USED (mm^2)	SYMBOL	SIZE (mm^2)	SYMBOL	
6	M.V.MOTORS ABOVE 5.5KW & LESS THAN 30KW 63A SW.SOCKETS,BATTERY CHARGERS,LIGHTING SUB–DIST.BDS.,D.C.BDS.		44	25x6	5	25	2 SWG=38.6	17	25	29	AS PER CLAUSE 12.3.2 OF IS:3043
7	M.V.MOTORS RATED 5.5KW & BELOW		7	8 SWG= 13	6	5	10 SWG=8.3	18	6	30	–DO–
8	ALL MINOR EQUIPMENT RATED FOR 250V & BELOW		–	10 SWG= 8.3	7	–	10 SWG=8.3	18	6	30	
9	NON ELECTRICAL EQUIPMENT,SUCH AS VESSELS STRUCTURES IN HAZARDOUS AREA & LIGHTNING PROTECTION CONDUCTORS		32x6	35x6	4	–	25.4x3.18=81	16	–	–	AS PER IS:2309

NOTE:–EARTHING CODUCTOR SIZES FOR ITEMS AT SL.No.4,5,6 & 7 SHOULD BE CHOSEN AS HALF THE POWER CABLE SIZES ACTUALLY USED.

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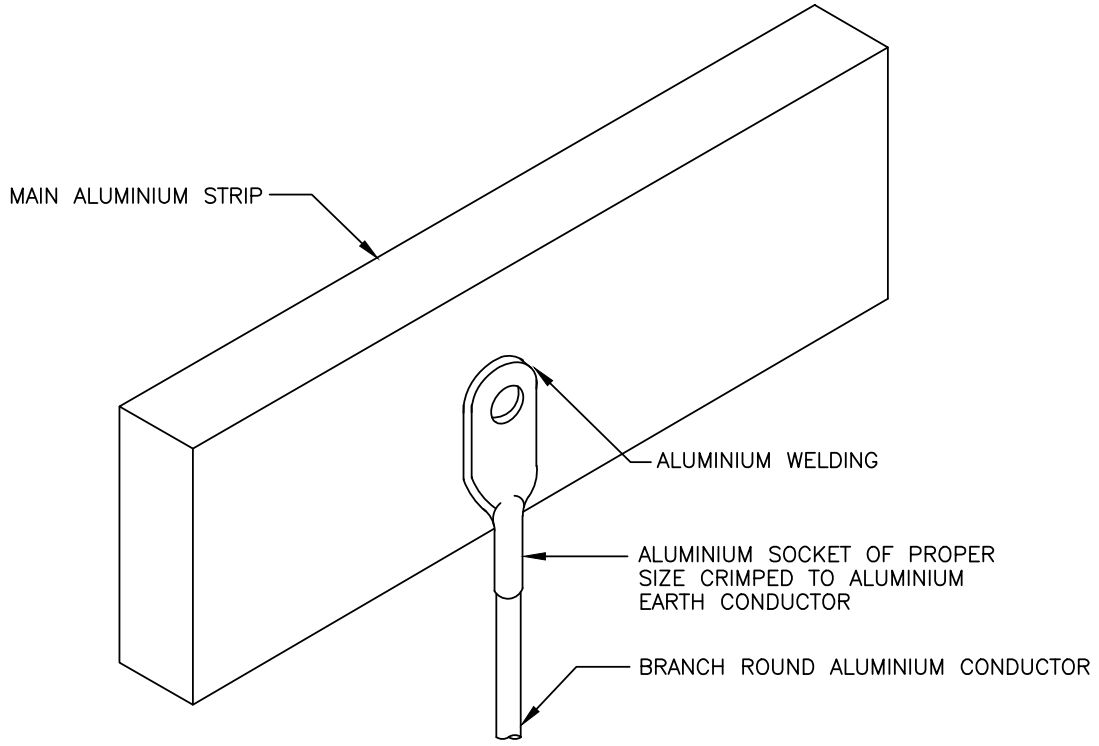
EARTHING CONDUCTOR DETAILS

PC183–PDS:E 602

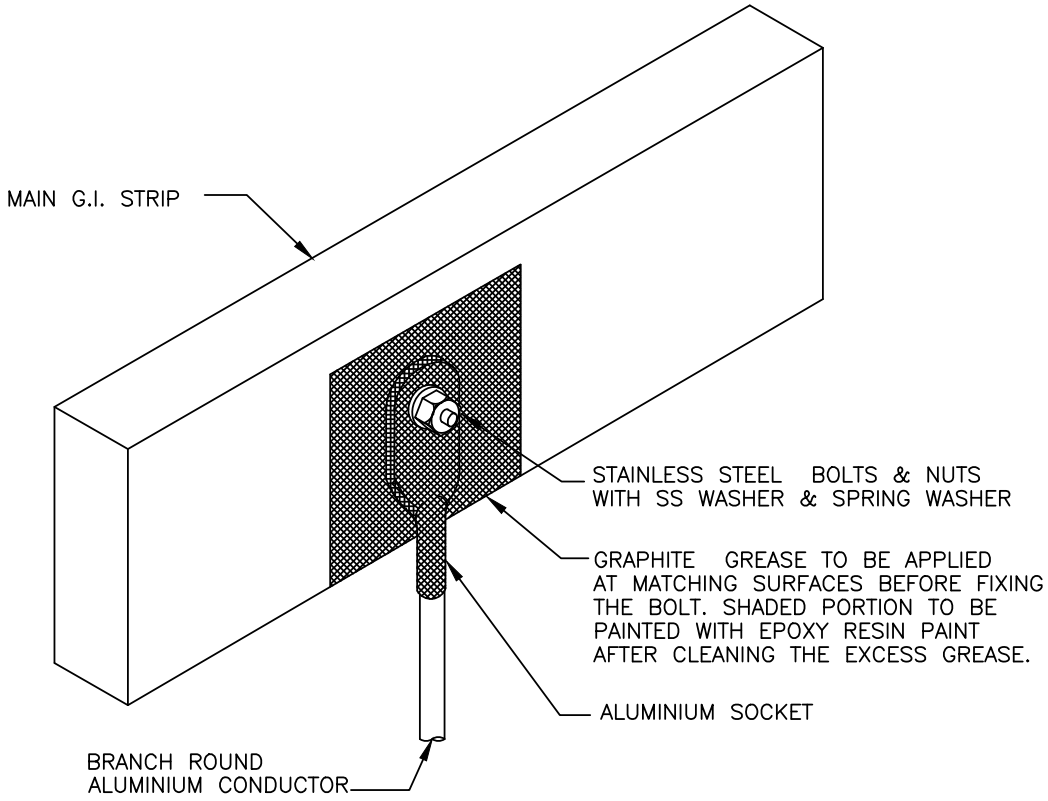
DOCUMENT NO.

REV. 0

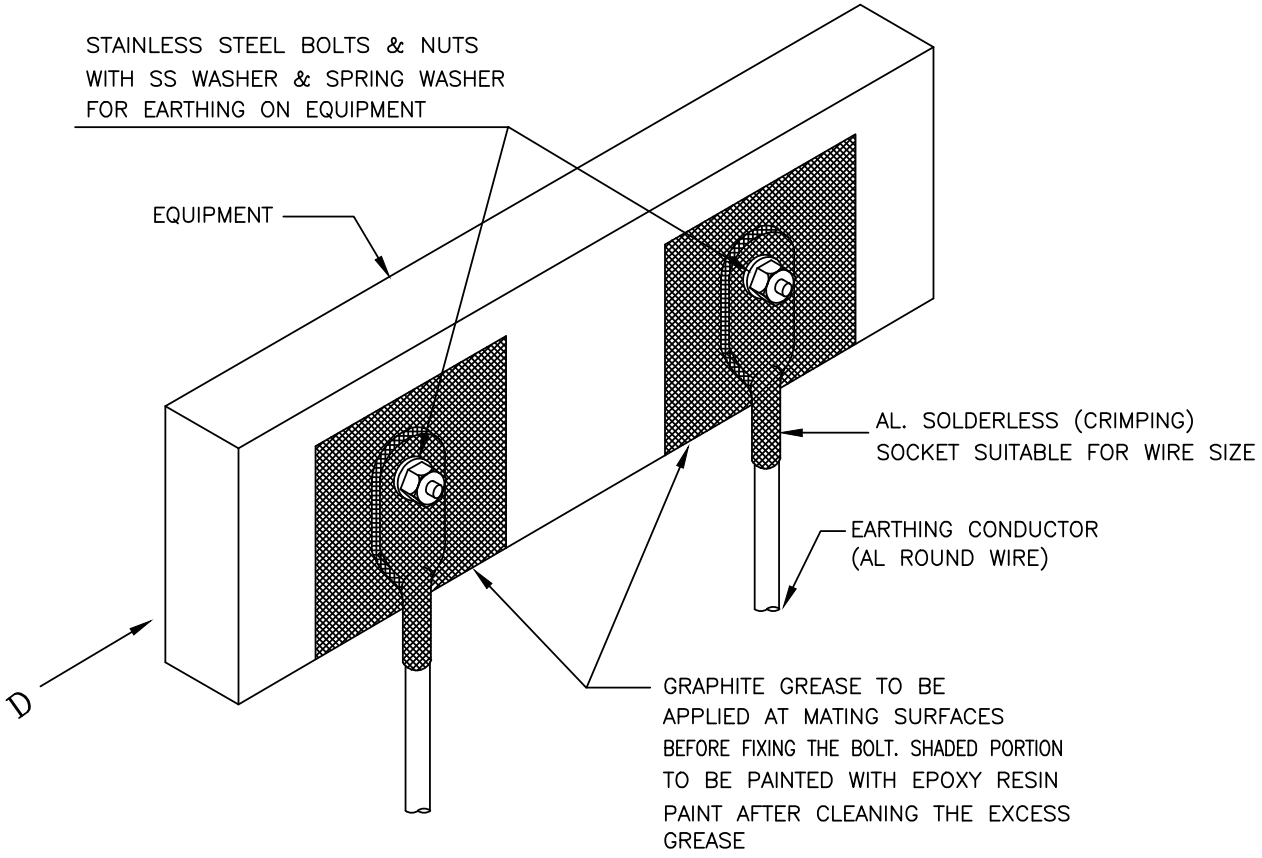
SHEET 2 OF 2



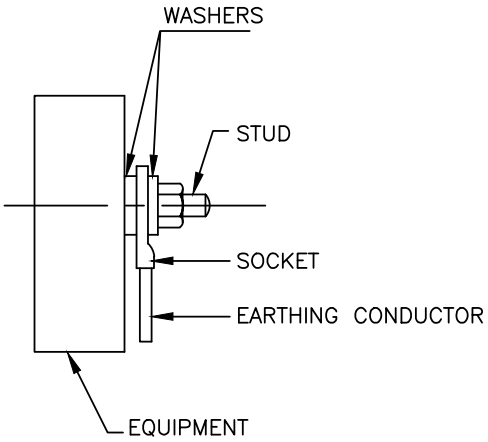
' T ' JOINT ALUMINIUM STRIP TO ROUND ALUMINIUM CONDUCTOR



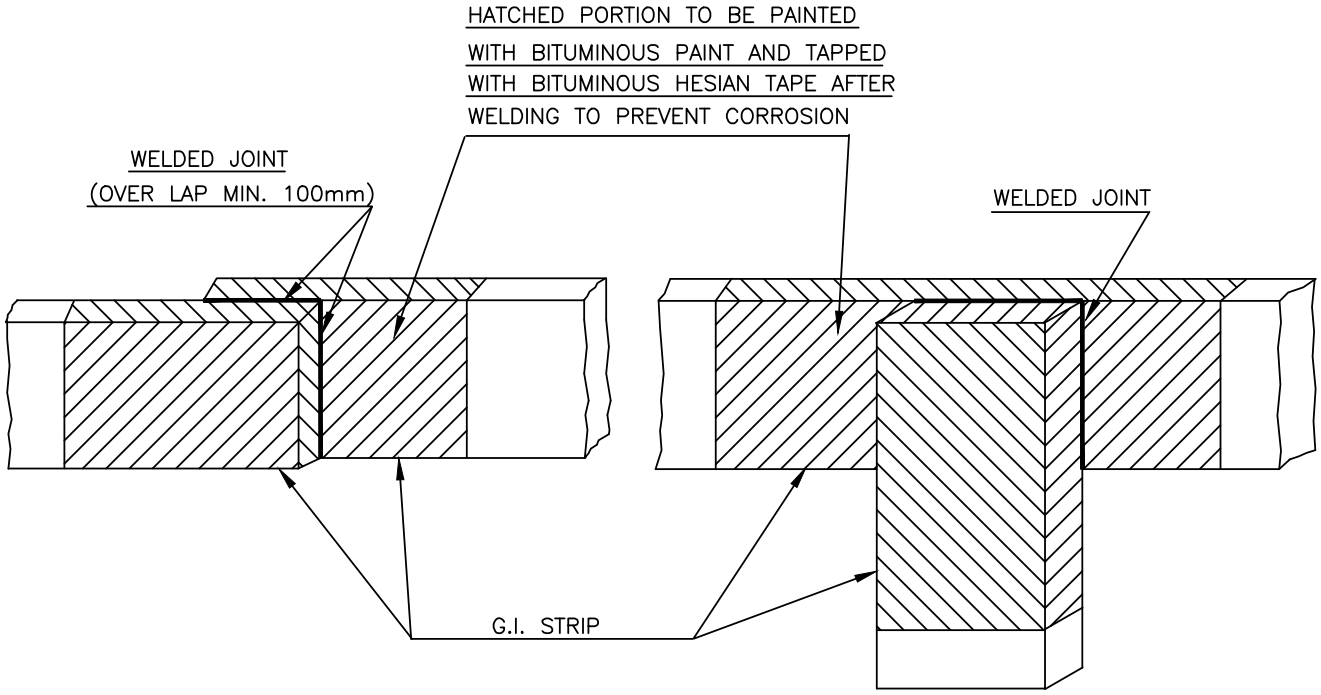
' T ' JOINT G.I. STRIP TO ROUND ALUMINIUM CONDUCTOR



ARRANGEMENT OF DOUBLE EARTH CONNECTIONS TO EQUIPMENT

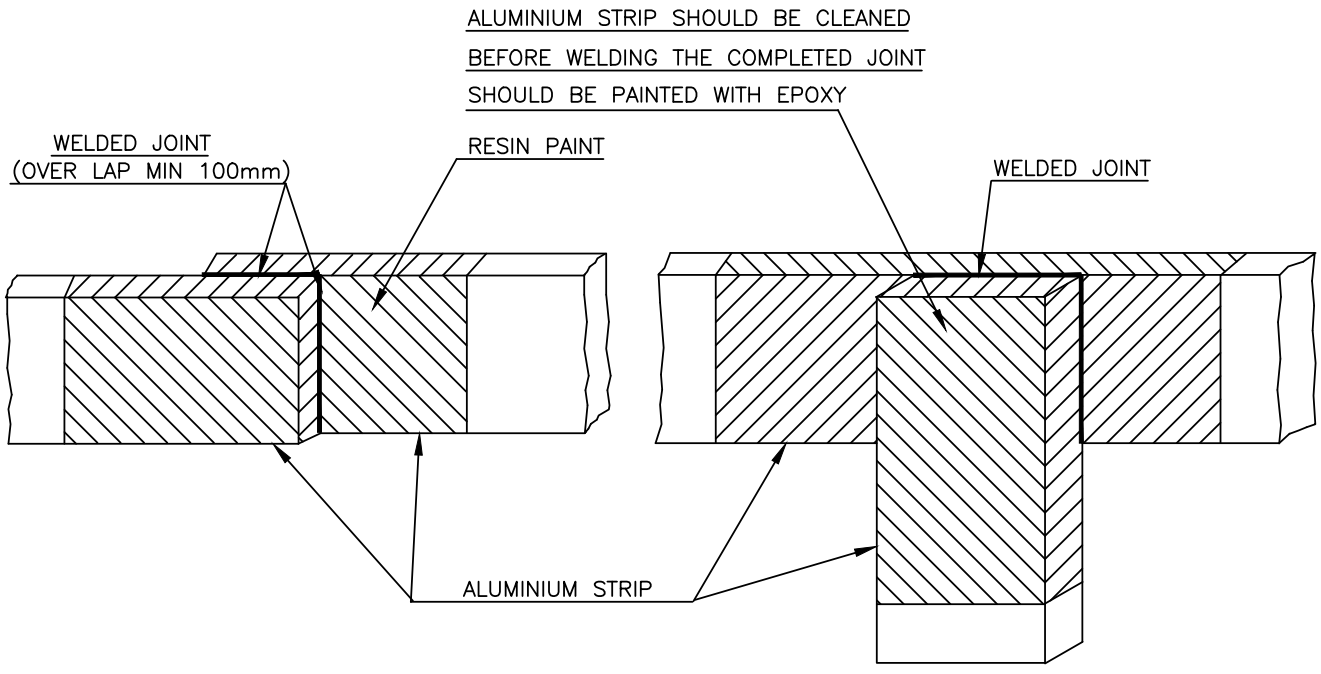


V I E W F R O M – D



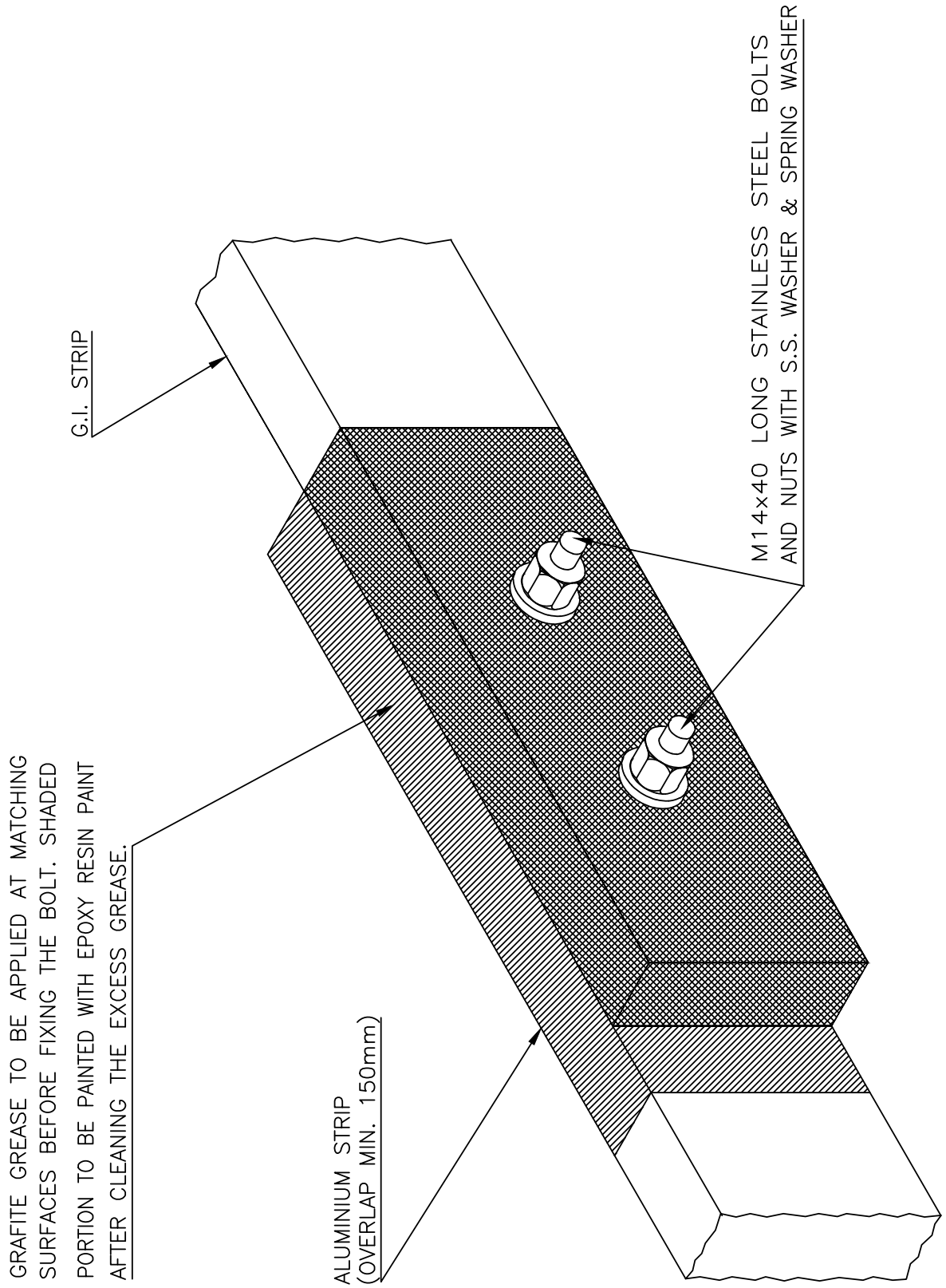
STRAIGHT JOINT G.I TO G.I. STRIP

" T " JOINT G.I. TO G.I. STRIP



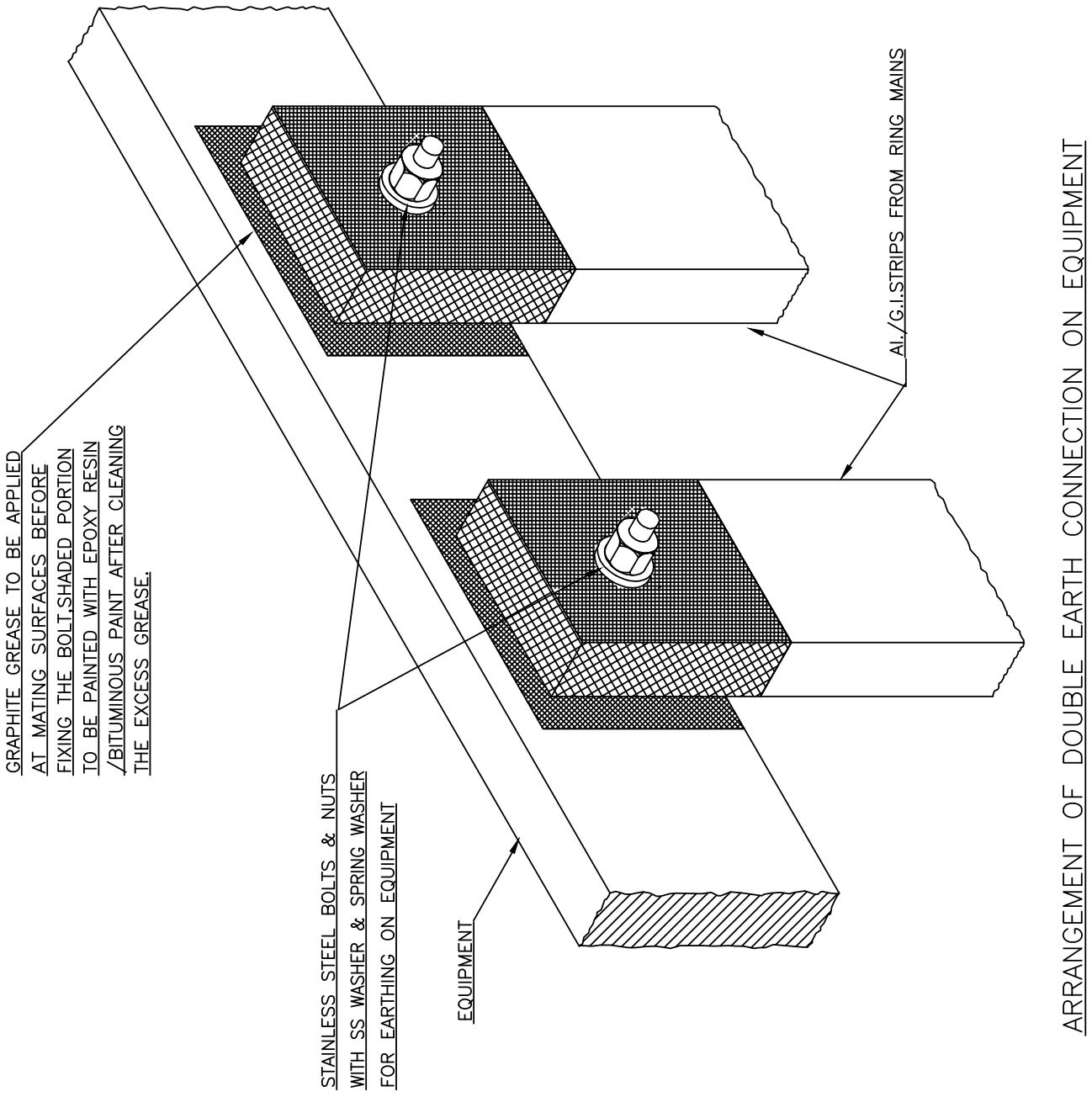
STRAIGHT JOINT AL. TO AL. STRIP

" T " JOINT AL TO AL STRIP



ARRANGEMENT OF LAP JOINT BETWEEN

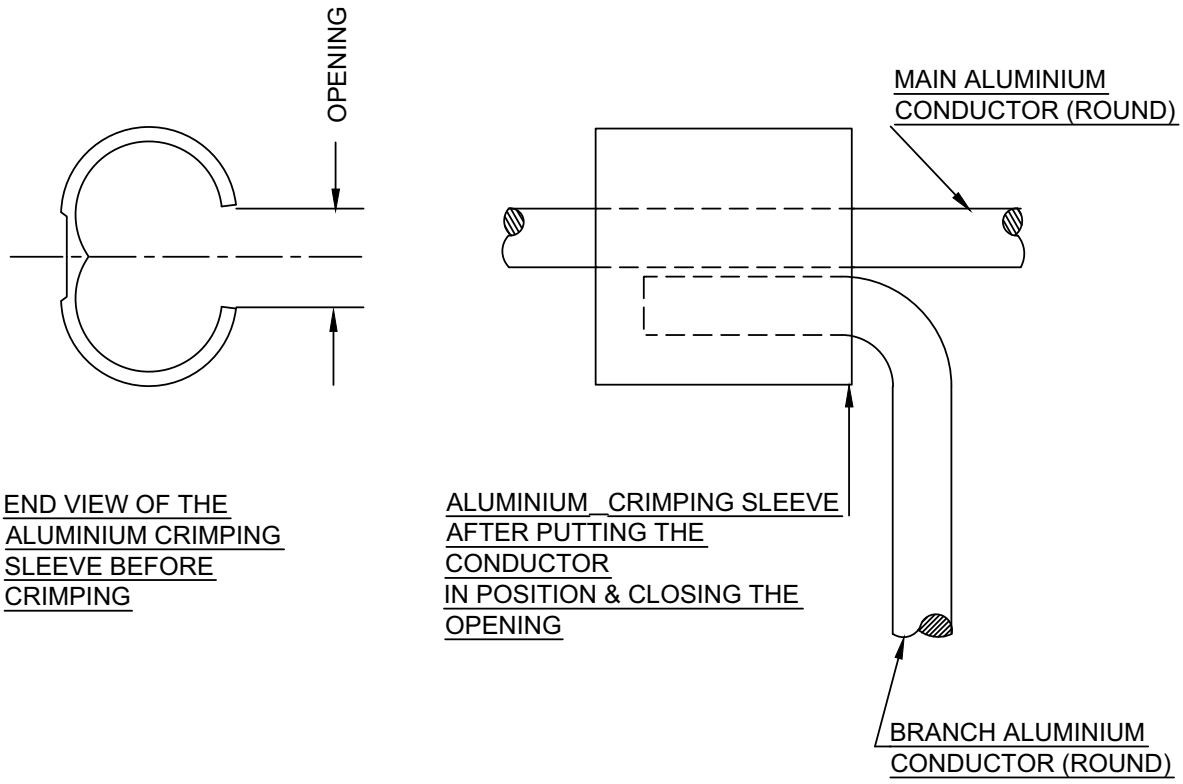
AI. EARTH STRIP TO G.I. EARTH STRIP



ARRANGEMENT OF DOUBLE EARTH CONNECTION ON EQUIPMENT

NOTE:-

EPOXY RESIN PAINT SHALL BE USED FOR AL STRIP AND BITUMINOUS PAINT FOR G.I.STRIP.

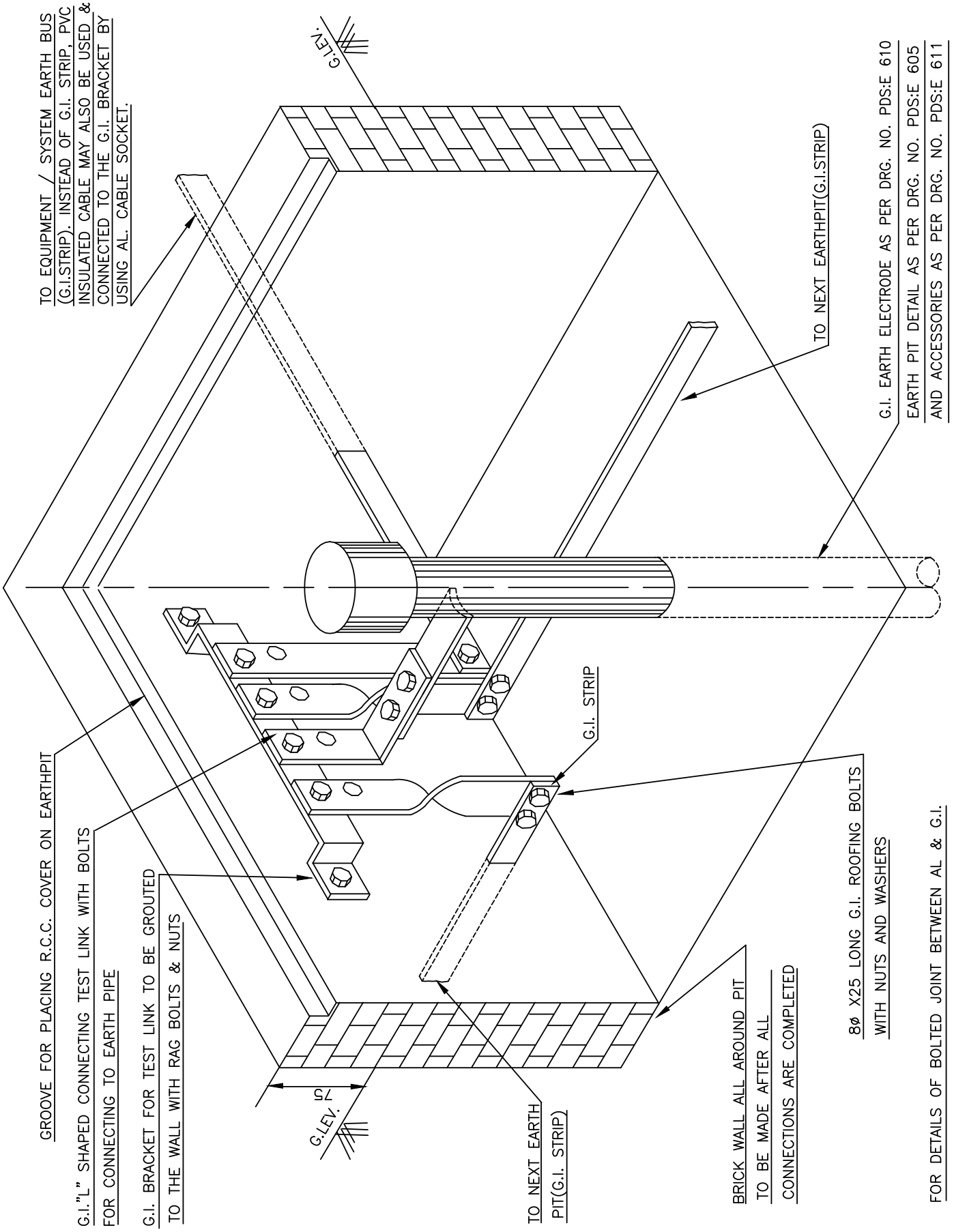


"T" JOINT ROUND ALUMINIUM CONDUCTOR TO ROUND ALUMINIUM CONDUCTOR (CRIMPING TYPE)

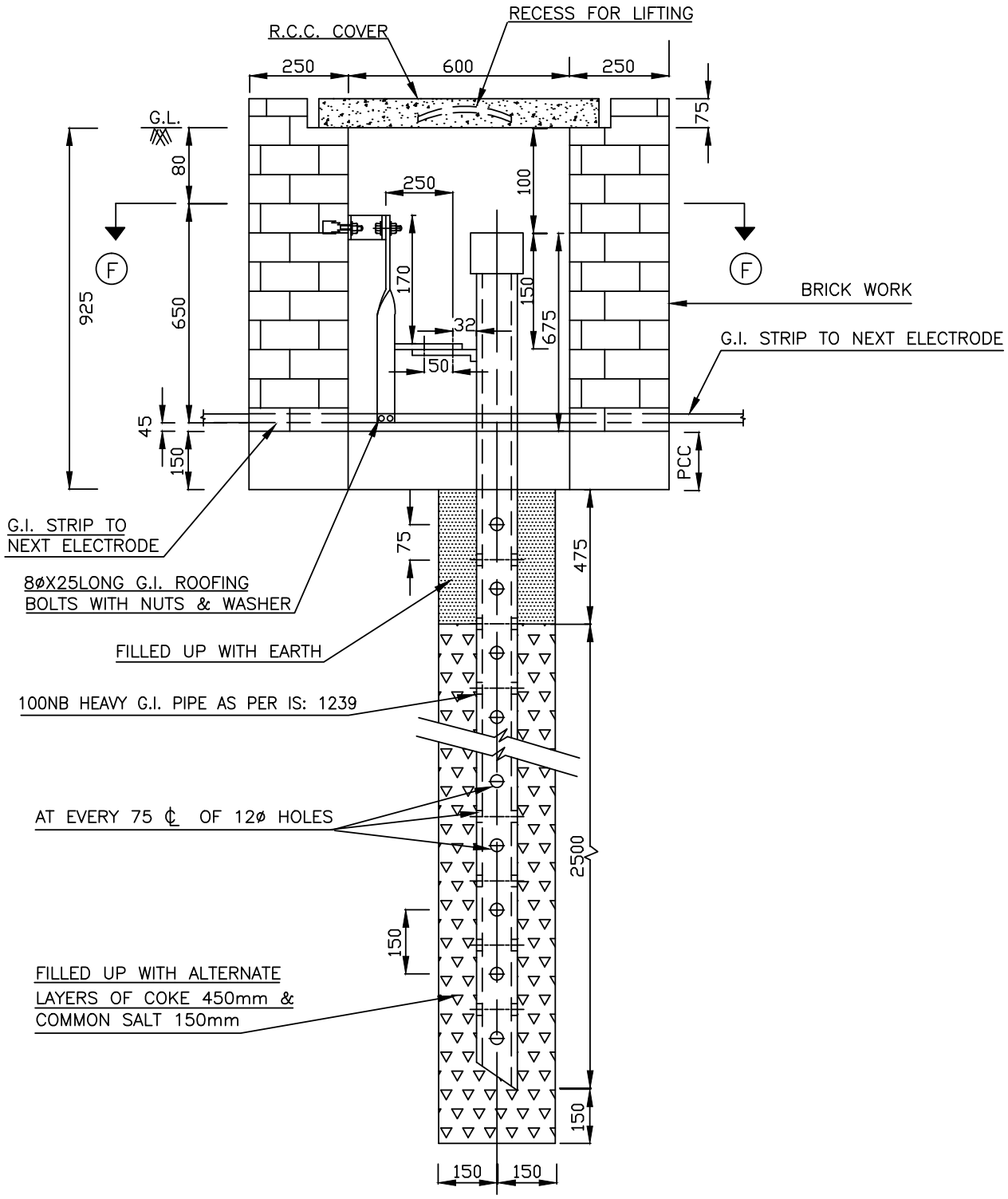
NOTE :-

USE CORRECT SIZE OF COMPRESSION DIES.

पी डी आई एल PDIL	TYPICAL DETAILS OF CONNECTIONS IN EARTH PIT	PC183–PDS:E 604	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

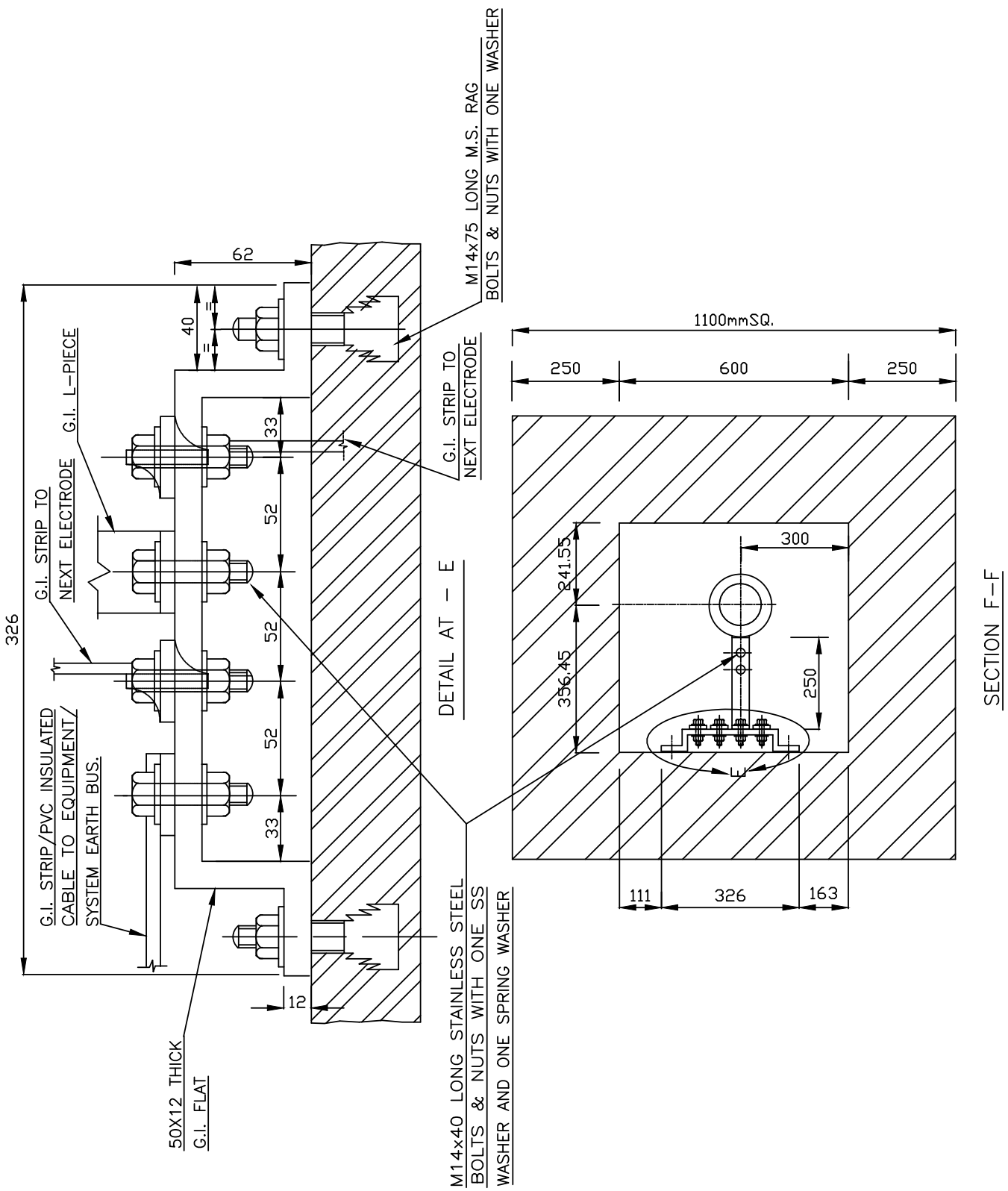


पी डी आई एल PDIL	EARTH PIT DETAILS	PC183-PDS:E 605	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	

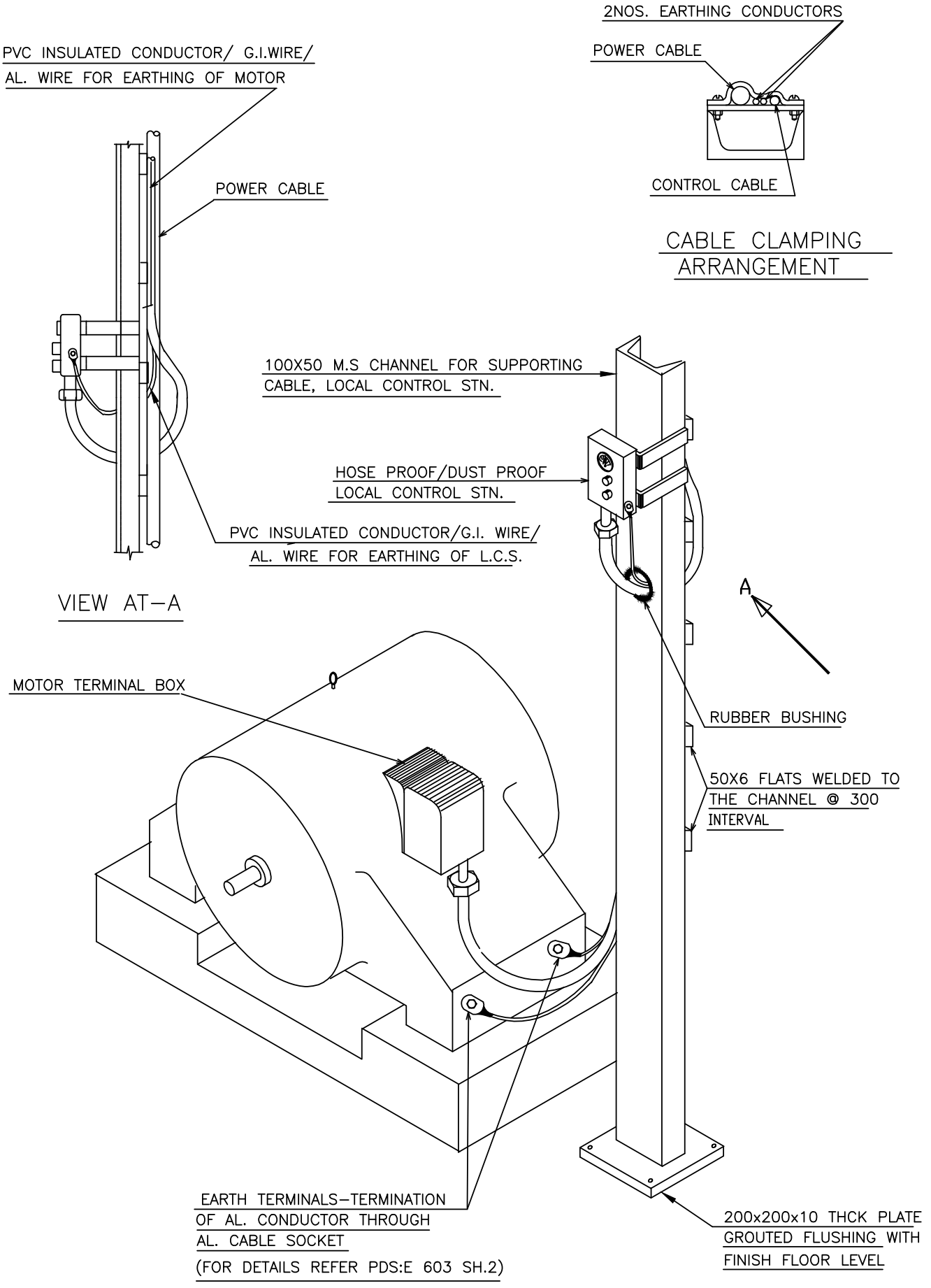


SECTIONAL ELEVATION OF EARTH PIT

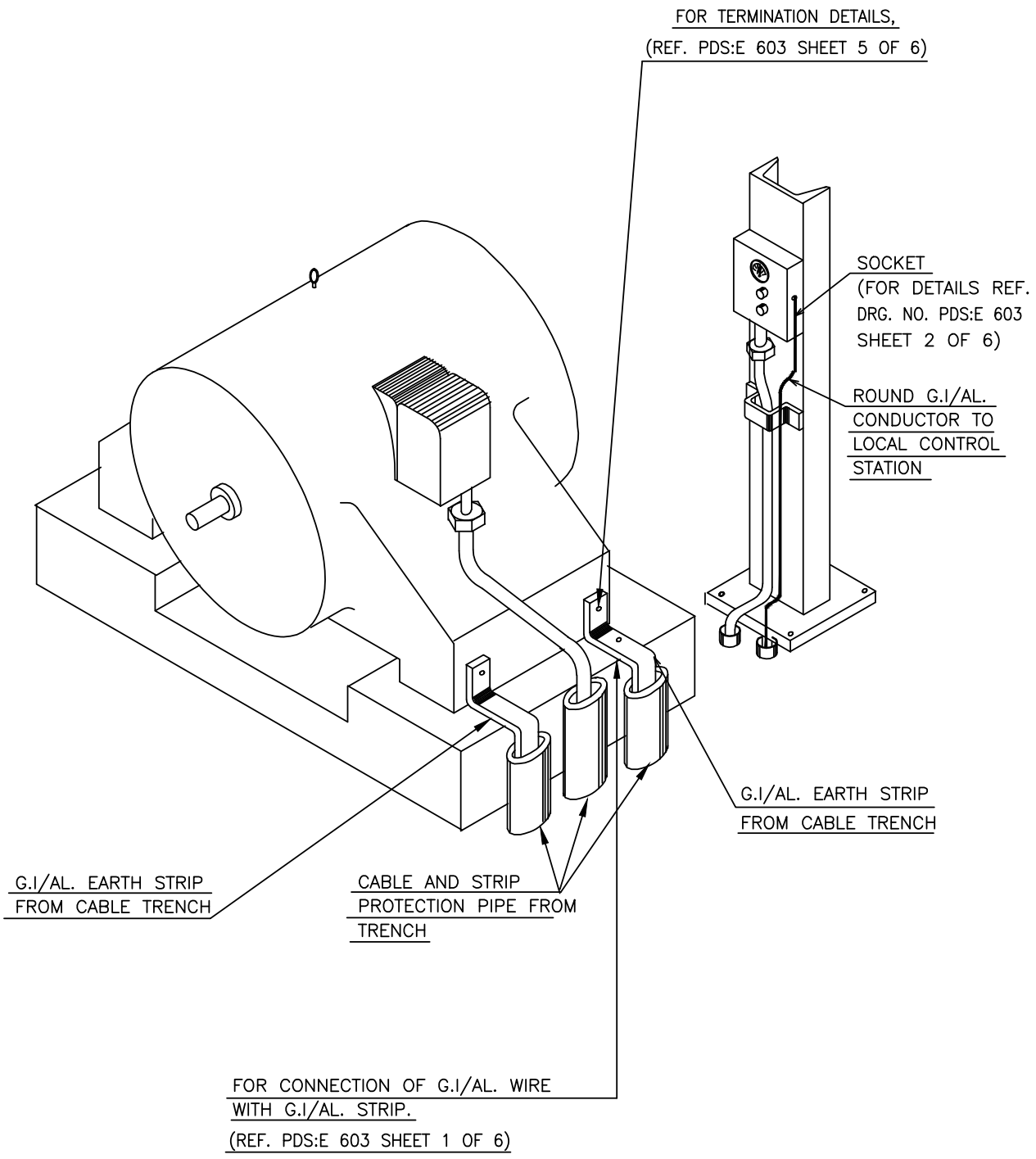
पी डी आई एल PDIL	EARTH PIT DETAILS	PC183-PDS:E 605	0
		DOCUMENT NO.	REV.
		SHEET 2 OF 2	



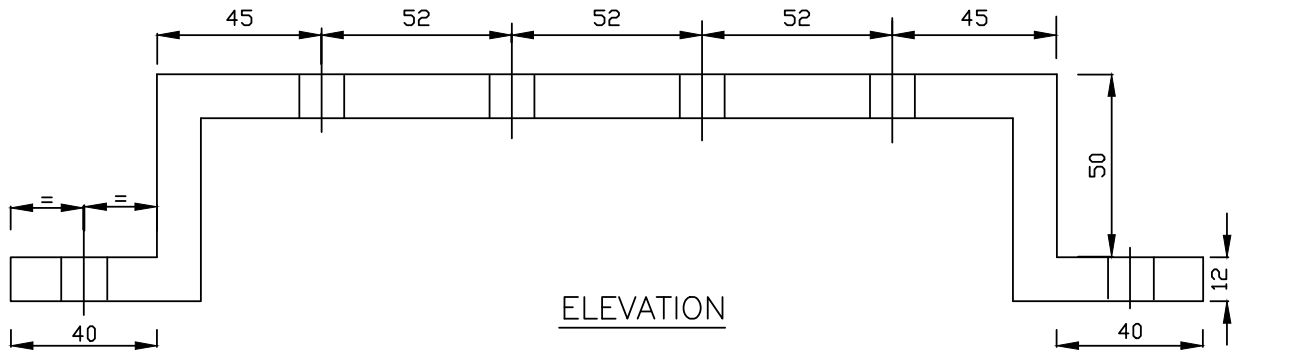
पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF EARTHING FOR MOTOR AND START STOP PUSH BUTTON STATION	PC183–PDS:E 606	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	



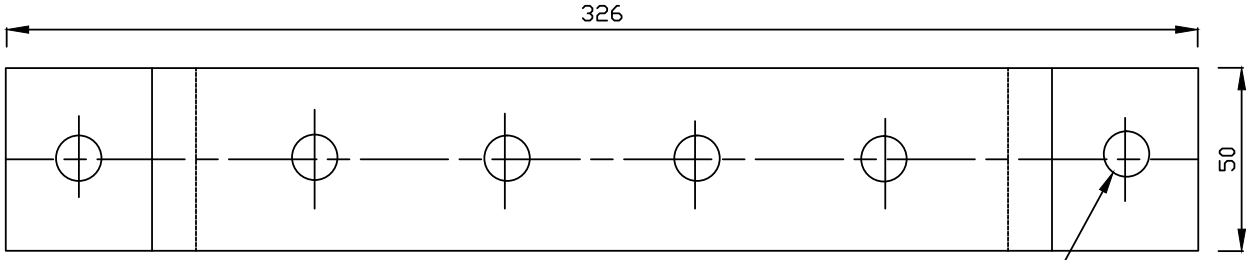
पी डी आई एल PDIL	TYPICAL ARRANGEMENT OF EARTHING FOR MOTOR AND START STOP PUSH BUTTON STATION	PC183-PDS:E 606	0
		DOCUMENT NO.	REV.
		SHEET 2 OF 2	



पी डी आई एल PDIL	GI / AL ACCESSORIES FOR EARTH PIT	PC183–PDS:E 611	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 2	



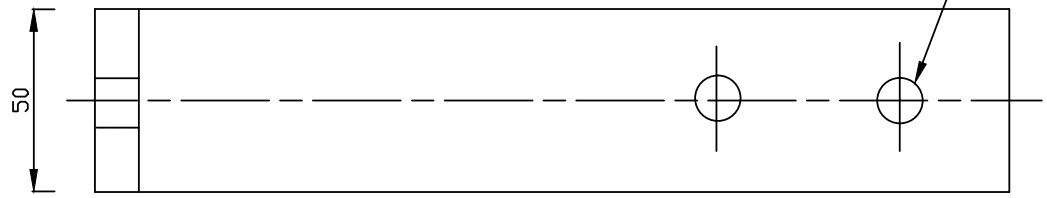
ELEVATION



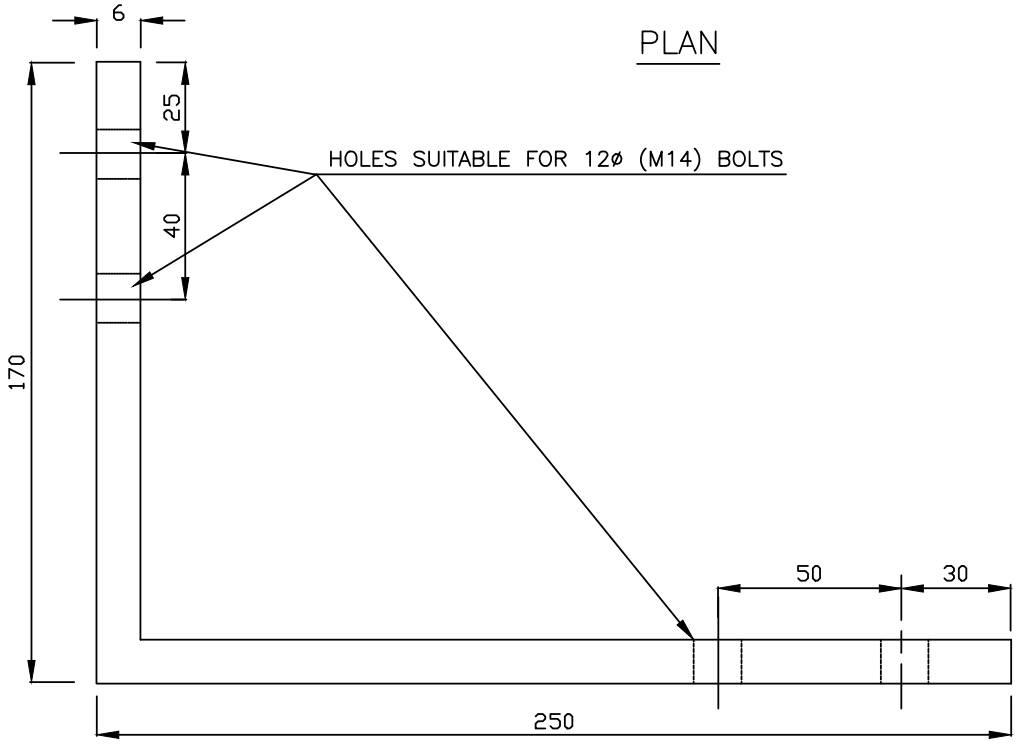
PLAN

HOLES SUITABLE FOR 12ø (M14) BOLTS

G.I. TEST LINK

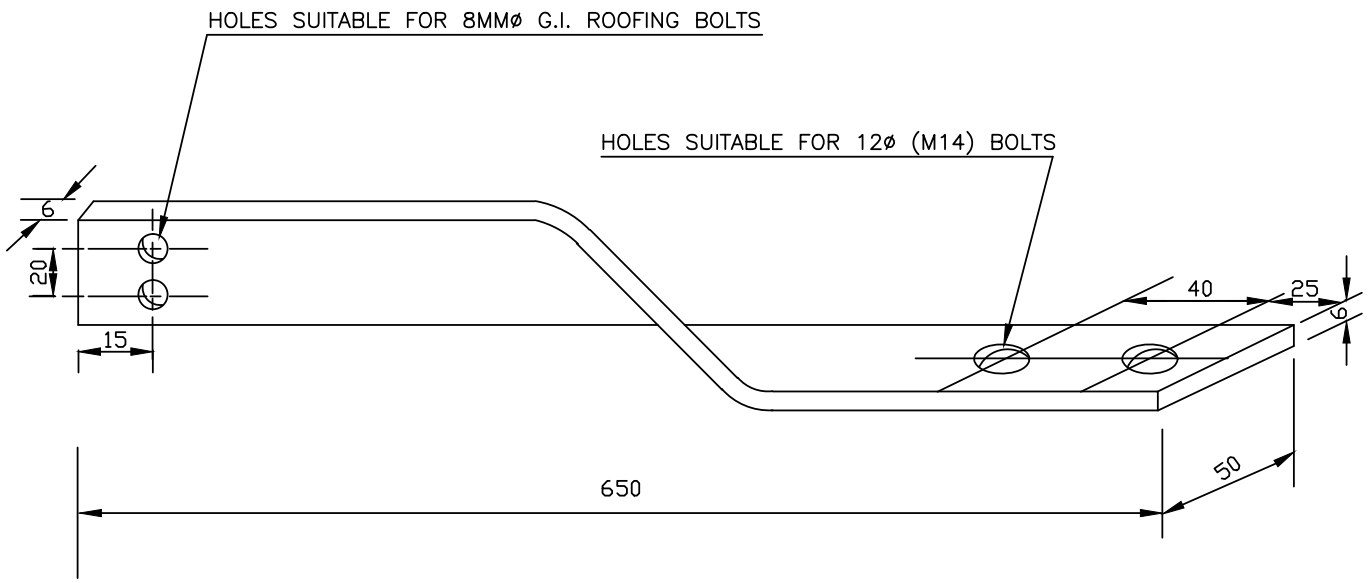


PLAN

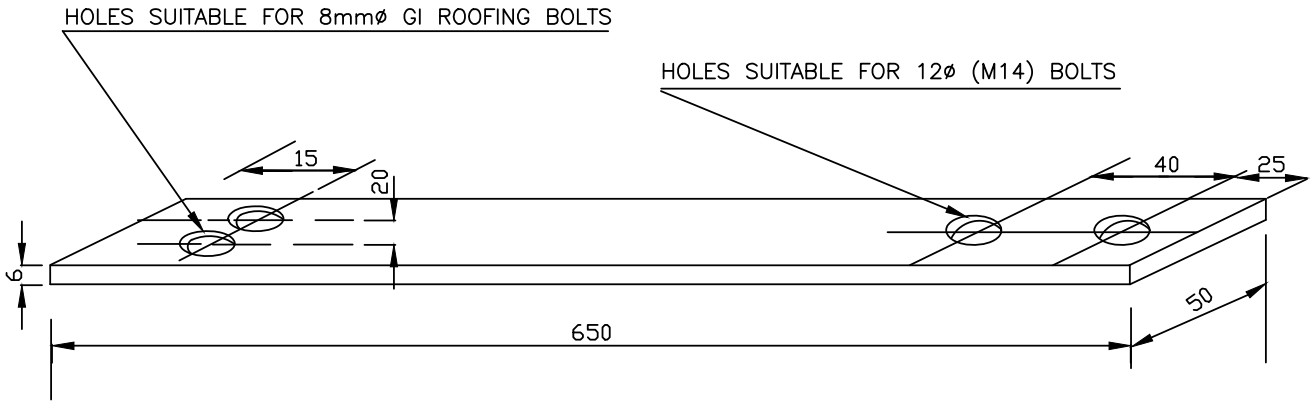


ELEVATION

G.I. 'L' PIECE

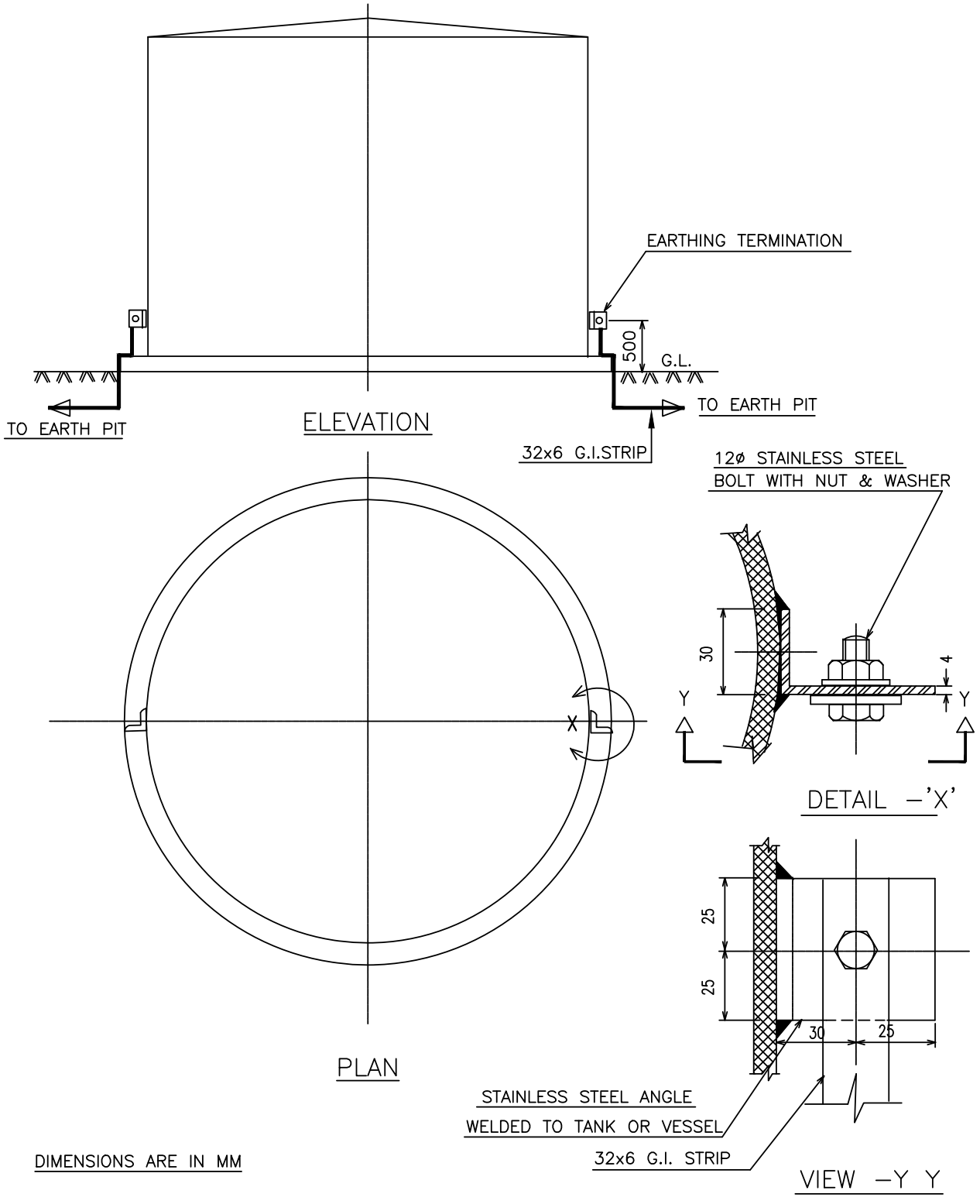


CONNECTING TWISTED ALUMINIUM FLAT PIECE



CONNECTING ALUMINIUM / G.I. FLAT PIECE

पी डी आई एल PDIL	EARTHING OF STORAGE TANK & VESSEL	PC183–PDS:E 613	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

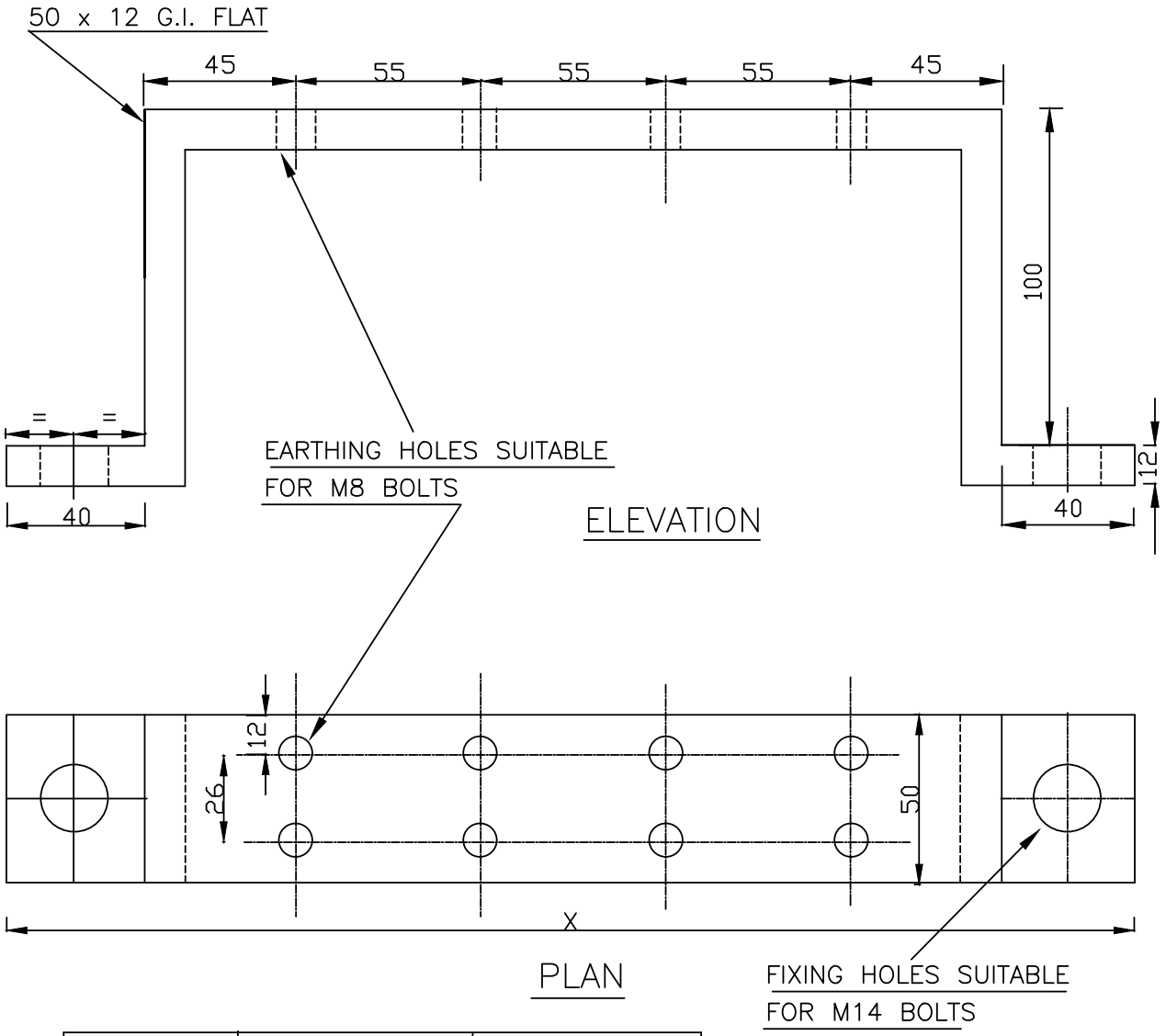


DIMENSIONS ARE IN MM

THE NO. OF EARTH CONDUCTOR SHALL BE AS FOLLOWS

EQUIPMENT WITH ANY DIMENSION	HAZARDOUS AREA	NON–HAZARDOUS AREA
≤ 3 Mts.	1	1
> 3 Mts. ≤ 30 Mts.	2	1
> 30 Mts.	3	2

पी डी आई एल PDIL	G.I. EARTH BUS	PC183-PDS:E 615	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	

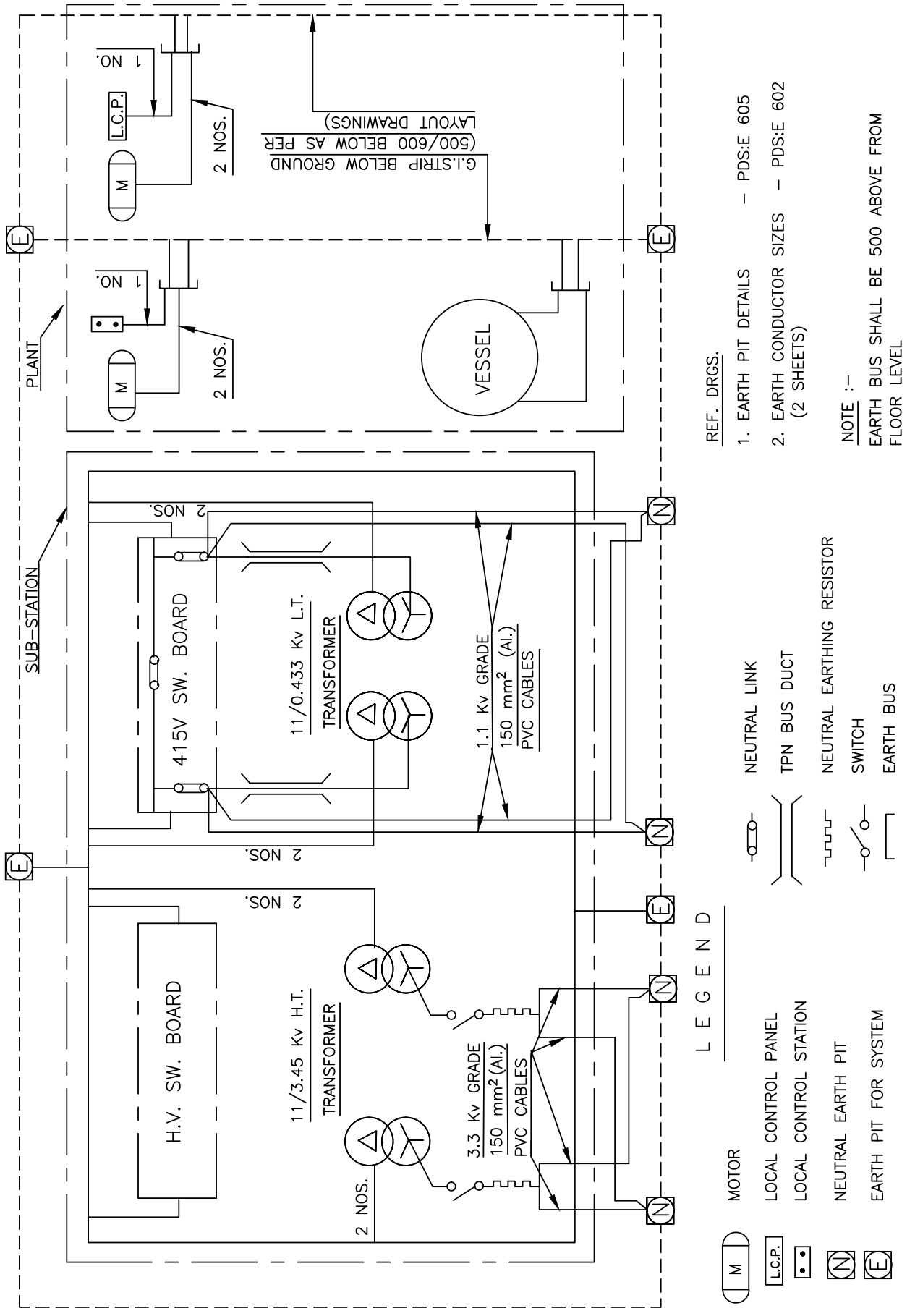


TYPE OF EARTH BUS	NO.OF EARTHING HOLES	OVERALL LENGTH x (mm)
1	8	335
2	10	390

NOTES:-

1. LOCATION OF EARTH BUS TO BE DECIDED AS PER EQUIPMENT POSITION AT SITE.
2. EARTH BUSES SHALL BE LOCATED ON STRUCTURES/COLUMNS WALLS/EQUIPMENT FOUNDATION ETC.
3. MOUNTING HEIGHT OF EARTH BUS SHALL NOT BE LESS THAN 500mm FROM FINISHED FLOOR LEVEL
4. ALL DIMENSIONS ARE IN mm

पी डी आई एल PDIL	TYPICAL ARRANGEMENT FOR NEUTRAL AND EQUIPMENT EARTHING	PC183 – PDS:E 617	0
		DOCUMENT NO.	REV.
		SHEET 1 OF 1	



SECTION VI – 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

PROJECT: COAL / PET COKE / LIMESTONE HANDLING FROM RAILWAY SIDING TO STORAGE YARD

PLANT : INTEGRATED COAL BASED FERTILISER COMPLEX, AT TALCHER, ANGUL DISTRICT, ODISHA (INDIA)

0	16.06.2021	ISSUED FOR TENDER	GC	GC	UPT
P	16.10.2020	ISSUED FOR REVIEW	GC	GC	UPT
REV	**DATE**	**PURPOSE**	**PREPD**	**REVWD**	**APPD**

CONTENTS

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SL.NO.	DESCRIPTION	DOCUMENT NO.
1	DESIGN PHILOSOPHY & SCOPE FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS	PC183/4009/P-II/ 3.4
	ANNEXURES	
2	CIVIL ENGINEERING DESIGN BASIS (CIVIL & STRUCTURAL WORKS)	(ANNEXURE-A) (70 PAGES)
3	CIVIL ENGINEERING DESIGN BASIS (GENERAL CIVIL WORKS)	(ANNEXURE-B) (18 PAGES)
4	CIVIL ENGINEERING DESIGN BASIS (ARCHITECTURAL)	(ANNEXURE-C) (31 PAGES)
5	TECHNICAL SPECIFICATION (ES -2516) • FOR CIVIL, STRUCTURAL & ALLIED WORKS • FOR BORED CAST- IN - SITU PILES	(ANNEXURE-D) (79 PAGES)
6	QUALITY ASSURANCE PLAN	(ANNEXURE-E) (5 PAGES)
7	CIVIL & STRUCTURAL VENDOR LIST	(ANNEXURE-F) (9 PAGES)
8	TOPOGRAPHICAL SURVEY DRAWING	(ANNEXURE-G) (2 PAGES)
9	REFERENCE DRAWINGS	(ANNEXURE-H) (5 PAGES)
10	SOIL INVESTIGATION REPORT	(ANNEXURE-I) (598 PAGES)

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1.0 GENERAL

1.1 The scope of Civil, Structural and Architectural Works under this Contract given hereunder establish the minimum basic requirements for civil-structural works for Lump-sum Turn-key (LSTK) contracts. This standard specification shall be read in conjunction with the Design philosophy documents from other department (Process, Mechanical & Electrical.etc) issued for the Job and Standard Specification for Material & Construction requirements.

1.2 This document defines the design philosophy & Brief scope of works under this Contract for Civil, Structural and Architectural Works for the "***Coal / Pet Coke / Limestone Handling from Railway Siding to Storage yard for Integrated ROM Based Fertilizer Complex at Talcher***" and associated allied services within battery limit.

1.3 The scope of Civil, Structural and Architectural Works under this Contract shall include carrying out Micro-Grading & Leveling, Detailed Design, Drawings, Supply, Procurement of all materials, Construction, Demolitions, Supervision of all relevant Civil and Structural Works including providing all labour, supervision, material, scaffolding, construction equipment, tools, tackles and plants, supplies, transportation, all incidental items though not indicated or specified but reasonably implied or necessary for successful completion of the project.

1.4 This engineering design basis defines the minimum design criteria that shall form the basis for carrying out detailed structural design and engineering of all plant and non-plant structures and buildings. All data required in this regard shall be taken into consideration for acceptable, satisfactory and trouble-free engineering of the structures.

1.5 Compliance with this design basis and / or review of any of the contractor documents shall in no case relieve the contractor at the contractual obligations. All structures shall be designed for the satisfactory performance of the functions for which they are being constructed, abiding all relevant Indian Standards (Latest Revisions).

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2.0 SCOPE OF CIVIL, STRUCTURAL AND OTHER ALLIED WORKS

The scope of work under this contract includes the complete civil, structural and other allied works associated with the ***"Coal / Pet Coke / Limestone Handling from Railway Siding to Storage yard for Integrated ROM Based Fertilizer Complex at Talcher"*** and associated allied services within battery limit.

The general description of structures / facilities shall be read in conjunction with the technical requirements & specifications given elsewhere in this document. The tentative sizes of various process units, utilities, storage facilities and Plant structures / building and non-buildings with demarcated with areas on the plot plan is provided for reference.

Scope of the CONTRACTOR shall include but not limited to the following:-

a) Engineering related to site leveling, Micro-grading & preparation.

b) Soil Investigation, if required for specific design.

c) Structural Analysis and design calculations as per specifications laid down in Civil Engineering Design Basis, enclosed in the tender. For all **Civil, structural and other allied works** including but not limited to foundation, underground RCC structure, pile, pile-cap, plinth beam, RC superstructure, steel super structure, trenches, drains, pits etc.

d) Architectural design and drawings including details for doors, windows, partitions, false floor, false ceiling, toilet, finishes etc.

e) General Arrangement and construction drawings for foundations, underground structures, plinth/tie beams, pile, pile-cap, slab and sumps /pits etc.

f) General Arrangement and construction drawings at grade level showing foundations, extent of paving, trenches, drains, pits etc.

g) General Arrangement and construction drawings for superstructure (RCC and structural steel) at all levels.

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h) RCC drawings showing all necessary details, such as opening, recess, embedment parts such as anchor bolts, sleeves and insert plates, etc. if any, for foundations and structures

i) General Arrangement and detail drawings for access roads, storm water drains, effluent drains, cable trenches, sewerage, manholes, pits, sumps with all necessary details.

j) Bar Bending Schedules for all RCC works.

k) Structural steel detail construction drawings for all steel structures.

l) Fabrication drawings with all details for all steel structures.

m) Coordination with OWNER / PMC for various activities including approvals of design basis, drawings, material samples, laboratory test results etc.

n) Procurement of all items necessary for completion of scope of work.

o) Construction of all units / structures, items of work included in scope of work.

p) As built drawings & final documentation.

q) Obtaining Statutory Approvals.

r) Adherence to Quality Assurance Plan

2.1 DETAILED SCOPE OF WORK

The dimensions & elevations of various units shall be furnished by LSTK contractor. All dimensions shall be finalized by the contractor during detail engineering phase & shall be get approved by Owner / PMC.

It is the contractor's responsibility to design safe, sturdy and robust structures, foundations etc. to withstand all static and dynamic forces in accordance with design specifications and engineering specifications laid down in the document.

The following plants and facilities shall be under the scope of the LSTK CONTRACTOR shall include but not limited to the following:-

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2.1.1 The work shall have to be carried out both below and above ground level and shall be involving, basements, equipment foundations, slabs, beams, columns, footings, rafts, walls, steel frames, brick walls, stairs, trenches, pits, finishes, complete architectural aspects, drainage, sanitation, water supply (from terminal points to various buildings, conveyor galleries), and all other ***civil, structural and architectural works associated with the Coal / Pet Coke / Limestone Handling Plant from Railway Siding to Storage yard.***

2.1.2 The work to be performed under this specification for civil, structural and architectural items include works for sub-structures and super structures for the entire Coal / Pet Coke / Limestone Handling Plant from Railway Siding to Storage yard including auxiliary systems/services as per approved drawings and specification, including supply of materials and labours etc. for the following :

a) Wagon Tippler Complex

All sub and super structures of wagon tippler and requirement for auxiliaries including maintenance house, access shafts, sumps, stairs, railings MCC and wagon tippler control room and tunnel for Conveyor complete. All civil, structural and architectural works associated with wagon tippler complex including finishing works complete.

b) Conveyor system

All sub structures of tunnel for Conveyor system and requirements for auxiliaries including all Civil, structural, Architectural and finishing works complete.

All Civil works for over ground conveyor gallery and trestle from Pent house to Transfer towers as per Material handling layout drawing for complete system and requirements for auxiliaries including all Civil, structural, Architectural and finishing works complete.

c) Transfer towers

All sub and super structures and requirement for auxiliaries including all civil, structural and architectural works associated with transfer towers including finishing works complete.

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d) Reclaim Hopper

All sub structures including tunnel, sumps, ramp for Reclaim hopper for Conveyor and requirements for auxiliaries including all Civil, structural, Architectural and finishing works complete.

e) Pent House

All sub and super structures and auxiliaries' works including all civil, structural and architectural works associated with Pent house including finishing works complete.

f) Pump House

Pump houses with RCC framed structure and underground/over ground water tank as per approved system requirement including pump foundations and all Civil/Architectural and finishing works complete.

g) Wagon tippler Substation cum Control room

All sub and super structures and auxiliaries' works including cable trench/cable spreader room, transformer foundation etc. with toilet facilities complete.

Control room for Wagon tippler shall be located at 1st floor for complete view of operation.

All civil, structural and architectural works associated with Substation cum Control room including finishing works complete.

h) Misc. Fixtures/Stairs/Ladders. Etc.

Providing and fixing embedment e.g. inserts, bolts, embedded plate, edge protection angles, ladders, railing, toe guard etc. complete for all structures wherever required as per approved system requirement.

i) Misc. Structures & Foundations for Various Services

All foundation for various services e.g. Ventilation, Dust Suppression, Dust Extraction, Service & potable water pipe lines, cable trenches, transformer foundation yard lighting etc. all complete as per the approved system requirement.

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2.2 SITE RELATED INVESTIGATION & WORK

2.2.1 SOIL INVESTIGATION

a) The Soil Investigation Report carried out for proposed plant area is enclosed with the tender. This is indicative only and is enclosed purely for information/guidance purpose to the bidder. However Bidder shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit.

b) In any case, the Bidder has to carryout detailed Soil investigation after the award of contract and submits Soil investigation report with recommendations for Owner's review and approval. The recommendation given in approved final report becomes binding on the contractor. The Bidder is not eligible to increase his cost or demand any extension of time because the final report is in variance from preliminary report furnished by Owner.

c) The Soil Investigation Report for Coal Gasification based Ammonia & Urea plant complex area is attached with this document as Annexure-F. This is indicative only and is enclosed for reference to the bidder for bidding purpose only.

2.2.2 TOPOGRAPHICAL / CONTOUR SURVEY

a) The OWNER has carried out a preliminary topographical survey of the proposed plant area. However the proposed plant site was developed. The Topography survey drawing for plant complex area is attached with this document as Annexure-E. This is indicative only and is enclosed for reference to the bidder for bidding purpose only.

b) Graded site shall be handed over to the contractor. However, The CONTRACTOR shall carry out his own topographical survey. For the purpose of surveying the Contractor's scope is not limited only up to Battery Limit, but shall extend up to the adjacent roads around the unit.

c) Before commencement of work / Contour Survey, the CONTRACTOR shall clear the site from all the debris lying on the site if any.

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d) At bidding stage, the CONTRACTOR shall visit the site and study the existing site conditions & existing structures, etc.

2.2.3 SITE CONDITIONS

Levels like Finished Ground Level (FGL) and Highest Point of Paving (HPP) shall be finalized by the CONTRACTOR in consultation with OWNER / PMC based on contour survey of the unit, levels of adjacent units and levels of adjacent roads.

2.2.4 GRADING

a) Fairly graded land site shall be provided to the CONTRACTOR. However, micro grading works shall be in COTRACTOR's scope.

b) The CONTRACTOR shall establish the finished grade levels of buildings after studying the existing site conditions, high flood level so as to maintain proper efficient drainage of the plant area at no extra cost to OWNER / PMC. These grade levels shall be approved by the OWNER / PMC.

c) Wherever filling / cutting is involved stone pitching should be provided as slope protection to protect the areas.

2.2.5 TRANSFER OF BENCHMARK

The Benchmark will be made available inside plant premises. However, it may be verified at CONTRACTOR's side. All Bench Mark (BM) levels of the survey shall be established with reference to the nearest GTS benchmark available. Precision leveling shall be carried out for establishing the BM at site by carrying levels from GTS BM adopting double circuit leveling. Precision theodolites used shall be of one-second accuracy.

2.3 DETAILED ENGINEERING

2.3.1 GENERAL

a) The CONTRACTOR shall carryout Analysis and Design of the structures required for this document and shall prepare all the required Architectural, Civil and Structural drawings needed for correct and accurate construction as per the Design Specifications given in this document.

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b) The CONTRACTOR shall submit a Detailed Schedule for release of documents and drawings for review / approval to PMC / CLIENT, within 2 weeks / or mutually agreed period in writing from date of award of the Contract. Such a schedule shall be made in line with the overall Project Schedule given in the document.

c) The CONTRACTOR shall strictly adhere to the approved schedule. The Format of Submission of the above mentioned schedule shall be mutually discussed and finalized after award of the job.

d) Construction of various structures / facilities, whose designs and / or drawings are specially identified in the document submission requirements for approval by PMC, shall not be taken up for construction at site till they are approved by PMC and comments given by PMC are incorporated.

e) For other structures / facilities, the CONTRACTOR shall directly submit the Approved for Construction (AFC) drawings to PMC for information before, taking up construction.

f) It shall be the responsibility of the CONTRACTOR to accommodate all the functional requirements such as access, cutouts, clearances, interference etc. while designing / detailing of various structures / facilities.

g) Complete analysis, design and all drawings of each independent structure / facility shall be submitted in one lot so as to facilitate overall systematic review by PMC.

h) Only after the necessary architectural drawings are approved by the OWNER / PMC to their satisfaction, then the design drawings shall be reviewed and approved by the PMC.

i) The CONTRACTOR shall keep the OWNER / PMC informed of any major design revisions simultaneously in progress.

j) Approval of construction drawings prepared by the contractor shall not relieve the Contractor of his responsibility regarding the adequacy of design and correctness of the drawing, Engineering and Construction. The sole responsibility of the correctness of Design, Engineering & Construction shall lie with the Contractor irrespective of the fact that the Drawings/Documents submitted are reviewed or not reviewed by Owner/PMC. The Contractor shall correct all faulty

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design & construction detected at any stage of work without any cost & time implication to PMC or the Owner.

2.3.2 DESIGN CALCULATIONS

a) The CONTRACTOR shall prepare the design calculations based on the standard accepted practice and guidelines from PMC / OWNER.

b) All design calculations shall be written systematically, legibly and submitted for approval as per standard accepted practice.

c) For structures, analysis and design shall be done on latest version of **Staad Pro Software** only**.**

d) For other miscellaneous works, latest software's as necessary shall be used. Design calculations shall be done on A4 size sheet only.

2.3.3 DRAWINGS

a) The CONTRACTOR shall prepare

- Drawings for statutory approvals.
- Civil & structural design & construction drawings, architectural drawings based on the standard accepted practice and guidelines from PMC / OWNER.
- Bar bending schedules.
- Fabrication drawings.
- As-built drawings.

b) Detailing / drafting shall be done both on AUTOCAD & Tekla Latest Version only. Drawing size used shall be preferably of A1 size only. For foundation layout, drainage plans, paving plans and revised contour plans. A0 size drawings can be used if necessary.

2.4 CONSTRUCTION

a) Construction of all civil and structural works including all material, labour, supervision, tools and tackles etc. shall be carried out by the CONTRACTOR

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b) Procurement and supply of all materials viz. cement, reinforcement, structural steel etc. shall be in the scope of CONTRACTOR.

c) All materials shall be procured in consultation with the Owner or as per the approved vendor list given elsewhere in this document. All materials of construction must be of ISI approved brand.

d) All materials and construction shall confirm to the specification given elsewhere in this document.

e) Materials of construction, construction methodology etc. shall be such, so as to protect the structures and foundations against the harmful effect of chemical, fumes etc. present in the plant, its vicinity, in ground and / or subsoil water.

f) The CONTRACTOR shall be responsible for obtaining the statutory approval from local authorities such as Inspector of Factories, Development Authorities, Municipal Corporation and other concerned authorities before starting the work.

g) The CONTRACTOR shall ensure that the facilities are constructed in accordance with the APPROVED FOR CONSTRUCTION drawings and specifications.

h) The CONTRACTOR shall maintain and operate an adequate system of control of availability of latest drawings and specifications, at all the places where work is performed.

i) Construction shall include excavation in all types of soils / rock inclusive of necessary dewatering as applicable.

j) The CONTRACTOR shall redo / repair all the existing facilities viz. roads, paving, drainage etc. which are damaged during transportation, construction and erection activities performed by him.

2.5 TEMPORARY SITE BUILDINGS & FACILITIES

a) The Contractor shall provide for at his cost the following buildings & facilities for proper execution and quality control of the job, while meeting the provision stipulated by Factory Rules regarding staff welfare facilities.

- Site office
- Store room

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- Temporary Workshop and Garage shop
- Fabrication yard
- Quality Control / Testing Laboratory

b) All temporary work shall be so constructed as not to interfere with any permanent work or with the work of other agencies. If it is necessary to remove any of the temporary work at any time to facilitate execution of the work or work of other agencies, such removal and re-erection if required, shall be carried out by the Contractor, at the discretion of the Engineer without any delay and any extra cost on this account shall be borne by the Contractor.

c) Contractor has to make his own arrangement for making access/ roads/ approaches to the site for transportation of his men material and equipment. Nothing extra will be paid to contractor for this.

2.6 ROADS, PAVING AND HARD STAND

2.6.1 ROADS

a) The CONTRACTOR shall be responsible for complete planning and construction of the roads for access to all buildings and units of the plant from the existing roads within the battery limit including necessary tie-in connections. All works associated with shifting of Roads and related services (e.g. all type of drainages, culverts etc.) as required, for the proposed site, shall be in the scope of contractor.

b) Contractor shall provide Footpaths (as applicable) for maintenance and operational requirement of plant as per the equipment layout and as per detailed engineering requirement. Any additional approach roads around unit, substation, and other areas to facilitate crane movement or any other vehicle movement during construction shall be in contractor's scope of work. Crossings for all services shall be in the scope of contractor. Additional WBM layer and premix carpeting of damaged road during construction shall be in the scope of contractor.

c) All roads around each facility shall be made good while handing over after completion of construction activity. Any culverts, pipe way bridges, cable

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crossings, electric road crossings, road crossings for Caustic sewer system, fire water lines, drinking water lines, etc. coming below the main roads and approach roads shall be in Contractor's scope of work and shall be designed for crane loads. The design of road cross section shall be in the scope of contractor based on the CBR values, to be obtained by the contractor during survey.

2.6.2 PAVING

a) The CONTRACTOR shall provide RCC pavement in entire process unit area and in associated facilities as per design requirements. For the purpose of paving the Contractor's scope is not limited only up to Battery Limit, but shall extend up to the adjacent roads around the unit.

b) RCC pavement of suitable type shall be designed and provided for areas where vehicle movement is envisaged for operations & maintenance requirements and rest of the areas shall be provided with lighter RCC pavement as per design requirements.

c) The contractor shall design the pavement sections taking care of the geo-technical recommendations and get approval from PMC during detailed engineering. The contractor shall ascertain extent of heavy-duty RCC pavement and heavy-duty pavement shall be designed / provided for required crane weight or any other heavier crane proposed to be used by the contractor for erection and maintenance. Hardstand for erection of heavy equipments by cranes shall be ascertained by the contractor & provided as required. Demarcation shall be clearly shown on drawing. The contractor shall design hardstand required for the erection of heavy equipment as per erection loads. The contractor shall carry out dismantling of hardstand, if required as per directions of Engineer-in-charge, disposal of material outside compound wall after completion of erection wherever required.

2.6.3 HARD STAND

Based on soil data, the hard stand required for erection of heavy equipments to be Designed and provided as per equipment erection philosophy / type of cranes to be used inside and outside the battery limit of units. Dismantling of hardstand if

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required, as per directions of Engineer-in-Charge, disposal of material outside the boundary wall shall be in the scope of contractor.

2.7 SURFACE DRAINAGE, STORM WATER DRAINS AND CULVERTS

The Contractor's scope work includes providing all internal services such as water supply, sanitary sewerage, drainage and storm water drains etc. and connecting the same to nearest external prevailing facilities complete in all respects in around and within the Unit battery limit.

2.7.1 STORM WATER DRAIN SYSTEM

a) The CONTRACTOR shall study the existing drainage system as per actual site conditions and ensure proper drainage system around and within the battery limit for all roads. The Storm Water Drains shall be connected to the existing drainage system at suitable tie-in points to be decided in consultation with OWNER / PMC during detailed engineering.

b) For the purpose of drainage the Contractor's scope is not limited only up to the Unit Battery Limit but shall extend up to the adjacent drainage network around the unit. Construction of storm water drains in around and within the Unit battery limit and connecting the same to nearest main storm water drain including providing cross drainage facilities (i.e. RCC Box culverts and RCC pipe culvert) for drainage of storm water of the area shall be carried out strictly in accordance with the "Technical specification (ES-2516)" provided with tender.

c) The drainage system shall be by gravity. Storm water drains shall be sized for the peak discharge arising discharge arising out of either rain water or fire fighting water.

2.7.2 SANITARY AND PLUMBING SYSTEM

d) The CONTRACTOR shall provide proper underground drainage system for sewage disposal and its connection to common sewage treatment plant. These shall be connected to existing sewerage system at suitable tie-in points to be decided in consultation with OWNER / PMC during detailed engineering.

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e) The CONTRACTOR's scope work includes Supply and fixing of building plumbing for sanitary system, drinking water, sanitary sewer system including disposal facility i.e. connecting to nearest sanitary sewer manhole complete as per standards, specifications and direction of Engineer-in-charge.

f) All plumbing and sanitary works within new buildings and disposal of sanitary waste up to nearest manhole available is in contractor's scope of work. All the sanitary fixtures and fittings shall be as per approved Architectural drawings/ specifications and relevant Indian / International Standards.

2.7.3 DRINKING WATER SYSTEM

a) The CONTRACTOR shall study the existing drinking water distribution piping system as per actual site conditions and ensure proper drinking system inside the building and facilities within the battery limit at suitable points to be decided in consultation with OWNER / PMC during detailed engineering.

b) Providing HDPE drinking water storage tank (min.1 day storage Capacity) over building roof with distribution piping system inside the building up to different user points including taking tapping from external feeder supply line from the main headed running outside the package unit battery limit up to storage tank inlet with an isolation valve (in valve pit) at ground level.

c) The CONTRACTOR's scope work includes Supply and lay the drinking water underground directly buried or aboveground on pipe rack. A minimum dia 2" (exact size of pipes to be ascertained by contractor), drinking water header to safety shower & eye wash units, drinking water post in unit area and drinking & sanitary in toilet blocks/ buildings shall be provided. The same shall be hooked up to main drinking water header available on pipe rack outside the scope limit along with supply including installation of isolation valve in valve pit.

2.7.5 CABLE CROSSING

For all electrical / instrument cables crossing the main / approach roads, suitable road crossings either by PVC pipes encased in concrete or RCC ducts / culverts shall be provided as per Electrical / Instrumentation requirements. Crossings shall be designed crane loads required for erection

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2.7.6 RCC TRENCHES / CHANNELS

a) CABLE TRENCHES

RCC Electrical / Inst. cable trenches with pre-cast RCC covers shall be provided as per structural standards and electrical / instrumentation requirements. Trenches and covers in crane movement area shall be designed to withstand crane movement required for erection. Cable trenches within scope limit shall be filled with sand before placing of precast cover.

All trenches for electrical cables for other purposes shall be of RCC. The trench cover shall be of precast concrete with edge protection angle and lifting devices. Suitable inserts and opening shall be provided as per service requirement. Suitable drainage and walking arrangement inside trench shall be provided.

b) PIPE TRENCHES

RCC trenches sand filled with pre-cast RCC cover shall be provided for all U/G firewater headers in paved areas. Trenches and their covers in crane movement area shall be designed to withstand crane movement required for erection.

2.8 STRUCTURES & BUILDINGS

Contractor's scope shall include various technological/ Process structures steel & R.C.C. structures, pipe rack, buildings, equipment foundations, pits, cable trench, sheds, etc. as per the approved Plot Plan or mentioned in this tender document, required for the complete execution and commissioning of the plant.

2.9 SIZING OF VARIOUS FACILITIES

Sizing, nos., location etc. of various facilities viz. buildings, pipe rack, structures, equipments, etc. shall be in the scope of the bidder. Any change of sizing, addition of any structure / facility indicated by Owner/PMC, based on functional requirements and as well as local rules and regulations, etc, shall be in the Contractor's scope, at no extra cost to OWNER / PMC.

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2.10 SURFACE FINISHING'S

The CONTRACTOR shall be responsible for complete planning and detailing of all surfaces finishes viz. painting, flooring etc as per specifications given in the Tender. Also same shall be mentioned in respective architectural / civil drawings issued by the contractor.

2.11 ACID / ALKALI PROOF LINING

The CONTRACTOR shall be responsible for surface treatment of floors, exposed portion of foundations, pits and basins against acid / alkali as per process requirement.

2.12 ANTI-TERMITE TREATMENT / DAMP PROOF COURSE / WATER PROOFING

The CONTRACTOR shall provide anti-termite treatment, damp proof course and water proofing as per design basis. Water proofing (for all open terraces) of all buildings shall be done by water proofing PU coating with treatment also, of approved Brand and make.

2.13 SITE CLEANING

During construction and on completion of construction (inclusive all internal and external finishes), cleaning all the debris, waste materials scattered in and around the site and disposal of the same shall be in the scope of the CONTRACTOR with the consent of the OWNER/ PMC.

2.14 DISPOSAL OF SURPLUS EARTH

The CONTRACTOR shall dispose-off all surplus and unserviceable earth (if any), outside the plant in accordance to local Governing authority, at his own cost with the consent of OWNER/ PMC.

Disposal shall be done at a place outside the plant, with the consent of the OWNER/ PMC. Location of disposal area shall be decided by the CONTRACTOR and the required necessary approvals from the local bodies shall be the CONTRACTOR's responsibility.

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2.15 REMOVAL OF UNDERGROUND AND ABOVE GROUND STRUCTURES

All above ground structures will be demolished by Owner. Proposed site area shall be handed over to the contractor as in where is basis after demolition. All underground facilities /structures shall be demolished /removed by the Contractor provided removal of former will not disturb the functions of existing plant. Rerouting of cables / pipes etc. encountered during excavation in the plot shall be in CONTRACTOR's scope of work.

Existing underground installations found, if any, such as foundations and pipelines, which fall /obstruct the construction activities, shall have to be removed by The Contractor. Existing piles if any, needs to be adjusted while making new piling / foundations.

2.16 STATUTORY REQUIREMENT, RULES AND REGULATIONS

CONTRACTOR shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Tariff Advisory Committee, Water act of Pollution control board, Explosives act, local civil authority including building use permission etc. Provisions of Safety, health and welfare according to Factories act shall also be complied with. Statutory clearances and norms of State Pollution Control Board shall be followed.

CONTRACTOR shall obtain approval of Civil / Architectural drawings from OWNER/ PMC before taking up the construction work.

All the facilities shall conform to all Local Rules and Regulations, Factory Inspector, Rules, TAC rules etc. whichever is more stringent.

Getting the approval of the various documents through the various authorities shall be in the Contractor's scope at no extra cost to OWNER / PMC.

2.17 CONSTRUCTION METHOD & EQUIPMENT

The Contractor shall submit drawings and write-up indicating his construction methodology for execution of work with elaborate explanation for construction work e.g. deep underground structures for Wagon Tipler, Reclaim Hopper, TTs,

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tunnels building and trestle foundation, preventive arrangements to avoid damage to existing structures (if any).

2.19 OTHER MISCELLANEOUS WORKS

2.19.1 SCOPE OF WORK IN OUTSIDE BATTERY LIMIT (OSBL) AREA

Scope work includes in outside battery limit area, if any civil & structural work required for completion of work

2.19.2 It is not the intent to specify herein all the works in the scope of this contract. The scope also includes all other buildings, structures and works necessary which are not specifically mentioned here but required for construction, operation and maintenance of the "***Coal / Pet Coke / Limestone handling from Railway Siding to Storage Yard***" are deemed to be included in the scope of the Contractor. All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detail specification.

3.0 GENERAL DESCRIPTION OF STRUCTURES & SERVICES

Some of the salient features for structures involving major civil & Architectural works are furnished below for guidance. The requirement furnished in design specification from other department (Process, Mechanical & Electrical.etc) shall also be read in conjunction to this general description.

It includes the Civil, Structural and Architectural works related mainly to the following areas (but not limited to):

3.1 TRACK HOPPER, WAGON TIPPLER AND MACHINERY HATCHES

Track Hopper, Wagon Tippler, Machinery Hatches and Under- ground Tunnel

3.1.1 Track hopper and machinery hatches shall consist of underground portion, its supporting enclosure structures/basement shall be of Reinforced cement concrete (RCC) and above ground portion, which shall be of structural steel shed covered with permanently Colour coated profiled steel sheets.

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3.1.2 The structural arrangement to be adopted for the design and construction of underground portion of track hopper and machinery hatches shall be as shown in tender drawing. It essentially consists of RCC frames spaced at approx. 3.0M centers with RCC wall panels on the sides and RCC raft at the bottom, fixed to the frames. The top beam of the RCC frame supports the rail supporting beams and the coal hopper. Minimum thickness of RCC raft at bottom shall be 600 mm. Minimum thickness of RCC side walls shall be 600 mm at bottom and 300 mm at top. No columns shall be provided inside the Machinery Hatches.

3.1.3 The vertical and inclined portion of coal hopper, the beams and top of coal tray in the track hopper structure as shown in the tender drawing shall be provided with 50 mm thick guniting (shotcreting). Complete inside surfaces of Wagon tippler & reclaim hopper shall also be provided with 50mm thick guniting. Details of shotcreting have been given elsewhere in this specification.

3.1.4 Expansion joints shall be provided at a maximum distance of 40m unless otherwise shown in the tender drawing. 600 mm wide water stop fabricated with 22G copper plate with bitumen board fillers and polysulphide sealing compound as specified elsewhere shall be used as expansion joint material. Construction joints shall also be provided with 600mm wide water stop 22G copper plate.

3.1.5 Insert plates details shall be provided as per the system requirements. Floor of wagon tippler and machinery hatch shall be provided over sand filling / PCC filling. Floor shall be provided cross slope towards side drains. Cross slope shall not be more than 1:50. Side drain shall be sloped towards sump where sump pump shall be provided. The slope of the side drain shall not be more than 1:400. Side drains and sump shall have removable type steel grating cover. Gratings shall be galvanized to grade 610 gm/m2.

3.1.6 Water proofing / Damp proofing of underground portion of track hopper and machinery hatches, Wagon tippler, reclaim hoppers, tunnels, underground (i. e. basement) portion of transfer houses shall be done by providing the following treatments:

a) Chemical injection grouting for inner faces (details as specified elsewhere).

b) Polymer modified cementitious coating on earth side face as per the following:

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i) On the outer surface of walls, frames and roof slabs coming in contact with earth, polymer modified cementitious coating in two layers as specified and as per manufacturer's specifications shall be provided directly on the concrete surface.

ii) 50 mm thick Plain cement concrete (PCC) (1 : 2 : 4 with 10 mm nominal size stone aggregates) shall be provided under the raft i.e. over the lean concrete, followed by polymer modified cementitious coating in two layers (slurry mix application) as per manufacturer's specification. 50 thick P. C. C. (1: 2: 4) with 10 mm nominal size stone aggregates shall then be laid over the polymer modified cementitious coating before laying the raft.

3.1.7 Track hopper shall have removable type steel grating cover. The opening size for the grating shall be 350 mm x 320 mm. Machinery hatches shall have removable steel chequered plate cover. Track hopper grating shall be built of min. 100mm x 20mm thick flats in one direction and 100mm x 16mm thick flats in other direction. No painting/galvanization shall be provided in gratings. However, two coats of red oxide primer to be provided immediately after fabrication.

3.1.8 Steel gratings of mesh size 350 mm x 320 mm for wagon tippler hopper shall be provided. The grating shall be built of min. 200mm x 28mm thick flats in main direction and min. 100mm x 20mm thick in secondary direction. The hopperand gratings shall be designed for movement of front end loader/ bulldozer over them. Bull-dozer weight shall be considered as about 35T. No painting/galvanization shall be provided in gratings. However, two coats of Red oxide Primer to be provided immediately after fabrication

3.1.9 Catwalk shall be provided along the track hopper.

3.1.10 Each machinery hatch shall be provided with a pair of RCC stair for providing access to the base of track hopper / machinery hatch. Both the stairs shall be interconnected at suitable height.

3.1.11 Plinth protection along with drains shall be provided along the Track Hopper and around machinery hatches. However, 5m wide paving shall also be provided around machinery hatches.

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3.1.12 The track hopper, wagon tippler are deep underground structures which are subjected to direct load from the loaded wagons / loco due to the rake movement over it, in addition to load due to coal filled hopper and lateral earth pressure. The railway loads, analysis and design of track hopper, machinery hatches, wagon tippler, transfer point and the portion of tunnel subjected to rail loads shall be as specified in design criteria. Coefficient of dynamic augmentation shall be worked out for a train speed of 30 kms per hour

3.1.13 Earth pressure to be considered for design shall be due to earth pressure at rest (Ko) condition only. Earth pressure due to surcharge intensity of Railway Loads (where applicable) or Uniformly Distributed Load (UDL) of intensity 2 T / Sq. M. whichever is critical, shall be considered in the design.

3.1.14 A minimum safety factor of 1.2 against uplift of track hopper, machinery hatches, wagon tippler, transfer points (underground or with basement) and tunnels, due to ground water shall be ensured during execution and after execution, considering dead weight of the structure to be 0.9 times only, ground water table at adjoining formation level and soil wedge angle of not more than 15 degrees.

Also, FOS against uplift, to be taken as 1.0, considering the dead wt. of structure and soil resting on side projections if any in the vertical plane. Inclined wedge action of soil shall not be considered in this case.

3.1.15 The walkway floor shall have non-skid finish. Walkway width and hand railing shall be provided as specified in the tender drawing.

3.1.16 Wherever, slope of tunnel exceeds 10^{o}, RCC steps shall be provided for the entire width of each walkway.

3.1.17 Track hopper structure shall be analyzed and designed for the worst load combinations. However, it shall be analyzed for the following load combinations also.

(a.) Load Combination - I

(1.) Hopper full

(2.) Maximum load from Railway Track

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(3.) Earth pressure without surcharge and subsoil water pressure

(4.) Maximum load from steel columns for shed

(5.) Maximum load from paddle feeder support

(6.) Maximum load from coal tray.

(b.) Load Combination - II

(1.) Hopper full

(2.) Maximum load from Railway Track

(3.) Earth pressure with surcharge and subsoil water pressure

(4.) Maximum load from steel columns for shed

(5.) Maximum load from paddle feeder support

(6.) Maximum load from coal tray.

(c.) Load Combination - III

(1.) Hopper empty

(2.) No load on Railway Track

(3.) Earth pressure with surcharge and subsoil water pressure

(4.) No load from steel columns for shed

(5.) Dead load only from paddle feeder supporting structure

(6.) Dead load only from coal tray.

3.2 OVERHEAD / GROUND CONVEYOR GALLERIES AND TRESTLES

3.2.1 Overhead conveyors shall be located in a suitably enclosed gallery of structural steel. The overhead gallery shall consist of two vertical latticed girders having rigid jointed portal frame at both ends. Cross beams at floor level supporting conveyor stringer beams shall be made of single rolled steel beam or single channel section (ISMB or ISMC) or plate girder. Horizontal bracings are to be provided at top & bottom plan of the gallery (latticed girders shall be braced together in plan at the top and bottom). Common end portal frame shall not be used for adjacent conveyor spans. Roof truss shall be provided at upper node points of latticed

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girders to form an enclosure. The maximum span of overhead gallery shall be limited to 25 meters unless higher span is required due to site conditions, which shall be subject to approval of the Engineer. The gallery should as far as possible be erected as a box section keeping all the vertical and horizontal bracing tied in proper position. The gallery should be checked for all erection stresses that are likely to develop during handling and erection and if required, temporary strengthening of gallery members during erection shall be made

3.2.2 Seal plates under the conveyor galleries shall be provided in such a way that complete gallery bottom shall form a leak proof floor.

3.2.3 The ground conveyors shall be located in suitably enclosed gallery of structural steel consisting of rigid portal frames spaced at regular intervals and suitably braced. Plinth protection along with drains shall be routed along the ground conveyors.

3.2.4 For double stream conveyor gallery, two side and one central walkway of suitable width shall be provided. Both sides of central and side walkways shall be provided with pipe handrails all along the conveyor gallery. Hand railing should not be supported on conveyor supporting stringers. The walkways shall be chequered plate construction with anti - skid arrangement. The anti - skid arrangement will consist of welding of 10 mm square steel bars at a maximum spacing of 500 mm along the length of the gallery. Where the slope of walkway is more than 10^{o}, chequered plate steps with nosing and toe guard shall be provided. The floor of conveyor gallery all along the gallery length, shall be provided with minimum 12 gauge thick seal plates and other drainage arrangements as specified elsewhere

3.2.5 Conveyor gallery shall have permanently colour coated galvanized steel sheet covers on roof and both sides. However in roof, a panel of minimum 1.5 m x 1.5 m area at about 6.0 m center shall be provided with translucent sheets of polycarbonate material for natural lighting. A continuous slit opening of 500 mm shall be provided on both sides just below the roof sheeting. Adequate provision of windows shall be kept on both sides of conveyor gallery as appended in Mechanical Section (Belt conveyor system). Windows shall be provided with wire mesh as specified elsewhere in this specification.

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3.2.6 Cross - over with chequered plate platform and ladder for crossing over the conveyors shall be provided at approximately every 100 M intervals of conveyor. Crossover shall preferably be located over four-legged rigid trestle location.

3.2.7 For railway tracks passing below overhead conveyor gallery and along conveyors, the railway clearances both underground as well as over ground shall have to be adhered to for design, execution and erection of foundations, trestles, galleries etc., so that movement of locomotives and wagons is not hampered in any way during execution and afterwards. However at the location where the overhead conveyor gallery crosses road / rail line, minimum clearance of 8.0m above the road crest / rail top shall be provided.

3.2.8 For calculation of coal load on moving conveyor, a multiplication factor 1.6 shall be used to take care of inertia force, casual over burden and impact factor etc.

Thus coal load per unit length of each moving conveyor shall be

$$1.6 \times \frac{\text{Rated Capacity of Conveyor system}}{\text{Conveyor Belt Speed}} \times \frac{1100}{800}$$

3.2.9 It should be noted that for structural design, unit weight of coal shall be assumed as 1100 Kgs. / Cu. M. instead of 800 Kgs. / Cu. M. considered for system sizing purpose.

3.2.10 Conveyor Gallery structure shall be designed considering both conveyors operating simultaneously.

3.2.11 Conveyor gallery and supporting trestles located between transfer houses / buildings shall be arranged in any one of the following ways.

a) All gallery supporting trestles shall be four legged type only. One end of each gallery span shall be hinged to the supporting trestle and the other end shall be slide type. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

b) In between transfer houses / buildings, four legged trestles shall be placed at a maximum interval of 90 metres. The arrangement shall be such so as to ensure that force in the longitudinal direction (i. e. along the conveyor length)

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of conveyor gallery of length not more than 90 m is transferred to any four legged trestle. In the space between each successive four legged trestles, two legged trestles shall be provided at regular intervals. The end supports resting on the four-legged trestle can have either ends hinged or one hinge and the other on slide type depending on the arrangements. Slide type support shall be with P. T. F. E. bearings to allow both rotation & longitudinal movements.

3.2.12 End of conveyor gallery which will be supported over transfer house, shall be so detailed that only vertical reaction is transferred from conveyor gallery and no horizontal force in longitudinal direction is transferred from conveyor gallery to transfer house structure and vice - versa.

3.2.13 The walkways for on-grade galleries shall be raised and paved with 100 mm thick PCC (M15) chequerd finish at top resting over 150 mm thick (min) retained sand filling. The raised floor shall be retained by continuous brick walls at both sides of enclosures running along length of the conveyor and the surface of the wall shall be plastered and finished with cement based paints externally as per specification. All on ground and over ground trestle foundations shall be resting on firm strata.

3.3 UNDER GROUND TUNNELS FOR CONVEYORS

All underground tunnels shall be of RCC considering box sections. The roof of the tunnel shall be straight. The profile of the tunnels is shown in tender drawing. Underground RCC structures shall be as per IS.456. The tunnel shall have water proofing as specified elsewhere. Floor shall be non skid type and shall be provided with proper slope to drain out water by means of drains, running along the length of tunnel and connected to sumps. RCC steps shall be provided in slopping portion of tunnel. The risers for walkway steps shall not exceed 150mm. Hand rails of 32 NB GI pipes (Med. quality) shall be provided along both sides of the walls. Sufficient insert plate shall be provided at the side of the tunnel for Mechanical / Electrical / Instrumentation requirements.

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3.4 UNDERGROUND TRANSFER TOWER/RECLAIM HOPPERS

3.4.1 All underground transfer towers shall be of RCC construction as per IS 456 with waterproofing treatment. Reclaim hopper shall be constructed same as that of Wagon Tippler. The intermediate floor and basement floor shall be provided with floor finish as per specification. Other requirement for internal drainage etc. shall be as specified elsewhere. Reclaim Hoppers shall be provided with 50 mm thick guniting with a surface treatement to impart abrasion resistance.

3.4.2 All underground transfer towers shall be provided with minimum 1.50m wide RCC stair with hand railings as per specification. Risers for steps shall not exceed 180mm and tread width shall not be less than 250mm. Hand rails shall comprise of 32 NB M.S. pipe (Medium Duty) and 1.1m high verticals not exceeding 1.8m c/c with 2 nos. 32 NB M.S. pipe horizontal placed at top and mid height respectively and continuous flat iron toe guard at bottom.

3.5 OVER GROUND TRANSFER TOWERS (TTS)

3.5.1 All over ground transfer towers shall have RC foundations resting on firm strata. All intermediate floors shall be of RCC construction. The ground floors for buildings shall be of RCC over PCC sub base over min. 230 thick compacted boulder/stone soling. The RC floors shall be provided with floor finish as per specification. The cladding shall be of brick work plastered on both faces upto 1.0 M from ground floor. All along the periphery, the RCC floor (where no brick walls are provided) shall be provided with one brick thick and 250mm high brick wall and 1.0m high hand rail from floor shall be provided. Flooring shall be ironite finish.

3.5.2 The over ground portion of all transfer towers shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding (from lowest working floor level till top) and RCC floors over structural beams.

3.5.2 Adequate steel doors and windows for proper natural lighting and ventilation shall be provided. In addition to steel windows, panels of suitable size to suit the architectural treatment and made of translucent sheets of polycarbonate material shall also be provided on the side cladding for natural lighting.

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3.5.3 Roof shall be provided with troughed profile permanently colour coated GI sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water. Mineral wool insulation (as per IS: 8183) having a density of 32 kg/cum for glass wool or 48 kg/cum for rock wool, bound in polythene bags shall be used, with or without framed strips 25x3mm (min.) at maximum 300mm c/c to hold the insulation between the runners, keeping in position with galvanized hexagonal wire netting of 0.3mm wire dia. & 19mm mesh size as per manufacturer's recommendations.

3.6 PENT HOUSE

The pent houses shall be of RCC framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides and treated with cement based paint as per specification. Roof shall be provided with roof water proofing treatment as specified elsewhere. Adequate nos. of steel doors and windows shall be provided for natural lighting and ventilation. Adequate provision shall be made for roof drainage. Roof shall be provided with rain water down comer pipes etc.

3.7 PUMP HOUSE

The pump house shall be framed structure of structural steel work with permanently colour coated profiled steel sheet side cladding, grade slab and RCC foundations etc. The lower portion of side cladding for a height of minimum 2.5m above the finished floor level shall be left open. Roof shall be provided with troughed profile permanently colour coated sheet with slope of 1 in 5 for quick drainage of rain water. Brick wall (1m height above FFL) shall be provided with plastering on both sides and treated with cement based paint as per specification all around the periphery of pump houses.

3.8 CONTROL BUILDING & MCC BUILDING

3.8.1 Control Building & MCC Buildings shall be RCC framed structures with columns, beams, slabs and foundations etc. Cladding shall be of brickwork with plastering on both sides. Roof shall be provided with roof water proofing treatment, as

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specified elsewhere in the technical specification. Suitable arrangement shall be provided so as to prevent ingress of water into the cable trenches inside the building from cable entry locations.

3.8.2 All air - conditioned areas, shall be provided with the suspended permanently colour coated aluminium false ceiling system with under deck insulation. Roof shall be provided with roof water proofing treatment with Roofosol or equivalent. 50mm thick average thickness Foam concrete insulation shall be provided conforming to IS: 13205.

3.8.3 Control panel room for control room near wagon tippler shall be provided with thick wired glass (min. 5.5 mm thick) on all sides so as to permit operators to have full view on operation of wagon tipper.

3.8.4 Adequate aluminium doors and aluminium glazed windows shall be provided for natural lighting, ventilation and view. All windows in air conditioned rooms shall have hermetically sealed double glazing. All outer face of brick wall shall be finished with cement paint and inside surface shall be white/colour wash except for control room which shall have acrylic emulsion paints over plaster of paris.

3.8.5 All electrical buildings shall be provided with toilet facilities with two toilets fixtures as stated for 20 (twenty) users and drinking water supply facilities.

3.9 COLOUR COATED AND OTHER SHEETING WORK

3.9.1 For floor/roof decking, troughed permanently colour coated metal decking sheet, shall conform to any one of the following –

(i) of steel with zinc coated to class Z275 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.8mm of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326.

(ii) of steel with zinc coated to class Z275 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.6mm of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A653M / grade S350GD as per EN 10326 / grade G550 as per AS1397 / grade SS550 as per ASTM A653M / grade S550GD as per EN 10326.

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3.9.2 For roofing & side cladding, troughed permanently colour coated sheets (internal or external) shall conform to any one of the following –

(i) of steel with zinc coated to class Z275 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.6mm of grade G250 as per AS1397 / grade SS255 as per ASTM A653M / grade S250GD as per EN 10326.

(ii) of steel with aluminium-zinc alloy coated to class AZ150 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.5mm of grade G350 as per AS1397 / grade SS340 class 4 as per ASTM A792M / grade S350GD as per EN 10326.

(iii) of steel with aluminium-zinc alloy coated to class AZ150 with minimum bare metal thickness (i.e. excluding the thickness of coating and painting) of 0.4mm of grade G550 as per AS1397 / grade SS550 as per ASTM A792M / grade S550GD as per EN 10326.

3.9.3 Steel shall be colour coated with total coating thickness of 35 microns (nominal) dry film thickness (DFT) comprising of Silicon Modified Polyester paint (SMP with silicon content of 30% to 50%) or Polyester paint, of 20 microns (nominal) SMP or polyester paint on one side (exposed side) over 5 micron (nominal) primer coat and 5 micron (nominal) SMP or Polyester paint over 5 micron (nominal) primer coat on other side,(SMP and Polyester paint shall conform to Product type 4 of AS/ANZ 2728.

3.9.4 Sheet shall be of approved profile, sectional properties, colour and shade.

3.9.5 Chemical composition of troughed permanently colour coated metal decking sheets and metal sheet for roofing and side cladding, shall conform to the provisions of the same reference code to which the mechanical properties conform to. Mechanical properties shall be confirmed by relevant tests.

3.9.6 Tolerance on minimum BMT (bare metal thickness) shall be (+/-) 0.04 mm. All necessary structural calculation for checking the adequacy of the profiled sheet for strength and deflection criteria is to be done taking into consideration the

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maximum permissible negative tolerance over the specified BMT i.e. BMT minus 0.04mm is to be considered.

3.9.7 Plain permanently colour coated steel metal sheets for ridge and hips, flashings, trimmings, closure for vertical and horizontal joints, capping etc shall confirm to the same requirements as those of troughed permanently colour coated metal sheet for roofing and side cladding.

3.9.8 For metal decking the sectional modulus and moment of inertia of troughed profile per meter width shall be so as to limit the deflection of sheets to span/250 for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS:801 for satisfying the deflection and strength requirements.

3.9.9 For metal roofing and side cladding, the sectional modulus and moment of inertia of troughed profile per metre width shall be such that the deflection of sheets is limited to span/250 for two span condition. The sectional modulus and moment of inertia of troughed profile shall be computed as per the provisions of IS: 801 for satisfying the deflection and strength requirements. No increase in allowable stress is permissible under wind load condition.

3.9.10 Maximum spacing of the fasteners shall be 390 mm c/c along the length of beams/purlins / runners. However exact spacing shall be as per the design done by the bidder for the fasteners considering the wind load, self load and other associated loads. Minimum diameter of the fastener shall be 5.5 mm and at least 3 nos. of fasteners shall be used per sheet.

3.9.11 Sealant used for cladding shall be butyl based, two parts poly sulphide or equivalent approved, non-staining material and shall be flexible enough not to interface with fit of the sheets.

3.9.12 Filler blocks as a trough filler shall be used to seal cavities formed between the profiled sheet and the support or flashing. The filler blocks shall be manufactured from black synthetic rubber or any other material approved by the Engineer.

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3.9.13 For insulation of cladding, mineral wool conforming to IS: 8183 shall be used. The density shall be 32 or 48 kg. /Cu.M. for glass or rock wool respectively. The nominal thickness of insulation shall be 50mm.

3.9.14 Special coated fasteners shall be used conforming to corrosion resistant class 3 as per AS3566 and shall be tested to 1000 hours salt spray test.

3.9.15 The dimensional tolerances of profiled sheets for sheet length, sheet cover width, straightness, squareness, depth of profile, radius and angle of curved sheets, ripple of side lap, etc. shall be as per “Manufacturing tolerances for profiled metal roof and wall cladding & roofing” by The Metal Cladding & Roofing Manufacturers Association Limited, UK.

3.9.16 Sheets shall be laid with a minimum overlap of 15 cm at the ends and side laps shall be of one trough length subject to a minimum of 50 mm, having a proper water tight arrangement. The minimum lap of sheets with ridges, hips and valleys shall be 15 cm measured at right angles to the line of the ridge, hip and valley respectively.

3.9.17 Metal decking sheets shall be laid over the supporting beams/purlins with a minimum bearing of 50 mm and end projection of 75 mm at lap joints.

3.9.18 Flashings, cappings, trimming, closure for vertical/horizontal joints, ridge and hips etc. shall be provided with a minimum lap of 15 cm. The lapping of sheets shall provide the dust free, airtight enclosure. If required, this may be achieved by using 2-parts polysulphide sealing compound or butyl tape.

3.9.19 Distorted, blemished or water stained sheets shall not be used.

3.9.20 Side and end laps of the sheets shall be made weather proof by securing them with the fasteners not less than 4.8mm dia with 2.0 mm thick neoprene washer. Maximum spacing of the fasteners should not exceed 500 mm.

3.9.21 Precautions shall be taken during the erection of the sheets to ensure that partially erected sheets are protected from damage at all times and particularly during inclement weather. Sheets shall be laid over the supporting

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purlins/runners with a minimum bearing of 50 mm and end projection of 75 mm at lap joints.

3.9.22 Side cladding for Crusher House, Transfer points, pump house & conveyor galleries (including roof) shall have single skin troughed profile permanently colour coated sheets. However, roof of Crusher House and transfer points shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets.

3.9.23 The polycarbonate sheet to be used for cladding purpose shall have toughed profile to match with the metal cladding profile. Minimum 2.0mm thick fire retardant and UV resistant polycarbonate clean sheet of GE plastic or equivalent approved make shall be used for cladding. The polycarbonate sheet shall be installed along with the metal cladding so as to have a watertight lapping arrangement. Suitable detailing shall be made to cater for the thermal expansion. IS:14434 to be referred for other details.

3.9.24 Polycarbonate sheet to be used for fixed glazing purpose shall be minimum 6mm thick multi (twin) wall fire retardant (Continuous use under temperature 100^{o}C), impact resistant and ultraviolet resistant.

3.10 ROOF DETAILS

3.10.1 R. C. C. parapet wall shall be provided over roofs of all buildings. Parapet wall shall have suitable coping. External face of parapet wall of the buildings provided with metal cladding shall also be finished with metal cladding of design and colour as per approved architectural drawings. Junction of roof and parapet shall be provided with 150 x 150 mm size concrete fillet.

3.10.2 Application of polymerised mastic over the RCC roof to achieve smooth surface as primer coat.

310.3 Application of high solid content liquid applied urethane based elastomeric water proofing membrane, over the primer coat, to give uniform joint less dry film thickness of minimum 1.5 mm (as per ASTM C 836 and C 898).

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3.10.4 For efficient disposal of rain water, the run off gradient for the roof shall not be less than 1: 100. This gradient shall be provided by screed concrete M-15 (using 12.5 mm coarse aggregate) and / or cement mortar (1: 4) over the elastomeric water proofing membrane with 25mm thick cement mortar (1:4) topping.

3.10.5 Wearing course at top, shall consist of 25 mm thick P. C. C. (M-15) cast in panels of maximum 1.2 x 1.2 m size and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealing compound / elastomeric water proofing membrane. Pathways for handling of materials and movement of personnel shall be provided with 22 mm thick chequered cement concrete tiles as per IS : 13801 for a width of 1000 mm in place of P. C. C.

3.10.6 Roof of transfer points and crusher house shall be provided with troughed profile permanently colour coated sheet on outside and plain permanently colour coated sheet on inside with 50mm thick mineral wool insulation in between the two sheets. A slope of 1 in 5 shall be provided for quick drainage of rain water.

4.0 QUALITY ASSURANCE PLAN

Contractor shall ensure the quality of civil works by engaging a third party supervision /inspection and provide test results to Owner / PMC for information. The Quality Assurance Plan is attached for reference as Annexure – D and the contractor is obliged to follow it.

5.0 COMPLETENESS OF WORK/CONTRACT

a) The scope of work mentioned in the contract / NIT is not the comprehensive one, but gives total idea/outline of the scope of work; however contractor shall be responsible for completeness of the job for the purpose indicated elsewhere to make the system fully functional, operational and durable as per latest IS standards.

b) The work furnished shall be complete in every respect with all mounting, fittings, fixtures and standard accessories etc. normally provided for such item/equipment

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and or needed/required for erection, completion and safe operation of the item/equipment/system as required by applicable codes though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

c) Any additional items and materials which are not specifically mentioned but are required to complete the system offered, in every respect in accordance with the technical specifications and required for safe operation and guaranteed performance shall also be deemed as included in the scope of work of this tender. Contractor shall not be eligible for any extra payment in respect of such mountings, fittings, fixtures, and accessories etc. which are needed/ required for safe operation of the item / equipment/system, as required by applicable codes of the country though they may not have been explicitly spelt out in the NIT/Contract.

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SECTION VI– 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE-A: CIVIL & STRUCTURAL DESIGN BASIS

PROJECT: COAL / PET COKE / LIMESTONE HANDLING FROM RAILWAY SIDING TO STORAGE YARD

PLANT : INTEGRATED COAL BASED FERTILISER COMPLEX, AT TALCHER, ANGUL DISTRICT, ODISHA (INDIA)

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1.0 GENERAL

1.1 SCOPE

This engineering design basis defines the minimum design criteria that shall form the basis for carrying out detailed structural design and engineering of all plant and non-plant structures and buildings. All data required in this regard shall be

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taken into consideration for acceptable, satisfactory and trouble-free engineering of the structures.

Compliance with this design basis and / or review of any of CONTRACTOR documents shall in no case relieve the CONTRACTOR at the contractual obligations. All structures shall be designed for the satisfactory performance of the functions for which they are being constructed.

1.2 UNITS OF MEASUREMENT

Units of measurement in design shall be in metric system.

1.3 DEFINITIONS

CCE	Chief Controller of Explosives
TAC	Tariff Advisory Committee
NFPA	National Fire Protection Association
IS	Indian Standards
Owner	TFL
Consultant	PDIL
LSTK contractor	Successful LSTK Bidder of The Tender

1.4 CODES AND STANDARDS

The design shall be in accordance with established codes, sound engineering practices and shall conform to the statutory regulations applicable to the country.

1.4.1 The main codes and standards and statutory regulations considered as minimum requirements are as follows Latest revision of these shall be followed.

a) National Building Code of India : 2005

b) IS: 875 (Part 1) – Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Part 1 – Dead Loads).

c) IS: 875 (Part 2) - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Part 2 – Imposed Loads).

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d) IS: 875 (Part 3) - Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures (Part 3 – Wind Loads).

e) IS: 1893 (Part 1):2002 –Criteria for Earthquake Resistant Design of Structures (Part 1 – General Provisions and Building).

f) IS: 1893 (Part 4):2005 –Criteria for Earthquake Resistant Design of Structures (Part 4 – Industrial Structures including Stack-Like Structures).

1.4.2 STRUCTURAL STEEL

a) IS: 800 – Code of Practice for General Construction in Steel

b) IS: 802 – Code of Practice for use of structural steel in overhead transmission line towers.

c) IS: 1161 – Code of Practice for Circular hollow sections/pipes.

d) IS: 4923 – RHS & SHS sections.

e) IS: 2629 – Recommended practice for hot dipped galvanizing on iron and steel.

f) IS: 2633 – Methods for testing uniformity of coating of zinc coated articles.

g) IS: 6533 – Code of Practice for design and construction of steel chimney.

h) IS: 6745 – Method for Determination of mass of zinc coating.

i) IS: 814 – Covered Electrodes for manual metal arc welding of Carbon and carbon manganese steel.

j) IS: 816 – Code of Practice for use of Metal arc welding for General Construction in mild steel.

k) SP-06 – (Part 1 to Part 7) - Handbook for Structural Engineers.

1.4.3 REINFORCED CONCRETE AND MASONRY WORK

a) IS: 456 – Plain and Reinforced Concrete – Code of Practice

b) SP:16 - Design Aids for Reinforced Concrete to IS: 456

c) SP: 34 – Handbook of Concrete Reinforcement and Detailing.

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d) SP:24 – Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced

e) SP: 20(S & T) – Explanatory Handbook on Masonry Design and Construction.

f) IS: 2911 (Part 1 to Part 4) – Code of Practice for Design and Construction of Pile Foundation.

g) IS: 2950 (Part 1) – Code of Practice for design and construction of Raft foundation.

h) IS: 2974 (Part 1 to Part 5) – Code of Practice for design and construction of Pile Foundations.

i) IS: 3370 - Code of Practice for Concrete Structures for storage of liquids.

j) IS:4326 – Code of Practice for earthquake resistant design & construction of buildings

k) IS: 13920 – Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

l) IS:1172 - Code of basic requirements for water supply, drainage & sanitation

m) IS:1742 - Code of practice for building drainage

n) IS:1905 - Code of practice for structural use of unreinforced masonry

o) IS: 2212 - Code of practice for brick work

1.4.4 ROADS AND SANITARY WORKS

a) IS: 2065 - Code of practice for water supply in buildings

b) IS: 8835 - Guidelines for design of surface drains.

c) IRC: 6 - Code of practice for road bridges, Section-II Loads and stresses

d) IRC: 19 - Standard Specifications And Code of Practice for Water Bound Macadam

e) IRC: 37 - Design of flexible pavements

f) IRC: 58 - Design of rigid pavements

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Note: The above list is suggestive and not exhaustive. Apart from these basic codes any other related codes shall also be followed wherever required.

In case of any difference between Codes provision and this design basis, the stringent one should govern the design.

1.4.5 In case of any conflict / deviations amongst various documents, the order of precedence shall be as follows:

a) Statutory Regulations

b) Job Specifications

c) Engineering Design Basis

d) Standard Specifications

2.0 MATERIALS OF CONSTRUCTION

Type of Structure	Materials of Construction
Piperacks Technological Structures/Platforms Shed type structures (e.g. compressor shed, Pump shed)	Structural Steal (unless required otherwise from process requirement or operation considerations)
Opening Platforms in steel structures	Steel gratings
All buildings (except blast-proof control-	RCC frames with hollow/solid concrete block
Blast proof control room building	RCC
Gratings	Steel

3.0 DESIGN LOADS & COMBINATIONS

The following design loadings shall be considered

- Dead loads including self weight
- Live load
- Wind load
- Seismic load

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- Equipment load
- Dynamic load
- Load from lifting appliances
- Erection loads / maintenance loads
- Thermal load
- Earth pressure / Hydrostatic Loads
- Any other load not mentioned above, but applicable

These loadings shall be applicable to all structures irrespective of the material employed for construction.

3.1 BASIC LOADS

3.1.1 DEAD LOAD (DL)

Dead load shall comprise of the weight of all permanent construction including walls, fire proofing, floors, roofs, partitions, stairways and fixed services.

The unit weight of materials in general, shall be in accordance with IS: 875-1987.

Unless noted otherwise following unit weights shall be adopted.

Reinforce Concrete	:	2500 kg/m³
Plain Concrete	:	2400 kg/m³
Structural steel	:	7850 kg/m³
Backfill Soil	:	1800 kg/m³
Operating floor with grating	:	100 kg/m²
Staircase (steel)	:	140 kg/m²
Ladder	:	40 kg/m²
False ceiling	:	60 kg/m²
Heavy duty tar felting	:	30 kg/m²
6/8 mm Thick. Raised Pattern Chequered plate	:	55 kg/m²
25 mm Thick Grating	:	40 kg/m²
Hand Rail	:	150 kg/m
Ladder	:	40 kg/m

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Operating floor with grating : 100 kg/m²

Electrical Panel Load : As per Actual panel loads

Instrumentation Panel Load : As per Actual panel loads

3.1.2 LIVE LOAD (LL)

Live loads shall, in general, be as per IS: 875. However, the following minimum live loads shall be considered in the design of structures to account for maintenance and erection phases; if equipment layout / vendor drawings indicate loads of greater magnitude, the same shall be adopted.

(1) Live Loads on locations other than roofs

The Design Live Loads shall be those appropriate to the actual situations but shall not be less than the following values:

a) Process Building / Technological Structure (Open / Enclosed type)

- Operating area : 5.0 kN/m²
- Maintenance area : 7.5 kN/m²
- Ground floor : 10.0 kN/m²

b) Compressor House/TG House

- Operating area : 7.5 kN/m²
- Maintenance area :7.5 kN/m² or as specified by Machine vendor whichever is more
- Ground floor : 10.0 kN/m²

c) Service Platform

- Vessel / Tower : 3.0 kN/m²
- Isolated platform (for valve operation) : 2.5 kN /m²
- Access way : 2.5 kN/m²
- Cross over : 2.0 kN/m²
- Pipe rack walkways : 2.5 kN/m²
- Gantry girder walkway : 3.0 kN/m²

d) Storage Areas

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- Light Storage Areas : 5 KN/m²
- Heavy Storage Areas :- 12 KN/m²

e) Substation / Control Room

- Panel floor : 10.0 kN/m² (Minimum) or Subjected to actual panel load Whichever is more.
- Battery Room : 5 KN/m2
- Lobby : 5 KN/m2
- Exit way : 5 KN/m2
- Miscellaneous partition : 1.0 kN/m²
- Other areas : 5.0 kN/m²

f) Office building

- Office area : 3.0 kN/m²
- Entrance lobby : 5.0 kN/m²
- Exit way : 5.0 kN/m²
- Miscellaneous partition : 1.0 kN/m²
- Document Storage area : 10.0 kN/m²

g) Laboratory

- Upper floors : 4.0 kN/m²
- Ground floor : 5.0 kN/m²

h) Cooling Tower

- Operating platform / Hot water Basin cover slab : 3 kN/m²

i) GT Building / DM Plant / ETP

- Operating platforms : 3.0 kN/m²
- Ground floor : 5.0 kN/m²

j) Ware House & Work Shop

- Light : 5 kN/m^2
- Medium : 7.5 kN/m^2
- Heavy : 10 kN/m^2

k) Staircase

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- Process Building : 5.0 kN/m²
- Technological structure : 5.0 kN/m²
- Office : 5.0 kN/m²
- Substation / Control Room : 4.0 kN/m²
- Laboratory : 4.0 kN/m²
- Service platform : 2.5 kN/m²

(2) Live Loads on roof

a) Flat Roof, sloping roof with slope < 10 degree

- With Access : 1.5 kN/m²
- Without Access except for maintenance : 0.75 kN/m²

b) Sloping roof with slope > 10 degree

- For roof membrane sheet or purlins : 0.75 kN/m² less 0.02 kN/m² for every degree increase in slope over 10 degrees subject to minimum of 0.40 kN/m²

Loads on account of equipment and incidental loads shall be taken over and above the loads indicated in the table.

For all other buildings not covered in above Table, the imposed loads shall be taken as specified in IS: 875 (Part II)

1 kN/m² allowance shall be made for services supported from below the floor.

Live load on various types of roofs shall be as per the requirements given in IS: 875.

3.1.3 WIND LOAD (WL)

Definition of basic wind speed shall be peak gust velocity averaged over 3 second time interval at 10 m height above mean ground level with 50 years mean return period. The design life span of all structures, except temporary structures, and boundary wall shall be taken as 50 years. Life span of temporary structures and boundary wall can be lesser and shall be as per IS: 875.

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The Wind forces on buildings / structures and equipments due to effects of wind shall be calculated as per IS 875 (Part-3) except for switchyard structures and transmission towers for which IS: 802 shall be applicable

To account for surface area of piping, platforms and other attachments fixed to the equipment, the surface area of the equipment (vessel/column) exposed to wind shall be increased by 20% or as specified in the mechanical data sheets of the equipment.

Basic wind Speed (Vb) = 50 m/s upto 10 m height.

Risk Coefficient (k1) = Refer Table 1, IS 875 (Part-3)

Factor (k2) = Refer Table 2, IS 875 (Part-3)

(Coefficient K2 shall be worked out based upon structure height, structure class and terrain category)

Terrain = Category 1 (Open Sea Coasts)

Topography Factor (k3) = 1.0

Importance factor for Cyclonic Region (k4) = 1.15 (Industrial structure)

Design Wind Speed (V_Z) = Vb*k1*k2*k3*k4 m/s

Design Wind Pressure (p_Z) = $0.6*V_Z^2$ N/m^2

3.1.4 SEISMIC LOAD (SL)

All buildings, structures, foundations shall be designed to resist the effects of earthquakes in accordance with IS: 1893 (Part 1):2002 and IS: 1893(Part 4):2005. Seismic loads shall be as per IS: 1893 (Latest Revision).

3.1.4.1 DESIGN SITE CONSIDERATION

The Project site falls in seismic zone III that indicates that Site has moderate probability for occurrence of earthquakes.

SEISMIC PARAMETERS

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Seismic design forces shall be determined based upon the following parameters. Buildings of different materials of construction and lateral force resisting systems shall be investigated separately.

Item	Value	Reference
Seismic Zone	Zone -III	Fig.1 Map Showing Seismic Zones of India (IS:1893-Part 1)
Zone Factor	0.16	Table 2 (IS:1893-Part 1)
Response Reduction Factor (R)	As per table 3 of IS1893 Part 4	
Importance Factor	As per table 2 (IS:1893-Part 4)	
Damping	5% for RCC Structure	Clause 7.8.2.1 (IS:1893-Part 1)
	2% for Steel Structure	

3.1.4.2 CATERIOZATION OF STRUCTURES/EQUIPMENTS

To perform well in as earthquake, the structures/buildings should possess adequate strength, stiffness and ductility. The importance factor for any structure shall be determined based upon the category in which the structure lies. Structures shall be classified into the following four categories as per IS: 1893 (Part-4).

Categorization of individual structure and buildings shall be taken from Table-6 of IS: 1893 (Part-4).

3.1.4.3 DESIGN ACCELERATION DUE TO VERTICAL EARTHQUAKE

When effects due to vertical earthquake loads are to be considered, the design vertical force shall be calculated in as specified in cl 6.4.5 of IS: 1893 (Part 1) .

Vertical acceleration values shall be taken as 2/3 of the corresponding horizontal values.

3.1.5 EQUIPMENT LOAD (EQ)

3.1.5.1 EQUIPMENT CATEGORY

a) EQUIPMENT CATEGORY-I

The weight of equipment category I such as pumps, compressors, motors etc., shall be derived as far as possible from Manufacturer's data and shall include controls, auxiliary machinery, piping etc. The equipment load shall be

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categorized if required for use in various loading combinations as empty and operating.

b) EQUIPMENT CATEGORY-II

This category consists of loads from equipments such as vessels, columns, heat exchangers, condensers, settlers, filters and the like, complete with their piping.

In accordance with the various load combinations for the category of equipment, the following weights/loads shall be included in the calculations.

3.1.5.2 EQUIPMENT WEIGHTS

a) Empty Weight (Ee)

This is the dead weight of vessels, columns, etc. completely installed) including platforms and ladders, piping, insulation and fireproofing) and ready for operation, however, without liquid filling. Weights will be derived from manufacturer's data.

b) Operating Weight (Eo)

This is the empty weight plus the maximum weight of contents of vessels, columns, etc. during normal operation of the plant, Weight of pipes full of product (liquid/gases) plus the weight of insulation and anchor loads if any.

c) Hydrostatic Test Weight (Et)

When Hydrostatic pressure testing of equipment is required at site and is done after installation, the weight of equipment, completely filled with water shall be incorporated in the design of the supporting structure. Only one biggest system shall be considered to be tested at a given time.

The empty / operating / test weight of process equipment including contents and all fixtures, platforms, ladders and attached piping etc, shall be considered. If piping weight is not indicated separately or not included in the weight of the equipment, the same shall be taken as 10% of the weight of the equipment.

3.1.5.3 EXCHANGERS / FABRICATED EQUIPMENTS

When exchangers are supported on structures, the supports shall be designed for vertical and horizontal forces (bundle pulling force or friction forces). The

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vertical loads shall be categorized into empty weight, operating weight and test weight.

Weight distribution over two (2) saddles of an exchanger shall normally be as follows:

Exchanger Type	Channel Side	Shell Side
Floating head type	60%	40%
Fixed tube sheet type	50%	50%
Kettle type	45%	55%
U-tube and other type	67%	33%

3.1.5.4 SPECIAL CONSIDERATIONS

a) Bundle Pull

Bundle pull forces for different types of exchangers shall be taken as under :-

Fixed type - Nil

Kettle type - 0.30 x Bundle weight

All other types - 0.86 x Bundle weight or 30 N/mm of diameter whichever is greater.

Total Bundles Pull shall be considered on fixed pedestal alone

b) Thermal Expansion

Horizontal force due to thermal expansion of horizontal vessels / exchangers shall be relieved by using slotted holes and slide plates and remaining force derived from the product of the sliding saddle 'gravity load' and the coefficient of friction shall be applied to each support. The coefficient of friction shall be as under:

i) Teflon to Teflon : 0.08

ii) stainless steel to Teflon : 0.10

iii) steel to steel : 0.30

iv) steel to concrete : 0.45

c) Non-Static Loading

Foundations and structures supporting vessels subject to surge loading, such as Deaerators shall be designed with sufficient stiffness and rigidity to resist a notional horizontal forces of 10% of those derived from the Vessel's operating weight or the given surge load whichever is the greater. The forces shall be

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applied at the vessel's centre of gravity and act longitudinally OR transversely. Consideration shall be given to bracing these structures.

The design of foundations and structures supporting agitated vessels, centrifuges, reactors and other variable load equipment shall take full account of all the loading data provided by the equipment vendors. Where no loads are available, consideration shall be given to applying force at 10% of operating weight. In addition, for dynamic effect loads will be increased by 50% of steam agitated equipment and 25% for mechanical agitated vessels.

Where two or more similar items of such equipment are supported on a common foundation or structure, the design must be based on the assumption that these items will resonate in phase.

3.1.5.5 ROTATING EQUIPMENT

Comprehensive loading data of mechanical equipment, such as, fans, blowers, pumps, compressors, D.G. Sets, turbines, motors engines etc., as furnished by the equipment vendor shall be considered.

3.1.6 PIPE RACK LOADS

For designing the pipe rack superstructure and foundation the following loads shall be considered.

a) PIPING LOADS FOR ERECTION/ EMPTY (P_E):

Empty loads of pipes coming at each tier shall be considered. Pipe empty weight shall comprise only empty weight of pipes excluding the contents but includes the insulation weight wherever applicable. These loading shall be as per piping loading data.

b) PIPING LOADS FOR OPERATION (PO):

This shall mean, the load of piping during normal operating conditions, including the weight of internals fluids & insulation.

In case of gas/steam carrying pipes, the material content shall be taken as 1/3rd volume of pipe filled with water.

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Piping Loads shall be calculated considering the pipe diameters and piping arrangement (as per Piping Stress Analysis report) subject to minimum of 150 Kg/m2 over entire span.

c) PIPING LOADS FOR TESTING (PT):

Test loads shall comprise of the maximum design loads i.e Empty weight of the pipe plus the weight of test medium contained in a set of simultaneously tested piping systems. Unless otherwise specified a minimum specific gravity of 1.0 shall be used for the test medium.

Vertical Loading

Actual weights of pipes coming at each tier shall be calculated. In calculating the actual weight of pipe, the class of pipe, material content and insulation, if any, shall be taken into consideration. Insulation density shall be taken as 2600 N/m³ minimum. In case of gas / steam carrying pipes, the material content shall be taken as one-third volume of pipe filled with water. The total actual weight thus calculated, shall then be divided by the actual extent of the span covered by the pipes to get the uniformly distributed load per unit length of the span. To obtain the design uniformly distributed load, over the entire span, the u.d.l. obtained as above, shall be assumed to be spread over the entire span. However, minimum loading for any piperack shall not be less than 1.25 kN/m². In case, the calculated loading is higher than 1.25 kN/m², this shall be rounded off to the nearest multiple of 0.25 (i.e., 1.50, 1.75 kN/m²)

Vertical loads of flare pipe shall be taken as one third full of water for piping within units & one sixth full for outside unit battery line. All flare line independent support shall be of four legged braced open lower type construction.

In addition to piping load, gravity loads due to encasement, if any, shall be considered.

d) FRICTION FORCE (LONGITUDINAL & TRANSVERSE)

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i) Pipe rack and supports shall be designed to resist the friction induced by the piping. Where the pipes are of similar diameter and service condition, the friction force at each tier on every portal, both in longitudinal and transverse directions shall be 10% of the design vertical loading of the pipes for four or more pipes supported on a tier, and 30% of the design vertical loading of the pipes for single to three pipes supported on a tier.

ii) Longitudinal friction force shall be considered as uniformly distributed over the entire span of the beam at each tier and transverse friction force shall be considered as a concentrated load at each tier level. Friction forces on T-supports and trestles shall be taken as 30% of the vertical loading. Both longitudinal and transverse friction forces shall be considered to be acting simultaneously.

iii) For two-phase fluid flow/transfer lines frictional force shall be minimum 50% of the weight of pipe including contents & insulation, acting simultaneously in transverse & longitudinal direction.

e) ANCHOR AND GUIDE FORCE (AL)

The Anchor or Guide Forces in longitudinal and transverse directions shall be as per piping stress analysis results. These loads shall be considered for local / global design of members / structure as appropriate. In absence of information of anchor force it shall be considered as 10 % of Operating weight of pipe per pipe tier.

f) LOADING ON INTERMEDIATE BEAM AT TIER LEVEL

Intermediate beam at tier level shall be designed for 25% of load on main portal beams in transverse direction. A reduction of 10% in vertical loading shall be considered for main portal beams, if intermediate beams are provided.

g) LOADING ON LONGITUDINAL BEAMS

Longitudinal beams connecting portal columns shall be sufficiently strong to sustain 25% of the load on the transverse beams. The total load shall be assumed as two equal concentrated loads acting at 1/3rd span. Other longitudinal axial forces coming on it from the design of the supporting system shall also be simultaneously taken into account in the design of the longitudinal beam. Friction

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& anchor forces, if specifically given by the Piping Specialist, shall also be catered for in the design. Loads from monorails, when supported from these beams, shall also be considered to be acting simultaneously along with all other loads mentioned above.

h) CABLE TRAY AND WALKWAY LOADS

The estimated actual load from electrical, instrumentation trays shall be considered at the specified locations, together with walkways, platforms for valve operation, wherever provided.

i) PIPE WIND FORCE

Transverse wind loading shall be calculated depending on the width of the piperack as per the following table. This force shall be considered irrespective of the height between two tiers.

Width of Piperack	Wind Force at each Tier level(N)
Upto 4 m	1.25 x p x s
Above 4 m but upto 6 m	1.50 x p x s
Above 6 m but upto 10 m	2.00 x p x s
Above 10 m	projected height x p x s

Where p = Horizontal wind pressure as per IS:875 (N/m²)

s = Spacing of portals (m)

For pipe racks of width greater than 10 m, the projected height shall be lesser of the following two:

i) 0.8 x (diameter of largest pipe including insulation (m) + tan 10º x (width of rack (m).

ii) height between consecutive tiers

For flare header or any other line supported on extended leg of piperack, the wind force shall be considered separately.

j) PIPE SEISMIC LOADS

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Seismic loads shall be as per IS: 1893 (latest version).Pipe racks should be adequately braced in all possible directions, consistent with function requirements.

Limiting permissible horizontal deflection for piperack shall be height / 325.

3.1.7 IMPACT AND VIBRATORY LOADS

Structures subjected to impact or vibratory loads shall be designed as per the provision of IS: 875 & IS: 2974. Requirements for monorails and overhead cranes shall be as per IS: 800, IS: 875 or manufacturer's data, whichever is more stringent.

3.1.8 EARTH PRESSURE (EP)

Earth Pressure shall mean pressure of the soil acting on the underground structures and / or foundations of retaining walls, dikes etc. Earth pressure to be considered for design shall be due to earth pressure at rest (Ko) condition only.

3.1.9 HYDROSTATIC / LIQUID PRESSURE (LP)

Hydrostatic / Liquid Pressure shall mean pressure of the liquid acting on the underground structures Pit/Basin walls etc.

3.1.10 TRAFFIC LOADS (TR)

Traffic Loads for plant engineering and construction shall be defined as the following loads according to the governing condition at construction, operation and maintenance. Unless otherwise specified, appropriate IRC Loading (Class A-A) shall be applied to the design of road crossing constructions such as drainage pipes and cable trench.

3.1.11 CONTINGENCY LOADS

3.1.11.1 RCC STRUCTURES

All floor slabs and beams shall be designed for a concentrated load of 10 KN acting simultaneously with the uniform live load, but not with actual concentrated loads from equipment, piping etc. This load shall be placed to result in maximum moment and / or maximum shear.

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This load shall not be considered for the design of columns, foundations and in overall frame analysis. For floor slabs, the load shall be considered to be distributed over an area of 0.75 m x 0.75 m.

3.1.11.2 STRUCTURAL STEEL

For process plants, the following contingency additional loading shall be applied to individual beam elements, these shall be applied as point loads to produce worst shear and bending stresses:

- Platform Walkways 3 kN
- Secondary Floor Trimmers 5 kN
- Primary / Grid beams 10 kN

3.1.12 MISCELLANEOUS LOADS

Apart from the specified live loads, possible overloading during construction / hydro-test maintenance / erection shall also be considered in the design Job specifications and shall also be referred to, for any specific loading.

Hydrostatic pressure shall be adequately accounted for, in the design of structures, below ground water table.

All the handrails, parapets, parapet walls, balustrades shall be designed for horizontal load mentioned in Table 3 of IS-875 (Part-2).

3.2 LOAD COMBINATIONS

Structural analysis and design shall take into consideration, worst combination of the above loads under different phases, such as, Erection, Operation, Hydro-test, Shutdown, Maintenance, and Blast for control room, as applicable.

3.2.1 FOR FOUNDATION DESIGN

LOAD CONDITION	LOAD COMBINATION
OPERATING	$DL + LL + E_O$
	$DL + LL + E_O \pm WL$
	$DL + E_O \pm WL$
	$0.6 X (DL + E) \pm WL$
	$DL + E_O + LL \pm SL$

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	DL + E_O ± SL
	0.6 X (DL + E_O) ± SL
ERECTION	DL + E_e ± WL
	0.6 X (DL + E_e) ± WL
TESTING	DL +E_t ± WL
	0.6 X (DL + E_t) ± WL

3.2.2 FOR CONCRETE DESIGN

LOAD CONDITION	LOAD COMBINATION
OPERATING	1.5 X (DL + LL + E_O)
	1.2 X (DL + LL + E_O ± WL)
	1.5 X (DL + E_O ± WL)
	0.9 X (DL + E_O) ± 1.5 X WL
	1.2 X (DL + E_O + LL ± SL)
	1.5 X (DL + E_O ± SL)
	0.9 X (DL + E_O) ± 1.5 X SL
ERECTION	1.5 X (DL + E_e ± WL)
	0.9 X (DL + E_e) ± 1.5 X WL
TESTING	1.5 X (DL + E_t ± WL)
	0.9 X (DL + E_t) ± 1.5 X WL

3.2.3 FOR STRUCTURAL STEEL DESIGN

LOAD CONDITION	LOAD COMBINATION
OPERATING	DL + LL + E_O
	0.75 X (DL + LL + E_O ± WL)
	0.75 X (DL + E_O ± WL)
	0.75 X (DL + E_O + LL ± SL)
	0.75 X (DL + E_O ± SL)
ERECTION	0.75 X (DL + E_e ± WL)
	0.8 X (DL + E_e)
TESTING	0.75 X (DL + E_t ± WL)
	0.8 X (DL + E_t)

The design shall be governed by worst load combinations.

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4.0 DESIGN CRITERIA FOR FOUNDATIONS

4.1 DESIGN BASIS FOR FOUNDATION

This document defines the minimum design criteria that shall form the basis for carrying out detailed structural design and engineering of all plant and non-plant structures/building foundations, equipment foundation, misc. support foundation, etc. All data required in this regard shall be taken into consideration for acceptable, satisfactory and trouble-free engineering of the structures.

Soil Investigation report attached with the bid is only indicative. However, the contractor is required to carry out confirmatory soil investigation, through the party approved by PMC / OWNER, and submit the report for Review / Approval. The report should contain all necessary details about suitable foundation system(s) for Project area.

Foundations shall be designed to permit field hydro test for all vessels and towers in operating position, excluding those vessels that are not designed for hydro test.

Type of foundations and other pertinent details thereof to be adopted shall be as per Soil Investigation report recommendations which are more stringent among the two.

Following clauses describe the general guidelines to be followed while designing the foundations; these clauses do not per se stipulate the type of foundations to be followed.

4.2 SHALLOW FOUNDATIONS

Foundation sizing for shallow foundations shall be based on working loads, not on loads which may have been increased by factors for the purpose of concrete design.

For load combinations including seismic forces, the Safe Bearing Pressure of Soil and the Safe Bearing Load of piles shall be increased as permitted in IS: 1893.

Grade of concrete to be used in foundation shall in general be as per the philosophy adopted for the entire structure. However, minimum cement content, type of cement, and any remedial actions, if required for foundations due to aggressiveness of subsoil water, shall be as stated elsewhere in this document.

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Permissible settlements of Foundations

For open foundations, the total permissible settlement and differential settlement will be governed by IS: 1904/ IS: 13063 respectively and from functional requirements whichever is more stringent. However total settlements of foundation resting on soil will be restricted to following:

Foundation Type	Allowable settlement (mm)
Shallow Foundations in unit areas, utility areas and foundations for plant buildings including substation, compressor house, control room, technological structures	25
Shallow Foundations Supporting non-plant buildings	25
Continuous Raft Foundation	40
Pipe Racks	25
Pump House	25

Note: for all other foundation settlement criteria shall be as per IS code requirements

4.2.1 GROUND WATER TABLE

The ground water table (GWT) and other pertinent details thereof to be adopted shall be as per Soil Investigation report recommendations.

The ground water table (GWT) within project limit varies from 0~2m* (Approx.) depth from existing ground level. However, the Ground water levels shall be considered at ground level while checking stability against uplift.

4.2.2 UPLIFT ON FOUNDATIONS

In the design of foundations, the upward pressure of water, where applicable, shall be taken as the full hydrostatic pressure applied over the whole area. Ground water table shall be assumed to be at ground level for calculating the hydrostatic pressure. Any other upward load shall also be included in the design.

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Partial contact between the foundation and soil strata shall be considered wherever applicable. The footing will be checked for minimum contact area and maximum bearing pressure will be calculated for the actual contact area only.

Allowable loss of contact area between underside of foundation and soil (due to resultant overturning moment) under different loading conditions shall be as given below.

Load Combination description		Allowable % Loss of Contact Area
A	Operating Load case (Plant operating, with or without Live Loads, for worst cases)	0 % to 10%
	Operating Load Case with Wind or Earthquake (with or without Live Loads, for worst cases)	up to 25%
B	Operating Load case (Plant operating, with or without Live Loads, for worst cases)	0 % to 20%
	Operating Load Case with Wind or Earthquake (with or without Live Loads, for worst cases)	up to 30%

Where A = Foundations on Soil B = Foundations on Rock

4.2.3 SOIL AND HYDROSTATIC PRESSURE ON WALLS BELOW GRADE

In the design of walls below grade, provision shall be made for the lateral pressure of adjacent soil. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or whole of the adjacent soil is below a free water surface, computations shall be based on the weight of the soil diminished by buoyancy, plus full hydrostatic lateral pressure.

The lateral pressure from surcharge loads shall be taken in addition to the lateral earth pressure loads.

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4.2.4 STABILITY OF FOUNDATIONS/ SUB-STRUCTURES

Foundations shall be checked for stability against overturning, sliding & uplift. While checking stability, the following shall be considered;

a) Stability against Overturning

Minimum Stability Ratio i.e. Factor of safety required against overturning (M_R/M_O) both being calculated at the leading edge of the foundation considering all forces and moments.

M_R = Resistant moment and M_O =Over turning moment

b) Stability against Sliding

The resistance to sliding shall be calculated from the following, where applicable:-

1) Foundation / soil friction

2) Passive soil resistance to the side of the foundation

3) Passive soil resistance of soil bearing against keys

c) Stability against Uplift

Ground water levels shall be considered at ground level while checking stability against uplift. Beneficial load of backfill can be included only in circumstances where it will never be removed.

d) Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground storage tanks, pits, trenches, basements, etc. Minimum factor of safety of 1.25 against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, the mass located vertically above and the inclined portion depending on the θ angle of soil. the projected area of the base slab shall be taken in to consideration.

e) Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.

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f) In cases where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

g) All building sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other latest relevant IS codes. However following minimum factor of safety shall be followed.

h) Foundations shall be checked for stability against overturning, sliding & uplift. While checking against uplift, the following shall be considered.

FOUNDATION DESIGN – FACTORS OF SAFETY

Type of Structures	Minimum factor of safety against overturning		Minimum factor of safety against Sliding		% Weight of Overburden over projected plan area of footing
	With wind or seismic	Without wind or seismic	With wind or seismic	Without wind or seismic	
All Buildings/ Structures / Eqpt. In Units	1.5	2.0	1.5	1.5	100
Pipe Rack (Offsite)	1.5	2.0	1.5	1.5	50
Flood Light Mast	1.5	-	1.5	1.5	50**
Retaining Wall	1.5	2.0	1.5	1.75	100
Over Head water tank	1.5(empty) 2.0(full)	-	1.5	-	50**
Blast Resistant Structures	1.5	2.0	1.5	1.5	100
Flare supporting Structures	1.5	-	1.5	-	50**

** In case area is paved, overburden shall be based on NGL (for area under filling) or 600 mm below HPP, whichever is lower. In case of unpaved area, it shall be w.r.t. FGL.

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Buoyancy from high ground water levels shall be taken into account in investigating stability against uplift.

4.2.5 FOUNDATION ON SOILS

The bearing capacity used in design shall be based on both shear strength of soil as well as settlement.

Footings shall be embedded into a sound, non-degradable surface having sufficient depth to provide adequate bearing resistance.

Piping failures of fine materials through rip-rap or through drainage backfills behind abutments shall be prevented by properly designed, graded soil filters or geotextile drainage systems.

4.3 PILE FOUNDATIONS

a) Piling shall be considered when footings cannot be founded on granular soil or stiff cohesive soils within a reasonable depth. Piles shall also be used where the spread footings shows an unacceptable amount of settlement.

b) Piles shall be designed as per IS: 2911. However, pile capacity shall be proven by a sufficient number of initial load tests before preparing piling plans.

c) The increase in Safe Working Load permitted as per codal provisions, under load combinations including wind / earthquake shall apply equally to uplift and sheer conditions, subject to confirmations by the piling Contractor with respect to the particular piling system. Pile capacity may be similarly increased in blast condition to 1.5 times the permissible capacity under compression, tension and shear modes.

d) Design capacity shall be established by conducting sufficient number of initial load tests. Routine pile load tests shall also be carried out as per IS 2911 (Part 4) on working piles. When any major machinery is to be supported on piles, behaviour of the piles under dynamic loading conditions as established by necessary field tests shall be considered.

e) The capacity of pile groups shall be obtained by applying appropriate group efficiency factors. Where piles pass through filed ground, the available pile safe

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working load shall be suitably reduced to account for negative skin friction caused by settlement of fill. Where suitable, consideration shall be given to reducing drawdown effects by slip coating the piles

f) When any major machinery is to be supported on piles, behavior of the piles under dynamic, loading conditions, as established by necessary field test, shall be considered.

g) While computing horizontal capacity, piles shall be treated as fixed head or free head depending on the degree of fixity at the top.

4.4 FOUNDATIONS

a) Foundation shall be proportioned in such a way that the allowable soil bearing capacity is not exceeded and the resulting settlement is within the acceptable limit in case of shallow foundation. For pile foundations, load on pile shall not exceed acceptable limit.

b) Foundation sizes and depths shall be planned considering subsurface conditions and surrounding underground constructions such as adjacent foundations, underground pipes and cables, trenches, pits, roads as well as the slope of ground.

c) Isolated footing shall be planned for each foundation. However, where adjacent footings interfere with each other, combined footing may be provided.

d) Where applicable the elevation of foundation top shall be in accordance with the process, mechanical and piping requirements.

e) For structures supported on strip footing of width one meter or less, suitable tie beams shall be provided connecting all the footings at foundation level.

f) Masonry walls shall be supported on continuous plain cement concrete mats / plinth beams. Top of plinth beams shall be located at least 300 mm below the finished grade level. Fouling of plinth beams with cable trenches, drains, pipe ducts etc shall be avoided by suitably lowering the beam levels.

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4.4.1 FOUNDATIONS FOR ROTATING AND RECIPROCATING EQUIPMENTS

a) Foundations and structures supporting rotating machinery shall satisfy the requirements of IS: 2974 and any other parameters as per machine vendors. Foundation block extensions supporting auxiliary equipment's requiring rigid positioning with respect to the main equipment shall be detailed to act integrally with the block.

b) Generally, foundations and structures supporting rotating machinery shall be so proportioned that their natural frequency shall not fall within the range of 0.8 to 1.2 of normal operating speed of the equipment.

c) Foundation for rotating and reciprocating equipment's such as turbines, engines, compressors and generators shall be designed to secure the dynamic stability of the foundation system, as well as the static stability.

d) Dynamic stability for foundation supporting heavy vibrating equipment's like the following shall be secured by dynamic analysis in general:

- Heavy vibrating equipment,

- Equipment sensitive to vibration,

- Equipment causing large dynamic force

e) All foundations for dynamic equipment's shall be isolated from floor or any other static foundation by providing filler board all around foundation. Clear air gap shall be provided in Superstructure to avoid transmission of vibration to adjacent structures. Special note shall be given on the drawing in this respect, and suitable details be shown as required.

4.4.2 GENERAL REQUIREMENTS FOR DESIGN

Following minimum requirements shall be taken into account for foundation design in principle.

a) Further, design shall be carried out such that amplitude of vibration during normal operation or other critical conditions shall not exceed the allowable amplitude specified by the equipment manufacturer or IS: 2974,whichever is more stringent. The above design criterion may be omitted for centrifugal pumps and fans and

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other minor rotating equipment weighing less than 1 ton or if the mass of the rotating parts are less than 1/100th of the mass of foundation installed directly on concrete foundation provided that the weight of foundation is not less than 3 times of the equipment weight. In such cases, dynamic analysis is not necessary.

b) Foundation for heavy vibrating equipment shall be kept independent of building floors/ foundations and other adjacent foundations.

c) Foundation weight shall be at least three times the weight of the rotating equipment and five times the weight of the reciprocating equipment.

d) The weight of foundation slab shall not be less than the combined weight of the structure and the machine.

e) Foundation shall be of uniform rectangular/ square shape. Beams and columns of foundations shall be of uniform rectangular/ square shape.

f) The horizontal eccentricity, in any direction, between the center of gravity of the machine - foundation system and the center of base contact area or centroid of the pile group, shall be within 5% for block foundations and 3% for frame foundations. However, in highly compressible soils no eccentricity shall be permitted.

g) The geometric layout of the foundation and structure shall be basically symmetric with respect to the vertical plane passing through the rotational axis of the equipment.

h) Minimum reinforcement as per requirements of IS: 2974 shall be provided unless required otherwise by design.

i) Soil stress below foundations under dead loads shall not exceed 80% of the allowable soil bearing capacity for static loading.

j) It shall be ensured that there is no transfer of vibrations from machine foundations to any part of the adjoining structures. In case such machine is sitting on building floors, approved damping pads shall be used with prior approval of OWNER / CONSULTANT.

4.4.3 DYNAMIC ANALYSIS

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Dynamic analysis shall be performed by suitable and approved method so that dynamic feature can be evaluated correctly:

Following effects shall be taken into account:

- Dynamic features of subsoil
- Dynamic features of supporting foundation system
- Dynamic effect of the foundation system
- Dynamic forces of equipment

Data of dynamic load to be used for the dynamic analysis shall be supplied by Equipment Supplier and shall state unbalanced force due to:

- Eccentricity of dynamic mass of rotating equipment
- Different crank arrangement of reciprocating equipment

4.4.4 EVALUATION OF DYNAMIC ANALYSIS

a) Foundations shall be so designed that natural frequency of the foundation system shall not resonate with the following:

i) Operating speed of the motor.

ii) Operating speed of the machine.

iii) 2 times operating speed of the machine

(This condition shall be complied only when the manufacturer has furnished the unbalanced forces related to 2 times the operating speed of the machine)

iv) Critical speed of the machine (for centrifugal machines).

Natural frequency of the foundation shall be ±20% away from the above mentioned frequencies. However, amplitudes of vibration of the foundation block shall always be checked to be within permissible limits

Where deviations (resulting from inaccuracies in soil parameter measurements, approximations in design method, etc.) from calculated natural frequencies, leading to amplitudes in excess of specified limits, are foreseen, provisions for

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increasing foundation mass without removal of the machine and without affecting surrounding space availability or connected piping shall be made, if possible.

b) Allowable amplitude due to dynamic load

Amplitude of the foundation systems for vibrating equipment shall be calculated through dynamic analysis by using dynamic load supplied by supplier and the allowable amplitude shall conform to supplier's requirement.

If supplier's requirement on amplitude is not specified, following criteria shall be applied:

The amplitude of vibration of the foundation in any direction, at any point in the foundation or structure shall be such that, it will fall down the zone ACC' for the specific exciting frequency as given in IS: 2974 (Part I)-1982 figure 3 "Amplitude Limits of foundation block ".

4.4.5 COMPRESSER FOUNDATIONS

Each structure and foundation supporting a compressor, pump or other machinery having significant dynamic unbalance shall be designed to resist the peak loads specified by the manufacturer. Vibration amplitudes of the supporting structure or foundation shall be kept within acceptable limits for dynamic forces that occur during normal machine operation.

For the foundation supporting minor rotating equipment weighing less than one ton or if the mass of the rotating parts is less than one hundredth of the mass of the foundation, no dynamic analysis is necessary.

The design of machine / equipment foundation shall be as per ISO 1940-1/ ISO-10816-2, IS: 456 and IS: 2974. The provisions of DIN 4024 shall also be followed for machine foundations.

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

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Analysis and design of the COMPRESSER foundation shall be carried out in accordance with relevant codes IS: 2974 Part-3 and IS: 456 and/or manufacturer's requirements. Dynamic analysis shall be carried out using finite element software. The dynamic analysis shall consist of free vibration analysis and forced vibration analysis. Unbalanced loads for normal operating condition as given by machine manufacturer and/ or ISO-1940 whichever is more shall be used for calculating dynamic response.

The static analysis shall include all operating conditions, load cases and abnormal loads like loss of blade, unbalance and seismic forces.

Natural frequencies and amplitude of vibrations of COMPRESSER foundation shall be as per relevant applicable code of practices as indicated above and/or as per manufacturer's requirements. Amplitudes calculated shall be ensured to be within the permissible limits as specified by the manufacturer. In the absence of specified criteria, amplitude shall be limited to alarm limit specified in ISO 10816–2. The Compressor foundations shall also be designed to meet the manufacturer's static deflection criteria, if any.

The minimum reinforcement in Compressor base raft shall be 0.12% on top face and 0.2% on bottom face Shrinkage reinforcement due to thermal expansion/connection shall be provided in 3D grid pattern in the base raft. .

The number of construction joints in the pedestal will be kept to minimum to achieve the monolithic behaviour of the structure. The base raft shall be cast in a single pour with construction joints at the top of the raft. The subsequent construction joints shall be provided in columns at the top of mezzanine floor and below the top deck. Continuous concreting shall be done for top deck/ beam portion. Special care shall be taken during concreting of pedestal to avoid cold joints and to ensure proper compaction and curing of concrete.

The pedestals supporting Compressor shall be completely isolated from Compressor building at all the floors by suitable gaps to prevent the transfer of vibrations. All foundations of major equipment subject to heavy vibrations shall be separated from adjoining part of building and other foundations. Joints at floor /

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slab shall be suitably sealed. All appendages to such foundations shall be reinforced suitable to ensure integral action.

4.5 TANK PAD FOUNDATIONS

Tanks shall be supported on compacted sand filling contained within ring walls. The ring walls will be designed for hoop tension resulting from side pressure exerted by sand fill due to surcharge of storage tank full with water. The ring foundations shall be designed as per the provisions of IS: 456 and IS: 11089.

4.6 LIQUID RETAINING R.C.C. STRUCTURES AND BASEMENTS

4.6.1 All liquid retaining / storage R.C.C. structures shall be leakpoof and designed as uncracked section in working stress method as per IS:3370. However, the parts of such structures not coming in contact with the liquid, shall be designed according to IS:456 except ribs of beams of suspended floor slabs and counterforts of walls (located on the side remote from liquid) and roof of liquid retaining structures which shall be designed as uncracked section. Hot/cold water basin, and other primary framing members of Cooling Towers and similar liquid retaining structures, which remain constantly in contact with water (stored / sprayed) shall be designed as uncracked sections. No increase in permissible stresses in concrete and reinforcement shall be made under wind or seismic conditions for such structures.

4.6.2 RCC water storage tanks and other water retaining structures like clarifier, water storage tank, water treatment structures like filter house, underground tanks, cooling tower basin, cooling water channels and also substructure of pump houses shall be designed in accordance with IS: 3370-2009.

4.6.3 All liquid retaining / storage structures shall be designed assuming liquid up to the full height of wall, irrespective of provision of any overflow arrangement. Pressure relief valves or similar pressure relieving devices shall not be considered in underground water retaining RCC structures. Hot water basin in cooling tower shall be designed for the weight of water up to top of parapet wall.

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4.6.4 Base slab and columns of the pump houses will also be designed for the condition of different combination of pump sumps being empty during maintenance stages with ground water level at formation level.

4.6.5 Intermediate dividing pier of pump sumps and partition wall in channel will be designed considering water on one side only and other side being empty for maintenance.

4.6.6 Storm water drains shall be designed as per IS: 456 using Limit State method.

4.6.7 Earth pressure for all underground structures will be calculated using coefficient of active earth pressure or at rest depending upon the boundary condition.

4.6.8 The walls and base slabs of liquid retaining storage structures shall be provided with reinforcement on both faces for thicknesses greater than 150 mm.

4.6.9 In all liquid retaining structures, PVC water bars (230 mm wide, 6 mm thick) shall be provided at each construction/ expansion joint. PVC water bars shall be of minimum 150/230 mm width and 6 mm thickness, and generally shall be riffed/serrated type with a central bulb Kicker type PVC water bars shall be used for the base slab and in other areas where it is required to facilitate concreting.

4.7 DE-WATERING OF DEEP EXCAVATIONS

For deep underground structures like track hopper, machinery hatches, tunnels and underground transfer houses, requiring open excavation with extensive de - watering, completely dry working conditions during excavation, shuttering, placement of reinforcement, concreting, water proofing of structures, backfilling and any other operation shall be maintained by suitable de - watering method of suitable capacity.

5.0 DESIGN CRITERIA FOR REINFORCED CONCRETE STRUCTURES

5.1 GENERAL

a) All buildings, structures, foundations, machine equipment foundations, liquid retaining storage structures, trenches, pits etc. shall be of RCC and designed based on the following IS codes (latest revision with all amendments, issued there

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to) in general, and other relevant IS codes applicable : IS:456, 875, 1893, 1904, 2911, 2950, 2974, 3370, 4326, 4991, 4998, 5249, 6403, 8009, 13920.

b) Only limit state method as per IS: 456 shall be followed for the design unless otherwise specified elsewhere in this document for special structures.

c) All skeletal structures shall be of frame type construction, and detailing shall be as per provision of IS: 13920.

d) Where the specified design depth of groundwater table so warrants, all underground pits, tunnels, basements, etc. shall be leak-proof R.C.C. construction using water proofing compounds.

5.2 RCC FRAMED STRUCTURES

All reinforced concrete framed structures will be rigid/moment resisting frames along both longitudinal & transverse directions.

The suspended floor slab will be considered as continuous over secondary beams and will not form part of framing system. However, it will be considered to transfer shear to the framing system and also assumed to act as diaphragm element to resist lateral forces.

The concrete frame members will be designed by Limit state method in accordance with IS-456.

The effective length of concrete pedestals supporting structural members shall be 1.5 times the actual length. The reinforcement for column shall be as per the design requirement. However the minimum reinforcement shall be 0.8% of the effective sectional area or 0.15% of the gross cross sectional area or as per the requirement of IS: 13920 whichever governs. The floor beam/roof beam & wall beams shall not be designed for compression. Minimum reinforcement criteria / minimum and maximum reinforcement for various structural elements such as beams, columns, footings, slabs, walls, pedestals etc as per relevant IS code.

5.3 DESIGN BASIS AND REQUIREMENTS

5.3.1 Framing Systems shall be arranged so that the stiffness of structure can be well balanced and the structural stability can be secured.

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5.3.2 Structural analysis and section design shall be made in accordance with the applicable codes, standards and specifications and by using the validated software's and approved methods.

5.3.3 In case of heavy and/ or tall equipments installed on the reinforced concrete structure, the floor beam and framing column arrangement shall be so planned that the firm anchoring and structural stability shall be assured.

5.3.4 Pits and basins shall be designed to withstand the water pressure, earth pressure, buoyancy and surcharge where required. Pits and Basins containing liquids shall be designed for both full and empty conditions and partition walls between compartments shall be designed for alternative liquid pressure on either side. Dykes shall be designed to withstand the pressure of containing liquid for both full and empty conditions.

5.3.5 <u>Minimum Dimensions of Concrete Members</u>

a) Member sizes shall be as per Design Requirements. However, minimum dimensions of structural members shall be as given below:

Pile cap…… : 500 mm

Levelling concrete……... : 50 mm

Grade slabs……. : 150 mm

b) Underground Pit/Reservoir (Below ground Water table) – Walls & Base Slab… : 150 mm

c) Underground Pit/Reservoir (Above ground Water table) – Walls & Base Slab… : 150 mm

d) Liquid retaining / Leak-proof structures

- Walls & Base Slab…….. : 150 mm
- Columns & Pedestals……. : 300 mm width,

e) Beams……..……. : 300 mm width,

f) Floor / Roof slab…….. : 150 mm

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g) Walkway…… : 1500mm wide, 100 mm thick

h) Parapet/Chajjas/Cantilever canopy slab...: 100 mm

i) Cable/Pipe trench Walls & Base slab…. : 100 mm

j) Precast Trench Cover / Precast Floor Slab……. : 125 mm

k) Louvre/Fin (not in contact with liquid) ……. : 100 mm

l) Louvre (in contact with liquid) ……. : 125 mm

m) Base slab with beams ……. : 200 mm

n) Base slab without beams……. : 300 mm

a) Insert plate……..…….. : 10 mm

b) Corner angle…….. : 6 mm

c) Footings (All types with or without beams) …….. : 300 mm

Note: Tapered footings shall not have thickness less than 150 mm at the edges. Minimum average thickness shall not be less than 300 mm

5.3.6 Minimum Height of Pedestals above Finished Grade Level

The minimum height of outdoor and indoor pedestals (supporting equipment / structures) above the highest paving level/finished floor level shall be:

Building plinth : 450 mm above finished ground level

Pedestals for structural columns:

Open paved area : 300 mm (min.) OR as indicated in Equipment layout drawing

Open unpaved area : 300 mm

Covered area(building etc.): 300 mm (min.) OR as indicated in drawing

Storage tank foundation : As per equipment layout

All equipment supporting foundations / pedestals

Open area : As required but not less than 300 mm

Covered area : As required but not less than 150 mm

Stair Pedestals : 300 mm (min.) OR as indicated in equipment

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Layout drawing.

Ladder pedestals : 300 mm

5.3.7 Minimum Clear Cover to Main Reinforcement

For structural elements which are exposed to fire (i.e. structures which are designed for fire resistance), consider nominal cover criteria as per IS 456 table 16 and as per relevant fire rating. Reinforcement shall have concrete cover not less than twice the diameter of bar at end. Minimum cover to main bar shall be:

a) Slab (roof & floor)…….: Free face…... 25 mm or dia of bar whichever is greater.

Canopy, Chajjas, Waist Slab..: Face in contact with earth……..: 30 mm

b) Beam…… : Top & Bottom…….. : 45 mm

: Side……... : 45 mm

: Face in contact with earth……. : 50 mm

c) Column and pedestal…….. : Super Structure…….. : 50 mm

: Face in contact with earth……. : 50 mm

d) Retaining wall,…….. : Face in contact with earth……. : 45 mm

Basement and Pit wall : Free face……. : 45 mm

e) Liquid retaining……. : Face in contact with liquid……. : 45 mm

Structure: : Face in contact with earth……. : 45 mm

: Free face……. : 45 mm

f) Plinth beam……... : Top ……..…….. : 50 mm

: Bottom…….. : 50 mm

: Sides…….: 50 mm

g) Foundation…… : Top ……..…….. . : 50 mm

: Bottom…….. ……. : 50 mm

: Sides……. : 50 mm

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h) Pile…… :Sides…… : 75 mm

i) Pile cap…… : Bottom…….. : 100 mm

: Top & Sides…… 75 mm

j) The above requirements shall not be applied to concrete construction of trench, local foundation, minor platform foundation, sump pit/ manhole, paving and other miscellaneous concrete construction, for which minimum clear cover shall be 25 mm.

5.3.8 Minimum Bar Diameter (Except for Blast Proof Construction)

Piles – Main Bars…….. : 12 mm

Piles – Ties…… : 8 mm

Major Foundation…….. : 10 mm

Block Foundation - Main Bars…… : 10 mm

Block Foundation - Tie Bars…… : 8 mm

Minor Foundation (Local foundation etc.)…… : 8 mm

Column, Pedestal - Main Bars…… : 12 mm

Column, Pedestal – Ties…….. : 8 mm

Beam - Main Bars…… : 12 mm

Beam - Anchor Bars…… : 10 mm

Beam – Stirrups…… : 8 mm

Slab - Main Bars…… : 10 mm

Slab - Distribution Bars…… : 8 mm

Wall - Main Bars…… : 10 mm

Wall - Distribution Bars…….. : 8 mm

Minor Elements such as Chajjas, Lintel Beams, etc……... : 8 mm

Slab and Wall for Blast proof building ……..…: 12 mm

5.3.9 Bar Spacing

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Minimum and maximum bar spacing for Foundations, Slabs, Stirrups for Beams, and Ties for Columns, Pedestals, Walls etc. shall be as per IS 456 & IS:13920. Bar spacing shall be provided in multiples of 25 mm.

5.3.10 Expansion Joints

Concrete structures

Expansion points in concrete structures shall be provided at 30-35 m centers. The expansion joint shall be provided preferably by way of twin columns on a common foundation. Sliding joints shall be avoided as far as possible.

5.3.11 Deflections

Deflections in concrete structures shall in general be limited by adherence to the limits on span by depth ratio for beams and slabs and length to lateral dimension ratios for columns as prescribed in IS: 456. Where special functional / serviceability requirements or large spans demand actual deflections and / or crack widths shall be calculated and the following limits adhered to:

- Total deflection due to all loads including the Effects of temperature creep and shrinkage : Span/250
- Crack width (for non-liquid retaining structure) : 0.3 mm
- Total horizontal deflection between two floors : Storey height/200

5.4 BUILDING SLABS ON GRADE

The specifications given in Table-1 shall be followed.

Sl. No.	DESCRIPTION	FLOORING TYPE		
		I	II	III

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1.a	Sub Grade	Earth fill base compacted to 95% dry density	Yes	Yes	Yes
1.b		Rubble soling	230 Thick	230 Thick	150 Thick
2.a	Structural Grade Slab	Lean concrete 1:5:10 over 1.b layer	50 Thick	50 Thick	50 Thick
2.b		Stable in Grade M20 concrete (Reinforced with 8 mm dia bars @ 200 c/c both ways) over lean concrete	150 Thick	150 Thick	100 Thick
			R/F placed centrally	R/F placed in two layers at top & bottom	No reinforcement required
3	Finish	Floor finish	As/Architectural detail	As/Architectural detail	As/Architectural detail

TYPE I: Plant buildings such as Sub-stations, Control Rooms, Process Operators' Room, Pump Houses, Utility Compressor Houses, D.M. Plant, E.T.P., Parking Areas, Stores, Porches.

TYPE-II : Warehouses, Workshops, Cement Godowns, Fire Stations, Process Compressor House.

TYPE III: Non Plant Buildings (viz. Administration, Laboratory, Canteen, Time Office, Gate House, Training Centre, Guest House, Residential Building)

5.5 RCC AND STEEL CHIMENY

RCC and steel chimneys shall be designed as per IS: 4998 and IS: 6533 respectively.

5.6 CULVERTS

Culverts shall be designed as per the following IRC codes of practices and manual. Where crane access is specified, the culverts shall be designed for the crane loads.

a) Standard specifications and code of practice for Road Bridges IRC 5

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(Section – I - General features of design)

b) Standard specifications and code of practice for Road Bridges IRC 6
(Section-II – Load and Stresses)

c) Guidelines for Evaluation of Load Carrying Capacity of Bridges SP 37

6.0 CRITERIA FOR MASONRY WORKS

6.1.1 GENERAL

All masonry works shall be designed in accordance with IS:1905, IS:1597, IS:2185, IS:4326 and other relevant IS Codes as applicable. All external brick, stone and hollow concrete block masonry walls shall be of minimum 230, 350 and 250 mm thickness respectively. ES 2516, enclosed with the tender may be referred for details. Masonry shall be plastered with CM 1:6, 12 mm thick on inside surfaces and 20 mm thick on outside surfaces.

6.1.2 CEMENT MORTAR

All masonry work shall be constructed in 1:6 cement sand mortar except half brick partition walls which shall be constructed in 1:4 cement sand mortar with 2 nos.8mm dia. M.S bars provided at every fourth course properly anchored with cross walls or pillars.

6.1.3 MASONRY WALL

a) All masonry walls from ground floor shall be placed on R.C.C. grade beams. However, light internal partitions may be placed on ground floor slab.

b) All brick masonry (M 7.5 grade) walls shall be considered as 230mm thick, except for partition walls which will be 115 mm thick. However, for fire barrier walls minimum thickness shall be considered as 350 mm.

c) All in-filled brick (M7.5 grade) panels shall be designed to transfer horizontal loads from wind and seismic to the structural frameworks without damage and the extent of brick panel dimensions shall be as per the recommendations in IS. All half masonry wall shall be provided with reinforcement consisting of 2 Nos. of 8mm diameter bars at every fourth layer.

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6.1.4 FIRE WALLS

Thickness of all masonry firewalls shall be as per Electricity Rules but not less than 345 mm.

7.0 DESIGN CRITERIA FOR STEEL STRUCTURES

This Specification covers the Requirements for the Design of Steel Structures such as Steel Buildings (Shelters & Sheds), Pipe Rack, Local Pipe Supports, Cable Racks, Equipment Supporting Structures, Platforms & Walkways, Staircase, Ladders, Handrails, Crane Gantry, Girders and Monorails flare stack, etc.

Excluded from the scope of this Specification are the Design Requirements for Platforms / Stairs / Ladders / Handrails directly attached to equipment and Stacks including Support Structures.

7.1 GENERAL / DESIGN METHODS

7.1.1 Design fabrication and erection of the above work shall be carried out in accordance with the following IS Codes as applicable to the specific structures, viz, IS:800, 801, 802, 806, 814, 816, 875, 1893, 6533, 9595, etc. Basic consideration of structural frame work shall primarily be stability, ease of fabrication/erection and overall economy, satisfying relevant Indian Standard Codes of Practice. Steel structures adequately braced in vertical and horizontal planes, consistent with functional requirements, shall be preferred over structure having moment connections. Moment connections, if adopted, shall be fully rigid as per IS:800. Where fully rigid joints are adopted they shall generally be confined to the major axis of the column member. Flare stack supporting structure shall be adequately braced on all four faces.

7.1.2 Structural elements, continuously exposed to temperatures above 200º C, shall be designed for reduced stress as per Table-4 of IS: 6533 (Part-2). The expected temperature of steel components shall not be allowed to exceed 400 º C. The structures connected to column, heater vessels working at high temperatures shall not be rigidly connected with staircase and adjoining structures, which are on ambient temperatures.

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7.1.3 Crane gantry girders shall generally be of welded construction and of single span length. Chequered plate shall be used for gantry girder walkway flooring.

7.1.4 Monorails shall be provided for all pumps and motors located in buildings, sheds and in open areas having rating more than 55 KW. For pumps and motors of smaller ratings, monorails shall be provided if directed by Owner / PMC.

7.1.5 Electro-forged/Welded hot dip galvanized MS gratings shall be minimum 25 mm deep. The maximum size of voids in the grating shall be limited to 30 mm x 55 mm. The minimum thickness of galvanizing shall be 120 microns. Gratings shall be suitable for the operation and maintenance loads for the floors.

7.1.6 Welded connections shall be adopted as far as practicable, except for cases where bolted connections are required viz. (Galvanized) electrical switchyard structures and transmission towers. Structural connections shall have minimum two bolts of 16 mm dia. unless otherwise limited by the size of members.

7.1.7 Lock nuts shall be provided for anchor bolts of tall structures, tall process columns, vibrating equipment, etc.

7.1.8 Minimum two nuts shall used for all anchor bolts except for ladder, stair and hand rail

7.2 DESIGN BASIS FOR STEEL FRAMED STRUCTURES

7.2.2 DESIGN CONSIDERATIONS

Design of steel structure will be carried out by Limit state method in accordance with IS-800-2007code with specific reference to other relevant IS codes wherever required.

The distance between point of lateral restraint shall form the basis for finding out the allowable stress in axial compression and bending.

Concrete floors where the compression flange of beam embedded to a minimum of 10mm into RCC shall be considered to provide continuous lateral support to the top (compression) flange of the support beams. However where large cut outs are provided in the floor slabs horizontal floor bracing shall be provided.

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Floors for vibrating machines of all kind together with supporting framework shall be adequately braced in both horizontal and vertical planes. Floors or structure supporting mechanical equipment shall be designed to minimise vibration, avoid resonance and maintain alignment and level.

Horizontal plan bracings shall be of angle / tee section located at the upper portion of framing secondary beams so as to make lateral strain effective in compression zone.

Interaction ratio shall be restricted to 0.9.

7.2.3 DESIGN BASIS AND REQUIREMENTS FOR SPECIFIC APPLICATIONS

a) Framing and bracing shall be planned so that the stiffness of the structure can be well balanced with the loads and the structural stability can be secured.

b) Vertical & Horizontal bracings shall be arranged properly, considering the following requirements:

- Plant Layout
- Equipment / Piping arrangement
- Structural Layout
- Construction, operation & maintenance requirement.

c) Expansion joints shall be provided at 80 – 100 m centres, where possible, column bracing shall be provided at the center of a longitudinal frame, rather than at the ends so as to avoid constraints on free expansion. An expansion joint for the structure shall be as per clause 3.10 of IS: 800-2007.

d) Structural analysis and members selections shall be made in accordance with the applicable codes, standards and specifications and by using the validated software and approved methods.

7.2.3.1 PIPE & CABLE RACK STRUCTURES

a) The pipe and cable rack structures will be of structural steel construction and will accommodate the pipes/cables trays with proper access, walkways,

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operating platforms, and adequate working space for erection and maintenance.

b) The size and no. of tiers will be finalised during detailed design depending upon the size and number of pipes and cable trays.

c) All transverse frames will generally be braced below the pipes with head room for personnel movement to transmit the lateral forces to foundation level and the lateral forces in longitudinal direction will be taken care through vertical bracing in longitudinal direction. However, the detail framing shall be decided based on General arrangement & load data during detailed engineering.

d) The structural frames will be designed to become adequately rigid to carry the forces from the pipelines at anchor points without undue deflection. The pipe and cable rack structure will be designed for longitudinal thrust forces arising out of friction between pipe and support point by provision of suitable vertical bracing in longitudinal direction.

e) In case the pipe is routed on the ground on sleepers, the height of the pipe above ground shall be 300mm.

f) Longitudinal beams are required to support piping entering or leaving the pipe rack and to support intermediate transverse beams. Longitudinal beams may also be required for structural continuity, and in braced bays, for structural stability. The spacing of transverse beams depends on the diameter of the piping and the type of cable trays to be supported.

g) The positions of anchor bays shall be determined as per the requirement of Piping stress and support. During the structural arrangement finalization, special consideration shall be given to take care of the torsion in the structural members arising due to cable supports.

h) When buildings are situated alongside pipe racks (e.g., compressor buildings), care shall be taken to line up the pipe rack frames with the building frames. This will facilitate the piping runs. For the same reason, anchor bays with vertical diagonal bracing shall be located away from compressor buildings.

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i) A continuous longitudinal tie/strut member may be provided at the center of span and suitably framed with the horizontal bracing system at the anchor bays to reduce the horizontal span of transverse beam at each tier.

7.2.3.2 TECHNOLOGICAL STRUCTURES

a) These are mainly for supporting Horizontal Heat Exchanger & vessels installed on steel structures. Preferred method of structural arrangement is, bracing in one direction (longitudinal) and moment connection in other direction (transverse). For structure configuration, due considerations to be given for erection/ installation/ operation and maintenance requirements.

b) Platforms are provided around the equipments and hence head room clearance to be critically checked.

7.2.3.3 FLOORS, PLATFORMS AND WALK WAYS

a) Platform and Maintenance walkways shall be minimum 1000 mm wide and shall be made of grating flooring unless otherwise specified. Platforms below the airfin coolers shall be provided with GI grating/ RCC platform. Space for piping, conduits, lighting fixtures shall be above the headroom.

b) The minimum clear headroom over platforms and walkways shall be 2500 mm to the lowest point of overhead structural framing or equipment.

c) Chequered plates shall be minimum 6 mm thick.

7.2.3.4 STAIRS & LADDERS

a) Stairs / Cage Ladders shall be provided from grade level to highest operating level. All buildings with flat roof shall be made accessible. All stairs shall have not more than twelve (12) risers in one flight. Height of risers shall be 150mm to 166mm (maximum 180mm for fire escape stairs) and width of treads shall be 250 mm (minimum). Minimum width of stairs shall be 1200 mm. Minimum headroom of 2500 mm to be maintained in all staircases.

b) All staircases shall be in structural steel unless otherwise noted.

c) Escape staircase shall be provided in plant and non-plant buildings as per Fire Regulation Rules in suitable locations.

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d) No ladders shall be permitted, except for large field erected tanks and secondary means of egress from isolated areas where placement of stair is not practical, ladder may be used. Platforms shall be connected with walkways where necessary. All platforms shall have kick plates at edge of platform. Operating platforms shall not be less than 1000 mm wide Emergency escape ladders shall be provided for platforms with dead ends. All Platforms from the elevator lobby shall extend to main staircases.

e) Ladders shall be 450 mm wide and shall be made of stringers with 20 mm diameter M.S. rungs at 300 mm (max.) intervals.

f) The flight of Ladder without the intermediate platform shall not exceed 6000 mm. However, wherever feasible, staircase shall be provided.

g) Ladders over 4500 mm in height or originated from a point which is 4500 mm or more above grade, shall be provided with safety cages, originating 2500 mm from the bottom.

h) Ladder access openings shall be provided with the safety chain.

i) Ladders shall preferably be vertical; however in no case the angle with the vertical shall exceed 5 degrees

j) Preferably side step Ladders shall be provided & all ladders shall be installed “facing the equipment”.

7.2.4 GENERAL CONSIDERATION IN STEEL STRUCTURE

7.2.4.1 PERMISSIBLE STRESSES

a) The permissible stress will be as per relevant IS Code.

b) Permissible stresses in bolts shall be as specified in IS: 800 and IS4000.

c) Appropriate increase in allowable stresses as per relevant IS Code.

d) Limiting Permissible Stresses

Permissible stresses in structural members shall be as specified in various codes.

IS:800 - Hot rolled sections (excluding transmission towers and Switchyard structures).

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IS:801 - Cold formed light gauge sections

IS:802 - Transmission towers & switchyard structures

IS:806 - Tubular Structures

Permissible stresses in bolts shall be as specified in:

IS:800 - Hot rolled sections

IS:801 - Cold formed light gauge sections

IS:802 - Transmission towers & switchyard structures

IS:806 - Tubular Structures

Permissible stresses in welds shall be as specified in:

IS:801 - Cold formed light gauge sections

IS:806 - Metal Arc Welding

7.2.4.2 PERMISSIBLE DEFLECTION

a) PIPE RACK AND EQUIPMENT SUPPORTING STRUCTURE

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

Allowable deflection of beams and columns, to support Pipe and / or Equipment directly during normal operation, shall be as stated below for unfactored load.

i) Pipe Rack Beams : Span / 240, but not more than 30 mm

ii) Equipment Supporting Structure

Static Equipment Supporting Beams : Span / 300, but not more than 30mm

Vibrating Eq't/hoist Supporting Beams : Span / 300, but not more than 30mm

Other Beams : Span / 300, but not more than 30mm

iii) Horizontal sway at top of Column of Each

Storey for Open framed structures :Height / 300

For Cladded structures :Height / 300

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Pipe Rack :Height / 300

iv) Cantilevers : Span / 150 but not more than 20 mm at end

b) CRANE GIRDERS

- Allowable Vertical and Horizontal deflection of girders for traveling cranes during normal operation, depending on types, shall be as stated below

i) Gantry girder for manually operated crane : Span / 500

ii) Electric overhead traveling crane upto 50 T : Span / 750

iii) Electric overhead traveling crane over 50 T : Span / 1000

iv) Other moving loads such as charging cars, etc. : Span / 600

Crane gantry girder due to surge : Span / 400

Building main columns at crane rail : Height/400

Gantry girder (to be checked as per the requirement of crane)

Open gantry columns at crane: as per the requirement of crane gantry girder rail level due to action of Crane surge load only

- Monorails and Hoist Beams : Span / 500
- Joists : Span / 300
- Purlins supporting any type of roofing material : Span / 200

  Under (dead load + live load) or (dead load + wind Load) conditions
- Other structural components : As specified in relevant IS

v) Gratings / Chequered Plates : Span / 200 or 6 mm whichever is minimum

vi) Minimum capacity of monorail shall be: 3 MT or 1.5 times weight of concerned equipment's whichever is higher.

The limiting permissible horizontal deflection for multistoried steel structure/ building including flare stack shall be Height/325.

7.2.4.3 MINIMUM THICKNESS & SIZES OF ELEMENT

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall

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mean flange thickness regardless of web thickness. Structural steel members exposed to significantly corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgement in each instance.

Trusses, purlins, girts and bracing : 6 mm

Columns and beams : 8 mm

Flare Trestles, Stiffeners : 8 mm

Base plates :10 mm & above

Chequered plates : 6mm o/p & above

Grating flats :5 mm

COLUMN BASE PLATE

For major Structure : 16 mm thick.

For minor Structure : 12 mm thick.

Stiffeners : 8 mm thick.

GUSSET PLATE

Thickness of Gusset Plate required in trusses & girders shall be maximum of the followings:

(a) Up to and including 12 m span : 8 mm

(b) Above 12 m : 10 mm

The flange width of purlins supporting light weight concrete slab shall not be less than 65 mm and for those supporting roof sheeting and wall cladding it shall not be less than 50 mm. Width of steel rolled section connected to other member shall be at least 50 mm. The depth of beams for platform of all structures shall not be less than 125 mm.

For cold formed sections which may be used for purlins & girts the minimum thickness criteria shall be relaxed.

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7.2.4.4 SLENDERNESS & DEPTH RATIO

The slenderness ratio of main members in tension, compression or bending shall be in accordance with IS: 800.

The following limiting ratios of depth to span shall be considered as a general guide.

a) Truss 1 / 10 ~ 1/12

b) Rolled beams and girders for Ordinary floors and rafters 1 / 24

c) Supporting floor beams for vibrating Machines / equipment's 1 / 15

d) Roof purlins and girts 1 / 45

e) Gable columns 1 / 30

7.2.4.5 MINIMUM COVER TO FOUNDATION BOLTS

a) Minimum distance between a Standard Holding down Bolt or Anchor Sleeve and the face of Foundation/pedestal shall not be less than 6 x (dia of bolt) mm.

b) Minimum distance between the inside surfaces of the anchor boxes and the outside surface of the foundation shall be 75 mm.

c) Clear distance between the edge of the base plate or base frame to the outer edge of the pedestal shall be minimum 50 mm.

d) In general, anchor bolts for structural steel columns are embedded into the pedestal. Clear distance from the edge of the sleeve or anchor plate to the edge of the pedestal shall be minimum 75 mm or the distance from center of anchor bolt to the edge of pedestal shall be 6 times bolt diameter or 125 mm, whichever is greater.

7.2.4.6 TRANSMISSION TOWER AND SWITCH YARD STRUCTURE

a) The minimum thickness of various structural components shall be as per IS: 802

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b) The minimum thickness for rolled beams and channels shall be mean flange thickness regardless of the web thickness.

c) All electrical switchyard structures and transmission towers shall have bolted connections, and designed on the basis of IS: 802.

d) The minimum thickness of tubes shall be as specified in IS: 806.

e) For structural members exposed to marked corrosive action, corrosion allowance shall be added as specified elsewhere, or otherwise suitably protected against corrosion.

f) The minimum thickness of structural components (except gratings & chequered plates) which are directly exposed to weather and inaccessible for repainting shall be 8 mm.

7.2.5 CLADDING AND RAINWATER GUTTERS

All roof and cladding sheets should be galvalume sheet of 0.5 mm total coated thickness with 550 MPA grade steel confirming to AS 1397 with AZ150 grade coating.

Translucent sheets shall be provided, in non-process areas only, intermittently where day lighting is required. Rainwater gutters of Galvanized / Zinc coated sheets and UPVC rainwater pipes shall be provided for proper roof drainage.

7.3 GALVANISING

Galvanising of the Structural members shall be as per IS: 4759 and IS: 2633. Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process.

All burrs and irregular edges of the structural steel members to be galvanised shall be ground smooth before galvanising.

Purity of Zinc to be used for galvanising shall be 99.5 % as per IS : 209 (latest edition). The weight of the zinc coating shall be at least 610 Gms. / m2 unless noted otherwise.

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

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

All galvanised members shall be treated with sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.

Wherever galvanised bolts, nuts, washers, accessories, etc. are specified these shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.

8. 0 MATERIALS

Unless otherwise specified in the drawings, material specifications shall conform to the following.

8.1 CEMENT

Cement used for all concrete works both above and below ground shall be as follows:

- For Foundation & Sub-structures - Ordinary Portland cement (OPC) type confirming to 53 grade or 43 grade
- For Super structures - Ordinary Portland cement (OPC) type confirming to 53 grade or 43 grade
- Cement shall be procured from Owner's approved Vendor List only.

8.2 AGGREGATES

Aggregates used in the concrete works shall be locally available gravel or crushed stone conforming to IS: 383.

Unless otherwise specified, the maximum size of aggregates shall be as follows:

For large foundations and mass concrete

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: 40mm graded down (provided the pitch of reinforcement is more than 100mm).

For others: 20mm graded down.

8.3 REINFORCEMENT

High yield strength deformed TMT steel bars of grade Fe500D conforming to IS: 1786 shall be used. The Minimum dia. used shall be 8mm.

Binding wire used for tying the reinforcement shall conform to IS: 280 unless specifically mentioned herein or in engineering drawings or other engineering design basis prepared for the individual units/structures.

All reinforcement bars shall be procured from SAIL / TISCO /RINL or Owner's approved Vendor List.

8.4 CONCRETE GRADE

8.4.1 REINFORCED CEMENT CONCRETE (RCC)

8.4.1.1 Grade of concrete to be used in foundation shall in general be as per the philosophy adopted for the entire structure. However, minimum cement content, type of cement and any remedial actions, if required for foundations due to aggressiveness of subsoil water, shall be as stated elsewhere in this document.

8.4.1.2 All R. C. C. works to the done under this specification, unless specified otherwise shall be design mix concrete. Minimum grade of concrete for various structures shall be as follows:

a) M35: For railway load bearing structures like Track hopper, wagon tipplers, major machine foundation, underground & water-retaining structures such as, manholes, cooling tower etc.

b) M30: For all other underground / sub structural R. C. C. work.

c) M25: For R. C. C. superstructure works including ground floor slabs, trenches & drains.

d) The minimum grade of reinforced concrete shall be M25.

e) Pre-cast concrete shall be of minimum grade M35.

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8.4.1.3 From durability consideration the minimum cement content, exposure Condition and maximum water-cement ratio for Plain concrete and Reinforced concrete shall be as per IS:456. However, if soil investigation report recommendations require higher cement content and / or specified type of cement, the same shall have precedence.

8.4.1.4 Maximum cement content shall not exceed 450 kg/m³.

8.4.1.5 For concreting of underground structures requiring water tightness, plasticizer cum water proofing admixture shall be added to the concrete mix.

8.4.1.6 Both coarse and fine aggregates shall conform to IS: 383 for concrete, shotcreting etc. unless otherwise mentioned.

8.4.2 PLAIN CEMENT CONCRETE (PCC)

8.4.2.1 75mm thick lean concrete of grade M10 shall be provided under all RCC foundations except under base slab of liquid retaining structures where 100mm thick lean concrete of grade M15 shall be used. The lean concrete shall extend 75 mm beyond the foundation for normal foundations and 100mm under liquid retaining structures.

8.4.2.2 Plain Cement Concrete (PCC) of grade M20 of minimum 150mm thickness shall be provided under all masonry wall foundations.

8.4.2.3 Concrete for encasing, if used, shall be M20 with 10 mm down aggregates.

8.4.2.4 Plain cement concrete of grade M20 of minimum 40mm thickness shall be provided as damp proof course at plinth level of all masonry walls and to be coated with 3mm thick bitumen emulsion or minimum 100 mm thk RC band of M20 grade admixed with approved integral waterproofing compound as DPC in all the RCC frame structure building.

8.4.2.5 Lean concrete of grade M7.5 shall be used as filler material wherever loose sub grade exists by removing loose soil / fill or where the levels are made up to the desired founding level; however making-up of levels for placing the foundation at a shallower depth from NGL / FGL (from that as specified in the soil investigation report) by means of filling of lean concrete shall not be resorted to.

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8.4.2.6 In addition to conducting various tests as mentioned in IS: 456, Contractor shall also to check workability of fresh concrete at site, slump test to be performed. Any specific requirement regarding grade and thickness of PCC to be provided shall be incorporated in the drawing.

8.5 FOUNDATION / ANCHOR BOLTS

8.5.1 Anchor Bolts shall be of mild steel bars of grade E 250 Grade A conforming to IS: 2062. Preferably limit state method to be followed for working out strength of anchor bolts.

8.5.2 All equipment foundation bolts / templates shall be designed and supplied by equipment vendor. Foundation bolts for steel structures shall be designed and supplied by contractor as per standard drawings or approved equivalent.

8.5.3 In case of no tension loads in the anchor bolts of equipment such as small towers, tanks, heat exchangers, pumps, blowers, compressors, etc. anchor bolts shall generally be set in anchor boxes unless embedment is required.

8.5.4 Anchor bolts for heavy towers, which are subject to pull out force, shall be embedded into the foundation at the time of placing concrete using templates.

8.5.5 All anchor bolts shall also be provided with additional lock nut.

8.6 INSERT PLATES AND EMBEDDED ITEMS

8.6.1 Insert plates shall be of structural steel quality grade E 250 Grade A conforming to IS: 2062 and shall be provided with mild steel lugs and /or TMT bar lugs as per drawings/ standards.

8.6.2 Mild steel bars shall conform to IS: 432.

8.6.3 Unless otherwise specified, all structural steel shall be weldable structural steel “Standard Quality” (Fe 410 WA), in accordance with code IS: 2062.

8.6.4 All embedded steel items (exposed to atmosphere) shall be hot-dip galvanized in accordance with IS: 2629, except if noted otherwise on the design drawings.

8.6.5 All inserted and embedded items shall be accurately placed or template in and be securely anchored prior to placing concrete.

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8.7 STRUCTURAL STEEL

8.7.1 Mild Steel

a) Rolled sections shall conform to grade designation E250, Quality A and shall be semi killed/killed conforming to IS: 2062.

b) Plates shall be of grade designation E250, Quality BR, killed, tested for impact resistance conforming to IS 2026. Plates beyond 20mm and up to 40 mm thickness shall be controlled rolling. Plates beyond 40mm thickness shall be normalizing rolling and shall also be ultrasonically tested as per ASTM-A578 level B.

c) Pipes for handrail shall conform to medium grade of IS: 1161

d) Chequered plates shall conform to IS: 3502 and steel shall conform to grade A of IS 2062.

e) Seal plates shall conform to IS : 1079 (semi - skilled quality)

8.7.2 Medium & High Tensile Steel

a) Rolled section and plates shall be of minimum grade designation E350, Quality B0, conforming to IS 2062. Plates beyond 20 mm and up to 40 mm thickness shall be controlled rolling. Plates beyond 40 mm thickness shall be normalizing rolling and shall also be ultrasonically tested as per ASTM-A578 level B.

b) All plates up to and including 40mm thickness shall be ultrasonically tested on audit basis to check the laminations.

c) Steel Pipe shall conform to IS: 1239 (Medium)

- Ordinary Black Bolt shall conform to IS: 1367 Class 4.6
- High Strength Bolt shall conform to IS: 1367 Part 3 Class 8.8
- Steel Grating :IS: 2062 (Grade A) with Hot-dip Galvanized with coating 900 gms/m2
- Rail :IS: 3443.

All Structural steel material shall be procured from Owner's approved Vendor List.

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8.8 GROUTING

8.8.1 Unless otherwise specified by equipment manufacturers, top of foundations except for local foundations shall be provided with an allowance for grouting as specified below:

(a) Foundation for large heavy duty compressors, generator, etc……..…: 50 mm

(b) Foundation for big towers (>20 m) …..……..: 50 mm

(c) Other foundation bases for columns, trusses, etc…….. : 25 mm

8.8.2 Grouting under the column base plates/ shoe plates including sleeves and pockets shall be done with non-shrink cementations grout (Min. M40) as per manufacture specification.

8.8.3 The thickness of grout shall not be less than 25 mm and shall not be more than 50 mm.

8.8.4 For all grouting work below equipment bases and for anchor bolt pockets for equipment foundations grout shall be non-shrink grout as per manufacture specifications.

8.8.5 For grouting work for anchor bolt pockets & base plates of major equipment's (compressors, turbines, etc. of weight over 2500 kg or above 300 kw rating, or surface over 3 m) a non-shrink epoxy grout shall be composed as per the specifications of the equipment manufacturer as per the approved list / as per the decision of EIC. At the time of detailed engineering, grouting system / material shall be specifically mentioned in drawings issued for construction.

8.8.6 Ordinary grout consisting of 1 part of OPC and 2 parts of clean, dry well graded sand mixed with water to obtain the required consistency shall only be used under the base plates of cross-overs, short pipe supports (not exceeding 1.5 m height) and small operating platforms (not exceeding 2 m height) not supporting any equipment.

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8.9 ANTI-TERMITE TREATMENT

8.9.1 No anti –termite treatment shall be provided inside the unit areas. Offsite and utility buildings shall be provided with anti –termite treatment as per IS: 8944 and IS: 6313.

8.9.2 Chloropyrifos emulsifiable concentrates (1%) confirming to IS: 8944 shall be used for treatment of soil for protection of buildings attack by subterranean termites.

8.10 MISCELLANEOUS APPLICATIONS

8.10.1 ADMIXTURES

Admixtures shall conform to IS: 9103 and to be mixed with concrete (if required) strictly as per manufacturer's recommendations.

8.10.2 PLINTH PROTECTION

Each building shall be provided with 1.0 m wide concrete M15, 100 thick laid on 75 mm thick M7.5 concrete with 8 Tor @ 250 c/c both ways Reinforcement bars all round as plinth protection. A surface drain to be provided along-with plinth protection which shall be connected to the drainage system.

8.10.3 RAMPS

Ramps for building entrance shall be cast in situ R.C.C. designed as a grade slab and the slope of ramps shall not be less than 1 in 10. Minimum thickness of the slab shall be 150 mm.

8.10.4 HOT BITUMEN PAINT

All underground structures including top surface of foundations shall be painted with two coats of hot bitumen paint of grade 20/30 with quantity of bitumen at least 1.2 kg/m² per coat.

8.10.5 INSULATION

For equipment with temperatures over 200º C, or sub zero temperatures, insulation shall be provided between equipment base / lugs and concrete / steel structure.

8.10.6 PTFE (POLY TETRA FLUOROETHYLENE) BEARING

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The bearing shall be of reputed make and manufacturer as approved by the Engineer, for required vertical load and end displacement/rotation. PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/sq.cm. In order to prevent cold flow in PTFE surface it shall be rigidly bonded by a special high temperature resistance adhesive to the stainless steel substrata. The stainless steel surface that slides against the PTFE is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of stainless steel plate shall be between 1.0 mm to 1.5 mm.

9.0 CHEMICAL INJECTION GROUTING

Minimum, 12 mm dia (NB) threaded nozzle of suitable length, shall be provided over the surface and along the construction joint line in a grid pattern at a spacing not exceeding 1.5 m c / c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete.

For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes.

After the nozzles are fully set, neat cement slurry admixed with water soluble non - shrink polymer / monomer based chemical shall be injected through the net - work of nozzles with low pressure grout pumps at a pressure of about 2.0 Kgs. / cm2. Cement slurry shall be prepared by mixing cement with non-shrink polymer/monomer @ 500 gm/50 kg bag of cement and water, ensuring that Water: Cement ratio does not exceed 2 (by weight). Wetter the structure, lesser should be the water cement ratio. The property of the polymer/monomer should be such that when it is mixed with water @0.5% by weight of water, the viscosity of the resultant solution (water and polymer/monomer) should not be more than 1.2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue, till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more

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than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Engineer.

10.0 POLYMER MODIFIED CEMENTITIOUS COATING

10.1 MATERIALS

Modified liquid polymer blend shall be a dispersion containing 100 % acrylic based polymer solids. Polymer shall be mixed in the ratio of 1 cement: 0.5 polymer (for minimum solid content of polymer 30%).

Portland cement based dry powder.

Clean, fine specially prepared quartz sand approximately 0.6 mm size

10.2 MIXING

The liquid polymer shall be stirred well and cement based powder shall then be added slowly to make a Slurry Mix. For preparation of Brush Topping Mix, quartz sand shall be added slowly and mixed well till a homogeneous mixture is obtained. The mix shall be used within half an hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.

10.3 PROPERTIES OF COATING

It must adhere to wet surface.

It should develop adequate bond strength, with the concrete surface, not less than 2 N / Sq. mm.

Co - efficient of permeability shall be about 5x10-10 Cm / Sec.

Water absorption after continuous soaking shall not be more than 1 %.

The materials shall be permeable under water vapour.

The material shall be resistant to acids and alkalies present in the soil and underground water with normal pH value between 4 and 14.

The co - efficient of thermal expansion of the material shall be close to that of concrete.

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10.4 APPLICATION

The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water. For exterior underground part, application (b) pertaining to Brush topping Mix shall be followed.

a) For Slurry Mix

A minimum of 2 coats shall be applied on the surface. The first coat being applied, when the surface is still damp and left to harden for 4 to 6 hours. After 4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1 : 1 Kgs. / m2 in the 2 coats. A lap of 75 mm shall be provided at the joints.

The coating shall be air dried for 4 to 6 hours and, thereafter, cured for 7 days after the application of last coat.

b) For Brush Topping Mix

This shall be applied in two coats. A primary coat of slurry mix can also be first applied on the surface as first coat. After the coating has dried up, a coat of Brush Topping Mix shall be applied over it with a push broom or any other similar brush. It shall be left in broom finished condition. The nominal thickness shall be 1.5 mm and minimum thickness shall be 1.0 mm. A lap of 75 mm shall be provided at the joints. It shall be ensured that no pinhole exists and rebrushing shall be done to cover the pinholes, if any.

The Coating shall be air dried for 4 to 6 hours and thereafter cured for 7 days after the application of last coat.

Rate of application of coating shall be established to achieve the required thickness.

11.0 PAINTING

Paint system shall be adopted with type of environment envisaged in and around the plants as per requirements mentioned in separate document for painting specifications.

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Painting of all steel structures, including seal plates, hand rails, steel doors & windows, ventilators, louvers, Rolling Shutters Stair Cases (except gratings), etc. shall be with paints as per following:

11.1 MATERIALS

Zinc silicate primer (minimum 75 micron Dry Film Thickness - DFT) shall be inorganic (Ethyl) self curing high built (Solid by volume minimum 60%) formulation as per BS : 5493 (Inorganic Zinc rich systems).

Intermediate (Under) coat (minimum 75 micron DFT) shall be of epoxy based titanium di-oxide / micaceous iron oxide pigmented high performance (solid by volume minimum 60%) epoxy coating as per BS : 5493 (two pack chemical resistant under coats).

Finish coat (minimum 75 micron DFT) shall be of epoxy based colored pigmented high performance (solid by volume minimum 60%) epoxy coating as per BS: 5493 (two pack chemical resistant finishes).

Final finish coat (minimum 25 Micron DFT) shall be of polyurethane colour pigmented (solid by volume minimum 40%) as per BS: 5493 (two pack chemical resistant finishes).

All paints including primer shall be of reputed brand / manufacturer and as approved by the engineer.

11.2 PREPARATION OF SURFACE

The surfaces shall be blast cleaned to near white metal surface (Sa 2 ½) i.e. 2nd quality (requiring at least 95% of the surface completely cleaned) as given in BS : 4232 . For blast cleaning shot blasting shall be used.

Approved type of abrasives shall only be used for blast cleaning of steel surfaces by shot blasting. Suitable enclosure shall be provided to carry out the blast cleaning operation. If required prior approval from the factory inspector / pollution control board etc. shall be obtained regarding the method of blast cleaning and abrasives used therein.

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Immediately after blast cleaning of the steel surfaces, primer coat shall be applied onto the surfaces.

11.3 APPLICATION OF PAINT

a) The contractor shall submit the total painting scheme and works shall be started after the approval of the scheme, from the engineer.

b) Painting works shall be carried out on structural as per the approved scheme. The total painting scheme to be submitted to the engineer shall include the following:

i) Method of blast cleaning giving the details and sizing of various equipment required, abrasive used, enclosure provided to avoid contamination of the adjoining area, expected productivity on an eight (08) hour shift working etc.

ii) Arrangement of airless spray with the equipment rating.

iii) Drying time to be allowed before the application of subsequent coat.

iv) Recommended paint for primer, intermediate (under) coat, finish coat and final finish coat with their brand name and designation, considering the requirements of BS : 5493 for long range (typical time to first maintenance 10 to 20 years), life for exterior exposed non polluted inland atmosphere.

v) Number of coat and the thickness of each coat to be applied to achieve the specified thickness of each coat i.e. primer, intermediate (under), finish and final finish coats.

vi) Environmental conditions i.e. ambient temperature and humidity at the time of application of the paint.

vii) Quality control setup for painting i.e. checking of surface preparation, thickness of each coat, quality of applied paints vis-à-vis the approved sample etc.

viii) Method of touch up painting for surfaces damaged during handling, transit, erection, welding, subsequent to painting, removal of the temporary supports etc.

ix) Reference of relevant Indian / International standards for the testing and acceptance.

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c) Before application of inorganic zinc silicate primer, the steel surfaces shall be blast cleaned to near white metal surface (Sa 2 ½).

d) Primer paint and intermediate (Under) coat shall be done by airless spray. However finish coat and final finish coat can be applied either by spray and or brush.

e) All subsequent coats shall be applied only after acceptance of the previous applied coat. Inaccessible surfaces shall be primer painted before shop assembly.

f) For final touch up painting of surfaces, which are damaged during handling, transit, erection, etc. surfaces shall be well prepared, by rubbing the entire damaged area using wire brush, emery paper etc. and shall be provided with minimum 100 micron (DFT) of self priming high build epoxy based primer followed by intermediate, finish and final finish coats as described elsewhere in this document. Touch up painting of areas welded subsequent to painting and areas exposed after removal of temporary supports shall also be carried out in same way.

g) Rectification of the damaged painted surfaces on account of welding / handling etc. of each coat shall be done by touch up painting, before the application of next coat, using minimum 100 micron (DFT) self priming high build epoxy based primer followed by various coats in sequence of thickness as specified elsewhere.

11.4 ACCEPTANCE CRITERIA

All painted surfaces shall be uniform and pleasing in appearance.

Dry film thickness of each coat shall be checked and measured by using elcho-meter. The thickness as measured shall not be less than the minimum thickness specified for the coat of paint under relevant clauses of the technical specification.

Measurement of paint thickness shall be as per “SSPC : The society for Protective Coatings Paint Application Standard no. 2” titled “Measurement of Dry Coating thickness with magnetic gages”.

Colour, texture shall match exactly with the approved sample.

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SECTION VI– 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE- B: CIVIL ENGINEERING DESIGN BASIS

(GENERAL CIVIL WORKS)

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1.0 GENERAL

1.1 SCOPE

This engineering design basis defines the design criteria that shall form the basis for carrying out design and engineering of items under general civil, viz. roads, paving, drainage, etc.

1.2 UNITS OF MEASUREMENTS

Units of measurement in design shall be metric system.

1.3 DEFINITIONS

CCE	Chief Controller of Explosives
TAC	Tariff Advisory Committee
NFPA	National Fire Protection Association
IS	Indian Standards
Owner	TFL
Consultant	PDIL
LSTK Contractor	Successful bidder of the tender

1.4 CODES AND STANDARDS

The design shall be in accordance with established codes, sound engineering practices and shall conform to the statutory regulations applicable to the country.

1.4.1 The main codes, standards and statutory regulations considered as minimum requirements are as follows. Latest revision of these shall be followed.

IS:456 Code of practice for plain and reinforced concrete

IS:800 Code of practice for general construction in steel

IS:875 Code of practice for design loads (Other than earthquake for buildings & Structures

IS: 1172 Code of basic requirements for water supply, drainage & sanitation

IS: 1742 Code of practice for building drainage

IS: 1905 Code of practice for structural use of unreinforced masonry

IS: 2065 Code of practice for water supply in buildings

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IS: 8183 Bonded Mineral wool

IS: 8835 Guidelines for design of surface drains

IS: 11134 Code of practice for setting out of buildings

IS: 8640 Recommendations for dimensional parameters for industrial building

IS: 2502 Code of practice for bending and fixing of bars for concrete reinforcement

IS: 2095 (Part-1) Gypsum Plaster Boards - Specification

IS: 2469 Glossary of terms relating to gypsum

IS: 2542 (Part -2) Methods of test for gypsum plaster

IS: 2547(Part-1) Gypsum building Plaster

IS: 4905 Methods for random sampling

IS: 12679 Specification for by –product gypsum for use in plaster, blocks and boards

IS: 4926 Code of practice for ready mixed concrete

IS: 9012 Recommended practice for shotcreting

IS: 10262 Guidelines for concrete mix proportioning

IS: 4971 Recommendations for selection of industrial floor finishes

IS: 3483 Code of practice for noise reduction in industrial buildings

IS: 2065 Code of practice for water supply in buildings

IS: 1641 Code of practice for fire safety of buildings (general): General principles of fire grading and classification

IS: 1642 Code of practice for fire safety of buildings (general): Details of construction

IS: 1644 Code of practice for fire safety of buildings (general): Exit requirements and personal hazard

IS: 12456 Code of practice for fire protection of electronic data processing installation

IS: 3935 Code of practice for composite construction

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IS: 11384 Code of practice for composite construction in structural steel and concrete

IS: 15988 Seismic Evaluations and Strengthening of Existing Reinforced Concrete Buildings – Guidelines

IS: 1346 Code of practice for waterproofing of roofs with bitumen felts

IS: 9918 Code of practice for in-situ waterproofing and damp-proofing treatment with glass fibre tissue reinforced bitumen

IS: 1200 (Part 1 to 28) - Methods of measurement of building and civil engineering works.

IS: 13592 Unplasticized Polyvinyl Chloride (PVC-U) pipes for soil and waste discharge systems inside buildings including ventilation and rainwater system

IS: 14333 High density polyethylene pipe for sewerage.

IRC: 15 - Standard Specifications and Code of Practice for Construction of Concrete Roads.

IRC: 6 Code of practice for road bridges, Section-II Loads and stresses

IRC: 19 Standard Specifications and Code of Practice for Water Bound Macadam

IRC: 37 Design of flexible pavements

IRC: 58 Design of rigid pavements

Factory Rules for State

Note: The above list is suggestive and not exhaustive. Apart from these basic codes, any other related codes shall be followed wherever required.

1.4.2 In case of any conflict / deviations amongst various documents, the order of precedence shall as follows:

a) Statutory regulations

b) Job specifications

c) Engineering design basis

d) Standard specification

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2.0 DESIGN CRITERIA –GENERAL

2.1 SITE GRADING

2.1.1 The work area shall be cleared and stripped completely of all bushes, roots, trees, Shrubs and other vegetation, organic matter and other objectionable materials. All these should be completely uprooted and removed, and not merely scraped at the surface.

2.1.2 The grading of the area shall be done by cutting and filling with the following:

a) Cutting Area : Thoroughly rolled and compacted.

b) Filling Area : Compacted in layers not exceeding 20cm to achieve minimum 95% of maximum dry density

2.1.3 Site grading philosophy shall be based on following:

FFL of the adjacent paved area is .....m above Mean Sea Level (To be decided later).

However, levels like Finished Ground Levels (FGL) and Highest Point of Paving (HPP) shall be finalized by the CONTRACTOR, in consultation with OWNER / PMC, based on contour survey of the Unit, levels of adjacent units and levels of adjacent Roads.

2.1.4 Slope in Graded Areas

a) General Site Grading : 1 in 500 to 1 in 1000

b) Micro grading, after completion of major Construction (for road corridors) : 1 in 200

c) Tanks Farms : 1 in 200 to 1 in 300

2.2 ROADS

2.2.1 Contractor shall design cross section of roads, including roads for crane access, as per IRC 37. However, the minimum section to be adopted shall be as given in clause 2.2.7 Ruling gradient shall not exceed 1 in 20. If existing roads are to be used for erection purposes, the same should be strengthened to cater for erection

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loads. It should be ensured that use of existing roads does not hinder normal activities in existing plants.

All roads surface shall be prepared in accordance with Section-16 of CPWD Specifications & designed in accordance with IRC 37 (Latest revision) for crossing of drains, pipes, cable trenches etc; suitable culverts shall be provided. The culverts shall be designed for class `AA' loading and also checked for class `A' loading in accordance with IRC.

2.2.2 Road Width

Category	Width*	Carriageway Width
I. Road around unit and its Primary access	12.5 m	10.5 m (three lane road or width to suit crane type)
ii. Roads for high lifts crane	2.0 m+ c.w. width	3 m + outer width of crawlers of required Capacity crane.
iii. Plant approach road	9. 0m	7.0 m (two lane)
iv. Roads around tank farm	7.5 m	5.5 m
v. Patrolling roads (along boundary wall)	6.0 m	4.0 m
vi. Access to building	5.5 m	3.5 m
vii. Foot path	1.0 m	…….

* Width of the road to be finalised as per site condition in consultation with client / PMC.

2.2.3 Camber : 1 in 50

2.2.4 Radius of curve: 12 m for 8 m wide carriage way roads, 8 m for 5.5 m wide Carriage way width & 15 m for roads of higher carriageway width.

2.2.5 Pavement Type: Concrete pavement at all roads to be used for crane movement (Requirement of crane movement route and its specification to be finalised in consultation with client /PMC)

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2.2.6 Extents: As per Plot Plan / Equipment Layout drawing / scope drawing.

2.2.7 Clearance: Minimum 8.0 m to underside of pipe racks.

2.2.8 Minimum Cross Section

i) Sub base: The sub base shall be 300 mm layer of crushed / broken size stones on well compacted earth or approved fill.

ii) Base course: The base course shall be 225 mm stone size thick water bound Macadam consisting of 3 layers of 75 mm each.

iii) Bituminous wearing course / RCC: The wearing course shall be 75 mm thick for roads with crane duty and 50 mm thick for roads without crane duty. However, roads for crane movement, concrete pavements shall be provided.

2.2.9 Crossings

a) Pipe Ways under roads & rails : RCC Box Culverts

b) Storm Water Culverts Under road / rail. : RCC Box Culverts

c) Electric / Instruments Cable : RCC duct bank with PVC Pipe lass – 1 (IS 4985)

2.2.10 Finished Road Top Levels Above FGL.

When box culverts for pipe ways : 1.05 m (minimum)

Ways are provided : 1.6 m at box culvert location with a slope from 1.05 m to 1.6 m above FGL

When overhead bridges are : 1.05 m around hazardous units

Provided for pipe ways : 0.40 m to 0.60 m for others areas

Other areas : 0.40 m to 0.60 m

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2.3 CONCRETE PAVING (WITHIN PLANT AREAS)

2.3.1 GENERAL

RCC paving to be done for entire battery limit and extend up to extend up to the adjacent roads around the unit. The contractor's scope is limited to all round the peripherical roads. Heavy duty paving shall be designed for heavy vehicular traffic movement as per IRC Loading.

Concrete paving shall be laid in cast-in-situ panels of 3.0 meter X 3.0 meter size, with expansion joints spaced approximately 15.0 m c/c, each panel being cast in a single pour.

Hard stands should be designed and provided by contractor, based on required crane capacity, here called for by Owner, the same shall be demolished after erection, and surface made good.

Provision of trenches, drains, sealing of trench covers, inserts, thickening for pipe / equipment supports etc. shall be made while construction pavements, as detailed in drawings.

Acid / alkali / chemical resistant coating as required shall be applied in areas where such corrosive materials are likely to come in contact with concrete.

Suitable drainage arrangements will be provided within curbed areas around pumps, for drainage leaks. Similarly, suitable drainage arrangement shall be provided at streaming points also.

2.3.2 JOINTS

Expansion joint of 20 mm shall consist of 20 thick impregnated fibre boards. Filled at top with joint sealing compound 20 x 25

Equipment / column pedestals will be separated from paving with 20 thick sand fill and Sealing compound 20 x 25.

Contraction joints will be sealed by sealing compound 10 x 40.

2.3.3 Slope: 1 in 100 (minimum)

2.3.4 Minimum requirements of paving in various areas

a) Paving within Process & Utility areas for maintenance compatible to crane movements / dropout / : Type – 1 (200 mm thk. RCC)

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Loading / Unloading areas /

Vehicular movement areas

b) Non vehicular movement areas

i) Unit : Type –II (150 mm thick RCC)

ii) Offsite pump station : Type –II (100 mm thick RCC)

iii) Bullet Area : Type –II (100 mm thick RCC)

iv) Utilities : Type –II (150 mm thick RCC)

c) Pipe rack : PCC 1:3:6 (100 mm thick)

Paving and trenches including covers in process units shall be suitable for Hydra crane movement. Where movement of bigger cranes for maintenance is envisage paving and trenches including covers shall be designed for the loads arising from the same.

2.4 SURFACE TREATMENT

The surface treatment for the various areas shall be provided as enumerated in the table below.

AREA	RC CONCRETE PAVING	ASPHALT PAVING	50 thick PCC 1:3:6 ON 115 thick brick soling	GRAVEL	100 THK PCC 1:3:6	ACID / ALKALI PROOF COATING
Operating Areas of Process units (including crane movement roads)	X (Type I /II Paving as per cl. 2.3.4)					
Around Transformers In substation						
Roads (excluding roads having crane movement)		X				
Approaches to units		X				
Tank farms			X			
Acid / alkali / storage / handling area						X
Parking		X				
Hardstands	X					

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Pathways	X					
Pipe ways					X	
' X ' Indicating applicable option						
Notes: 1. Existing services where interfering with the new construction should be located and rerouted as instructed by Owner / Consultant. 2. Micro-grading shall be carried out by the Contractor over graded areas to bring the FGL to indicated levels including provision of required slopes and finishes.						

2.5 STORM WATER DRAINAGE

2.5.1 Storm water drains shall be sized for the higher discharge arising out of either rain water or fire fighting water.

2.5.2 Rain water run-off shall be computed by the formula:-

Q = KIA / 360

K is run-off coefficient given below.

A is area (hectares) contributing to the drain

I is rain fall intensity (mm / hr.)

Q is the discharge.

2.5.3 Design of drains shall be based on Manning's formula:-

$V=R^{2/3} S^{1/2} / n$

V is velocity of flow m/s,

R is hydraulic radius,

S is slope,

n is roughness coefficient taken as 0.013 for plaster surface, 0.015 for cast-in-situ concrete, 0.017 for brick lined.

The following parameters are to be ensured to be within limits specified while sizing

Minimum velocity of drains	:	0.6 m/s
Maximum velocity of drains	:	2.4 m/s
Minimum depth of drains	:	300 mm
Minimum width of rectangular drains	:	300mm (for depth<500mm)

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Minimum width of drains : 500 mm (depth > 500mm)

Run off coefficient 'K'

a.	paved area	concrete	-	1.0
		Bituminous	-	0.9
b.	unpaved areas		-	0.7
c.	unusable areas like Green belt		-	0.4

2.5.4 DRAINS WITHIN PROCESS UNITS

Rain water falling on such portion of paved areas of process unit where it is not likely to get contaminated, shall be collected in open rectangular RCC drains. These drains shall be covered by gratings, and shall be generally connected to periphery drains, which at battery limit shall have a double valve chamber. This will permit discharging the rain water either to storm water network, or to the battery limit CRWS manhole. Drains shall be designed for the maximum of rainwater / firewater on same principles as storm water drains.

2.5.5 CULVERTS AND ROAD / RAIL CROSSINGS

Road / Rail and storm water drain crossing shall by RCC box culverts, designed for the Relevant IRC loads for roads, and track loads for rail. The relevant lateral loads due to wheel / track loads on the soil adjacent to wall on crossing shall be considered on the walls. Approval from the rail authorities on culvert design shall be in the scope of LSTK contractor.

Drain to adjacent to roads / pavement where heavy crane movement is anticipated shall be Concrete drains, designed to resist the lateral thrust due to wheel loads.

Pipe culverts, if instructed to use by Owner/PMC, shall comprise of R.C.C. pipes (class NP-3, IS: 458) under roads; and R.C.C. pipes (class NP-4, IS: 458) under rail lines

2.5.6 TANK FARM DRAINAGE

Tank farm drainage system should be provided in such a way that the storm water discharge shall be either sent to storm water open ditch or to the oily water sewer by providing valve pit outside the dyke wall depending on its contamination.

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2.5.7 DISPOSAL OF STORM WATER

Storm water drains shall not be combined with oily waste sewer / CRWS/combined sewer system, etc. For disposal of storm water references shall be made to the 'scope' document.

2.5.8 OIL CATCHER

An oil catcher with baffle wall type arrangement shall be provided a storm water ditch before it leaves the battery limit of the unit, & tank farm.

2.6 WATER SUPPLY

Existing drinking water piping shall be extended to new facilities. Adequacy of header branch line etc. shall be ensured; else additional lines shall be run.

2.7 SANITARY SEWERS

2.7.1 GENERAL

Sanitary sewerage will not be combined with storm water.

Building drainage shall be designed as a dual pipe system with separate soil & waste pipe.

Sewers shall be designed for discharging 3 times average flow flowing half full in case of lateral sewer, and flowing 2/3 full in case of Main sewer. The minimum and maximum clearing velocities shall be 0.75 m/s and velocity 2.4 m/s respectively. Velocity shall be calculated by Manning's formula with n=0.015

Minimum pipe size shall be 100 mm and all pipes shall preferably be salt glazed stoneware unless abnormal soil conditions or high velocity dictates otherwise.

2.7.2 Sanitary sewer shall be led into the existing sewerage system leading to waste water treatment plant (WWTP). Where system is not available, septic tank/soak pit shall be provided.

2.7.3 Cover for Sewer Line shall be minimum 600 mm.

Under road, sewer shall be protected by concrete encasement or minimum cushion shall be 1200 mm.

Under railway, the sewer shall be protected as per railway standards.

2.7.4 MATERIAL OF CONSTRUCTION

a. Material of Construction for Manholes shall R.C.C. M30.

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b. Material of Construction for Sewer

Sanitary Sewer

i.	Toilet block to inspection chamber	-	CI pipes as per IS: 3486/1729) or UPVC, as directed.
ii.	Gravity main & lateral	-	Salt glazed stoneware / C.I./ R.C.C. Class P1 (as per IS:458)
iii.	Pressure main	-	C.I. pipes (as per IS: 1536 an IS: 1537)
iv.	Offsite Pumping, if any	-	CPVC pipes/GI as per PMS J2A(as directed)
v.	Manholes	-	R.C.C. M30

2.8 CONTAMINATED EFFLUENT SEWERS

2.8.1 PROCESS UNIT

Contaminated rain water / floor wash / fine water shall be collected through catch basins located in the contaminated areas of the process unit and shall be send to the oil catcher / CRWS pit / CRWS header. The continuously contaminated area of all pumps shall be segregated by kerb wall; discharge from such kerbed areas shall be collected in OWS network and not in CRWS network.

CRWS shall be designed for contaminated water due to rain water or Fire water, whichever is more.

The quantities of contaminated rain water shall be worked out based on the contaminated process area in the unit block.

Sewer shall be sized flowing full with peak flows taking future requirements or 2/3 full without future requirements.

CRWS manholes shall be R.C.C. (M30) construction. For trapping of gas or prevention of spread of fire through CRWS from one area to another, a liquid seal of minimum 150 mm shall be provided in manhole along with suitable vents. Location of sealed manholes should be decided accordingly. The vents on the manholes should extend minimum 2.0 m above the pipe rack or 1.0 m above buildings, or if in open areas extending min 3.0 m above FGL with frame arresters.

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CRW sewers in process units and tankage areas shall be of mild steel /Carbon steel conforming to IS: 3589

2.8.2 TANK FARM AREA

Tank farm areas, not containing tanks for corrosive materials, shall be drained by surface drains. Waste water shall be led to a sand trap and then to a valve chamber which shall either drain the water to storm water drain or oily water drain. Waste water from tank farm areas containing corrosive / hazardous materials shall be drained by chemical sewers to neutralization tank / ETP.

2.9 OTHER PROCESS DRAINS

Other process drains shall be oily water sewers, closed blow down sewers or chemical Sewers. Sizing, layout, material specification, corrosion protection etc will be as per u/g piping design Basis.

Oily water sewer convey water contaminated with oil, e.g. from reflux drums, separators, Cooling / quench water for compressor / pump, process wash water, floor and paving Drains in oily areas etc. These are conveyed either to WWTP or oil separator by means Of U/G steel pipes through sealed manholes.

Blow down are liquid streams containing water / oil / chemicals that are required to be drained from process equipment under different operating situations like start-up, shutdown etc. Blow down systems are closed piped systems in which streams are collected in underground blow down drums and then pumped to respective slop / field tanks.

Chemical sewers carry effluents containing chemicals which require separate treatment from oily water streams. These are generally corrosive and require pipe of materials resistant to corrosion or lined pipes.

Closed blow down sewers shall be closed piping systems as shown in piping drawings. These will lead to underground blow down drum / drums which shall be protected by a concrete pit as detailed in drawings. Before entering the blow down drum, a valve chamber shall be provided for the sewer .Sewer cleanouts will be provided at start / end charges in direction and at 45 m intervals on straight length.

Other aqueous blow downs within process areas will be collected by funnels and routed through oily water sewers to sealed manholes. A common oily water

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header will route these streams to the plant oily water sewer network leading to waste water treatment plant.

Small neutralization pits hall be provided near battery rooms to treat floor wash in battery rooms. Water from these pits will further be routed to storm water drains.

Dyked areas around emergency booths shall drain into a gully trap which shall be connected to the chemical sewer network.

Oily water & contaminated rain water catch pits / manholes shall be of reinforced concrete to the chemical sewer network with internal coal tar epoxy lining.

Manhole for acid / alkali sewer shall be of reinforced concrete (M30). Exposed steel work shall be provided with coal tar epoxy coating.

2.10 STORAGE TANK FOUNDATION AND DYKE WALLS

2.10.1 Proposed Ammonia Storage tank shall rest on the deck slab at the required level above ground which in turn shall be supported by short columns over the pile cap.

The storage tank foundations shall be designed to sustain the forces at the tank bottom within permissible settlement, under operating and hydro-test conditions.

Tanks less than 2.5m dia. may rest directly on a concrete pedestal with anti corrosive layer.
Tanks greater than 2.5m dia. but less than 10.0 m dia. may be supported on RCC ring all with sand / murrum fill.
For tanks greater than 10m dia, Tank Pad Foundations shall be provided as per relevant design Codes.

2.10.2 Anticorrosive layer shall be provided as per specifications for tank pads of 50 thick premix Carpet over 50 thick bitumen sand mixed with additions of kerosene / oil as required.

2.10.3 STORAGE TANK DYKE WALLS / FIRE WALLS

Dyke walls / Fire walls shall be provided. Walls shall be plastered brick work conforming to standard relevant Codes. DYKE walls shall be designed for retaining liquid in case of rupture of the largest tank in the farm. It shall be minimum 600mm thick to enable persons to walk on the wall top. If space permits, Dyke walls shall be provided with ramps on both sides at suitable places, for

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movement of vehicles for tank cleaning purpose. Fire walls shall only be 600 mm high (min.) or as shown in drawings / as instructed. They shall only retain spillages, to prevent fire spread.

2.11 BARRICADE

Contractor shall design a suitable barricading system for protection of existing facilities. Barricade shall be of G.I. sheet cladding with suitable supporting system of height and extent shown in drawings or as instructed by Owner / Consultant. Water spray system shall be incorporated where felt necessary by Owner / Consultant. Localized G.I. sheet barricading shall be provided from operational constraint requirements as directed by Owner / consultant.

2.12 TRENCHES

Trenches shall be of RCC with inserts or other suitable arrangement required to support Cables pipes etc. Pre-cast concrete covers with lifting arrangement shall be provided on top. In paved areas, the top will be flush with finished floor level. Covers shall overlap walls and joints with paving shall be sealed to prevent water entry. In unpaved areas, walls shall be raised above ground level by 100 mm. Trench floors shall be provided with a nominal slope to drain pits, where any water entering trenches can collect and be detained to the nearest contaminated rain water sewer / storm water sewer. Trench covers shall be designed for the vehicle load relevant to the area where the trench is located. Cable trench shall be of leak proof construction.

2.13 HARD SURFACES

Hard surface of PCC 1:3:6, (100 mm thick) over suitable bedding (brick / stone soling) Shall be provided below all new pipe tracks and / or extended potion of existing pipe Tracks. This shall extend 600 mm on one side for track width less than 6 m, and 900mm On either side for pipe track having width 6 m or more, end it shall have approach @ 500 M c/c from nearest road.

Hard surface of PCC 1:3:6 (100 mm thick) over suitable bedding (brick / stone soling) of approximate size 1 m x 1 m shall be provided with proper approach near drain point of offsite piping, near drinking water installations, at washing facilities, etc., with suitable curbing and drainage arrangements as required for the fluid being handled.

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3.0 REMOVAL / REROUTING OF OBSTRUCTIONS

All underground or above ground structures / foundations which will cause obstruction to new structures / foundations, and which can be removed without disturbing any functions of the existing plant, shall be removed by the Contractor.

All existing underground or above ground facilities requiring rerouting due to fouling with new facilities shall be rerouted by the Contractor in such a manner that rerouted facilities keep on functioning as before.

NOTE:

Before finalizing the route connection to existing system, adequacies of existing system shall be checked by the contactor.

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SECTION VI – 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE- C: ARCHITECTURAL WORK DESIGN BASIS

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1.0 GENERAL

1.1 SCOPE

The design philosophy defines the minimum design requirements and procedures for carrying out architectural design, Interior design, Furniture design and engineering of buildings covered under this project. Relevant criteria shall be taken into consideration to achieve satisfactory and trouble free performance of the facilities.

1.2 UNITS OF MEASUREMENT

Units of measurement in design shall be in metric system.

1.3 DEFINITIONS

CCE	:	Chief Controller of Explosives
TAC	:	Tariff Advisory Committee
NFPA	:	National Fire Protection Association
IS	:	Bureau of Indian Standards
Owner	:	TFL
PMC	:	PDIL
LSTK Contractor	:	Successful LSTK bidder of the tender (To be selected)

1.4 CODES AND STANDARDS

The design shall be in accordance with established codes, sound engineering practices and shall conform to the applicable statutory regulations.

The main codes, standards and statutory regulations considered as minimum requirements are as follows:

a) National Building Code of India

b) Factories Act of State

c) Local Municipality or any other Authority's Bye-laws as applicable.

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d) Bye-Laws applicable of Town & Country Planning Organization.

e) Code of practice for building bye-laws IS : 1256

f) TAC (Tariff Advisory Committee) Rules

g) Indian Electricity Rules

h) Bureau of Indian Standards

Note: The above list is suggestive and not exhaustive. Apart from the basic codes any other related codes shall also be followed wherever required.

1.5 ORDER OF PRECEDENCE

In case of any conflict / deviations amongst various documents, the order of precedence shall be as follows:

a) Statutory Regulations

b) Job Specifications

c) Engineering Design Basis

d) Standard Specifications

2.0 DESIGN PHILOSOPHY / CRITERIA – GENERAL

2.1 ARCHITECTURAL DESIGN

Architectural design of buildings / sheds shall be in accordance with this design basis and references as stated herein, to facilitate the intended functions. The various types of requirements to be considered are described further.

2.2 BUILDING REQUIREMENTS

2.2.1 SPATIAL REQUIREMENTS

Spatial requirements inside a building / shed shall be decided based on activities to be performed in the building and consequent occupancy pattern, equipment layout etc. Spaces can be generally classified as functional spaces, circulation spaces, amenity spaces, utility spaces. They are elaborated further.

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2.2.1.1 FUNCTIONAL SPACES

Functional areas of any building / shed shall be constituted by the main activity for which the building is required. Various spaces/rooms shall be judiciously sized and shall be integrated logically to generate the total building plan taking into account the following parameters:

a) Activities, group of activities and consequent work-flow pattern.

b) Site conditions i.e., dimensions, contours etc.

c) Climatic conditions vis-à-vis orientation.

d) Safety regulations.

e) Lighting and ventilation.

f) Acoustics.

g) Services

h) Security

i) Economy

j) Aesthetics

k) Green building Concept as per Govt. Guidelines for the state

l) Specific requirement pertaining to particular buildings, if any

m) All other established architectural design parameters in practice.

The objective of spatial arrangement shall be to satisfy functional requirements and physical comfort and safety regulations as well as aesthetics which has significant role in creating a favourable working environment.

2.2.1.2 CIRCULATION SPACES

Following spaces are classified as circulation spaces. These spaces shall be provided as per required building services, for integrating various types of spaces and as means of access / exit / escape.

a) Corridors & passages.

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b) Staircases

c) Elevator

d) Entrance lobby / Foyer including Reception & waiting

e) Gangway / walkways

f) Equipment loading / unloading platforms

g) Emergency Exits

2.2.1.3 AMENITY SPACES

Following spaces are classified as amenity spaces:

a) Toilet (Gents & Ladies)

b) Drinking Water Facility

c) Locker & Change Room

d) Rest room / Lunch Room.

e) Pantry

f) First-Aid Room

Out of the above mentioned areas, a) Toilet, b) Drinking water, c) First Aid enclosures shall be mandatory requirement for occupied buildings / sheds. Other facilities shall be provided as required.

2.2.1.4 UTILITY SPACES

Utility spaces are space requirements which materialize due to provision of services like air-conditioning, pressurization, fire fighting, electrical, telephone, LAN etc. These spaces shall be provided as per required building services. Following are examples:

a) Air-conditioning plant room

b) Air handling rooms

c) Pressurization blower plant room

d) Electrical distribution panels rooms

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e) Telephone exchange equipment room.

f) Firefighting equipment room.

g) UPS room

h) Service ducts

i) Battery room

j) Store Room

2.2.1.5 SIZES OF SPACES

Sizes of various types of spaces shall be decided based on occupancy / equipment / Panel / furniture layout, clearance, maintenance & safety requirements & ventilation requirements.

However, following are the limiting sizes / dimensions for various purposes, which shall be adhered to:

a) Minimum area of any habitable room = 9.5 m² with minimum dimension restricted to 2.5 m

b) Minimum ht of any habitable room = 3 m which may be reduced to 2.75 m for air-conditioned areas. Due provision / clearance may be made for AC ducts above false ceiling if any. Headroom below beams should be min. 2.4 m.

c) Maximum ht of habitable rooms = As stipulated by the local bye-laws

d) Scale of accommodation for industrial work spaces = @ 14 m³ per occupants. Minimum clear height of such workspaces shall be 3.6 m. Heights above 4.25

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m shall not be taken into account.

2.2.2 DAY LIGHTING AND VENTILATION

2.2.2.1 DAY LIGHTING

Established level of illumination shall be maintained for all parts of the buildings by means of windows, ventilators, skylights, etc. Following references shall be adhered to in this regard:

a) National Building Code of India, Part-VIII, Section-1

b) IS:2440: IS 3646 (Part-II) : IS:7662 (Part-I)

c) State Factories Rules

d) Any other relevant rules / code etc.

Following architectural norms shall be adopted:

a) Direct solar illumination shall not be considered and only sky radiation shall be taken as contributing to illumination of the building.

b) Openings shall be provided with shading devices to avoid glare.

For the purpose of illumination, day lighting shall also be supplemented by artificial illumination.

2.2.2.2 VENTILATION

A. Natural Ventilation

Established level of ventilation in terms of air changes per hour shall be maintained for all spaces. Following references shall be adhered to for the purpose:

a) National Building Code of India, Part-III, Section-1

b) IS:3101 (industrial buildings), IS:3362 (residential buildings); IS:7662(Part-I)

c) State Factories Rules

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d) Any other relevant rules / Codes etc.

Natural ventilation shall also be supplemented by mechanical or electrical means of ventilation in all areas of habitation. Sufficient no. of Glazed / Louvered windows / ventilators shall be provided and supplemented by exhaust fans.

Non- electrical Turbo ventilator of S.S. makes of required size shall be provided in sufficient numbers over roof of all sheds of the entire scope of work.

B. Mechanical Ventilation

In addition to natural ventilation, if required mechanical or electrical ventilation shall be provided depending on the type of building and its use. Other relevant design basis shall be referred for its requirement and applications.

2.2.3 ACOUSTICS AND SOUND INSULATION

Specified acceptable noise level and reverberation time shall be maintained inside a building / shed. Following references shall be referred to for the purpose:

a) National Building Code of India

b) State Factory Rules

c) Limitations on decibel level stated elsewhere, if any, in the bid document

Required noise level in any space shall be maintained by means of

a) Segregating noise sources by buffer zones

b) Dampening of noise levels by damping devices

c) Providing Acoustic treatment with acoustic material (on walls, ceilings, floors, as required).

2.2.4 SAFETY REQUIREMENTS

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Safety from fire and like emergencies shall be taken into account in building / shed design. Buildings / sheds meant for human occupancy shall be provided with exits sufficient to permit safe escape of occupants in case of an emergency. The exits shall be in terms of doorway, corridors, and passage ways to internal / external staircase or to areas having access to the outside. Following references shall be adhered to this regard. Max distance to an exit from any point in a building shall not exceed 30 m. Control Room building shall be provided with emergency exit on the other side of entrance.

A minimum of two staircases and two exits per floor shall be provided in each building. Width of passage / corridor shall not be less than 1500 mm. Following references shall be referred to for the purpose design of Control Room building.

a) National Building Code of India, Part-IV

b) State Factories Rules

c) Any other relevant rules / codes

2.2.5 SITE PLANNING & LANDSCAPING

Site planning of building shall take into account aspects like inter-relationship of the buildings with the whole system, movement pattern, traffic and road net-work, safety regulations, service network, fire safety, climatic and environmental aspects.

Main and service / maintenance entrances of buildings shall be provided with vehicular access. All exit points shall also be provided with footpath / vehicular access. Truck movement space in accordance with traffic pattern shall be provided for the building as per the location of hoisting bay / loading, unloading platform. Road network and open space around the buildings shall be designed considering movement and functioning of fire tenders and cranes, etc.

Suitable landscaping treatment shall also be done around Control Room. Such treatment shall generally consist of lawns, road side plantation and beautification of building entrance areas. Standard landscape elements such

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as earth contours, paving, flower beds, hedges, shrubs, ground cover and ornamental trees shall be incorporated in landscape treatment. Necessary water supply / sprinklers shall also be provided.

2.3 BUILDING SERVICES

Following services shall be provided for all building / sheds as essential services:

2.3.1 WATER SUPPLY, DISTRIBUTION AND DRAINAGE, SANITARY SERVICES

The service is essential for all habitable buildings / sheds. All buildings with human occupancy shall have toilet and drinking water facility and accordingly water supply, distribution and drainage, sanitary services as per following references:

a) National Building Code of India, Part-IX, Section 1 & 2

b) State Factories Rules

Drinking water provisions, including one number water cooler per area shall be provided within an enclosure separated from the toilets. Space for janitor shall be provided in the toilets. All service pipes showing on the external wall shall be suitably concealed or shall be provided within a shaft.

Each building shall be equipped with approved PVC overhead water tanks of capacity not less than 2000 litres.

2.3.2 ELECTRICAL SERVICES

This service shall be provided as essential service for all buildings / sheds. Electrical services for buildings shall consist of electrical supply and distributions, electrical lighting installations, telephone network, fans, exhaust fans, lighting protection system etc. including all accessories, cabling etc. including emergency power supply, all as per requirement. All electrical wiring should be concealed. All electrical switches / sockets shall be of modular type as per the approved makes given separately.

2.3.3 AIR CONDITIONING AND HEATING

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Areas of control room, spaces housing equipment / machinery / panels etc. which required conditioned environment and certain specified areas like offices, specific office accommodation shall be suitably air-conditioned by split / package / centrally air-conditioned type units, as per requirement with respect to other relevant Design Basis.

Accordingly, AC Plant / AHU etc. of the required capacity, whenever required, shall be provided and housed, suitably.

2.4 AESTHETICS

Apart from the fulfilment of functional & safety requirement, aesthetic requirement of the buildings / sheds shall be taken care of in the design. As specific guidelines for achieving required aesthetics are difficult to establish, following guidelines shall be followed:

a) Preliminary Drawings including perspective views indicating architectural treatment minimum three different alternative proposals shall be submitted for OWNER's approval.

b) Following elements shall be considered as contributory elements to aesthetics and their design etc. shall be subjected to the OWNER's approval. Any change / modifications sought for aesthetics improvements with regards to these elements shall be carried out. Any incidental elements like brick masonry, RCC work etc. required for such changes / modifications shall also be added.

i) Building / shed shape and features

ii) Canopies, overhangs & shading devices

iii) Gutters

iv) Entrance / exit steps, door

v) Window / Ventilator composition

vi) External wall location with respect to columns

vii) Colour scheme, grooves in plaster

viii) Spatial arrangement

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ix) Aesthetic of the buildings should match with the surrounding existing facilities at the site.

2.5 BUILDING ELEMENTS

2.5.1 PLINTH PROTECTION

All the buildings & sheds shall be provided with minimum 1000 mm wide plinth protection around the building / shed. Level wise, it shall be 100 mm high above top of approach road level. In order to avoid accumulation of water outside the buildings, requirement of surface drains shall be examined on case to case basis for individual building and provided if necessary.

2.5.2 FINISHED FLOOR LEVEL (PLINTH FFL)

In general, Plinth FFL of the buildings, sheds shall be determined with respect to top of approach road or pavement. Unless noted otherwise on the reference drawings, following schedule shall be adhered to for FFL of various buildings & sheds.

a)	Sub Station Building		
-	Cable cellar floor	-	Top level of approach road + 450 mm
-	Transformer bay with pebbles	-	Top level of approach road + 150 mm
-	Single storey substation with trenches	-	F.G.L. (+) approx. 1000 mm high from top of road
b)	Transformer bay	-	Top level of approach road + 150 mm
c)	Vehicle, scooter, cycle shed including fire tender bays, repair shop	-	Top level of approach road + 300 mm
d)	False floor areas (Control Room)	-	As specified in the Instrumentation section of NIT

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e)	Loading, Unloading bays, platforms	-	Top level of approach road + 1100 mm
f)	Electrical rooms	-	As specified in the Electrical section of NIT
g)	Other Buildings / Shed (Process Operator's Cabin)	-	Top level of approach road + 450 mm from surrounding ground level.

Notes:

a) In case of approaches with different top levels, the highest top level of approach road / pavement shall be considered.

b) FFL shall be same throughout in a building / shed. Split levels any be considered in exceptional cases due to ground terrain etc.

c) FFL of external loading / unloading bays / platforms, toilet, pantry, kitchen shall be 6 – 12 mm lower than that of the building / shed's FFL to check ingress / spillage of rainwater.

d) FFL of Warehouses, stores may be kept lower than loading / unloading bays / platforms where forklifts etc. are used for internal movement of items. Adequate arrangement for negotiating the level difference shall be provided in that case.

e) Where applicable, existing levels of building / sheds shall be followed.

2.5.3 STEPS / RAMPS

Steps / ramps shall be provided for access to the buildings / sheds for pedestrian /vehicles movement, equipment entry, etc. Minimum 1500 mm wide platform shall be provided in between entrance door and steps / ramps. Following dimensions of the steps / ramps shall be adhered to:

a) Tread	:	300 mm minimum
b) Riser	:	175 mm maximum

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c) Slope of ramp	:	Not steeper than 1:10 slope
d) Ratio of tread & riser	:	2 Riser + Tread = 600 to 650 mm
e) Landing width	:	1500 mm minimum
f) Flight width	:	1500 mm minimum

Edge of treads shall be provided with friction grip strips

2.5.4 WALL

Following schedule shall be adhered to for wall material and thickness

a)	Rain water duct / shaft	:	Min.230 mm thick hollow/ solid concrete block work
b)	External walls	:	Min.230 mm thick hollow/ solid concrete block work
c)	Fire wall (Around transformers)	:	240 thick RCC or 355 mm (including plastering) thick hollow/ solid concrete block work wall / OR as per Electrical requirements. (IER/TAC)
d)	Internal partition wall	:	230 / 115 mm thick. hollow/ solid concrete block work wall depending on the overall length and height of the wall (refer notes below)
e)	Blast Proof Wall	:	Min 230 mm thick.RCC wall

Notes:

a) 115 mm thick partition walls shall be provided with RCC transoms and mullions for suitability.

b) Wherever conduits or pipes are required to be concealed within partition wall, the local wall thickness shall be increased suitably.

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2.5.5 DOORS

Doors shall be provided for access, security and safety to all rooms, functional areas in a building with all safety closures as per the requirement of OWNER. Air tight door shall be provided in pressurized area and in gaseous protection area. Emergency door shall be opened outwards. Sizes of the doors shall be determined on the basis of the following schedule:

a)	Equipment, Panel area	:	Maximum size of equipment including packing
b)	Other areas	:	Volume of movement through door
c)	Minimum door size at entrance	:	1500 mm x 2500 mm (masonry opening size)
d)	W.C. bath Cubicle door	:	800 mm x 2100 mm (masonry opening size)
e)	Minimum size of other doors	:	1000 mm x 2100 mm (masonry opening size)

Notes:

a) Entrance doors shall be provided covering full width of the entrance lobby. In that case the door shall be of composite type consisting of openable shutters & fixed panels. Entrance lobby shall be provided with elaborate canopy.

b) Rolling shutters min 2500 mm wide shall be provided for equipment entry for Switchgear room, Electrical room, A.C. Plant room etc. and also wherever size of opening exceeds 2500 mm x 2500 mm.

c) Mechanically operated rolling shutters shall be provided for main equipment entry opening, and also where opening size exceeds 8 m^2.

d) Fireproof door shall be with two hours fire rating as per statutory requirements.

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e) Blast resistant Control room entry door shall be provided with blast resistant baffle wall in front of entry door and shall have 45 degree / 90 degree overlap on both sides as per relevant standard/codes.

2.5.6 WINDOWS / VENTILATORS

Windows / ventilators shall be provided in all areas for natural lighting, ventilation, and visibility of working level. For the purpose of ventilation, total openable area of the windows / ventilators shall be as per Factories Act subject to a minimum of 15% of the floor area to be ventilated. However, for control room and in office areas, etc. where visibility from inside is also important, increased window area (as per discussion with Owner/PMC) shall be provided. Areas accommodating panels / equipment shall be normally provided with ventilators at high level for uniformity distributed lighting.

Notes:

a) Requirements of window / ventilation area as stipulated above are for maximum room height of 4000 mm. For heights more than 4000 mm, additional window / ventilator shall be provided in the same manner at every work area / platforms at all levels.

b) Wherever due to limitation of external wall area or other reasons, stipulated area of window / ventilator cannot be provided, suitable mechanical / electrical system shall be employed.

c) Fly mesh shutters shall be provided for windows / ventilators in Kitchen, Pantry, Dining hall etc.

d) Ventilator shall be able to serve as smoke vents in the event of fire.

e) For structures like workshop / warehouse / compressor shed with pre-coated or G.I. roof sheeting, suitable monitor may be added to provide proper ventilation.

f) Fireproof windows shall be provided as per TAC, electrical, process, etc. statutory requirements.

g) External windows shall have P.C.C. (1:3:6) sills, 100 thick.

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h) All glasses in windows & doors shall be toughened glass. Outside glasses shall be tinted toughened.

2.5.7 CANOPY / OVERHANG

RCC Canopy / Overhangs shall be provided at all entrances for rain / sun protection, accentuation of the entrances, and pedestrian movement as per the following schedule:

a) For all offices, control rooms, composite buildings / sheds accommodating offices, canopy shall be provided at all entrances. Size of the canopy shall be decided based on vehicle parking & pedestrian movement in addition to aesthetics of the building / shed. Bottom of canopy shall be minimum 2800 from top of drive way.

b) Overhangs shall be provided over all exits. Size of the overhang shall be decided on the aesthetics of the building / shed subjected to minimum of 1000 mm.

Blast proof Control rooms shall not have any projections on outer face of its walls except with false treatment for aesthetics of the building.

2.5.8 SHADING DEVICES

RCC Shading devices shall be provided over all windows, open able ventilators for rain & sun protection. These devices shall be in form of horizontal projections, vertical projected fins or combination of both as per building façade treatment. Minimum projection shall be 600 mm.

2.5.9 PARAPET

Parapets shall be of RCC for all buildings with minimum 500 mm high for non-approachable roof and 1100 mm high for approachable roof.

2.5.10 ROOF GUTTER

Gutter with rainwater pipes shall be provided for all the buildings / sheds for roof water drainage. Sizing of the gutter shall be based on areas to be drained and number of outlets. Gutters shall be of RCC or sheet metal depending on type of structure

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2.5.11 RAIN WATER PIPES, SPOUTS

PVC rain water pipes shall be provided for roof water drainage. Number of rain water pipes shall be decided on the basis of roof area, slope and rainfall intensity as per NBC-IX, Section-2. Rain water pipes shall be concealed as far as possible. RCC or GI spouts may be used for drainage of chajja / small canopies of ground floor. Dia of rain water pipe shall be 150 minimum.

2.5.12 ENTRANCE LOBBY

Entrance lobby shall be provided as a common entrance for all buildings / sheds accommodating separate functional spaces integrated together. Individual entries to such functional spaces shall be from this lobby by means of passages / corridors. Apart from common entry lobby, separate independent entries to these functional spaces shall also be provided if functionally required. Size of the entrance lobby shall be decided on the basis of volume of movement. Air lock lobby shall be provided for all entries with centrally air-conditioned spaces, and pressurized.

2.5.13 PASSAGE / CORRIDORS

Passage / corridors shall be provided to integrate various spaces. Width of the passage / corridors shall be as per statutory requirement, subject to a minimum width of 1500 mm.

2.5.14 SERVICE ENTRY

Separate service entry shall be provided for service areas such as kitchen, air-condition / pressurization plant room, electrical rooms. A common service entry may be provided depending on spatial arrangement.

2.5.15 EMERGENCY EXITS

Emergency exits shall be provided for all the building / sheds as per statutory requirements. Emergency exits for individual function spaces such as console area, cable cellar and switchgear hall shall also be provided. Emergency exits shall be located in such a manner that escape route is unobstructed & without

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passing through any other function areas. Corridors / staircases shall be provided as escape route.

2.5.16 STAIRCASES

Staircases shall be provided in multi floor buildings for vertical circulation & emergency exits. Number of staircases shall be based on building / shed sizes, emergency exit requirements, and travel distances to exit points as per statutory regulations. More than 500 sq m ground covered area shall have at least two stairs in line with NBC-Part-IV. Emergency exit requirements shall be as per safety distance requirement. At least one staircase shall be provided for access to the flat roof tops for maintenance. Stairway in a single run shall have the same slope. The vertical rise of the stairways shall not exceed 2.5 m for single flight. Following dimensions for staircases shall be adhered to:

a)	Stairs width	:	1500 mm minimum, (1000 mm minimum for emergency exit)
b)	Tread	:	250 mm minimum
c)	Riser	:	150 mm maximum
d)	Ratio of tread & riser	:	2 Riser + Tread = 600 to 650 mm
Number of risers for single flight shall be restricted preferably to 12 depending on occupancy.			

2.5.17 RAILINGS

Railings shall be provided in roofs, stairs and in all unprotected openings in slabs as a safety device. Railings in high level loading / unloading bay of substations shall be of removable type. Parapets shall be given precedence over railings in roofs.

2.5.18 TOILETS

Toilets shall be provided for all habitable buildings / sheds. Gents & ladies Toilet, drinking water enclosure & janitor space, all shall be provided as

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required. The fittings / fixtures provided for bath / toilet shall be of luxury / coloured type.

2.5.19 PARTITIONS

Brick masonry partition wall shall be provided for control building. If required partitions shall be provided for flexible space arrangement in office spaces, Control room etc. The partitions shall be modular, dismantleable type of Godrej or approved equivalent make

2.5.20 FALSE CEILING

2.5.20.1 False ceiling shall be provided normally in air conditioned areas. False ceilings shall be provided for following purposes:-

a. To reduce room volume and hide ducting etc. for air conditioned spaces.

b. To maintain acoustic level inside any space.

c. To reduce habitable room, corridor, lobby, and toilet heights located in high ceiling building/shed to a reasonable and satisfactory height of minimum 3000 mm.

d. In fire rated areas where walls and doors are required to be fire rated, false ceiling shall also have complementing fire rating. It is appreciated that false ceiling have limitations in their fire performance due to openings in them for lighting and air-conditioning. Therefore alternative systems to prevent puncturing the ceiling must be employed.

2.5.20.2 Suitable space shall be kept to enable suitable arrangement of service duct cable, piping and lighting fixtures.

2.5.20.3 Providing and fixing thermal insulation with Resin Bonded Fibre glass wool conforming to IS: 8183. Density 16 kg/m³, 50 mm thick, wrapped in 200G Virgin Polythene bags placed over existing false ceiling and held in position by criss-crossing GI wire.

2.5.20.4 False flooring as per latest specifications, as approved by Owner, to be provided

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2.5.21 UNDER DECK INSULATION

Underdeck insulation below RCC roof and over false ceiling (both locations) shall be provided for air-conditioned office / space.

2.5.22 FALSE / CAVITY FLOORING

False / cavity flooring, consisting of cement filled flooring sheets with antistatic lamination on the top, of approved make / as directed by Engineer in charge, shall be provided to accommodate under floor cabling in all areas. Extent of false / cavity flooring shall be as per functional requirements.

False flooring shall be fire rated to the level of fire rating of the walls, doors and suspended ceiling in the compartment.

Cavity flooring for Control Room buildings, specifications given in Instrumentation section is to be followed.

2.5.23 WATERPROOFING ON ROOFS

Waterproofing on roofs shall be of either by membrane / chemical compound, as directed by engineer in charge

Dash fasteners, if used, shall be of approved make or as directed.

3.0 BUILDING STRUCTURE

The layout of the buildings shall be finalized within 3 months after the effective date of contract.

The design considerations, type of buildings and specifications of various buildings shall be as generally defined under this clause, unless stated otherwise as per plant requirements:

S. No.	**Building**	**Design Consideration**	**Type of Building**
1	Operators & Maintenance/	Rack layout, occupancy	RCC blast resistance structure as per specifications/ relevant standard/codal requirements

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	Control Room building		including Hollow /Solid Concrete Block work infill walls
2	Sub station	Equipment layout, occupancy	RCC frame, hollow/solid concrete block work/ masonry infill walls
3	Compressor shed/ Technological structures/ etc	Equipment layout, occupancy	Structural steel Framed Structure

4.0 ARCHITECTURAL FINISHES / TRADES

(To be finalized in consultation with the client)

All the buildings shall be provided with Architectural finishes such as floor finishes, plastering & painting on walls & ceilings, doors / windows / ventilators, roof treatment, plinth protection, etc. pertaining to approved make/brand and best quality for industrial usage.

4.1 EXTERNAL FINISHES

(To be finalized in consultation with the client)

4.1.1 EXTERNAL WALLS

a) Substation Room, Operator & Maintenance building

Cement Based paint of approved Quality.

b) Control Room

Sand Stone Cladding

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4.2 INTERNAL FINISHES (To be finalised in consultation with the client)

4.2.1 FLOOR FINISHES

a) Office area, & Sub station

Vitrified tiles in glazed or matt finish / Marbo-granite tiles

b) Toilet, Drinking Water area

Granite flooring

c) Circulation area (Corridor / Passage etc. except Entrance Lobby) of Sub station

Control room --Kota stone flooring

d) Switch Gear, Cable Cellar, A.C. Plant Room, storage area

Switch gear Room for substation will have Kota Stone Flooring. Rest of the buildings will have heavy Duty Decorative Ceramic Tiles. / Hardcrete Floor, as directed by E.I.C

e) Battery Room

Acid resistant epoxy coating over IPS-flooring & 2100 high dado.

f) Entrance lobby, corridor lobby of main building

Granite flooring

NOTE:

Skirting shall be provided in all areas, which shall be of same material as that of flooring. Glass strip panel shall be provided in cement concrete flooring.

4.2.2 INTERNAL WALL FINISHES (To be finalized in consultation with the client)

a) Entrance lobby, Corridor lobby:

Granite stone cladding and plastic emulsion paint.

b) Office areas of Buildings:

Cement plaster, POP punning & plastic emulsion paint

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c) Circulation areas (Corridor/Passage etc. excepting Entrance lobby) of Buildings

Cement plaster, POP punning & plastic emulsion paint

d) Rack Room, Office Rooms, Operators Room

Cement plaster, POP punning & plastic emulsion paint

e) Switchgear Room / Electrical Room

Cement plaster & Plastic Emulsion paint (Switchgear Room)

f) Battery Room

Acid resistant epoxy coating over cement plaster up to 2100 height. Plastic emulsion paint above 2100 height.

g) Toilet, Drinking water area

Granite stone cladding / Marble / Ceramic tiles as directed by E.I.C

4.2.3 INTERNAL CEILING FINISHES: (To be finalized in consultation with the client)

a) Toilet Electric Operator, Rack room, MCC panel room, UPS

As described in Instrumentation and Electrical specifications

b) Aluminum tray panel false ceiling.

c) Other areas which do not have false ceiling

Cement plaster & white / color wash, plastic emulsion paint etc., as in the case of wall finish.

4.3 DOORS, WINDOWS & VENTILATORS

4.3.1 DOORS

a) All doors in Toilet / WC / Bath

Pressed steel frame, block board flush shutter with lamination on the both sides.

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35 mm flush door laminated with 01mm laminate from both sides

b) All doors of Electrical Room, A.C. Plant Room, Battery Room

Pressed steel frame with pressed steel shutter (or as specified in Electrical section).

c) Inside Control Room / Rack Room

Fire check door with 2 hours rating as required in perfect partition wall separating various fire zones (or as specified in Instrumentation section).

d) All other door of Control Room / Rack Room / Sub station

Glazed, powder coated Aluminum door with decorative etching (or as specified in Instrumentation section).

4.3.2 WINDOWS & VENTILATORS

a) Windows / ventilators

Glazed, powder coated aluminum window / ventilator.

4.4 SANITARY FITTINGS (**Make: Jaquar/Cera/Hindware/Perryware or equivalent**)

a) Water Closet for Control Room

Wall hung type colored European designer type WC.

b) Water Closet for Sub Station.

Pedestal type white European designer type W.

c) Water Closet (Indian).

Orissa type (Indian) pan white WC.

d) Wash basins for Control Room.

Round wash basin white / colored housed in granite counter with electronic sensors for water control, approved quality mirror. Front portion below the counter shall be covered with shutters of laminated boards.

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e) Wash basins for Sub Station / Satellite Control Room.

Wall hung wash basin with pedestal.

f) Plumbing fixtures.

Stainless steel bib cock, stop cock etc. fittings.

5.0 MISCELLANEOUS

5.1 ARCHITECTURAL DRAWING

5.1.1 Plant datum shall always be 100.00 metres and it's correspondence to the reduced level with respect to the mean sea level shall be indicated in the "NOTES" (Unless it is already established).

5.1.2 Location co-ordinates shall be indicated on grids.

5.1.3 Reference drawings, notes, holds list, schedule of finishes including painting, door and window schedules, area statement, notes on plastering, key plan, were necessary, shall appear in the first drawing sheet of a building. Subsequent sheets can cover them by a reference to the first sheet.

5.1.4 Elevations shall show physiographic to highlight features, human figures for scale, automobiles for headroom, trees and foliage for appearance.

5.1.5 False ceiling area shall be shown by hatching suitably.

5.1.6 False flooring area shall be shown by hatching suitably.

5.1.7 Air-conditioned rooms shall be identified suitably.

5.2 DESIGN

5.2.1 Entrances shall be elaborate and well sheltered to accommodate pedestrians and vehicles.

Provision for future extension, vertical and horizontal shall reflect in the work

5.2.2 Toilet, kitchen and pantry floors with waterproofing and sloped for drainage. The finished floor level shall be 25 mm below the general finished floor level.

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5.2.3 Tile drops shall be indicated where required. For example from general floor to toilet floor, toilet floor to WC / Shower floor, general floor to pantry, general floor to entrance platforms and so on.

5.2.4 Plumbing works, external drainage, schematic, flow, shall be indicated.

5.2.5 AC plant, cooling tower, Chiller units etc., where required, shall be located on building roof as far as possible and it shall be positioned and supported to transfer its load on to beams and columns and not to the slab. Such facilities should not be visible from outside. Suitable side cladding shall be provided for this purpose.

5.2.6 Access to all roofs via steel ladder. In case of accessible roofs at least one staircase shall go up to the roof.

5.2.7 Plinth beams level shall clear trenches if any.

5.2.8 Vertical ducts for running services must be examined.

5.2.9 Ventilator arrangement shall be provided unless situations strongly prevent or make it unnecessary. In addition to ventilation requirements, ventilators shall have the capacity to vent smoke in the event of fire.

5.2.10 Layout shall take into account the type of air-conditioning and built-in provisions shall be made to accommodate the equipment.

5.2.11 Walls on steel beams shall be constructed after wall below and up to the steel beam is constructed. This shall appear in the ‘Notes’ if applicable.

5.2.12 Gaps in floor cut outs shall be sealed with fireproof material for fire safety.

5.2.13 Openings in wall / cladding for pipes and cables from pipe rack / trays shall be made water tight primarily by means of design features.

5.3 BUILDING REQUIREMENTS

5.3.1 All free edges of chajjas and slab projections shall have drip mould in plaster 50 mm wide and 20 mm drop, unless the need is resolved in some other manner.

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5.3.2 Floor slab in WC areas shall be sunk by 500 mm and toilet, pantry, kitchen floor slabs shall be sunk by 200 mm at all levels (including terrace, where future extension is envisaged).

5.3.3 All partition walls within toilet kitchen areas shall be 115 mm thick and 2200 mm high.

5.3.4 All supporting framework members of partition walls within false ceiling areas shall go up to roof level, partitions shall go up to false ceiling level except where there are fire compartment wall where it shall be from floor to ceiling.

5.3.5 Preferably all cut out in slab shall be provided with 200 high kerb.

5.3.6 Groove in plaster, 20 wide x 10 deep shall be provided aesthetically to break extensive areas of plaster.

5.3.7 Flooring shall be done in panels, preferably in 3000X3000 size. With expansion joints provided at 25000 c/c.

Flooring contraction joint shall be provided as per design.

5.3.8 Parapet walls shall be at least 1100 mm high.

5.3.9 Roofs of RCC buildings should have mild slope towards rain water gutters.

5.3.10 All Instrument / Electrical cables at the junction of the building (outside) shall be covered with pre-cast RCC slab. Sleeve pipes should be provided for the cable in the brick wall including its sealing.

5.3.11 All new buildings shall be designed for vertical extension in future

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SECTION VI– 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE-D: TECHNICAL SPECIFICATIONS

FOR CIVIL, STRUCTURAL AND OTHER ALLIED WORKS

(ES-2516)

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1.0 GENERAL

1.1 Specifications of materials and workmanship shall be as described in the Central Public Works Department Specifications Vol. I & II (latest) include latest amendments, unless otherwise specified. These CPWD Specifications shall be deemed to form part of this contract. The **CONTRACTOR** shall procure and maintain copies of the latest CPWD Specifications at site for reference.

1.2 These technical Specifications shall be supplementary to the specifications contained in the CPWD specifications, wherever at variance, these Particular Specifications shall take precedence over the provisions in the CPWD Specifications.

2.0 CODES & STANDARDS

2.1 Wherever reference of IS Specifications/ or IS Codes of Practice are made in the Specifications/ Schedule of Rates or Preambles, reference shall be to the latest edition of IS (Bureau of Indian Standards).

IS - 383	Coarse & Fine aggregates from natural sources for concrete.
IS - 427	Distemper, dry, colour as required.
IS - 432	Mild Steel & Medium tensile steel bars.
IS - 456	Code of Practice for Plain and Reinforced Concrete.
IS - 515	Natural and Manufactured aggregates for use in mass concrete
IS - 730	Hook bolts for corrugated sheet roofing
IS - 800	Code of Practice for General Construction in Steel
IS - 1079	Hot rolled carbon steel sheets & strips

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IS - 1081 Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.

IS - 1161 Steel tubes for structural purposes.

IS - 1285 Wrought aluminium & aluminium alloy extruded round tube and hollow sections

IS - 1361 Steel windows for Industrial Buildings.

IS - 1363 Hexagon head bolts, screws & nuts of product grade C : Part - I Hexagon head bolts (size range M5 to M64)

IS - 1367 Technical supply conditions for threaded steel fasteners

IS - 1566 Hard - Drawn steel wire fabric for concrete reinforcement.

IS - 1786 High strength deformed steel bars & wires for concrete reinforcement.

IS - 2062 Steel for general structural purposes.

IS - 2116 Sand for masonry mortars.

IS - 2212 Code of practice for brickwork.

IS - 2386 Methods of test for aggregates.

IS - 2835 Flat transparent sheet glass

IS - 4021 Timber door, window and ventilator frames

IS - 4923 Hollow Steel sections for structural use.

IS - 4925 Concrete batching and mixing plant.

IS - 5410 Cement Paint

IS - 6477 Dimensions for wrought aluminium & aluminium alloys, extruded hollow sections.

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IS - 7318 Fusion welding of steel.

IS - 10262 Recommended guidelines for concrete mix design.

IS - 14871 Products in Fibre Reinforced Cement – Long Corrugated or Asymmetrical Section Sheets and Fittings for Roofing and Cladding - Specification

3.0 EARTHWORK

3.1 EXCAVATION

3.1.1 Excavation shall be carried out in soil of any nature and consistency, in the presence of water or in the dry, met on the site to the lines, levels and contours shown on the detailed drawings and **CONTRACTOR** shall remove all excavated materials to soil heaps on site or transport for use in filling on the site or stack them for reuse as directed by the Engineer-in-Charge.

3.1.2 Surface dressing shall be carried out on the entire area occupied by the buildings including plinth protection as directed without any extra cost. The depths of excavation shown on the drawings are the depths after surface dressing.

3.1.3 The site around all buildings and structures to a width of 3 metres beyond the edge of plinth protection, ramps, steps, etc. shall be dressed and sloped away from the buildings.

3.1.4 Black cotton soil, and other expansive or unsuitable soils excavated shall not be used for filling in foundations, and plinths of buildings or in other structures including manholes, septic tanks etc. and shall be disposed off within the contract area marked on the drawings, as directed, levelled and neatly dressed.

3.1.5 In case of trenches exceeding 2 metres depth or where soil is soft or slushy, the sides of trenches shall be protected by timbering and shoring. The **CONTRACTOR** shall be responsible to take all necessary steps to prevent the

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sides of trenches from caving in or collapsing. The extent and type of timbering and shoring shall be as directed by the **Engineer-in-Charge.**

3.1.6 Where the excavation is to be carried out below the foundation level of adjacent structure, the precautions to be taken such as under pinning, shoring and strutting etc. shall be determined by **Engineer-in-Charge**. No excavation shall be done unless such precautionary measures are carried out as per directions of **Engineer-in-Charge.**

3.1.7 Specification for Earth work shall also apply to excavation in rock in general. The excavation in rock shall be done such that extra excavation beyond the required width and depth as shown in drawings is not made. If the excavation done in depth greater than required /ordered. The **CONTRACTOR** shall fill the extra excavation with concrete of mix 1:5:10 as the foundation concrete at his own cost.

3.1.8 **CONTRACTOR** shall make all necessary arrangements for dewatering / defiling as required to carry out proper excavation work by bailing or pumping out water, which may accumulate in the excavation pit from any cause/ source whatsoever.

3.1.9 **CONTRACTOR** shall provide suitable draining arrangements at his own cost to prevent surface water entering the foundation pits from any source.

3.1.10 The **CONTRACTOR** is forbidden to commence the construction of structures or to carry out concreting before **Engineer-in-Charge** has inspected, accepted and permitted the excavation bottom.

3.1.11 Excavation in disintegrated rock means rock or Boulders including brickbats which may be quarried or split with crow bars. This will also include laterite and hard conglomerate.

3.1.12 Excavations in hard rock - meant excavation made in hard rock to be done manually, or by blasting using only explosives and / or pneumatic hammers. In case of blasting, control blasting should be adopted depending on site

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conditions. For using explosives **CONTRACTOR** shall follow all provisions of Indian Explosives Act / Rules 1983, corrected / revised up to date.

3.1.13 In case of hard rock excavation to be carried out using explosives the, **CONTRACTOR** shall obtain the written approval in advance.

3.1.14 The measurements for excavations shall be restricted and limited to minimum excavation line as per drawing for payment purposes.

3.1.15 Adequate protective measures shall be taken to see that the excavation does not affect or damage adjoining structures. The **CONTRACTOR** shall take all measures required for ensuring stability of the excavation and safety of property and people in the vicinity. The **CONTRACTOR** shall erect and maintain during progress of work, temporary fences around dangerous excavations at no extra cost.

3.1.16 Excavation in ordinary soil means excavation in ordinary hard soil including stiff heavy clay, hard shale, or compact moorum, or any materials, which can be removed by the ordinary application of spades, shovels, picks and pick axes. This shall also include removal of isolated boulders each having a volume not more than 0.50m³.

3.1.17 Excavation in soft rock includes limestone, sandstone, laterite, hard conglomerates, etc. or other rock which can be quarried or split with crowbars or wedges. This shall also include excavation of tarred pavements, masonry work and rock boulders each having a volume of not more than 0.25m³.

3.1.18 Excavation in hard rock includes any rock bound in ledges or masses in its original form or cement concrete for which in the opinion of the Engineer-in-Charge, requires the use of compressed air, equipment, sledge hammer and blasting or non-explosive materials viz. Acconex manufactured by A.C.C. Ltd. Specifications and instructions for use shall be as per manufacturer.

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3.1.19 In case of any difficulty concerning the interpretation of type of soil as mentioned above, the Engineer-in-Charge shall decide whether the excavation in a particular material is in ordinary soil, soft rock or hard rock and his decision in this matter shall be final and binding on the CONTRACTOR and without appeal.

3.2 FILLING

3.2.1 Back filling of excavations in trenches, foundations and elsewhere shall consist of one of the following materials approved by **Engineer-in-Charge.**

Soil

Sand

Moorum

Hard-core

Stone/gravel

All back filling material shall be approved by the **Engineer-in-Charge.**

3.2.2 Soil filling - Soil material shall be free from rubbish, roots, hard lumps and any other foreign organic material. Filling shall be done in regular horizontal layers each not exceeding 20 cm. depth.

3.2.3 Back filling around completed foundations, structures, trenches and in plinth shall be done to the lines and levels shown on the drawings.

3.2.4 Back filling around pipes in the trench shall be done after hydro testing is done.

3.2.5 Back filling around liquid retaining structures shall be done only after leakage testing is completed and approval of **Engineer-in-Charge** is obtained.

3.2.6 Sand used for filling under foundation concrete, around foundation and in plinth etc. shall be fine/ coarse, strong, clean, free from dust, organic and deleterious matter. The sand filling under foundation shall be rammed with Mech. compactor. Sand material shall be approved by **Engineer-in-Charge**.

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3.2.7 Moorum for filling, where ordered, shall be obtained from approved pits and quarries which contain siliceous material and natural mixture of clay. Moorum shall not contain any admixture of ordinary earth. Size of moorum shall vary from dust to 10 mm.

3.2.8 Hard-core shall be of broken stone of 90 mm to 10 mm size suitable for providing a dense and compact sub grade. Stones shall be sound, free from flakes, dust and other impurities. Hard core filling shall be spread and levelled in layers, 15 cm thick, watered and well compacted with ramming or with mechanical / hand compacts including hand packing wherever required.

3.2.9 If any selected fill material is required to be borrowed, **CONTRACTOR** shall make arrangements and procure such material from outside borrow pits. The material of source shall be subject to prior approval of **Engineer-in-Charge**. **CONTRACTOR** shall make necessary access roads to borrow areas and maintain the same, if such access roads do not exist, at no extra cost.

3.2.10 Plinth filling shall be carried out with approved material as described earlier, in layers not exceeding 150mm, watered and compacted with mechanical compaction machines. **Engineer-in-Charge** may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours, allowed to dry and then the surface again compacted as specified above to avoid settlements at later stage. The finished level of the filling shall be trimmed to the level specified. Compacted surface shall have at least 95% of laboratory maximum dry density. A minimum of one test per 250 sq. meters of compacted area shall be done.

3.2.11 Whenever the fill material (earth or soil) is purchased, **CONTRACTOR** shall get the approval of Engineer-in-Charge. The CONTRACTOR shall arrange to determine the following properties of the soil and shall get the approval of **Engineer-in-Charge**.

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1. Clay content : 15% to 20%
2. Laboratory dry density : Not less than 1600 kg/m³
3. Plasticity Index : Not more than 20

3.2.12 The fill shall be compacted using a vibrating compactor of not less than 1.5 tonne. The fill shall be thoroughly compacted in layers as directed but not more than 200 mm thick. Adequate water shall be used for compaction and the density after compaction shall be not less than maximum dry density obtained in test of IS: 2720 Part-8. Compacted surface shall have at least 90% of laboratory maximum dry density. A minimum of one test per 250 sq. meters of compacted area shall be done.

3.2.13 The Gravel fill shall be non plastic granular material, well graded, strong, with maximum particle size of 50 mm, with not more than 15% passing a 4.75 mm IS sieve, free of all debris, vegetable matter and chemical impurities.

3.2.14 All clods, lumps etc. shall be broken before compaction.

3.2.15 In case of grading/banking successive layers of filling shall not be placed, until the layer below has been thoroughly compacted to satisfy the requirements laid down in this specification.

Prior to rolling, the moisture content of material shall be brought to within +/- 2% of the optimum moisture content as described in IS 2720 Part-7. The moisture content shall preferably be on the wet side for potentially expansive soil.

After adjusting the moisture content as described, the layers shall be thoroughly compacted by means approved by Engineer-in-Charge, till the specified maximum laboratory dry density is obtained.

General, fill shall be placed in layers not exceeding 300 mm thickness and shall be thoroughly compacted to achieve a compaction of at least 90% of

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laboratory maximum dry density up to a depth of 600 mm below finished grade. Final fill of 600 mm thickness shall consist of preferably natural material in, as dug condition except that stones larger than 100 mm shall be removed. It shall be placed in layers not exceeding 150 mm thickness and compacted to achieve of at least 95% of laboratory maximum dry density. Each layer shall be tested in field for density and accepted by Engineer-in-Charge, subject to achieving the required density before laying the next layer. A minimum of one test per 250 sq meters for each layer shall be conducted.

If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-Charge to obtain the required density.

The filling shall be finished in conformity with the alignment, levels, cross-section and dimensions as shown in the drawing.

Extra material shall be removed and disposed off as directed by the **Engineer-in-Charge.**

4.0 PLAIN AND REINFORCED CONCRETE WORK

This specifications deals with cement concrete, plain or reinforced, for general use, and covers the requirements for concrete materials, their storage, grading, mix design, strength & quality requirements, pouring at all levels, reinforcements, protection, curing, form work, finishing, painting, admixtures, inserts and other miscellaneous works.

4.1 MATERIALS

4.1.1 Cement: Any of the following cements may be used as required.

IS - 269	Ordinary Portland cement, 33 grade
IS - 8112	43 Grade ordinary Portland cement
IS - 12269	53 Grade ordinary port land cement

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4.1.2 Water: Water used for mixing and curing concrete and mortar shall conform to the requirements as laid down in IS: 456. Sea water shall not be used for concrete work.

4.1.3 Aggregates: Coarse and fine aggregates for cement concrete plain and reinforced shall conform to the requirements of IS 383 and / or IS 515. Before using, the aggregates shall be tested as per IS: 2386.

Coarse aggregate: Coarse aggregate for all cement concrete work shall be broken or crushed hard stone, black trap stone obtained from approved Quarries or gravel.

Sand: Fine aggregate for concrete work shall be coarse sand from approved sources. Grading of coarse sand shall be within grading zones I, II or III laid down in IS: 383, table 4. If required the aggregates (both fine and coarse) shall have to be thoroughly washed and graded as per direction of **Engineer-in-Charge**.

4.2 MIXING

All cement concrete plain or reinforced shall be machine mixed. Mixing by hand may be employed where quantity of concrete involved is small, with the specific prior permission of the **Engineer-in-Charge**. 10% extra cement shall be added in case of hand mixing as stipulated in IS-456.

For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off site batching and mixing plants (IS 4926)

4.3 WATER CEMENT RATIO, LAYING & CURING

Water Cement Ratio, Laying & Curing shall be done as per IS: 456.

4.4 CONCRETE

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4.4.1 Concrete Grades lower than M 25 shall not be used in reinforced concrete.

4.4.2 A sieve analysis test of aggregates shall be carried out as and when the source of supply is changed without extra charge notwithstanding the mandatory test required to be carried out as per CPWD specification.

4.4.3 All tests in support of mix design shall be maintained as a part of records of the contract. Test cubes for mix design shall be prepared by the CONTRACTOR under his own arrangements and at his costs, but under the supervision of the **Engineer-in-Charge**.

4.5 DESIGN MIX CONCRETE

4.5.1 Design mix shall be allowed for major works where it is contemplated to be used by installing weigh batch mixing plant as per IS 4925. At the time of tendering, the CONTRACTOR, after taking into account the type of aggregates, plant and method of laying he intends to use, shall allow in his tender for the design mix i.e., aggregate/cement and water/cement ratios which he considers will achieve the strength requirements specified, and workability for concrete to be properly finished.

4.5.2 Before commencement of concreting, **CONTRACTOR** shall carry out preliminary tests for design mix on trial mixes proposed by him in design of mix to satisfy the **Engineer-in-Charge** that the characteristic strength is obtained. In this regard, CONTRACTOR may consult govt. approved/reputed institute to get design mix done as per IS 10262 at his own cost. The concrete mix to be actually used shall be approved by the **Engineer-in-Charge**.

4.5.3 Notwithstanding the above, the following shall be the maximum combined weight of coarse and fine aggregate per 50 kg of cement.

Grade of Concrete	Maximum weight of fine & coarse aggregates together per 50 kg of cement

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		(for nominal mix only)
1.	M - 10	480 kg
2.	M - 15	350 kg
3.	M - 20	250 kg

4.5.4 The workability of concrete produced shall be adequate, so that the concrete can be properly placed and compacted. The slump shall be as per IS 456.

4.6 TESTING OF CONCRETE

4.6.1 Testing of concrete, sampling and acceptance criteria shall be in accordance with IS 456.

4.7 PROPORTIONING

Mixes of cement concrete shall be as ordered. Where the concrete is specified by grade, it shall be prepared by mixing cement, sand and coarse aggregate by weight as per mix design. In case the concrete is specified as volumetric mix, then dry volume batching shall be done, making proper allowances for dampness in aggregates and bulking in sand. Equivalent volume batching for concrete specified by grade may however be allowed by the **Engineer-in-Charge** at his discretion.

4.8 PRE CAST CONCRETE

The specifications for pre cast concrete will be similar as for the cast in situ concrete. All pre cast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soft former of the units, shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with

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smooth neat cement finish or a layer of MS sheeting. The casting shall be over suitable vibrating tables or by using form vibrators as per directions of **Engineer-in-Charge**.

The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (Twenty Eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I .sheet metal. The yard shall preferably be fenced.

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

Pre cast concrete units, when ready shall be transported to site by suitable means approved by **Engineer-in-Charge**. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per the instructions of the **Engineer-in-Charge**. The CONTRACTOR shall render all help with instruments, materials and staff to the **Engineer-in-Charge** for checking the proper erection of the pre cast units.

After erection and alignment the joints shall be filled with grout or concrete as directed by **Engineer-in-Charge**. If shuttering has to be used for supporting the pre cast unit they shall not be removed until the joints has attained sufficient strength and in no case before 14 (fourteen) days. The joint between pre cast roof planks shall be pointed with 1:2 (1 cement : 2 sand) mortar.

5.0 STEEL REINFORCEMENT

5.1 Steel reinforcement shall comprise:

Mild steel bars conforming to IS : 432 Part-I.

Cold twisted bars conforming to IS: 1786

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CRS bars

TMT bars

Hard drawn steel wire fabric conforming to IS: 1566

5.2 All joints in reinforcement shall be lapped adequately to develop the full strength of the reinforcement as per provision of IS: 456 or as per instruction of **Engineer-in-Charge**.

6.0 FORM WORK

6.1 The shuttering or form work shall conform to the shape, lines and dimensions as shown on the drawings and be so constructed as to remain sufficiently rigid during placing and compacting of the concrete and shall be sufficiently tight to prevent loss of liquid from the concrete. The surface that becomes exposed on the removal of forms shall be examined by **Engineer-in-Charge** or his authorized representative before any defects are made good. Work that has sagged or bulged out, or contains honey combing, shall be rejected. All shuttering shall be plywood or steel shuttering.

6.2 The **CONTRACTOR** shall be responsible for sufficiency and adequacy of all form work. Centering and form work shall be designed & detailed in accordance with IS 14687 and approved by the **Engineer-in-Charge**, before placing of reinforcement and concreting.

6.3 STRIPPING TIME

Forms shall not be struck until the concrete has reached strength at least twice the stress to which the concrete may be subjected at the time of removal of form work. The strength referred to shall be that of concrete using the same cement and aggregates, with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work. Where possible, the form work shall be left longer as it would assist the curing.

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Note 1: In normal circumstances and where ordinary Portland Cement is used, forms may generally be removed after the expiry of the following periods:

1.	Walls, columns and vertical faces of all structural members	24 to 48 hours as may be decided by the **Engineer-in-Charge**
2.	Slabs (props left under)	3 days
3.	Beam soffits (Props left under)	7 days
4.	Removal of props under slabs 1. Spanning up to 4.5 m 2. Spanning over 4.5 m	 7 days 14 days
5.	Removal of props under beams & arches: 1. Spanning up to 6 m 2. Spanning over 6m	 14 days 21 days

For other types of cements, the stripling time recommended for ordinary Portland Cement may be suitably modified.

Note 2: The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

7.0 CEMENT CONCRETE BLOCK

Cement concrete block shall be machined made in the proportion of such that mix shall not be leaner than one cement to twelve combined aggregates (by volume) but having minimum strength of 7.5 MPa. Combined aggregate shall be graded as near as possible to IS: 383. The fineness modules of combined aggregate shall be between 3.6 and 4. The concrete block shall be properly

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cured as per IS-456. The surface of conc. block shall have even face without any honeycomb and free from cracks.

7.1 MORTAR

Cement and water shall confirm to the requirements laid down for cement concrete work.

7.1.1 Sand for concrete block masonry mortars shall be coarse sand generally conforming to IS: 2116. Maximum quantities of clay, fine dust, shall not be more than 5% by weight. Organic impurities shall not exceed the limits laid down in IS: 2116.

7.1.2 Mix of mortar for building concrete block shall be as specified in the item of work.

7.1.3 Mixing of the mortar shall be done in a mechanical mixer. When quantity involved is small hand mixing may be permitted by **Engineer-in-Charge**. Any mortar remaining unused for more than 30 minutes after mixing shall be rejected.

7.2 CONCRETE BLOCK MASONRY

The thickness of joints shall be 10 mm +- 3mm. Thickness of joints shall be kept uniform. In case of foundation and manholes etc. joints up to 15 mm may be accepted.

7.3 HALF CONCRETE BLOCK

All courses shall be laid with stretchers. Reinforcement comprising 2 nos. 6 mm dia MS bars shall be provided over the top of the first course and thereafter at every fourth course.

7.4 FIXTURES

All iron fixtures, pipes spouts, hold fasts of doors and windows which are required to be built into the wall shall be embedded in cement concrete blocks

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1:2:4 mix (1 cement :2 coarse sand :4 graded stone aggregate. 20 mm nominal size) of size indicated in the item.

7.5 CURING

Concrete block masonry shall be protected from rain by suitable covering when mortar is green. Masonry work shall be kept constantly moist on all faces for a minimum period of seven days.

8.0 STRUCTURAL STEEL WORK

This specification covers the technical requirements for the preparation of shop drawings, supply, fabrication, protective coating, painting and erection of all structural steel rolled sections, built up sections, plates and miscellaneous steel required for the completion of the work.

Steel

All structural steel used in construction within the purview of this contract shall, comply with one of the following Bureau of Indian Standard Specifications, whichever, is appropriate or as specified.

IS – 2062 Hot rolled sections and plates

IS – 1079 Cold formed light gauge sections

IS – 1161 Tubular sections

IS – 4923 Hollow sections (rectangular or square)

Fabrication

Fabrication of steel structure shall be carried out in conformity with the best modern practices and with due regard to speed with economy in fabrication and erection and shall conform to IS-800. All members shall be so fabricated as to assemble the members accurately on site and erect them in correct positions. Before dispatch to site the components shall be assembled at shop and any defect found rectified. All members shall be free from kink, twist, buckle, bend, open joints etc. and shall be rectified before erecting in position. Failure in this respect will subject the defective members to rejection.

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Fabrication Drawings:

Connections, splices and other details shall be suitably designed based on good Engineering practice.

Electrodes:

Electrodes used for welding shall comply with IS-814 or IS - 815.

8.1 MS BLACK/HIGH STRENGTH BOLTS AND NUTS

M.S.Black or high strength bolts, nuts and washers etc. shall be as per IS-800, IS-1363 and IS-1367. Manufacturer's test certificate shall be made available to the **Engineer-in-Charge**. For bolted joints, shanks and threaded bolts are to be used to ensure that threaded length do not encroach within the thickness of connected members of dimension beyond the following limit:-

1. 1.5 mm for connected members of thickness below 12 mm and
2. 2.5 mm for connected member of thickness 12 mm and above and that adequate shearing and bearing values required as per design are achieved.

Every portion work shall have its erection mark or numbers stencilled on the member for guidance in erection and bear all necessary marks of erections as directed by the Owner / Consultant.

8.2 No part of the work is to be oiled, painted (except contact surfaces) packed, bundled, crated or dispatched until it has been finally inspected and approved by the Owner / Consultant or his authorized representative. The whole steel work before being dispatched from the Contractor’s shop shall be dry and after being thoroughly cleaned from dust, mills scale, rust etc., and shall be given two coats of primer and one coat of final paint as per painting specification attached in this enquiry. Unless otherwise specified, all surfaces inaccessible after welding shall be given two coats of primer and two coats of paints as per painting specification attached in this enquiry.

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8.3 The Owner / Consultant or his authorized representative shall have free access at all reasonable time to all places where the work is being carried out, and shall be provided by the Contractor at his own expenses all necessary facilities for inspection during fabrication and erection. The Owner / Consultant or his authorized representative shall be at liberty to reject the work in whole or in part if the workmanship or materials do not conform to the terms of the specifications mentioned herein. The Contractor shall remove, replace or alter any part of the work as ordered by the Owner / Consultant or his authorized representative.

9.0 PAINTING ON STRUCTURAL STEEL

The following specification shall be used for painting of structural steel work.

9.1 SCOPE

This specification covers the technical requirements for shop and site application of paint and protective coatings and includes; the surface preparation, priming, application, testing and quality assurance for protective coatings of structural steelwork, plate work, handrails and associated metal surfaces, which will be exposed to atmospheric for industrial plants.

9.2 DEFINITIONS

C.S - Carbon steel and low chrome (1-1/4 Cr through 9 Cr) alloys

S.S - Stainless steel, such as 304,316, 321, 347,

Non-ferrous- copper, aluminium and their alloys.

High Alloy - Monel, Inconel, Incoloy, Alloy 20, Hastelloy, etc.

DF - Dry Film thickness, the thickness of the dried or curved paint or coating film.

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9.3 SAFETY REGULATIONS

Protective coatings and their application shall comply with all national, state, and local codes and regulations on surface preparation, coating application, storage, handling, safety, and environmental recommendations.

Sand or other materials producing silica dust shall NOT be used for any open-air blasting operations.

9.4 MATERIAL SAFETY DATA SHEETS

The latest issue of the coating manufacturer's product datasheet, application instructions, and material safety data Sheets shall be available prior to starting the work and shall be complied with during all preparation and painting / coating operations.

9.5 MATERIALS

All paints and paint materials shall be obtained from the company's approved manufacturer's list. All materials shall be supplied in the manufacturer's containers, durably and legibly marked as follows.

Specification number

Colour reference number

Method of application

Batch number

Date of Manufacture

Shelf life expiry date

Manufacturer's name or recognised trade mark.

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9.6 CODE AND STANDARDS:

Without prejudice to the provision of Clause 1.1 above and the detailed specifications of the contract, the following codes & standards shall be followed. Wherever reference to any code is made, it shall correspond to the latest edition of the code.

9.7 INDIAN STANDARDS:

IS-5: 1994 Colors for ready mixed paints and enamels.

IS-2379: 1990 Color codes for identification of pipe lines.

IS-2629: 1985 Recommended practice for hot-dip galvanizing on iron and steel.

IS-2633: 1986 Methods for testing uniformity of coating of zinc-coated articles.

IS-8629: 1977 Code of practice for protection of iron and steel structures from atmospheric corrosion.

IS: 110 Specification for Ready Mixed Paint, Brushing, Grey Filler, for Enamels, for Over Primers

IS: 101 Methods of test for ready mixed paints & enamels.

9.8 OTHER STANDARDS:

9.8.1 Swedish Standard: SIS-05 5900-1967 / ISO-8501-1-1988

(Surface preparations standards for Painting Steel Surface).

This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-in-charge.

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9.8.2 DIN: 53151 Standards for Adhesion test.

9.9 The paint manufacturer's, instructions shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

a) Instructions for storage to avoid exposure as well as extremes of temperature.

b) Surface preparation prior to painting.

c) Mixing and thinning.

d) Application of paints and the recommended limit on time intervals between coats.

9.10 SURFACE PREPARATION

9.10.1 Safety

All work in adjacent areas, which may negatively affect the quality of blast cleaning, and/or impose safety hazards, must be completed or stopped before the blasting operation starts.

9.10.2 Pre-Cleaning

Prior to surface preparation all weld spatter shall be removed from the surface, all sharp edges ground down and all surfaces cleaned free of contaminants including chalked paint, dust, grease, oil, chemicals and salt. All shop primed surfaces shall be water washed by means of suitable solvent, by steam cleaning, with an alkaline cleaning agent if necessary or by high-pressure water, to remove contaminants prior to top-coating.

9.10.3 Surface decontamination

Surface decontamination shall be performed prior to paint application when uncoated surface is exposed to a corrosive environment or existing paint work is to be repaired. Existing coatings shall be removed by abrasive blast cleaning, and then high pressure potable water shall be used to clean steel surfaces. Prior to application of coatings, the surface shall be chemically checked for the

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presence of contaminants. A surface contamination analysis test kit shall be used to measure the levels of chlorides, iron salts and pH in accordance with the kit manufacturer's recommendations.

Swabs taken from the steel surface, using cotton wool test swabs soaked in distilled water shall not be less than one swab for every 25m^2 of surface area to be painted.

Maximum allowable contaminant levels and pH range is as follows:

a) Sodium chloride :- Less than 50 microgram / cm^2;

b) Soluble iron salts :- Less than 7 microgram / cm^2; and

c) pH :- 6 – 8

If the results of the contamination test fall outside the acceptable limits, then the wash
water process shall be repeated over the entire surface to be painted, until the contaminant test is within the specified levels.

9.10.4 Abrasive blasting

All C.S materials shall be abrasive blast cleaned in accordance with relevant IS Codes. To reduce the possibility of contaminating S.S., blasting is not usually specified. However, for coatings which require a blast-cleaned surface for proper adhesion, S.S. may be blast cleaned using clean aluminium oxide or garnet abrasives (Free from any chloride or Iron / Steel contamination).When hand or power tool cleaning is required on S.S., only S.S. wire-brushes (including 410 S.S.) which have not been previously used on C.S. surfaces may be used.

The surface profile of steel surfaces after blasting shall be of preparation grade Sa 2-1/2 of Swedish Standards SIS-05-5900 (Latest Revision) or better according to ISO 8501-1 and shall be measured using the replica tape method or the comparator method.

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The roughness (profile) of blast-cleaned surfaces shall be Medium (G) according to ISO 8503-2: 1988 (appendix 1) unless otherwise specified. Medium defines a surface profile with a maximum peak-to-valley height of 60-100 microns, and G indicates that the surface profile is obtained by grit blasting. For the evaluation of surface roughness Comparator G shall be used.

Abrasive blast cleaning shall NOT be performed when the ambient or the substrate temperatures are less than 3 Degree Celsius above the dew point temperature. The relative humidity should preferably be below 50% during cold weather and shall never be higher than 60% in any case.

Abrasive blast cleaning shall be performed with a clean, sharp grade of abrasive. Grain size shall be suitable for producing the specified roughness. Abrasives shall be free from oil, grease, moisture and salts, and shall contain no more than 50ppm chloride. The use of silica sand, copper slag and other potentially silica containing materials shall not be allowed.

The blasting compressor shall be capable of maintaining a minimum air pressure of 7 kPa at the nozzle to obtain the acceptable surface cleanliness and profile.

The blast cleaning air compressor shall be equipped with adequately sized and properly maintained oil and water separators. The air supply shall be checked to ensure no oil and water contamination at the beginning of each work shift.

Blast cleaning abrasive shall be stored in a clean, dry environment at all times. Recycling of used abrasive is prohibited.

After blast cleaning, the surfaces shall be cleaned by washing with clean water (Pressure 7kg/cm^2 using suitable nozzles. During washing broom corn brushes shall be used to remove foreign matter.

Assessment of the blast cleaned surfaces shall be carried out in accordance with reference code.

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Blast cleaned surfaces which show evidence of rust bloom or that have been left uncoated overnight shall be re-cleaned to the specified degree of cleanliness prior to coating.

All grit and dust shall be removed after blasting and before coating application. Removal shall be by a combination of blowing clean with compressed air, followed by a thorough vacuum cleaning with an industrial grade, heavy duty vacuum cleaner.

All cleaned surfaces shall have protection from atmospheric corrosion as per IS8629:1977

9.10.5 Painting system to be used is indicated below:

1.Epoxy Painting:

Primer P 1-2 coats + finish paint FP1 (2 coats) where P1 is epoxy polyamide cured zinc chromate primer having DFT of 35 micron per coat and FP1 is epoxy polyamide cured finish paint having DFT (Dry Film Thickness) of 35 micron per coat.

Equivalent product chart for approved paint manufactures for primer P1 finish paint FP1 indicated above is enclosed.

2. For PU painting:

i) P1 – One coat of Ethyl silicate inorganic zinc primer having DFT of 70 microns per coat.

ii) IP1 – One coat of Epoxy MIO having DFT of 70 microns per coat.

iii) FP1 - One coat of finish epoxy paint using two pack Polyamide cured epoxy having DFT of 40 microns per coat.

iv) FP2 - One coat of Aliphatic Acrylic Polyurethane paint having DFT of 40 microns per coat.

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Equivalent product chart for approved paint manufactures for P1, IP1, FP1 & FP2 indicated above is enclosed.

9.10.6 All the surfaces must be abrasive blasted and 2 coats of primer plus 1 coat of finish paint applied in the fabrication shop before the same are shifted to site for erection. All the members must be suitably match marked for facilitating proper assembly.

After erection is over all surfaces shall be washed up as follows:

Washing with clean water (pressure 7 kg/cm^2) using suitable nozzles. During washing broom corn brushes shall be used to remove foreign matters.

Solvent washing if required to remove traces of oil grease etc.

After washing the surface as indicated above, the surfaces shall be suitably touched up to the extent required so that all the damages to the premiered surfaces caused during erection are done up.

a) The surfaces affected by welding and / or gas cutting during erection shall also be suitably touched up. Before touch up is taken up surfaces shall be prepared by mechanical means such as grinding, power brushing etc. to achieve surface finish to ST-3.

b) After touch up work is over as indicated above, all the surfaces shall be given one coat of finish paint to the required specification.

9.10.7 The following points must be observed for painting work:

a) Primer and paint shall be compatible to each other and should be from the same manufacturer.

b) The recommendation of the paint manufacturer regarding mixing, matching and application must be followed meticulously.

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c) Technical representative of paint manufacturer should be available at site as and when required by **Engineer-in-Charge** for their expert advice as well as to ensure that the painting work is executed as per the instruction of paint manufactures.

d) Paints and primers shall be supplied at site in original container with factory seal otherwise such paints and primers shall not be allowed to be used. Mode of application i.e. by spray, brush or roller shall be strictly as per recommendation of paint manufacturer.

e) Painting materials must be used before the expiry date indicated on the containers.

f) Number of coats and DFT per coat must be strictly followed as indicated above. If the desired DFT is not achieved for primer and finish paints in two coats (each), **CONTRACTOR** shall be required to apply extra coat (s) to achieve the desired DFT without any extra cost to **Engineer-in-Charge**.

g) Color shade for each coat of primer and finish paint must be different to identify the coats without any ambiguity.

h) Shade for the final finish coat shall be decided by **Engineer-in-Charge** at site.

i) All painting materials must be accompanied by manufacturers test certificates. However, Engineer-in-Charge has any doubt regarding quality of materials, he shall have the right to direct CONTRACTOR to get the doubtful material tested or and provided (by CONTRACTOR) testing agencies for which no extra payment shall be made to the CONTRACTOR and the charges shall deemed to be covered in the unit rates quoted for fabrication and erection of structural work.

j) DFT for paint shall be measured at least 20 points and mean DFT shall not vary by more than 10% than specified in DFT.

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k) Reliable and calibrated Instrument for measurement of DFT shall be arranged and provided by **CONTRACTOR** at his cost.

l) Thickness of each coat shall also be checked regularly to ensure uniformity in DFT.

9.10.8 Abrasive blasting and painting works, being a specialized job must be carried out through the approved agencies only.

9.10.9 Equivalent Chart for Various Paint Manufacturers for Epoxy paint

	ASIAN	**G & N**	**SHALIMAR**	**J & N**	**BERGER**	**BOMBAY**
P1	APCODUR - Epoxy Zinc Chrome Primer	AMERCOAT-71	EPIGARD-4 Zinc Chromate Primer	EPILAC Zinc Chromate Primer	EPILUX-4 Zinc Chromate Primer	PENTADUR PRIMER 1532
FP1	APCODUR CF 692	NEROLAC TWO COMP EPOXY	EPIGARD XL FINISH	EPILAC 974 ENAMEL	EPILUX-4 ENAMEL	PENTADUR ENAMEL 5534 GRAY

9.10.11 Equivalent Chart for Various Paint Manufacturers for PU paint

CODE	**ITEM**	**DFT PER COAT (MICRONS)**	**ASIAN**	**G & N**	**SHALIMAR**	**J & N**	**BERGER**	**BOMBAY**
P1	ETHYL SLILICATE INORGA-NIC ZINC PRIMER	70	APCOSIL 601	DYMET - COTE - 9	TUFFKOTE ZILICATE	J&N INORGA-NIC ZINC SILICATE PRIMER	ZINC ANODE 304	HEAPELS GALVO-SIL 1570
IP1	EPOXY MIO	70	APCO-DUR MIO	AMER COAT 385	EPIGUARD HB MIO	EPILAC HB MIO	EPILUX-4 HB MIO	PENTA-DUR HB MIO 4567

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FP1	TWO PACK POLYA-MIDE CURED EPOXY	40	APCO-DUR CF-692	NERO-LAC TWO COMP EPOXY	EPIGUARD XL	EPILAC 974	EPILUX-4 ENAMEL	PENTA-DUR ENAMEL 5534
FP2	ALIPHA-TIC ACRYLIC POLYURE-THANE PAINT	40	APCO-THANE 674	AMER-COAT 450 GL	SHALI-THANE	JN 992 PU FINISH PAINT	BERGA-THANE ENAMEL	PENTO-THANE 4513

10.0 STEEL / ALUMINIUM DOORS, WINDOWS AND VENTILATORS

10.1 The Steel doors, windows and ventilators shall be of the size and type as per IS-1361 and IS-1038. Fixing and glazing shall be done as per IS-1081 and as per manufacturer's instructions. The putty of approved make such as special gold size or equivalent conforming to IS-419 shall be used.

10.2 Aluminium doors, windows and ventilators shall be manufactured from wrought aluminium and aluminium alloy extruded round tube and / or hollow rectangular / square sections conforming to IS: 1285 & IS : 6477 or equivalent as approved by **Engineer-in-Charge**.

11.0 ROOFING & CLADDING

All roof and cladding sheets should be galvalume sheet of 0.5 mm total coated thickness with 550 MPA grade steel confirming to AS 1397 with AZ150 grade coating.

Translucent sheets shall be provided, in non-process areas only, intermittently where day lighting is required.

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12.0 FLOORING AND PAVING

12.1 SUB BASE OF FLOOR

12.1.1 The area to be paved shall be divided into suitable panels. Form work shall be provided. The boarding / battens shall be fixed in position with their toe at proper level, giving slope where required. Alternatively base concrete may be deposited in the whole area at a stretch.

12.1.2 Before placing the base concrete the sub-base shall be properly wetted and rammed. The concrete of the specified mix shall then be deposited between the forms where provided, thoroughly tamped and the surface finished level with the top edge of the forms. The surface of base concrete shall be spreader uniformly. The surface shall be finished rough to provide adequate bond for the topping. Two or three hours after concrete has been laid the surface shall be brushed with wire brush to remove any scum or Latinate and swept clean so that coarse aggregate is exposed.

12.2 CEMENT CONCRETE FLOOR FINISHES

12.2.1 The surface of base concrete shall be thoroughly cleaned by scrubbing with coir or steel wire brush. Before laying the toping, the surface shall be soaked with water at least for 12 hours and surplus water mopped up immediately before the toping is laid.

12.2.2 The forms shall be fixed over the base concrete dividing into suitable panels. Where glass dividing strips are provided, thickness of glass dividing strips shall be 4 or as indicated. Before placing the concrete toping, neat cement slurry at the rate of 2 kg/sq.m shall be then thoroughly brushed into the base concrete just ahead of the finish. The topping shall then be laid, thoroughly compacted by using screed board/plate vibrator. The surface floated with a wooden float to a fair and even surface shall be left for some time till moisture disappears from it.

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Junctions with skirting / dado or wall surfaces shall be rounded off using cement mortar 1:2 curing shall be carried out for a minimum of 7 days.

13.0 PLASTERING

13.1 Sand for plastering shall be 50% fine sand and 50% coarse sand from approved sources.

13.2 Preparation of surface shall be done as per CPWD specifications.

13.3 Cement mortar shall be of the mix as indicated in the items and shall be mixed as specified in the CPWD specifications.

13.4 Joints in walls etc. shall be raked to a depth of 12 mm, brushed clean with wire brushes dusted and thoroughly washed before starting the plaster work.

13.5 The surface shall be thoroughly washed with water cleaned and kept wet to saturation point before plastering is commenced.

13.6 Cement mortar as indicated, shall be firmly applied to the masonry walls in a uniform layer to the thickness specified and will be pressed into the joints. On concrete surfaces rendering shall be dashed to the roughened surface to ensure adequate bond. The surface shall be finished even and smooth. Hectoring wherever required shall be done as per directions of **Engineer-in-Charge.** Nothing extra shall be paid on this account.

13.7 All plaster work shall be cured for at least 7 days.

13.8 Integral water proofing compound shall be mixed with cement in the proportion recommended by the manufacturer. Care shall be taken to ensure that the water proofing material gets well and integrally mixed with cement. All other operations are the same as for general plaster work.

13.9 For sand face plaster undercoat of cement plaster 1:4 (1 cement : 4 sand) of thickness not less than 12 mm shall be applied similar to one coat plaster work.

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Before the under coat hardens the surface shall be scared to provide for the top coat. The top coat also of cement mortar 1:4 shall be applied to a thickness not less than 8 mm and brought to an even surface with a wooden float. The surface shall then be tapped gently with a wooden float lined with cork to retain a coarse surface texture, care being taken that the tapping is even and uniform.

14.0 EXTERIOR PAINTING OR APEX

14.1 Exterior painting shall be Apex.

14.2 Where shown on drawings for external surfaces of sand faced plaster, or any other surface, two coats of cement paint shall be applied of tint and shade as approved by the **Engineer-in-Charge**.

14.3 The surfaces shall be prepared as specified for white washing. Before applying cement paint the surface shall be thoroughly wetted to control surface suction. The surface shall be moist but not dripping wet, when the paint is applied. Not less than 24 hours shall be allowed between the two coats. In hot weather the first coat shall be slightly moistened before applying the second coat.

14.4 On external plastered surfaces (one coat primer + minimum 3 coat of paints), sand faced or plain plastered and concrete surfaces, apex weather proof paint shall be vigorously scrubbed on to work the paint into the voids and provide a continuous paint film free from pin holes and other openings.

15.0 GLAZING

15.1 Sheet glass glazing of doors, windows etc. shall be of selected quality glass conforming to IS: 2835. Toughened splinter proof industrial safety glass shall confirm to IS: 2553. No cracked chipped or disfigured glass shall be accepted Glass shall be in one piece for each pan.

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15.2 Glazing shall be fixed with timber or steel / aluminium beading as called for. Glass shall be back puttied and fixed with beading for a water tight and rattle free installation. Sizes of timber/ steel / aluminium beading shall be as directed.

16.0 PROTECTIVE COATING AND LINING SYSTEM

16.1 ACID PROOF TILES:

MATERIAL

1) TILES

These tiles shall be made of clays, feldspar, quartz, talc and vitrified at high temperature in ceramic kilns and kept unglazed so as to prevent from slipperiness. Tiles shall not absorb more than 2% of their own dry weight when soaked in water. Compression strength: 700 Kg/cm2 Min. & Flexural strength: 200 Kg/cm2 Min. It shall not lose more than 1.5% of it weight when soaked in acid.

Chemical compositions of tiles:

- Al_2O_3 : 22-24%
- SiO_2 : 60-65%
- Fe_2O_3 : 1.0-2.0%
- Alkalise : 10-12%

2) K-BASED SILICATE MORTAR

Acid Proof cement KSC is a potassium silicate based corrosion cement. Acid tile linings carried out with KSC cement are not subject to crystal formation in the pores of cement. Besides Bitumastic surface is joint-less, hence there is no danger of Acids percolating through the surface.

Characteristics of K-based Silicate mortar:

- Colour : White
- Density (lbs/Cub. ft.) : 130

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- Water Absorption : 2-5 %
- Tensile Strength (Psi) : 400
- Compressive strength (Psi) : 2800
- Bond Strength (Psi) : 180
- Coefficient of thermal expansion : 6.0 x 10^{-6}

3) BITUMASTIC MORTAR

It shall consist of an acid proof inorganic filler and blended bitumen. It shall be trowelled to concrete having total thickness of 10 mm.

Characteristics of Bituminous compounds:

- Density (Kg/m^3) : 2200
- Water content by mass percent (max) : 0.5
- Flash point °C ,min. : 35

Consistency

a) Before setting (test after 1 hr) min. : 100

b) After setting (test after 24 hr) min. : 80

Mastic shall be heated to 150-300^{o}C and shall be applied in 5 mm layers after surface is cleaned and dried.

4) BITUMINOUS PAINT

This is generally of heavy grade bituminous corrosion resisting paint. 2 coats of the paint shall be given, and drying time between the 2 coats shall not be less than 5 hours. Also, its drying time after second coat shall not be more than 8 hours. Its finish shall be smooth, glossy and elastic.

The primer shall confirm to the following requirements:

- Viscosity by standard tar viscometer, 4mm orifice at 25°C: 4 to 24
- Penetration at 25°C, 100g, 5sec in 1/100 cm : 20 to 50

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- Water content percent (max) : 0.2

APPLICATION

SL. NO.	DESCRIPTION	ITEM OR AREA
1.	Bituminous Paint (Primer)	Concrete surface
2.	10mm Bitumastic Laying in two layers each shall not be more than 5mm thick	Over Bituminous Paint
3.	One layer, 5mm Acid, K-based Silicate Type mortar	#
4.	10 mm thick Acid proof tiling	Over K-based Silicate

- Tiles should be fixed on bitumastic surface with the help of 5mm K-based silicate mortar.

16.2 EPOXY COATING

Characteristics of coated surfaces (after application)

- Compressive strength : min. 90 N/mm2
- Tensile strength : min. 10 N/mm2
- Abrasion resistance : as per Amsler 1.5 mm after 3000 revol.
- Bonding (joining) factor : 1

APPLICATION:

SL. NO	DESCRIPTION	APPLICATION
1.	One coat of two pack interpenetration polymer (Epoxy	Primer coat on Concrete surface

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SL. NO	DESCRIPTION	APPLICATION
	Phenolic) Thickness 60 micron per coat	
2.	One coat of two pack interpenetration polymer (Epoxy Phenolic) Thickness 100 micron per coat	Intermediate Coat over Primer Coat
3.	One coat of two pack interpenetration polymer (Polyurethane) Thickness 50 micron per coat	Final Coat over Intermediate Coat
4.	Sealing by polysulphide compound	This will be provided at all joints with foundation, pits & wall etc

16.3 ACID RESISTANT BRICK LINING

MATERIAL

These bricks are made of raw materials such as clay or shale of suitable composition with low lime and iron content, feldspar, flint or sand and vitrified at high temperature in ceramic kilns. Bricks shall not absorb more than 2% of their own wt. when soaked in water. Compression strength: > 700 Kg/cm^2. Bricks shall not lose more than 1.5% at their own weight when tested for acid resistance.

Chemical compositions of bricks are

a) Al_2O_3 22-24%

b) SiO_2 60-65%

c) Fe_2O_3 1.0-2.0%

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d) Alkalies 10-12%

1) K-BASED SILICATE MORTAR

Acid Proof cement KSC is a potassium silicate based corrosion cement. Acid brick linings carried out with KSC cement are not subject to crystal formation in the pores of cement. Besides Bitumastic surface is joint-less, hence there is no danger of Acids percolating through the surface.

Characteristics of K-based Silicate mortar:

- Colour : White
- Density (lbs/Cub. ft.) : 130
- Water Absorption : 2-5 %
- Tensile Strength (Psi) : 400
- Compressive strength (Psi) : 2800
- Bond Strength (Psi) : 180
- Coefficient of thermal expansion : 6.0×10^{-6}

2) BITUMASTIC MORTAR

It shall consist of an acid proof inorganic filler and blended bitumen. It shall be trowelled to concrete having total thickness of 10 mm.

Characteristics of Bituminous compounds:

- Density (Kg/m^3) : 2200
- Water content by mass percent (max) : 0.5
- Flash point °C ,min. : 35
- Consistency

  Before setting (test after 1 hr) min. : 100

  After setting (test after 24 hr) min. : 80

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Mastic shall be heated to 150-300^{o}C and shall be applied in 5 mm layers after surface is cleaned & dried.

3) BITUMINOUS PAINT(PRIMER)

This is generally of heavy grade bituminous corrosion resisting paint. 2 coats of the paint shall be given, and drying time between the 2 coats shall not be less than 5 hours. Also, its drying time after second coat shall not be more than 8 hours. Its finish shall be smooth, glossy and elastic.

The primer shall confirm to the following requirements:

Viscosity by standard tar viscometer, 4mm orifice at 25°C : 4 to 24

Penetration at 25°C, 100g, 5sec in 1/100 cm : 20 to 50

Water content percent (max) : 0.2

APPLICATION

SL. NO.	DESCRIPTION	ITEM OR AREA
.	Bituminous Paint (Primer)	Concrete surface
.	10mm Bitumastic Laying in two layers each shall not be more than 5 mm thick	Over Bituminous Paint
3.	One layer, 5mm Acid, K-based Silicate Type mortar	#
4.	One layer, 40mm Acid resistant Brick lining	Over K-based Silicate

#:- K-based Silicate mortar should be buttered on all sides of acid-resistant brick except the side facing the surface to be exposed to corrosives

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17.0 CULVERT WORK

17.1 PIPE CULVERTS

17.1.1 Reinforced concrete pipes shall be provided between the drain pits of storm water drains to cross the roads. These pipes shall be non-pressure type conforming to IS: 458 and class as specified in the nomenclature of the item. The pipes shall be laid between the drain pits with a uniform slope and with proper bedding, if required, as per approved drawings. The reinforced concrete pipes shall be manufactured by centrifugal process. All pipes shall be true to shape, perfectly straight, sound and free from cracks. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

17.1.2 Reinforced concrete pipes shall be laid, jointed and tested as per IS: 783. Pipes shall be laid true to alignment and gradients over cement concrete bed of 1:2:4 mix and / or encased, if required, as per approved drawings or as directed by Engineer-in-Charge. No deviations from the lines, depths of cuttings or gradients shall be permitted without approval in writing by Engineer-in-Charge. The joint between concrete drain pit wall and concrete pipe shall be done properly to make it water-tight. The pipe joints shall be spigot and socket joint (rigid type) for pipes of 600 mm. diameter and below and collar joint (rigid type) for pipes over 600 mm. diameter. For both types of joints, the annular space shall be filled up with cement and sand mortar 1:2 mix which shall be rammed with caulking tools. After the day's work, any extraneous matter shall be removed from inside of the pipes. Joints shall be cured properly as per IS: 783. Reinforced concrete pipes shall be tested hydraulically as per IS: 783. Refilling of trenches shall not be commenced until the entire length of the pipe has been tested and approved. The excavation of earth in trenches for laying the concrete pipes and refilling shall be done as per IS: 783.

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17.2 BOX CULVERTS

17.2.1 The box-culverts are to be provided across the roads joining the storm water drains on both sides of the road. These box-culverts shall be of either complete reinforced cement concrete construction or brick masonry and reinforced cement concrete construction as specified in the schedule of items. The box-culvert construction shall be carried out as per the approved drawings.

18.0 TECHNICAL SPECIFICATION FOR WATER SUPPLY, DRAINAGE & SANITATION

18.1 SCOPE

a) The supply, laying and installation of pipes / open surface drains for draining off rain / surface water, fire water, sewage, plant effluent / blow down / floor washings etc., with all fittings and fixtures including jointing.

b) The supply, laying and installation of pipes for supply of water with all fittings and fixtures including jointing.

c) The supply and installation of sanitary fixtures like water closets, urinals, wash basins, sinks etc., with all fittings and fixtures.

d) The supply and installation of toilet accessories like mirrors, shelves, towel rails, liquid soap containers etc., with all fittings and fixtures.

e) The supply and installation of overhead water tanks with all fittings and fixtures.

f) The supply and construction of ancillary works like manholes, drop connections, gully chambers, oil traps, soak pits etc., with all fittings and fixtures.

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18.2 GENERAL REQUIREMENTS

18.2.1 The Contractor shall furnish all skilled and unskilled labour, plant, equipments, scaffolding, men, materials, etc., required for complete execution of the work in accordance with the drawings and as described herein and / or as directed by the Engineer.

18.2.2 The Contractor shall make his own arrangements for locating the coordinates and positions of all works and reduced levels (RL) at these locations based on two reference grid lines and one bench mark which will be furnished by the owner. The Contractor has to provide at site all the required survey instruments etc., to the satisfaction of the Engineer so that the work can be carried out accurately according to the specification and drawing.

18.2.3 The Contractor shall make good to the satisfaction of the Engineer all cuttings / damages resulting from his operations during the installation.

18.2.4 Only tentative Plant layout shall be furnished by the Owner. Detailed working drawings showing the layout, installation and other details will be prepared by the Contractor and got approved from the Engineer.

18.2.5 The Contractor shall dispose of all unserviceable materials at least 50 m away from the plant boundary, unless otherwise directed by the Engineer. All serviceable material shall be stacked within a lead of 500 m as directed by the Engineer.

18.2.6 In case of any contradiction between the provisions stipulated in this module of technical specification and those of other modules like Excavation and Filling, Cast-in-situ Concrete and Allied works etc., the former shall govern.

All works shall be carried out by qualified / licensed plumbers.

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18.3 CODES AND STANDARDS

18.3.1 All standards, specifications, acts, and Codes of practice referred to herein shall be the latest edition including all applicable official amendments and revisions.

18.3.2 In case of conflict between this specification and those (IS Standards, codes etc.)

18.3.3 Some of the relevant Indian Standards, Acts and Codes referred to herein are given below:

IS	:	458	:	Precast concrete pipes.
IS	:	554	:	Dimensions for pipe threads, where pressure tight joints are made on threads.
IS	:	651	:	Salt glazed stoneware pipes and fittings.
IS	:	771 (Part-1 to 7)	:	Glazed fire clay sanitary appliances.
IS	:	774	:	Flushing cisterns for water closets and urinals.
IS	:	775	:	Cast iron brackets and supports for wash basins and sinks.
IS	:	778	:	Copper alloy gate, globe and check valves for water works purposes.
IS	:	781	:	Cast copper alloy screw down bib taps and stop valves for water services.
IS	:	782	:	Caulking lead.
IS	:	783	:	Code of practice for laying of concrete pipes.
IS	:	805	:	Code of practice for use of steel in gravity water tanks.
IS	:	1172	:	Code of basic requirements for water supply, drainage and sanitation.
IS	:	1239	:	Mild steel tubes, tubular and other wrought steel fittings.

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IS	:	1536	:	Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage.
IS	:	1703	:	Copper alloy float valves.
IS	:	1726	:	Cast iron manhole covers and frames.
IS	:	1729	:	Sand cast iron spigot and socket, soil waste and ventilating pipes, fittings and accessories.
IS	:	1742	:	Code of practice for building drainage.
IS	:	1795	:	Pillar taps for water supply purposes.
IS	:	2065	:	Code of practice for water supply in buildings.
IS	:	2326	:	Automatic flushing cisterns for urinals.
IS	:	2501	:	Solid drawn copper tubes for general engineering purposes.
IS	:	2548	:	Plastic seats and covers for water closets.
IS	:	2692	:	Ferrules for water services.
IS	:	2963	:	Copper alloy waste fittings for wash basins and sinks.
IS	:	3311	:	Waste plug and its accessories for sinks and wash basins.
IS	:	3438	:	Silvered glass mirrors for general purposes.
IS	:	3486	:	Cast iron spigot and socket drain pipes.
IS	:	3989	:	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS	:	4111 (Part-1 to 5)	:	Code of practice for ancillary structure in sewerage system.
IS	:	4127	:	Code of practice for laying of glazed stone-ware pipes.
IS	:	4764	:	Tolerance limits for sewage effluent discharged into inland- surface waters.
IS	:	4827	:	Electro plated coatings of nickel and chromium on

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copper and copper alloys.

IS : 5219 : Cast copper alloys traps.

IS : 5329 : Code of practice for sanitary pipe work above ground for buildings.

IS : 5382 : Rubber sealing rings for gas mains, water mains and sewers.

IS : 5822 : Code of practice for laying of welded steel pipes for water supply.

IS : 6163 : Centrifugally cast (spun) iron low pressure pipes for water, gas and sewage.

IS : 7231 : Plastic flushing cisterns for water closets and urinals.

IS : 7740 : Code of practice for construction and maintenance of road gullies.

IS : 8931 : Copper alloy fancy single taps combination tap assembly and stop valves for water services.

IS : 8934 : Cast copper alloy fancy pillar taps for water services.

IS : 9762 : Polyethylene floats for float valves.

IS : 10446 : Glossary of terms for water supply and sanitation.

IS : 10592 : Industrial emergency showers, eye and face fountains and combination units.

IS : 12592 : Specification for precast concrete manhole covers and frames.

SP : 35 : Hand book on water supply and drainage.

18.4 MATERIAL

18.4.1 All pipes, fittings, fixtures, appliances and accessories shall conform to the relevant Indian Standards as listed under Clause No. 3.0. These shall be obtained from an approved reputed manufacturer, and shall be approved, the

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Engineer. Wherever indicated by the Engineer, the Contractor shall submit samples of materials. These may be retained by him for subsequent comparison when bulk supplies are received at site. Ultimate choice of type lies completely with the Engineer.

18.4.2 The material brought to the site shall be stored in a separate secured enclosure, away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and item found damaged shall not be retained at site.

18.4.3 Chromium plating fittings and appliances shall be of grade-2. (10 micron thickness), conforming to IS: 4827.

18.4.4 Pipes

Unless otherwise specified, following types of pipes shall be used:

For water supply to buildings, fittings CPVC pipes conforming to IS 15778 shall be used.

For inlet connecting pipes to appliances / fittings, C.P. brass pipe of 15 mm N.B. with union of approved make shall be used. Standard length of 300 mm to 450 mm pipe shall be used to suit the site requirements.

For building sanitary work above ground, UPVC pipes, fittings and accessories conforming to IS: 13592/relevant IS Codes shall be used. Pipes shall be coated with coal-tar by hot dipping process for both inner and outer surfaces.

Glazed stoneware pipes used for sewer and drain shall conform to Grade A of IS: 651.

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RCC pipe used for sewer and drain shall conform to IS: 458. Class NP2 pipe shall generally be used. However, for road or railway crossing higher class of pipe or concrete encashment shall be provided to take care of higher load.

For drain and sewer line work in bad or unstable ground condition and under building, centrifugally cast (Spun) iron pressure pipes conforming to IS: 1536 shall be used. Class LA pipe with spigot and socket ends shall be used. Pipes shall be coated with coal tar.

PVC rain water pipes shall be used for roof drainage.

18.4.5 Above Ground Level

a) Galvanised mild steel pipes for water supply

i) For work above ground level, the galvanised mild steel pipes and fittings shall run on the surface of the walls, ceiling or in chase as specified or shown on the drawing. The fixing shall be done by means of standard pattern holder bat clamps, provided at no more than 90 cm and keeping the pipes about 1.5 cm clear of the wall. To conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc. Provided there is sufficient space to work on the pipes with the common tools. The pipes shall not ordinarily be buried in walls or solid floors. Under unavoidable situations, pipes may be buried for short stretch after providing adequate protection against damage. Union joints shall be provided for all required locations to facilitate maintenance.

ii) Where directed by the Engineer, a M.S. tube sleeve shall be fixed at a place the pipe is passing through. In case the pipe is embedded, it should be painted with anti-corrosive bitumastic paints conforming to IS: 158. The pipes shall be oiled and rubbed over the white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, tee etc., with the pipe wrench. All pipes and fittings shall be properly jointed and made complete water tight. Burr from the joint shall be removed after screwing.

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iii) The pipes and fittings shall be checked under working pressure. Any joint found leaking, shall be rectified and all leaking pipes removed and replaced. The pipes and fittings shall be tested to a hydraulic pressure of 6 kg/sq.cm. All pipes used for water supply should be thoroughly and efficiently disinfected before being taken into use. The method of disinfection shall be subject to the approval of the Engineer.

iv) The storage tanks and downtake distribution pipes shall be disinfected together as specified under clause no. 13.2 of IS: 2065-1983, using disinfecting chemical.

b) UPVC pipe above ground for Buildings Sanitary work

i) For sanitary pipe work above ground for Buildings, 1S:5329 shall be followed for general guidance. Proper ventilation shall be provided in the piping system. The single stack system shall not generally be provided.

ii) Plain pipes shall be secured to the walls at all joints with M.S. holder bat clamps. The clamp shall be made from 1.6 mm thick M.S. sheet of 30 mm width, bent to the required shape and size so as to fit tightly on the socket of the pipe, when tightened with screw bolts. It shall be formed out of two semicircular pieces, hinged with 6 mm dia M.S. pin on one side and provided with flanged ends on the other side with holes to fit in the screw holt and nut, 40 mm long. The clamp shall be provided with a hook made out of 27.5 cm long, 10mm diameter M.S. bar, riveted to the ring at the centre of one semicircular piece. C.I. brackets can also be used. The clamps shall be fixed to the wall by embedding their hooks in cement concrete block 10 x 10 x 10 cm (1:2:4 mix) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25 mm clear of finished face of wall.

iii) All soil pipes shall be carried up above the roof and shall have sand PVC terminal guard. The pipes above parapet shall be secured to the wall by means of clamps.

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iv) The pipes shall be fixed perfectly vertical or to the lines as directed. The spigot of the upper pipes shall be properly fitted in the socket of the lower pipe such that here is a uniform annular space for filling with the jointing material. The interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully jointed using solvent as per recommendation of manufacturer.

v) Floor trap shall be 'Nahni' or ordinary type and shall conform to IS:1729. The floor shall be suitably lowered to accommodate the trap and the top of the floor shall be properly sloped towards the trap for effective drainage. A chromium plated/galvanised grating shall be provided on the trap. The sunken floor slab shall be filled with light weight materials like cinder mixed with cement. Sunken slab shall be made watertight by means of Sika water proofing compound as recommended by the manufacturer.

c) Rain Water Down comers

i) Rain water downcomers and fittings shall be standard PVC rainwater downcomers shall run along and be secured to walls, columns etc. Where desired by the Engineer, these may have to be installed in chases cut out in the structure. All pipes shall be well secured to the walls and supported by adequately strong brackets. The brackets may be wrought iron clevis type, lip-ring type or perforated strap iron type, as approved by the Engineer. Suitable spacer blocks shall be provided against the vertical surface on which the pipe is fixed.

ii) All bends and junctions shall be supplied with water tight cleaning eyes. For improving the aesthetic appearance of the portion of building carrying rain water downcomers, the pipes may have to be concealed by encasing them with brick masonry, concrete, etc.

iii) Galvanised M.S. pipes shall be joined by using standard sockets or by welding. For welding of pipes, IS:11906 shall be followed. After welding, the welded area

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shall be coated with zinc rich paint after proper cleaning and preparation of the surface. Joints between successive lengths of pipe can be by collars according to provision of IS:1742-1983. All rainwater downcomers shall be provided with roof drain head of the shape and type as shown on the drawing. Unless otherwise specified, dome type drain head shall be used.

d) Khurras

i) The khurras shall be constructed before the brick masonry work in parapet wall is taken up, and it shall be 45x45cm in size, unless otherwise specified and be formed of cement concrete 1 :2:4 (1 cement: 2 sand: 4 graded stone aggregate of 20 mm nominal size).

ii) A PVC sheet 1 mx1 mx400 micron shall be laid under khurras and then cement concrete shall be laid over it to a minimum thickness of 3cm with its top surface lower than the level of adjoining roof surface by not less than 50mm.

iii) The concrete shall be laid to a size greater than the stipulated size of khurra in such a way that the adjoining terracing of brick tile overlaps the concrete on its 3 edges by not less than 7.5 cm. The concrete shall slope uniformly from the edges to the rainwater outlet. The concrete shall be continued at the same slope through the width of the wall into outlet opening to ensure a water tight joint.

iv) The khurras and the sides of outlet shall then be rendered with 12 mm coat of cement plaster 1:3 (1 cement: 3 sand). This shall be done when the concrete is still green and shall be finished with a floating coat of neat cement. The sides of khurras and the sides of openings shall be well rounded. The size of finished outlet opening shall be 10cm wide by 20cm high or as directed by the Engineer.

v) Iron grating shall be provided at the outlet to prevent chocking. The grating shall be 20×25cm with an outer frame of 15mm x 3mm MS flat, to which 4 nos. -

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10mm dia MS bars shall be welded in vertical direction, keeping an equal clear spacing of 2.5cm.

e) Rainwater Spout

i) No spout shall be less than 80 mm in diameter. The spacing of spouts shall be arranged to suit the position of openings in the wall.

ii) The spouts shall be of PVC, 60 cm long. These shall be perfectly sound, free from cracks, imperfections of glazing etc. These must be straight, cylindrical and of Standard nominal diameter, length and depth of socket. Full length of pipes shall be used on the work. These must be salt glazed and shall generally conform to IS: 651.

iii) These shall be provided at the mouths of khurras and shall be fixed in cement mortar 1: 4 (1 cement: 4 sand) with the socket embedded in the masonry and the spigot end projecting outside. The masonry around the pipe and socket shall be thoroughly wetted and the hole shall be given a coat of cement mortar around. The pipe shall then be inserted and fixed with a surround of mortar. In case the hole is made much larger than the size of the pipe. Cement concrete 1: 2: 4l (1 cement: .2 sand: 4 graded. stone aggregate of 12.5 mm nominal size) shall be used to fill in the annular space. The spouts shall slope downward at a slope of 1 in 6. The projection outside the wall shall be uniform and not less than 40 cm. The entrance with the pipe shall be smoothly rounded to meet the internal bore of the pipe to facilitate easy flow. Care shall be taken to ensure that the vertical plane through the centre line of the spouts in a row shall be true to line.

18.4.6 below Ground Level:

a) Trenches and other Excavation:

i) Except as mentioned hereunder, all work for earthwork shall be done as specified in relevant chapter of Excavation and Filling. The trenches shall be so

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dug that the pipe may be laid to the required alignment and at required depth. The cover shall be measured from top soil or other surface of the ground. Turf, top soil or other surface material shall be set aside, turf being carefully removed and stacked for use in reinstatement. The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

ii) If the trench is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected earth and compacted so as to provide smooth bedding for the pipe.

iii) The last 7.5 cm. of excavation shall be trimmed and removed as separate operation immediately prior to the laying of the pipe on their foundations. The width of the trench shall be such as to provide not less than 20 cm clearance on either side of the pipe. Excavation in road shall be so arranged as to cause minimum obstruction to traffic.

b) Laying of Pipes:

In no case, pipes shall be rolled and dropped into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe and pushed to the distance that it can go.

The pipe shall be laid with socket facing the direction of flow of water. The connection to an existing sewer shall as far as possible be done at the manhole.

c) Filling of Trench

Filling of the trench shall not be commenced until the length of pipes therein has been tested and passed. Special care shall be taken to pack under and sides of

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the pipes thoroughly with selected material. At least 300 mm over the pipe shall also be filled with selected earth.

18.5 MANHOLES

18.5.1 Wherever applicable manhole should be suitably designed & constructed.

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SECTION VI– 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE-D

TECHNICAL SPECIFICATIONS

BORED CAST- IN- SITU CONCRETE PILES

(ES-2516)

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1.0 SCOPE

1.1 This specifications cover the installation of bored cast-in-situ reinforced concrete vertical piles. Installation of bored cast-in-situ concrete vertical piles shall also conform to IS: 2911 (Part-1/Section-2).

1.2 This specifications also covers the technical requirements for load test (Initial and Routine tests) on reinforced concrete single vertical piles of to assess their vertical, horizontal and pull-out load carrying capacity.

1.2.1 Load tests on piles shall conform to IS: 2911 (Part-4).

2.0 GENERAL REQUIREMENTS

2.1 The work shall include mobilization of all necessary equipments, providing necessary engineering supervision through qualified and technical personnel, skilled and unskilled labour, etc. as required to carry out the complete piling work, load tests and submission of records / reports as per schedule.

2.2 The Contractor shall guarantee the "Safe Load" capacity of piles for various modes i.e., vertical, lateral and pull-out loads for piles installed by him.

2.3 Consequent upon award of work and prior to installation of piles, the Contractor shall submit design of piles in terms of allowable capacity, length, diameter, termination criteria, reinforcement, etc. for Owner's/ Consultant's approval. Owner's/Consultant's approval on pile design in no way absolve the Contractor for his responsibility to carry out all the initial (vertical, lateral and pull-out) load test of piles prior to installation of the job piles. The pile capacity to be used in design shall be arrived at from the initial load test of piles.

2.4 The Contractor shall make his own arrangements for locating the co-ordinates and position of piles shown in approved drawings and for determining the Reduced Levels (R.L) of these locations with respect to the single bench mark indicated by the Engineer-in-Charge. Two established reference lines in mutually perpendicular direction shall be indicated to the Contractor. The Contractor shall provide at site all the required survey instruments to the satisfaction of the Engineer-in-Charge so that the work can be carried accurately according to specifications and drawings.

2.5 In case of working piles, if the pile rejected due to any reasons, attributable to contractor the Contractor shall install extra piles at no extra cost to the Owner / Consultant. Further, the extra cost due to the increase in the pile cap size, if any, on account of extra piles shall be borne by the bidder.

2.6 It is essential that all equipment and instruments are properly calibrated both at commencement and immediately after the tests so that they represent true values. Certificates to this effect from an approved institution shall be furnished to the Engineer-in-Charge. If the Engineer-in-Charge so desires the contractor shall

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arrange for having the instruments tested at an approved laboratory at his own cost and the test report shall be submitted to the Engineer-in-Charge. If the Engineer-in-Charge desires to witness such tests Contractor shall arrange to conduct the test in his presence.

2.7 The complete jacking system including the hydraulic jack, hydraulic pump and pressure gauge shall be calibrated as unit. The complete unit shall be calibrated over its complete range of travel for increasing and decreasing loads same as that of test loads. The calibration certificate shall be submitted to the Engineer-in-Charge.

2.8 The reaction load to be made available for the test shall be at least 25 % greater than the maximum jacking force. The reaction system as relevant shall be designed for the total reaction load. All reaction loads shall be stable and balanced during all operations of testing. During testing, stability of reaction system shall be ensured.

2.9 The load applied on the pile shall be measured by a calibrated pressure gauge mounted on the jack with a least count of not more than 10 % of the safe load.

2.10 The displacement of pile (In vertical, horizontal and uplift) shall be measured using dial gauges having a least count 0.01 mm.

2.11 Load test shall be conducted at pile cut off level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable dewatering methods.

2.11.1 In case of initial vertical load test where the water table level is higher than the COL Contractor may use reaction piles for testing purposes in each case. Engineer-in-Charge may at his discretion decide to rise the COL above water table.

2.12 Full details of the equipment proposed to be used and the test setup with detail sketches shall be submitted to the Engineer-in-Charge, before making arrangement to carry out the tests, for his approval. Approval of the Engineer shall also be obtained after the test set up is complete prior to commencement of loading.

2.13 All operations in connection with pile load test shall be carried out in a safe manner so as to prevent the exposure of people to hazard.

2.14 If any test has to be discontinued, which in the opinion of the Engineer-in-Charge interferes with the load test results, and he decides to abandon the test, the Contractor shall install another pile for the purpose and repeat the test after correcting the fault and the cost of all such operations, including the cost of test pile, shall be at the Contractor's expense.

2.15 After completion of piling work contractor shall submit four copies of the following documents for Owners record and future reference:

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a. Initial load test data for all tests done along with the pile data and the analysis of the initial test results.

b. Pile data along with concrete mix design detail (note pile data shall contain details as per requirement of Annexure- A).

c. Routine load test data for all tests done.

d. A full record giving all details of test in the Performa shown in Annexure- B shall be submitted in triplicate to the engineer immediately on completion of each test. The record shall also include the plots of:

   i. Load VS. Settlement

   ii. Time VS. Settlement (for each increment of load)

   iii. Characteristic of the piles and the interpretation of the pile load test curve as per the criteria for safe loads as mentioned in the specification.

2.16 Before commencement of the work, the Contractor shall submit Quality Assurance Plan to the Owner/Consultant for their approval.

3.0 CODES AND STANDARDS

3.1 All standards and codes of practice referred to herein shall be the latest editions including all applicable Amendments issued.

3.2 All works shall be carried out as per the relevant Indian Standard Codes. In case of conflict between the specification and the IS codes referred to herein, the former shall prevail. Some of the applicable Indian Standards and codes are referred to here below:

IS: 432(Part I&II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS: 456	Code of Practice for plain and reinforced concrete.
IS: 1786	Code of practice for twisted steel high strength deformed bars for concrete reinforcement.
IS: 2911(Pr-I&II)	Code of practice for design and construction of pile foundations- Bored cast-in-situ concrete pile.
IS: 2911(Part-IV)	Code of practice for design and construction of pile foundation Load test on piles.
SP-34	Handbook on concrete reinforcement and detailing
IS: 5121	Safety code for piling and other deep foundations.
IS: 10262	Recommended guidelines for concrete mix design.
IS: 12330	Code of practice for Sulphate resistant Cement

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4.0 MATERIALS

4.1 GENERAL

All materials vise cement, steel, aggregates, water etc., which are to be used for pile construction shall conform relevant IS codes specifications for properties, storage and handling of common building materials. However, aggregates more than 20 mm shall not be used.

5.0 CONCRETE

5.1 Enclosed Technical Specifications for cast-in-situ concrete and allied works along with IS: 2911 Part I/Sec.2 - Code of Practice for Design and construction of pile foundations (Bored cast-in-situ concrete pile) shall be applicable to concrete works for piles. Use of plasticizer to control the water cement ratio shall be permitted on specific approval from Engineer-in-Charge.

5.2 GRADE AND MINIMUM CEMENT CONTENT

5.2.1 Design Mix of Concrete grade M-30 shall be used with OPC/PSC cement (Grade-53); the cement content shall be as per mix design conforming to IS: 10262. However, the minimum cement content shall be 400 Kg, per cubic metre of concrete. In case of piles subsequently exposed to free water or in case of piles where concreting is done under water or drilling mud using methods other than the tremie, 10 percent extra cement over that required for the design grade of concrete at the specified slump shall be used subject to minimum quantities of cement specified above.

5.2.2 For the concrete, water and aggregates specifications laid down in IS: 456 shall be followed in general. Natural rounded shingle of appropriate size may also be used as coarse aggregate. It helps to give high slump with less water cement ratio.

5.3 SLUMP OF CONCRETE

The slump of concrete shall vary between 150 mm to 180 mm for concreting in water- free unlined boreholes. For concreting by tremie, a slump of 150 mm to 200 mm shall be used.

6.0 REINFORCEMENT

6.1 The minimum area of longitudinal reinforcements shall be 0.4 percent of the sectional area calculated on the basis of outside area of casing or the pile shaft where casing is not used, whichever is more. The minimum number of longitudinal reinforcement shall be six(6) and its minimum diameter shall be 12 mm. The

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stipulated minimum reinforcement shall be provided for the full length of pile. Adequate reinforcement shall be provided to take full uplift loads.

6.2 The longitudinal reinforcement shall project up to development length as per requirements laid in IS: 456 in terms of multiple of bar diameter above cut off level unless otherwise indicated.

6.3 The minimum diameter of the links or spirals bar shall be 8 mm and the spacing of the links or spiral shall not be less than 150 mm. The laterals shall be lied to the longitudinal reinforcement to maintain its shape and spacing.

6.4 Reinforcement cage shall be sufficiently rigid to withstand handling and installation without any deformation and damage. As far as possible number of joints (laps) in longitudinal reinforcement shall be minimum. In case the reinforcement cage is made up of more than one segment these shall preferably be assembled before lowering into casing tube/pilebore by providing necessary laps as per IS: 456.

6.5 Laps shall be staggered as far as practicable and not more than 50% bars shall be lapped at a particular section. Lap joints shall be staggered by at least 1.3 times the lapped length (Centre to Centre).

6.6 Proper cover and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers cast specifically for the purpose.

6.7 Minimum clear cover to all main reinforcements in piles shall not be less than 50 mm unless otherwise specified.

7.0 PILE INSTALLATION

Installation of piles shall be carried out as per pile layout drawings, installation criteria and the direction of the Engineer-in-Charge.

7.1 EQUIPMENT AND ACCESSORIES

7.1.1 The equipment accessories for installation of bored cast-in-situ piles shall be selected giving due consideration to the sub-soil conditions, ground water conditions and the method of casting etc. These shall be of standard type and shall have the approval of the Engineer-in-Charge.

7.1.2 List of details of equipment and accessories proposed to be used for the job shall be submitted along with the bid.

7.1.3 The capacity of the rig shall be adequate so as to reach the specified founding level.

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7.2 CONTROL OF POSITION AND ALIGNMENT

7.2.1 Piles shall be installed as accurately vertical as possible. The permissible limits for deviation with respect to position and alignment (inclination) shall conform to IS: 2911 (Part-1/Sec.-2), which is reproduced below for ready reference.

a. The maximum deviation of vertical piles shall not exceed 1.5 per cent in alignment.

b. Piles shall not deviate more than 75 mm or D/10 whichever is more from their designed position at cut off level.

In case of piles deviating beyond these limits, the piles shall be replaced or supplemented by one or more additional piles without any extra cost to the Owner.

7.3. BORING

7.3.1 Boring operations shall be done by rotary or percussion type drilling rigs using direct, reverse mud circulation (DMC or RMC) methods or grab method. In soft clays and loose sands, bailer method, if used, shall be used with caution to avoid the effect of suction. Boring operations by any of the above methods shall be done using drilling mud.

7.3.2 The Contractor shall satisfy himself about the suitability of the method to be adopted for site. If DMC or RMC is used bentonite slurry shall be pumped through drill rods by means of high pressure pumps. The cutting tool shall have suitable ports for the bentonite slurry to flow out at high pressure. If on mobilization, the Contractor fails to make a proper bore for any reason, the Contractor has to switchover to other boring methods as approved by the Engineer-in-Charge at no extra cost to the Owner.

7.3.3 Working level shall be above the cut off level. After the initial boring of about 1.0 to 2.0 m temporary guide casing shall be lowered in the pile bore. The diameter of guide casing shall be of such diameter to give the necessary finished diameter of concrete pile. The centre line of guide casing shall be checked before continuing further boring. Guide casing shall be minimum 1.0 m length. Additional length of casing may be used depending on the condition of strata, ground water level etc.

7.3.4 Use of drilling mud (bentonite suspension/slurry) for stabilizing the sides of the pile bore is necessary wherever is likely to collapse in the pile bore. Drilling mud to be used shall meet the following requirement.

a) Liquid limit of bentonite when tested in accordance with IS: 2720(Part-V) shall be more than 300 percent and less than 450 percent.

b) Sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of

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soil in which the pile is to be cast. However the density of bentonite suspension after mixing with deleterious materials in the pile bore may be up to 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540 percent.

f) The pH value of the bentonite suspension shall be between 9 and 11.5

7.3.5 The bentonite slurry and the cuttings, which are carried to the surface by the rising flow of slurry shall pass through setting tanks of adequate size to remove the sand and spoils from the slurry, before the slurry is re-circulated to the boring. The bentonite slurry mixing and recirculation plant shall be suitably designed and installed.

7.3.6 The bentonite slurry shall be maintained at 1.5 m above the ground water level during boring operations and till the pile is concreted. When DMC and RMC method is used the bentonite slurry shall be under constant circulation till start of concreting.

7.3.7 The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm. However, the pile bore shall be of the specified size.

7.3.8 Socketing shall be done as per Geo-technical Report/ pile design requirement point of view wherever required.

7.4. CHISELING

7.4.1 Chiseling may be restored to with the permission of the Engineer-in-Charge below the socketing horizon. The chiseling tool or bit shall be of adequate size and weight so as to reach the desire depth.

7.5 LENGTH OF PILE

The length of pile below cut off level shall be as per pile drawing.

7.6 CLEANING OF PILE BORE

7.6.1 After completion of the pile bore up to the required depth, the bottom of the pile bore shall be thoroughly cleaned. Cleaning shall ensure that the pile bore is completely free from sludge /bored material, debris of rock/boulder etc. Necessary checks shall be made for pile bore as described in the subsequent clauses to confirm the thorough cleaning of the pile bore.

7.6.2 Pile bore shall be cleaned by fresh drilling mud through tremie pipe before start of concreting and after placing reinforcement.

7.6.3 Pile bore spoil along with used drilling mud shall be disposed off from site as directed by the Engineer-in-Charge.

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7.7 ADJACENT STRUCTURES

7.7.1 When working near existing structures care shall be taken to avoid any damage to such structures.

7.8 CONCRETING

7.8.1 Concreting shall not be done until the Engineer-in-Charge is satisfied that the pile termination level is reached and the pile bore is cleaned properly and thoroughly.

7.8.2 The time interval between the completion of boring and placing of concrete shall not exceed 6 hrs. In case the time interval exceeds 6 hrs. the pilebore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the proposed depth, and clean the pilebore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

7.8.3 Pile bore bottom shall be thoroughly cleaned to make it free from sludge or any foreign matter before and after placing the reinforcement cage.

7.8.4 Proper placement of the reinforcement cage to its full length shall be ensured before concreting.

7.8.5 Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS: 2911(Part-1/Sec.2). Drilling mud shall be maintained sufficiently above the ground water level.

7.8.6 Concreting operations shall not proceed if the contaminated drilling mud at the bottom of the pile bore posses density more than 1.25 T/Cu.m. or sand content more than 7%. The drilling mud sample shall be collected from the bottom of pilebore as mentioned in subsequent clause.

7.8.7 Consistency of the drilling mud suspension shall be controlled throughout concreting operations in order to keep the bore stabilized as well as to prevent concrete getting mixed up with the thicker suspension of the mud.

7.8.8 It shall be ensured that volume of concrete poured is at least equal to the theoretically computed volume of pile shaft being cast.

7.8.9 The temporary guide casing shall be withdrawn cautiously after concreting is done up to the required level. While withdrawing the casing concrete shall not be disturbed.

7.9 CUT OFF LEVEL (COL)

7.9.1 Cut off level of piles shall be as indicated in drawings released for construction or as indicated by the Engineer-in-Charge.

7.9.2 The top of concrete in pile shall be brought above the COL to remove all laitance and weak concrete and to ensure good concrete at COL for proper embedment in to pile cap.

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7.9.3 Concrete shall be cast upto Ground level, to permit overflow of concrete for visual inspection.

7.9.4 In the circumstance where COL is below ground water level, the need to maintain a pressure on the unset concrete equal to or greater than water pressure shall be observed and accordingly length of extra concrete above COL shall be determined by the Contractor with prior approval of Engineer-in-Charge.

7.10 SEQUENCE OF PILING

7.10.1 Each pile shall be identified with a reference number.

7.10.2 The convenience of installation may be taken into account while scheduling the sequence of piling in a group. This scheduling shall avoid piles being bored close to other recently constructed piles.

7.11 REJECTION AND REPLACEMENT OF DEFECTIVE PILES

7.11.1 The Engineer-in-Charge reserves the right to reject any pile which in his opinion is defective on account of load capacity structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer-in-Charge, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles as per the directions of the Engineer-in-Charge, at no extra cost to the Owner.

7.12 RECORDING OF PILING DATA

7.12.1 The Contractor shall record all the information during installation of piles. Typical data sheet for recording pile data shall be as indicated in ANNEXURE- A of this document and the Pile Load Test Data shall also be recorded as per the details indicated in Annexure- B of this document. On completion of each pile installation, pile record in triplicate shall be submitted to Engineer-in-Charge within two days of completion of concreting of the pile.

8.0 SAMPLING, TESTING, AND QUALITY ASSURANCE

8.1 Facilities required for sampling and testing materials, concrete, etc. in field and in laboratories shall be provided by the contractor. The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and this specification. Where no specific testing procedure is mentioned the test should be carried out as per the prevalent accepted engineering practice to the direction of Engineer-in-Charge. Test shall be done in presence of engineer of the engineer or his authorized representative. In case the Engineer requires additional tests, the contractor shall arrange to get these tests done and submit to the Engineer the test results in triplicate within three days after completion of any test.

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8.2 RECORDS

The contractor shall maintain records of all inspection and testing, which shall be made available to the Engineer. The Engineer at his discretion may waive some of the stipulations for small and unimportant concreting operations and other works.

8.3 UNSUITABLE MATERIALS

Materials found unsuitable for acceptance shall be removed and replaced by the contractor. The work shall be redone as per specification requirements and to the satisfaction of the Engineer at no extra cost to the Owner.

8.4 QUALITY ASSURANCE PROGRAM

8.4.1 The Contractor shall submit and finalize a detailed Field Quality Assurance program within 30 days from the date of award of contract, according to the requirements of this specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/ experienced manpower, preparation of field quality plan, etc. On finalized field quality plan, the Owner shall identify, customer hold points, beyond which the work shall not proceed without written approval from the Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated / corrected by the qualified persons as frequently as possible to give accurate testing results.

8.4.2 Frequency of sampling and testing, etc. and acceptance Criteria are given in Table- 1. The testing shall be done at field laboratory or any other laboratory approved by the Engineer-in-Charge. However, the testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. The materials shall be tested to all the specified requirements as per relevant IS codes before acceptance at manufacturers premises or at independent Government laboratory. Tests indicated in the Table- 1 are for cross checking at site the conformity of the materials to some of the specifications.

8.5 TESTING OF CONCRETE

8.5.1 Concrete and other materials shall be tested for quality and strength and other properties as per relevant IS codes.

8.5.2 One sample consisting of six test cubes shall be made from the concrete used in each test pile, three to be tested after 7 days and three after 28 days.

8.5.3 For working piles, minimum one sample consisting of six test cubes shall be made from the concrete for the first ten piles, three to be tested after 7 days and three after 28 days. Thereafter minimum one sample consisting of there test cubes for every 25 piles shall be tested for the 28 day cube strength.

8.5.4 In preparation of test cubes/specimens vibrators shall not be used.

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8.5.5 Concrete shall be tested for slump at every one hour interval.

8.5.6 Other materials like aggregates, reinforcement, etc., shall be tested as per relevant IS codes.

8.6 TESTING FOR POSITION AND ALIGNMENT

8.6.1 Each pile shall be checked for its position with respect to specified location. Each pile bore shall be checked for its alignment.

8.6.2 Permissible limits for deviation shall be as specified elsewhere in this section of specification.

8.7. PROPERTIES OF DRILLING MUD

8.7.1 Properties of drilling mud shall be checked as per the requirements specified in clause no. 7.03.4 of this specification. Prior to use in piling work and there after minimum once in a week or as found necessary by the Engineer one sample consisting of 3 specimens shall be tested.

8.7.2 Density and sand content of the drilling mud shall be checked at least in each pile for first 10- piles before concreting. In case of satisfactory results the frequency of sampling shall not be less than one in 25 piles.

8.8 CHECK FOR PILE BORE

8.8.1 On completion of boring and cleaning the bottom of each pile bore shall be checked by the methods as approved by the Engineer-in-Charge to ensure that it is free from pile bore spoil/debris and any other loose material, before concreting shall be done only after the approval of the Engineer-in-Charge.

8.8.2 For sampling of drilling mud from the pile bore the following method or any other suitable method shall be adopted.

A solid cone shall be lowered by a string to the bottom of pile bore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimize the leakage while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.

9.0 LOAD TEST ON PILES

9.1 TYPE OF TESTS

9.1.1 The Contractor shall carry out two categories of load tests i.e. Initial Load and Routine Load Tests in accordance with IS: 2911 (Part-4).

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9.1.2 Initial load test shall be conducted to assess the safe load carrying capacity of pile before start of installation of working piles. This shall include the following type of tests:

a. Cyclic compression load test to assess safe vertical load capacity.

b. Lateral load test to assess safe horizontal load capacity.

c. Tension load test to assess safe pull out load capacity.

9.1.3 The minimum number of Initial Load Test for each diameter of pile proposed shall be as under:

a. Vertical Compression : 2 No.

b. Lateral : 2 No.

c. Uplift /pullout : 1 No

9.1.4 Routine load tests of piles as per IS: 2911 (Part-4) shall be conducted to verify the load capacity of working piles. This shall include the following types:

a. Direct Compression load test for vertical load capacity.

b. Lateral load test for horizontal load capacity.

9.1.5 The minimum number of routine load test for each diameter and type shall be 1.5 percent of the total number of working piles. The number of tests may be increased up to 2 percent as decided by the Engineer -in-Charge in a particular case depending upon nature, type of structure and strata condition.

9.2 TEST PILE

9.2.1 The test piles for routine load test shall be identified by the Engineer-in-Charge.

9.2.2 A minimum time period of four weeks shall be allowed between the time of pile casting and testing Test pile head shall be prepared for testing purposes only one week after casting the pile.

9.2.3 The test piles shall be cut off at the proper level and provided with a proper cap so as to provide a plane bearing surface for the test plate and for proper arrangements for seating of the jack and dial gauges.

9.3 VERTICAL LOAD TEST

9.3.1 EQUIPMENT AND TEST SET UP

a) A steel plate of sufficient thickness not less than 50 mm shall be centred on the pile head to prevent it from crushing under applied load. The size of the plate shall neither be less than the pile size nor less than the area covered by the base of the hydraulic jack(s).

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b) The datum bars shall be supported on immovable supports preferably of concrete pillars or steel sections placed sufficiently far away from the test pile. The distance shall not be less than 3 times the diameter of test pile and in no case less than 2 metres from the edge of test pile. These supports shall be placed at a sufficient depth below ground to be unaffected by ground movements.

9.3.2 LOADING SYSTEM

The test load on the pile shall be applied in one of the following ways as approved by the Engineer-in-Charge.

a) By means of hydraulic jack(s) which obtain reaction from kentledge heavier than the required test load. While using this method care shall be taken to ensure that the centre of gravity of kentledge heavier than the required test load. While using this method care shall be taken to ensure that the centre of gravity of kentledgte is one the axis of the pile. The load applied by the jack(s) shall also be coaxial with the pile. The nearest edge of the crib supporting the kentledge stack shall not be closer than 1.5 metre to the edge of the test pile.

b) By means of hydraulic jack(s) which obtained reaction from anchor piles or/and suitable loading frame. While using this method all anchor piles shall be at a centre to centre distance of at least three times the test pile shaft diameter from the test pile and in no case less than 2 metres. Care shall be exercised to ensure that the datum bar supports are not affected by heaving up of the soil.

c) By means of hydraulic jack(s) which obtain reaction from suitable rock anchors. When this method is adopted, the anchor transferring the load to the ground shall not be closer than two times the test pile shaft diameter to the test pile and in no case less than 1.5 m.

d) By means of combination of kentledge, anchor pile, rock anchors.

9.3.3 MEASURING SYSTEM

Settlement of the pile shall be recorded by four dial gauges placed at diametrically opposite locations and suspended from the datum bar around the pile.

9.3.4 TEST PROCEDURE

The test shall be carried out by the Direct Loading Method in successive increments for routine load test and by the Cyclic Loading Method for initial load test as detailed below and as directed by the Engineer-in-Charge

a. DIRECT LOADING METHOD

The test shall be carried out as per the procedure outlined below:

i. The load shall be applied to the pile top in increments (steps) of about 20% of the rated capacity of the pile or as directed by Engineer. Each increment of load shall be applied as smoothly and expeditiously as possible. Settlement reading

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shall be taken before and immediately after the application of next increment and at 15, 30 minutes and thereafter at every half hour until application of the next load increment.

ii. Each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm/hr. or until two hours have elapsed whichever is earlier.

iii. The rate of movement of pile shall not be permitted to be extrapolated from period of test less than one hour.

iv. Loading on pile shall be continued till one of the following takes place:

v. In case of initial load test, applied load reaches three times the assumed safe load or the settlement of pile exceeds a value of 10 per cent of bulb diameter incase of under-reamed pile.

vi. In case of Routine load test, applied load reaches one and half time the safe load or the maximum settlement of test loading in position attains 12 mm.

vii. Where yielding of the soil does not occur, the full test load shall be maintained on the pile head for a minimum period of 24 hrs. after the last increment of load and settlement shall be recorded at 6 hours interval during this period.

viii. Unloading shall be carried out in the same steps as loading. A minimum period of 30 minutes shall be allowed to elapse between two successive stages of load decrement. The final rebound shall be recorded 6 hours after the entire test load has been removed.

b. CYCLIC LOADING TEST

The test shall be carried out to find out separately skin friction and point bearing capacity of single pile. However, this test is not applicable for under reamed piles. The test procedure shall be as given below:

i. In general this test shall be conducted on similar lines as mentioned in Direct Loading Method. In addition, alternate loading and unloading up to zero load shall be done in steps at each stage of loading. The load increment/decrement for each steps shall be 20% of the rated capacity. The readings of all the dial gauges shall be recorded at the end of each step and the total and net settlement for each stage shall be calculated.

ii. For each stage, the loading of each steps shall be maintained for 15 minutes before reaching the maximum load. The maximum load for each stage shall be maintained for one hour. The full test load shall be maintained on the pile head for 24 hours.

iii. Each step of unloading shall be maintained for 15 minutes and the subsequent rebound in the pile shall be measured accurately.

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iv. A period of 15 minutes shall be allowed to pass between the successive unloading and loading operations.

v. To find out separately skin friction and point bearing capacity of pile the procedure as given in Appendix- A of IS: 2911(Part-4) shall be followed.

9.3.5 ASSESSMENT OF SAFE LOAD

The safe vertical load on single pile from the load test shall be the least of following values:

a. 2/3 of the load at which the total settlement attains a value of 12 mm unless otherwise specified in tender documents.

b. 50% of the final load at which the total settlement equals 10 percent of the pile diameter in case of uniform diameter piles

9.4 HORIZONTAL LOAD TEST

9.4.1 EQUIPMENT AND TEST SET UP

a. The test plate shall be set in high strength grout to provide full bearing against the projected areas of the pile. The size of the test plate shall be adequate to accommodate the spherical bearing and transfer the load to the pile.

b. Sufficient clearance shall be allowed between the test pile and the datum bar for the anticipated lateral movement of the pile when datum bar (for fixing the dial gauge) is located on the opposite side to the point of load application.

9.4.2 LOADING SYSTEM

a. Loading shall be applied by a hydraulic jack of adequate capacity equipped with spherical bearing at the top of ram and bearing plate at the bottom side, abutting the pile horizontally and reacting against a suitable system.

b. The reaction may be provided by the wall of the excavated pit when the test is being conducted below ground level or by a neighboring pile, in which case thrust pieces shall be inserted on their end of the jack to make up the gap as approved by the Engineer.

c. Load shall be applied on the pile at or approximately at cut of level (COL).

9.4.3 MEASURING SYSTEM

a) The deflection shall be measured at a point diametrically opposite to the point of load application. In case such a measurements is not possible, the deflection shall be recorded using at least 2 dial gauges kept at a spacing of 30 cm. at a suitable height and the displacement interpolated at load point from similar triangles.

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b) Deflection of the pile at the level of load application shall be measured by dial gauge fixed to datum bar. The datum bar shall rest on immoveable supports as described elsewhere in this specification.

9.4.4 TEST PROCEDURE

a) The test procedure shall be similar to that for vertical load test.

b) Loading on the pile shall be continued till one of the following takes place:

i. In case of Initial load test applied load reaches thrice the assumed safe lateral load capacity of deflection of pile at the loading point exceeds.

ii. In case of Routine load test, applied load reaches one and half times the assumed safe load capacity or a deflection at the loading point exceeds 5 mm

9.4.5 ASSESSMENT OF SAFE LOAD

a) The safe lateral load of single pile shall be the least of following:

i. 50 % of the load for which the total deflection is 12 mm.

ii. Load corresponding to 5 mm total deflection.

iii. Load corresponding to any other specified displacement as per performance requirement.

b) Pile groups shall be tested under conditions as per actual use in the structure as far as possible.

However, for routine test (i) above is not applicable.

NOTE: The deflection of pile is at the cut off level of the pile.

9.5 PULL OUT TEST

9.5.1 EQUIPMENTS AND TEST SET UP

a. Uplift force may be applied by means of hydraulic jack(s) using a suitable pullout set up as approved by the Engineer.

9.5.2 LOADING SYSTEM

a. Load shall be applied along the longitudinal axis of the pile using an approved reaction system. Uplift forces on the pile may be applied directly to the test pile or through a lever system.

b. The reaction may be provided by neighboring piles or blocks constructed for this purpose.

c. The reaction supports/blocks/piles shall be at least 2.5 times the test pile diameter.

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9.5.3 MEASURING SYSTEM

a. Displacement of the pile shall be recorded using two dial gauges placed at diametrically opposite locations ad suspended from the datum bar around the pile. Datum bar shall be provided with immoveable supports as described elsewhere in this specification.

9.5.4 TEST PROCEDURE

a) The test procedure shall be similar to that for vertical load test.

b) The loading on pile shall be continued till one of the following takes place.

i. The loading on pile top equals three times the estimated safe load.

ii. The load- displacement curves shows a clear break (downward trend).

9.5.5 ASSESSMENT OF SAFE LOAD

a) The safe load of the pile shall be the least of the followings:

i. Two third of the load at which the total displacement is 12 mm.

ii. 50% of the load at which the load displacement curve shows a clear break (down work trend).

10.0 RECORDING OF DATA & PRESENTATION

10.1 The pile test data essentially concerns three variables, namely, load, displacement and time. These are to be recorded sequentially for the tests under consideration and shall be recorded in a suitable tabular form along with the information about the pile as per Annexure-A & B and Table-1 of this document.

10.2 The data may be suitably presented by curves drawn between the variables and safe loads shown on the graphs. Load displacement curve should be an assential part of presentation.

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A N N E X U R E - A

P I L E D A T A

1. Reference No. Location(Co-ordinates) _____Area.
2. Sequence of Piling
3. Pile diameter & Type
4. Working Level (Platform level)
5. Cut Off Level (COL)
6. Actual Length Below COL
7. Pile Termination Level
8. Top Of Finished Concrete Level
9. Date and Time of Start and Completion of Boring
10. Depth of Ground Water Table in the Vicinity
11. Type Of Soil at pile tip
12. Method of Boring Operation
13. Details of Drilling mud as used:
    a. Freshly Supplied Mud, Liquid Limit, Sand Content, Density, Marsh Viscosity, Swelling Index, pH value.
    b. Contaminated Mud Density, Sand Content.
14. SPT (N) values in soil (from the nearest bore hole) UCS value in rock (from the nearest bore hole)
15. Chiseling, if any From..... M. To..... M.
16. Date and Time of Start and Completion of concreting.
17. Method of placing concrete.
18. Concrete Quantity:

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Actual

Theoretical

19. Ref. Number of Test Cubes

20. Grade and Slump of concrete

21. Results of Test Cubes

22. Reinforcement Details:

Main Reinforcement	Stirrups: Type
No.:_____	No.:_____
Dia.:_____	Dia.:_____
Depth:_____	Depth:_____

23. Any other information regarding obstructions, delay and other interruption to the sequence of work

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ANNEXURE- B

PILE LOAD TEST : VERTICAL / HORIZONTAL / UPLIFT

Type of Equipment and method of boring	Plan of Test arrangement showing position and distance of Kentiledge, Supports, tension or compression piles and reference frame to test pile, etc.
Date of Cast	Commencement of Test Completion of Test Capacity of Jack Jack Constant Weight of Kentiledge Reaction pile details
Pile No.	Type of Pile Diameter Capacity Type of Test Initial /routine Loading Method Direct / Cyclic

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Rebound	
Net(mm)	
Average Settlement	
Dial Gauge Reading	
Load MT	
Pressure Gauge	
Time	
Date	

Submission of Test Results

i , Time vs. Settlement.

ii , Load vs. Settlement Indicating the Safe Load.

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TABLE-1: FREQUENCY OF SAMPLING AND TESTING

Sl.No.		Type of Material / Work	Nature of Test / Characteristics	Method of Test	No. of Samples & Frequency of Test	Acceptance Criteria
1		Pilebore size		Physical measurement`	Each Pile	Diameter as per drawing. Length as established by initial load test.
	a.	Diameter				
	b.	Length				
2		Bentonite (Mud)				
		properties				
	a.	Basic properties of Bentonite before use.	Liquid Limit, Marsh viscosity, Specific gravity, Sand content, Swelling index, pH value.	In Laboratory	Minimum one sample consisting of 3 specimen once in a week.	As per clause No. 7.03.4.
	b.	Contaminated mud from pile bore bottom before concreting	Density, Sand content	In Laboratory	In each pile for first 10 piles before concreting. In case of satisfactory results, the frequency of sampling may be reduced to one in 25 piles.	i). Density shall not be more than 1.25 Te/Cu.M. ii). Sand content shall not be more than 7%.
3		Position and Alignment		Physical or any approved method.	Each Pile.	As per specification.
4		Cleaning of pilebore	As per Cl.No. 8.08.0	Each	Pilebore should be free from bored material	

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SECTION VI – 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE-E: QUALITY ASSURANCE PLAN

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QUALITY ASSURANCE PLAN

SL NO.	MATERIAL/ OPERATION	NAME OF TEST	FIELD/ LAB.	TEST PROCEDURE	FREQUENCY OF CHECKING	EXTENT OF CHECKING	REFERENCE DOCUMENT
1.	Earthwork in excavation	Lines, levels & depth	Field	Measurement	As per decision of site engr.	100%	Specn. & approved drg.
2.	**Concrete work**						Test will be carried out while establishing mix. design
	a) Coarse aggregate	i) % of soft or deleterious materials	Lab.	As per IS 2386 Part IX,1963	Once for each source/supply & shall be repeated in case source is changed	-do-	Specn.& IS 2386 (Pt.IX) & IS-383
		ii) Particle size distribution	Lab/ Field	As per IS 2386 (Pt.I)	-do-	-do-	IS 383, Specn.
		iii) Specific Gravity	Lab	IS:2386 Part III, IS:456, IS:383	Once in 12 weeks or change of source whichever is earlier	-do-	IS:2386 Part III, IS:456, IS:383
	b) Fine aggregate	i) Silt content	Lab	Appendix -D of CPWD Specn.Vol.I	-do-	-do-	CPWD Specn.
		ii) Particle size distribution	Lab./Field	IS 383	-do-	-do-	Specn. & IS 383
	c) Cement	i) Physical properties	Lab	As per IS 269 & 4031	-do-	-do-	IS 269,1489,4031 & test certificate
		ii) Chemical properties	-do-	As per IS 4032	-do-	-do-	IS 4032 & test certificate
	d) Reinforcing bars						
	i) Deformed bars	Physical properties & dimensions	Field /Lab	As per IS 1139	-do-	-do-	IS 1139& test certificate
	ii) Cold twisted bars	-do-	-do-	As per IS 1786	-do-	-do-	IS 1786& test certificate
	iii) Hard Drawn Steel Wire Fabric	-do-	-do-	As per IS 1566	-do-	-do-	IS 1566& test certificate

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	iv) TMT bars	-do-	-do-	As per IS 1786	-do-	-do-	IS 1786& test certificate
	v) Placement, laps, hooks, spacers etc.	Physical	Field	As per IS 456	ALL	-do-	IS 456 & approved drawings
	e) Water	Chemical test	-do-	As per IS 3025-64	Single Test	-do-	IS 3025-1964
	f) Tests for concrete	i) Slump test	Field	As per IS 1199	For each batch of concreting	-do-	CPWD Specn. & IS 1199
		ii) Cube test at 7/28 days	Field/Lab.	As per IS 516	No. of cubes to be decided as per given in IS 456/ Specn.	-do-	IS 456,IS 516
	g) Shuttering / Formwork Checking of levels, dimensions, unevenness, joints, cleanliness, oiling etc.	Physical	Field	Measurement	All	-do-	As per drawing, CPWD specifications & instruction of E.I.C
3.	**Brick Work/Hollow Concrete Block/ Cement Concrete Block work**						
	a) Brick/ Hollow Concrete Block / CC Block work	i) Physical properties & crushing strength	Field/Lab.	As specified in Specn & IS 1077	Once for each source	100%	Specn. / IS 1077
	b) Mortar	Uniformity in mix	Field	As specified in IS 2250	As & when required	-do-	IS 2250
4.	**Steel works using tubular, angles, plates, channels etc.**						
	i) Structural steel & plates	Dimension, manufacturers, Specn. test certilficates	Lab.	IS:226 & 2062	Once for each source/supply	100%	IS Codes & test certificates
	ii) Welding electrodes	-do-	-do-	IS:814 & 815	-do-	-do-	-do-
	iii) Welding	Quality of weld, weld reinforcement, contour etc.	Field	Visual	As per discretion of site engr.	-do-	IS: 823
	iv) Painting on steel	Cleaning off rust dirt,	-do-	IS:123	-do-	-do-	IS Code, Relevant

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	works (synthetic enamel paint over 3 coats red oxide coat zinc primer)	grease etc. of coats.		1962			Specn.
5.	Providing & laying water proofing on roof	Thickness, slope etc.	-do-	As per Specn. & IS 2115	-do-	-do-	-do-
6.	**Flooring**						
	i) Cement concrete floor	Physical	Field	As per IS 1443	All	-do-	IS 1443
	i) Glazed tiles	Physical	Field	As per IS 13630	All	-do-	IS 13630 & Manufacturer's certificate
7	Pre-coated G.I sheet roofing laying & fixing.	Physical	-do-	As per IS 277 & 513	Once for each source/supply	-do-	IS code, spec. & Manufacturer's certificate
8.	Gypsum board false ceiling/ Prima board Armstrong false ceiling	Physical	-do-	IS 2095 & 2542	All	-do-	IS code, specn. & Manufacturer's certificate
9.	**Doors/windows/ventilators**						
	i) Glazing	Physical	-do-	IS 1081 & 2835	All	-do-	IS code, specn. & Manufacturer's certificate
	ii) Flush door shutters	Physical	-do-	IS 2095 & 2542	All	-do-	IS code, specn. & Manufacturer's certificate
	iii) Aluminium	Physical	-do-	IS 1948 & 1949	All	-do-	IS code, specn. & Manufacturer's certificate
	iv) Steel	Physical	-do-	IS 1038	All	-do-	IS code, specn. & Manufacturer's certificate

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10.	Plastering	Physical	-do-	As per specn.	All	-do-	Specn.
11.	White washing, snowmen, distemper	Physical	-do-	IS 712, 428 & 5410	All	-do-	IS code & specn.
12.	**Toiletries & sanitary fixtures**						
	IWC, EWC, Urinals, washbasins, G.I pipes & fittings, C.I pipes & stoneware pipes etc.	Physical	-do-	IS 771, 775, 774, 1239, 2065, 781, 1729, 1726,,651,4127 etc.	All	-do-	IS code, specn. & Manufacturer's certificate

Note: Parameters/guidelines fixed for the quality control in accordance with the contract document, IS Codes/Technical Specification etc. are just the synopsis of the whole constructional activities in a bid to visualise the total involvement at a glance. Mere compliance of the QAP does not relieve the contractor from overall responsibility to render best quality of work in conformity with all the relevant documents and the best engineering practices. In order to minimise the size of QAP, only salient/important features have been taken into account and other small/minor involvement will be dealt with individually as per the provision of contract.

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SECTION VI – 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE- F

CIVIL , STRUCTURAL AND ARCHITECTURAL VENDOR LIST

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1.0 CIVIL , STRUCTURAL AND ARCHITECTURAL VENDOR LIST

GENERAL NOTES:

a) Only 'First' Quality materials shall be used

b) OWNER / CONSULTANT reserve the right to choose any of the approved make / vendor as per this list. Make of the item not indicated and any other make for the specified item shall be subject to owner's / consultant's approval.

c) Specifications of manufacturer's items shall be checked against tender item / specifications before selecting any product or brand name. In case of any discrepancy, tender item / specifications shall prevail, and any such brand of item shall not be used which is not conforming to tender specifications even if it is listed in this vendor list.

d) In case of non-availability of any material among approved vendors / makes in a particular site / region, alternate vendor / make conforming to IS / BS etc. Shall be used subject to approval by OWNER / CONSULTANT.

SL. NO.	ITEM	NAME
1.0	**FLOOR FINISHING**	
1.1	CEMENT TILES (FLOOR/WALL)	a) EUROCON b) ALTRA TILE PVT. LTD. c) DAZZLE
1.2	TERRAZZO TILES	A) NITCO B) HINDUSTAN TILES
1.3	CERAMIC TILES	a) SOMANY CERAMICS b) H&R JOHNSON CERAMICS c) KAJARIA CERAMICS d) ORIENT CERAMICS
1.4	HEAVY DUTY FLOOR TILES	A) BHARAT TILES B) RESTILE CERAMICS C) PELICAN CERAMIC INDUS. D) PAVIT E) SONA TILES
1.5	INDUSTRIAL FLOOR HARDENER ADMIXTURE	a) PIDILITE INDUSTRIES b) SIKA c) CICO.

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1.6	PVC ROLLS	A) PREMIER VINYL B) ARMSRONG INARCO C) RMG POLYVINYL
1.7	PVC TILES	A) ARMSTRONG
1.8	PVC TILES/ROLL ANTISTATIC	A) PREMIER VINYL B) RMG POLYVINYL C) ARMSTRONG
1.9	ACID RESISTANT TILES(BATTERY ROOM)	A) H&R JOHNSON OR APVD. EQUIV.
1.10	MOSSAIC TILE	A) ITALIS B) SPECIFIC GLASS MUSSAIC INDIA LTD.
2.0	**WOODWORK**	
2.1	FLUSH DOOR	A) GREEN B) CENTURY DOORS C) KITPLY PRODUCTS
2.2	PLY WOOD/BLOCK BOARD	A) CENTURY B) KITPLY PRODUCTS C) GREEN PLY
2.3	PARTICLE BOARD (EXTRA GRADE)	A) BHUTAN BOARD B) NOVAPAN INDIA LTD.
2.4	MDF BOARD/MD PARTICLE BOARD (EXTRA GRADE)	A) NUCHEM LTD. B) MANGALAM TIMBER PRODUCTS LTD. C) WESTERN BIO SYSTEMS LTD.
2.5	DECORATIVE LAMINATES	A) CENTURY B) GREENPLY INDUS. LTD. C) MERINO D) ARCHID
2.6	MARINE PLYWOOD	A) CENTURY B) GREENPLY INDUS. LTD. C) MERINO D) ARCHID
2.7.0	**DOORS & WINDOWS FITTINGS**	
2.7.1	MORTICE LOCKS WITH HANDLES	A) GODREJ & BOYCE B) EVERITE AGENCIES (P) LTD. C) DOORSET
2.7.2	CYLINDRICAL PIN TUMBLER LOCK WITH KNOBS	A) GODREJ & BOYCE B) EVERITE AGENCIES (P) LTD.

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		C) DOORSET
2.7.3	HYDRAULIC DOOR CLOSER (OVER HEAD/ FLOOR)	A) OZONE B) EVERRITE AGENCIES (P) LTD. C) HARDWYN
2.7.4	MISC. DOOR FITTINGS HINGLE, TOWER BOLTS, LATCHES, SOPPER, STAYS, ALDROPS ETC.	A) EVERITE AGENCIES (P) LTD. B) EBCO DINSUTRIES D) OZONE E) HARDWYN
2.7.5	THREE WAY BOLTING LOCKING DEVICE HANDLE	A) SRIMA SALES & SERVICES B) DHIMAN INDUSTRIES
2.7.6	PANIC BAR LATCH (FOR EMERGENCY DOOR)	A) SRIMA SALES & SERVICE
2.7.7	UPVC WINDOWS	A) FENESTA B) ENCRAFT C) WINDOW MAGIC
2.7.8	FASTENERS	A) HILTI INDIA PVT. LTD. B) FISCHER
3.0	**STEEL / ALUMINIUM DOORS, WINDOWS & VENTILATOR**	
3.1	PRESSED STEEL DOORS WINDOWS & SECTION DOORS WINDOWS/ROLLING SHUTTER	A) RAYMUS ENGINEERS B) DHIMAN STEEL C) RDG ENGINEERING D) SUPER STEEL WINDOW CO. E) SKS STEEL INDUS.
3.2	ALMUNIUM / DOORS/ WINDOWS SECTIONS	A) JINDAL ALUMINIUM LTD. B) HINDALCO INDUSTRIES C) INDAL
3.3	FIRE-PROOF DOORS(APPROVED)	A) NAVAIR INTERNATIONAL B) RDG ENGINEERING
3.4	PVC DOORS / WINDOWS	A) SINTEX OR APPVD EQUIV.
3.5	PVC WATER TANKS	A) SINTEX OR APPVD EQUIV.
4.0	**PLASTERING**	
4.1	WATERPROOFING/ COMPOUND IN CEMENT PLASTER	A) STRUCTURAL WATER PROOFING CO. (P) LTD. B) PIDILITE INDUSTRIES C) SIKA D) KRISHNA CONCHEM
5.0	**ROOF TREATMENT (WATER PROOFING)**	
5.1	BRICK BAT COBA	A) INDIA WATER PROOFING CO. B) OVERSEAS WATERPROOFING CORPN.
5.2	ACRYLIC BASED CEMENTATIOUS PRIMER COATING FOR ROOF WATERPROOFING	A) STRUCTURAL WATER PROOFING CO. (P) LTD. B) SIKA QUALCRETE LTD. C) PIDILITE INDUSTRIES

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		D) KRISHNA CONCHEM
5.3	APP MODIFIED POLYMERIC WASTER PROOFING MEMBRANE	A) PIDILITE INDUSTRIES LTD. B) SIKA
5.4	PU BASED WATERPROOFING	A) PIDILITE INDUSTRIES LTD. B) SIKA C) BASF D) FOSROC
6.0	**PAINTING WORKS**	
6.1	PLASTIC EMULSION (INTERIOR/EXTERIOR)	A) ICI INDIA LTD. B) BERGER PAINTS LTD. C) ASIAN PAINTS LTD. D) SHALIMAR PAINTS E) KANSAI NEROLAC PAINTS LTD. F) M/s. Johnson & Nicholson
6.2	DRY OILBOUND DISTEMBER	A) ASIAN PAINTS LTD. B) KANSAI NEROLAC PAINTS LTD.
6.3	INDUSTRIAL / EPOXY/ ALIPHATIC ACRYLATE/ SYNTHETIC ENAMEL PAINTS	A) ICI/AKZO NOBEL INDIA B) BERGER PAINTS LTD. C) ASIAN PAINTS LTD. D) SHALIMAR PAINTS E) INTERNATIONAL MARINE COATINGS PVT. LTD. F) KANSAI NEROLAC PAINTS LTD. G) BOMBAY PAINT H) KRISHNA CONCHEM
6.4	WATERPROOFING CEMENT PAINT	A) KILLICK NIXON LTD. B) RAJDOOT PAINTS
6.5	WOOD MELAMINE POLISH	A) ASIAN PAINTS B) SHALIMAR PAINTS C) WEMBLY PAINTS
6.6	WATERPROOFING TRANSPARENT EXTERIOR WALL COATING (OVER PAINTED SURFACE)	A) PIDILITE INDUSTRIES B) SIKA C) KRISHNA CONCHEM
6.7	FIRE PROOF COATING	A) NAVAIR INTERNATIONAL OR APPVD. EQUIV.
7.0	**ROOFING SHEETS & ACCESSORIES**	
7.1	ASBESTOS SHEETS	A) ETERNIT EVEREST LTD. B) CHARMINAR INDUSTRIES

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		C) VISAKA
7.2	C.G.I. SHEETS	A) ISPAT INDUSTRIES LTD. B) STEEL AUTHORITY OF INDIA C) TATA STEEL D) JINDAL
7.3	PRECOATED G.I. PROFILE SHEETS FOR ROOFING & WALL CLADDING	A) ISPAT INDUSTRIES LTD. B) LLOYD INSULATION (I) LTD. C) STEEL AUTHORITY OF INDIA D) TATA STEEL E) JINDAL
7.4	ALUMINIUM SHEET (PLAIN/PROFILE)	A) INDIAN ALUMINIUM CO. LTD. OR APPROVED EQUIVALENT
7.5	FIBRE GLASS SHEETS & PANELS (MACHINE MOULD)ED	A) SIMBA FRP (P) LTD. B) GE INDIA C) DUROPLAST
7.6	PROOFING J/L HOOKS, BOLTS & OTHER ACCESSORIES (POLYMER COATED)	A) KATALIST CONSULTANT (P) LTD. B) ADVANCED MACHINE
8.0	**SANITARY PLUMBING FITTINGS & FIXTURES**	
8.1	SANITARY FITTINGS (W.C. WASH BASIN, URINAL ETC.)	A) HINDUSTAN SANITARY WARE & INDUS. LTD. B) PARRYWARE SANITARY WARE C) MADHUSUDAN CERAMICS D) NYCER CERAMICS
8.2	PLUMBING FITTINGS & FIXTURES	A) JAGUAR B) CERA C) HINDWARE
8.3	GLASS/MIRROR (SHEET/ FLOAT/ TOUGHENED/ LAMINATION	A) GUJARAT GUARDIAN LTD. B) SAINT GOBAIN C) ASAHI FLOAT
8.4	GI PIPES	A) JINDAL B) SURYA C) PRAKASH D) SWASTIK
9.0	**FALSE CEILING, FALSE FLOORING & UNDERDECK INSULATION**	
9.1	FLASE CEILING / WALL CLADDING (ALUMINIUM STRIP/ TRAY TYPE)	A) INTERARCH BUILDING PRODUCTS (P) LTD. B) HUNTER DOUGLAS C) MASCOT OVERSEAS
9.2	FALSE FLOORING	A) MULTI INTERIORS PVT. LTD. B) BESTLOCK SYSTEM & CONCEPTS C) LLOYD INDUSULATION (I) LTD. D) UNITED INSULATION E) A.R. & BROTHERS

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9.3	UNDERDECK/WALL HEAT INSULATION	A) BAKELITE HYLAM LTD. B) U.P. TWIGA F.G. LTD. C) LLOYD INDULATION (I) LTD. D) SUPEREME E) PIDILITE
9.4	OVERDECK HEAT INSULATION	A) LLOYD INSULATION (I) LTD. B) BEST PLASTRONICS LTD. C) PIDILITE INDUSTRIES LTD
9.5	GYPSUM BOARD TILES (FIBRE GLASS REINFORCED)/ PRIMA BOARD ARMSTRONG FALSE CEILING	A) SAINT GOBAIN
10.0	SPECIALITY PRODUCTS (CEMENT ADDITIVES/ ADMIXTURES / CORROSION INHIBITORS / SBR LATEX & ACRYLIC POLYMERS / EPOXY LATEX POLYMERS / FOOD GRADE EPOXY SURFACE TREATMENT/ EPOXY & CEMENTITIOUS GROUT/ EPOXY BONDING AGENTS & ANCHORS / SEALING / COATING	A) PIDILITE INDUSTRIES B) SIKA C) KRISHNA CONCHEM D) FOSROC E) BASF
10.1	EPOXY FLOOR COATING (BATTERY ROOM)	A) SIKA B) FAIRMATE C) CIPY POLYURETHANE D) KRISHNA CONCHEM
10.2	EPOXY PHENOLIC CHEMICAL RESISTANT COATING & MORTAR(SCREED) FOR FLOOR & WALLS	A) KRISHNA CONCHEM B) SIKA C) FOSROC D) BASF E) CIPY POLYURETHANE
10.3	CONCRETE REPAIR & REHABILITATION PRODUCTS	A) KRISHNA CONCHEM B) SIKA C) FOSROC D) BASF E) PIDILITE
10.4	PREMIXED CEMENTITIOUS MORTARS & MICROCONCRETE	A) KRISHNA CONCHEM B) SIKA C) FOSROC D) BASF E) PIDILITE

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10.5	GLASS/CARBON FIBRE WRAPPING FIBRE / LAMINATE / EPOXY	A) KRISHNA CONCHEM B) SIKA C) FOSROC D) BASF
10.6	CORROSION PROTECTION ANODES & CAPLETS	A) KRISHNA CONCHEM B) SIKA C) FOSROC D) BASF
11.0	**MISCALLANEOUS ITEMS**	
11.1	WOOD PRESERVATIVE	A) ASCU HICKSON LTD.
11.2	WALL SURFACE TEXTURED COATING	A) JOTUN B) SPECTRUM PAINTS C) BAKELITE HYLAM D) OIKOS
11.3	EXTERNAL ACRYLIC WALL COATINGS	A) KRISHNA CONCHEM B) SIKA C) FOSROC D) BASF E) PIDILITE F) ASIAN G) BERGER
11.4	PVC PLUMBING FITTINGS	**a)** SUPREME **b)** POLYPAC **c)** ASTROL
11.5	REINFORCED FIBRE GLASS WATERPROOFING FELT	A) SIKA B) U.P. TWIGA F.G. LTD.
11.6	ANTI TERMITE TREATMENT	A) PCI OR APPRVD EQUIV.
11.7	MATERIAL TEST HOUSE	A) IIT MADRAS B) GOVT APPROVED AGENCY
12.0	CEMENT	A) ACC B) J K CEMENT C) BINANI CEMENT D) JP CEMENT E) GUJARAT AMBUJA F) ALTRA TECH CEMENT G) BIRLA CORPN. LTD. H) GRASIM I) SHREE
12.1	SULPHUR RESISTANT CEMENT	A) SAURASHTRA CEMENT LTD. B) SHREE DIGVIJAY CEMENT
13.0	RCC DESIGN MIX	AP GOVT APPROVED AGENCY
14.0	WRAPPING COATING (I/C TAPE &	A) IWL OR APPROVED EQUIVALENT

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	PRIMER) IWL OR APPROVED EQUIPMENT	
15.O	FIRE PROOFING MATERIAL	A) CAFCO B) CARBOLINE
16.0	STRUCTURAL STEEL / CS PLATE	HEAVY SECTIONS MORE THAN 150 MM A) SAIL B) TATA STEEL C) RINL LIGHT SECTIONS LESS THAN 150 MM D) JINDAL E) ESSAR F) ISPAT INDUSTRIES
16.1	MS PIPES (HAND RAIL APPLICATION)	**a)** SURYA **b)** PRAKASH **c)** JINDAL
17.0	TMT BAR / REBAR	A) SAIL B) TATA STEEL C) RINL D) SHYAM STEEL INDUSTRIES LIMITED E) ELECTROSTEEL STEELS LTD F) SHRI RATHI STEEL LTD. G) SRMB SRIJAN PRIVATE LIMITED
18.0	GRATINGS/HANDRAILS	A) INDIANA GRATINGS B) WESTCOAST ENGINEERING C) GREATWELD GRATING D) KANADE ANAND UDYOG
19.0	WELDING ELECTRODE	A) ADOR B) ESAB C) D & H D) HANOVAR

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SECTION VI – 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE- G: LAND DEVELOPMENT / TOPOGRAPHICAL SURVEY DRAWING

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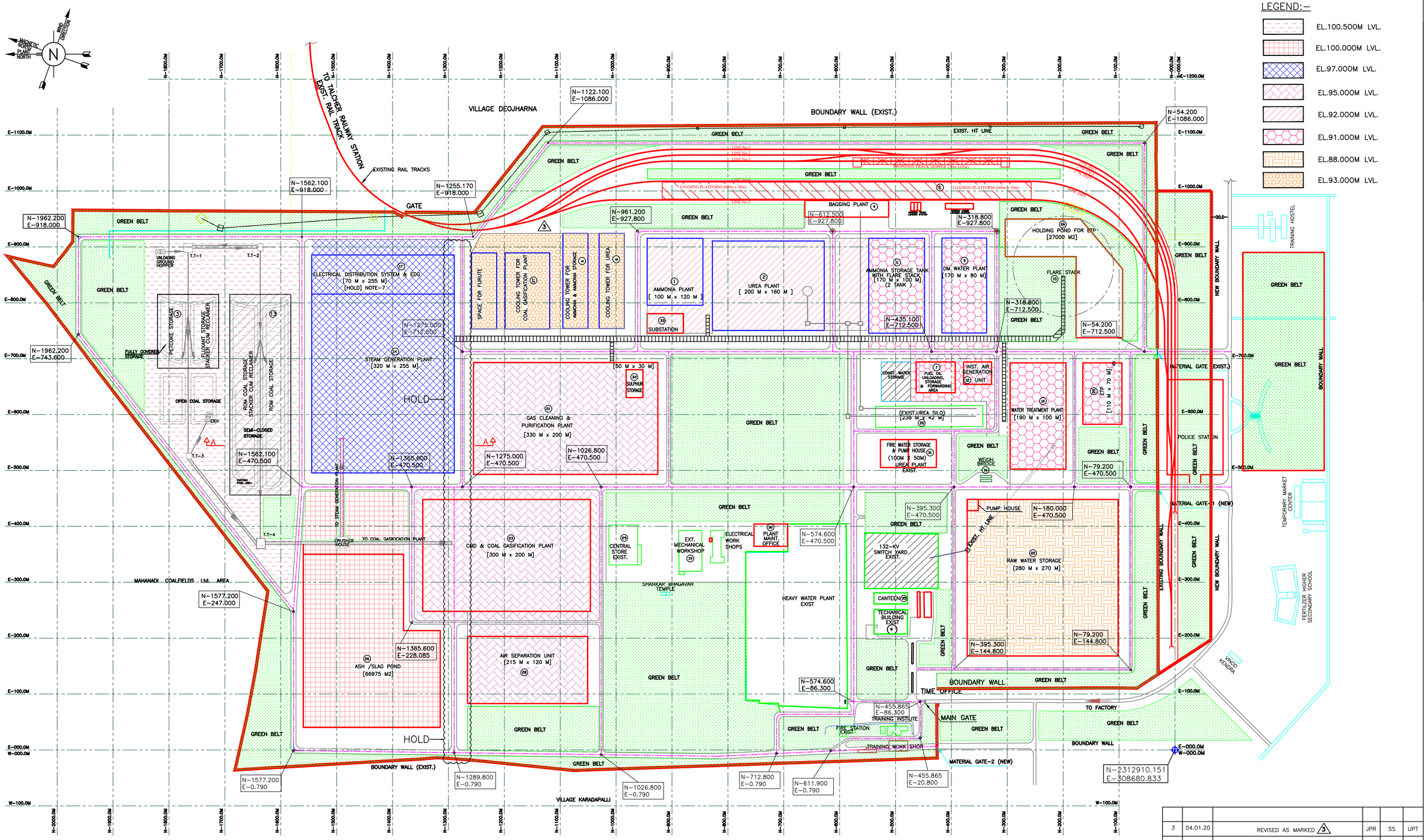

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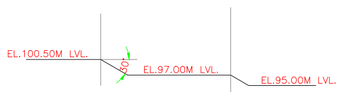
NOTE:–

1. ALL DIMENSION ARE IN MM AND LEVELS ARE IN M. UNLESS NOTED OTHERWISE.
2. THE DRAWING SHOULD NOT BE SCALED,ONLY FIGURE DIMENSION ARE TO BE FOLLOWED.
3. THE RESPECTIVE RLS. SHALL BE RECKONED FROM THE PERMANENT BENCH MARK.
4. FELLING OF TREES/CLEARING OF JUNGLES/SHRUBS SHALL NOT BE TAKEN UP IN THE AREA EARMARKED FOR THE GREEN BELT, EXCEPT ROADS WHERE LAND SHALL BE GRADED PROPERLY.
5. NO EARTH FILLING BUT ONLY CUTTING AND GRADING SHALL BE DONE IN THE ASH POND AREA. BUND WALLS SHALL ALSO BE RETAINED.

LEGEND :~

- PROPOSED FACILITIES
- EXISTING FACILITIES
- NEW RAILWAY TRACKS
- ROAD FACILITIES (TO BE USED)
- GREEN BELT AREA



SECTION A–A

S.NO.	REFERENCE DRAWINGS	NUMBERS
02.	TOPOGRAPHICAL & CONTOUR SURVEY DRAWING	SA/RCF/TALCHER/2017/TOPO–DWG_R2
01.	PLOT PLAN OF PROPOSED INTEGRETED COAL BASED FERTILIZER AND CHAMICAL COMPLEX	PC009–0000–0001_R6

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
3	04.01.20	REVISED AS MARKED 3	JPR	SS	UPT
2	29.08.18	ISSUED FOR CONSTRUCTION	SK	SS	UPT
1	19.12.17	GENERAL REVESION	SK	SS	UPT
0	15.12.17	ISSUED FOR CONSTRUCTION	SK	SS	UPT

Talcher Fertilizers

CLIENT : M/s. TALCHER FERTILIZER LIMITED

REV. 3

SHEET 1 OF 1

LOCATION : TALCHER, ANGUL DISTRICT, ODISHA(INDIA)

SCALE :~ 1 : 2200

TITLE : GENERAL LAND DEVELOPMENT PLAN

DRG. No.:~ PC150–0000–0205

FILE :~ PC150–0000–0205–R3

PDIL

PROJECTS & DEVELOPMENT INDIA LTD. NOIDA

SECTION VI – 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE- H – CIVIL REFERENCE DRAWINGS

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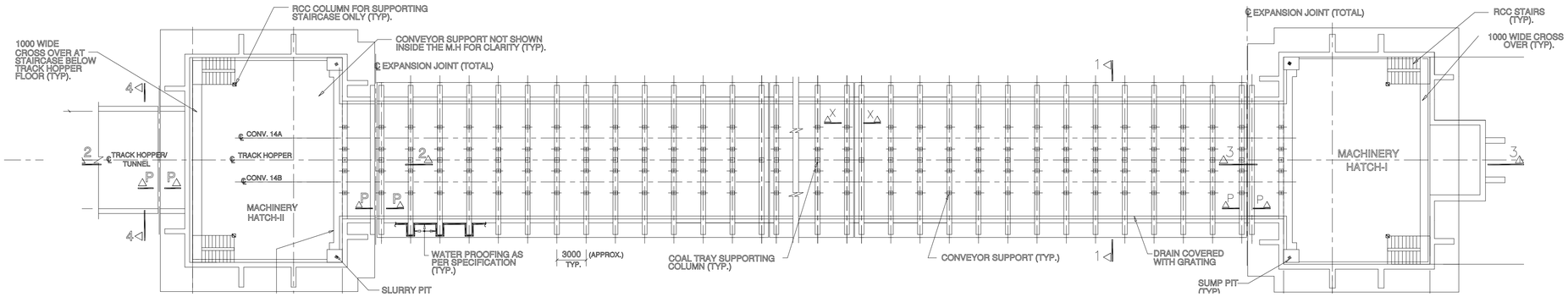
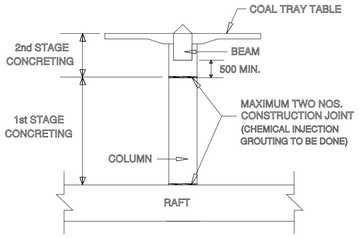
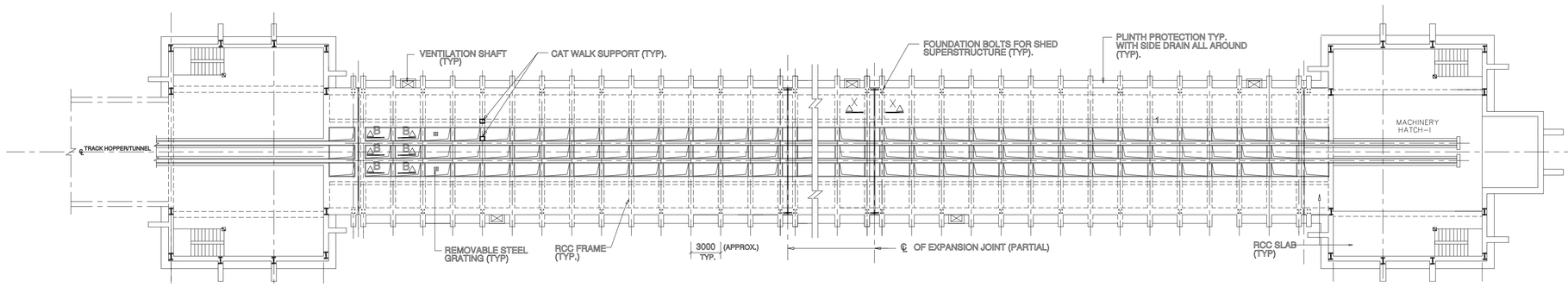


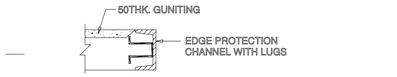
PLAN OF TRACK HOPPER AT RAFT LEVEL



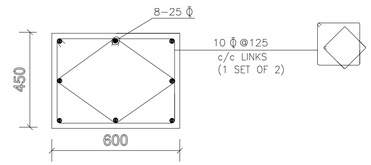
SKETCH SHOWING SEQUENCE OF CONCRETING FOR COAL TRAY COLUMN, BEAM & TABLE.



PLAN OF TRACK HOPPER AT FLOOR LEVEL (NEAR GROUND)

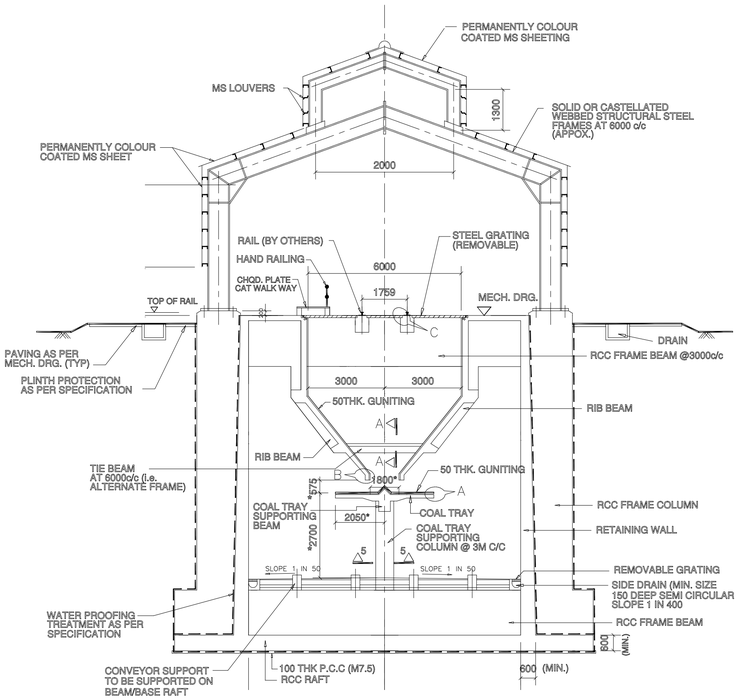


DETAIL–'A'

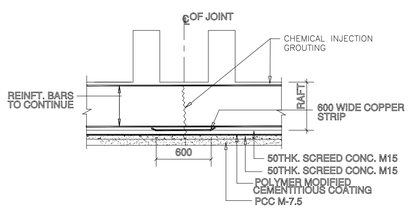


SECTION 5–5 (TYP.)

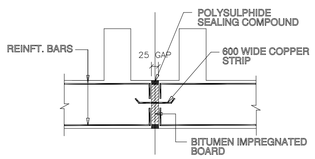
(SECTION SHOWS MINIMUM SIZE AND REINFORCEMENT TO BE PROVIDED BY BIDDER)
GRADE OF CONCRETE – M35
GRADE OF R/F STEEL – Fe415/Fe500



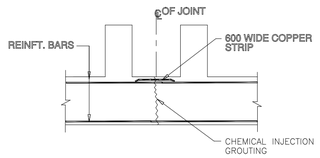
SECTION 1–1



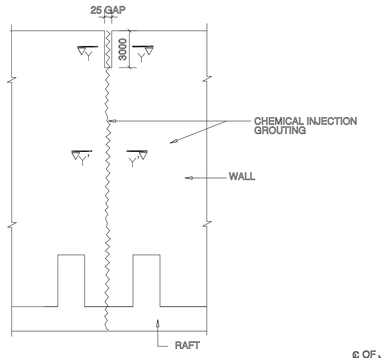
TYP. JOINT DETAIL FOR RAFT
(EXCEPT AT SECTIONS MKD. P–P)



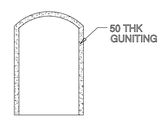
VIEW Y–Y



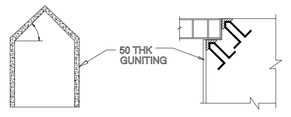
VIEW Y'–Y'



VIEW X–X

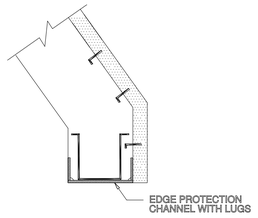


SEC. B–B

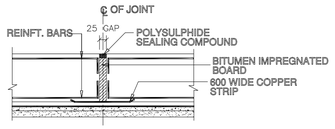


SEC. A–A

DETAIL–C



DETAIL–'B'



SECTION P–P
(FOR RAFT AS SHOWN)
(FOR WALL DETAILS SIMILAR TO VIEW Y–Y)

NOTES:

1. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METRES.
2. READ THIS DRAWING IN CONJUNCTION WITH RELEVANT MECH. DRGS.
3. NO COLUMNS SHALL BE PROVIDED INSIDE THE MACHINERY HATCHES FOR SUPPORTING THE ROOF.
4. OPENING FOR MACHINERY HATCHES NOT SHOWN FOR CLARITY.

FOR TENDER PURPOSE ONLY

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
P	16.10.20	ISSUED FOR TENDER PURPOSE ONLY	RP	GC	UPT

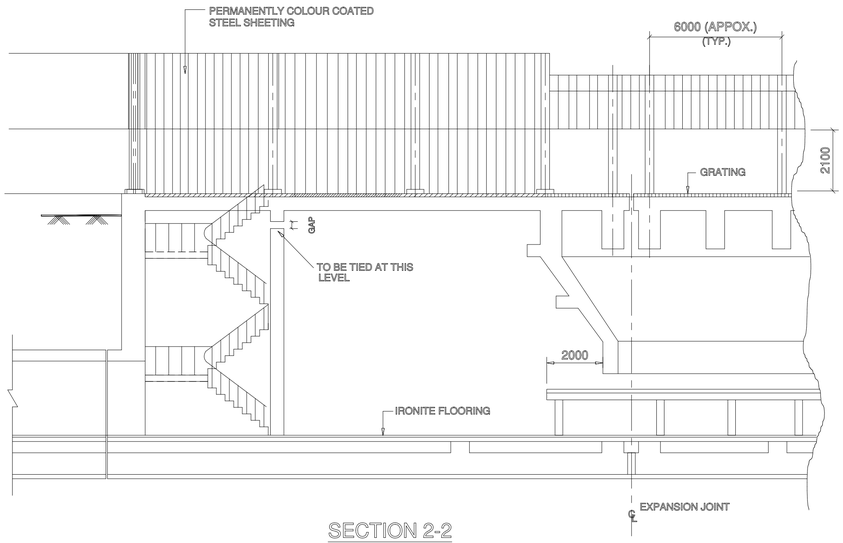
TALCHER FERTILIZER LIMITED

PROJECTS & DEVELOPMENT INDIA LIMITED NOIDA

REV. P | SHEET : 1 OF 4 | SCALE : | DWG. NO : PC183-1000-0101 | FILE : PC183-1000-0101_RP

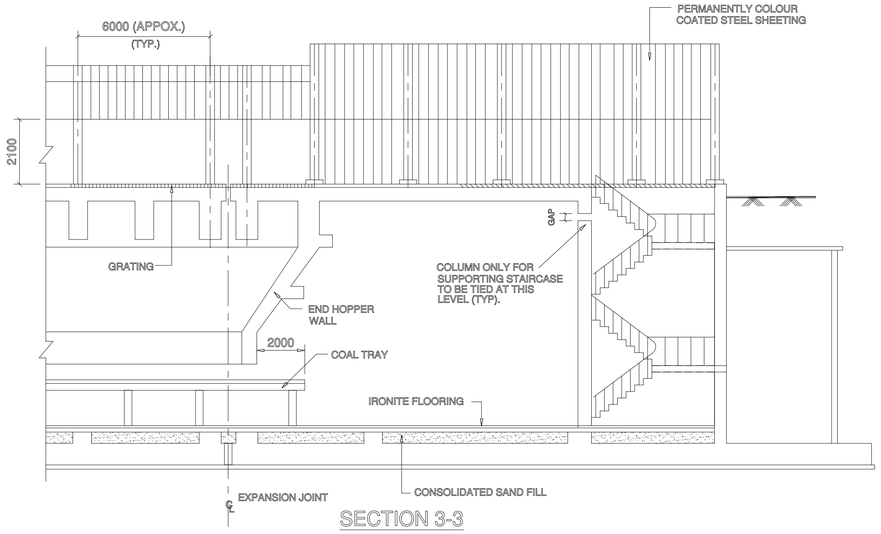
PROJECT : INTEGRATED COAL BASED FERTILISER COMPLEX, AT TALCHER, ANGUL DISTRICT, ODISHA (INDIA)

TITLE : COAL, PETCOKE & LIMESTONE HANDLING
GENERAL ARRANGEMENT AND DETAIL OF TRACK HOPPER & TUNNEL



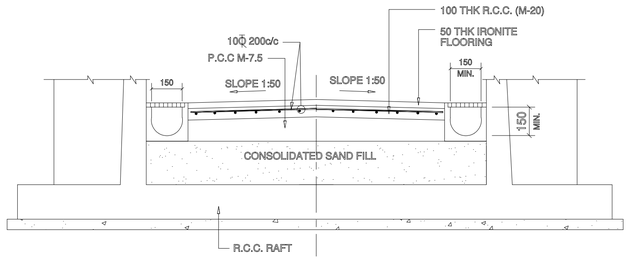
SECTION 2-2

(WATER PROOFING TREATMENT TO BE PROVIDED AS PER SPECIFICATION)

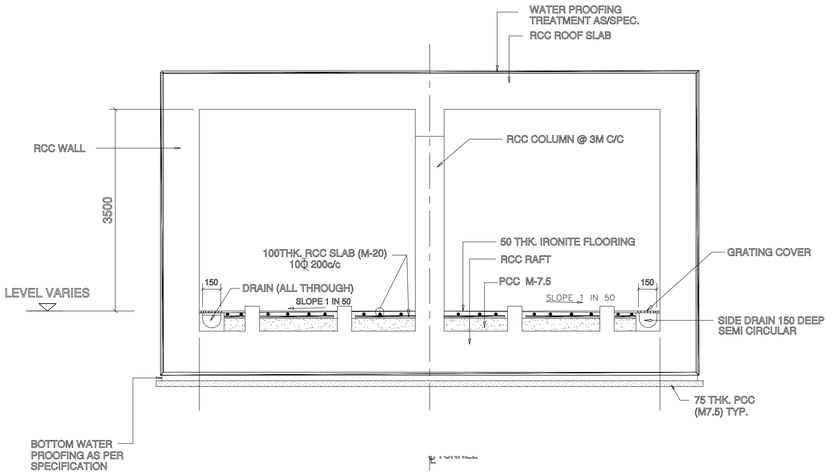


SECTION 3-3

(WATER PROOFING TREATMENT TO BE PROVIDED AS PER SPECIFICATION)



TYPICAL DETAIL OF FLOORING
(TRACK HOPPER / WT/ MH)



SECTION 4-4

NOTES:

1. ALL DIMENSIONS ARE IN MM & LEVELS ARE IN METRES.
2. READ THIS DRAWING IN CONJUNCTION WITH RELEVANT MECH. DRGS.
3. NO COLUMNS SHALL BE PROVIDED INSIDE THE MACHINERY HATCHES FOR SUPPORTING THE ROOF.
4. OPENING FOR MACHINERY HATCHES NOT SHOWN FOR CLARITY.

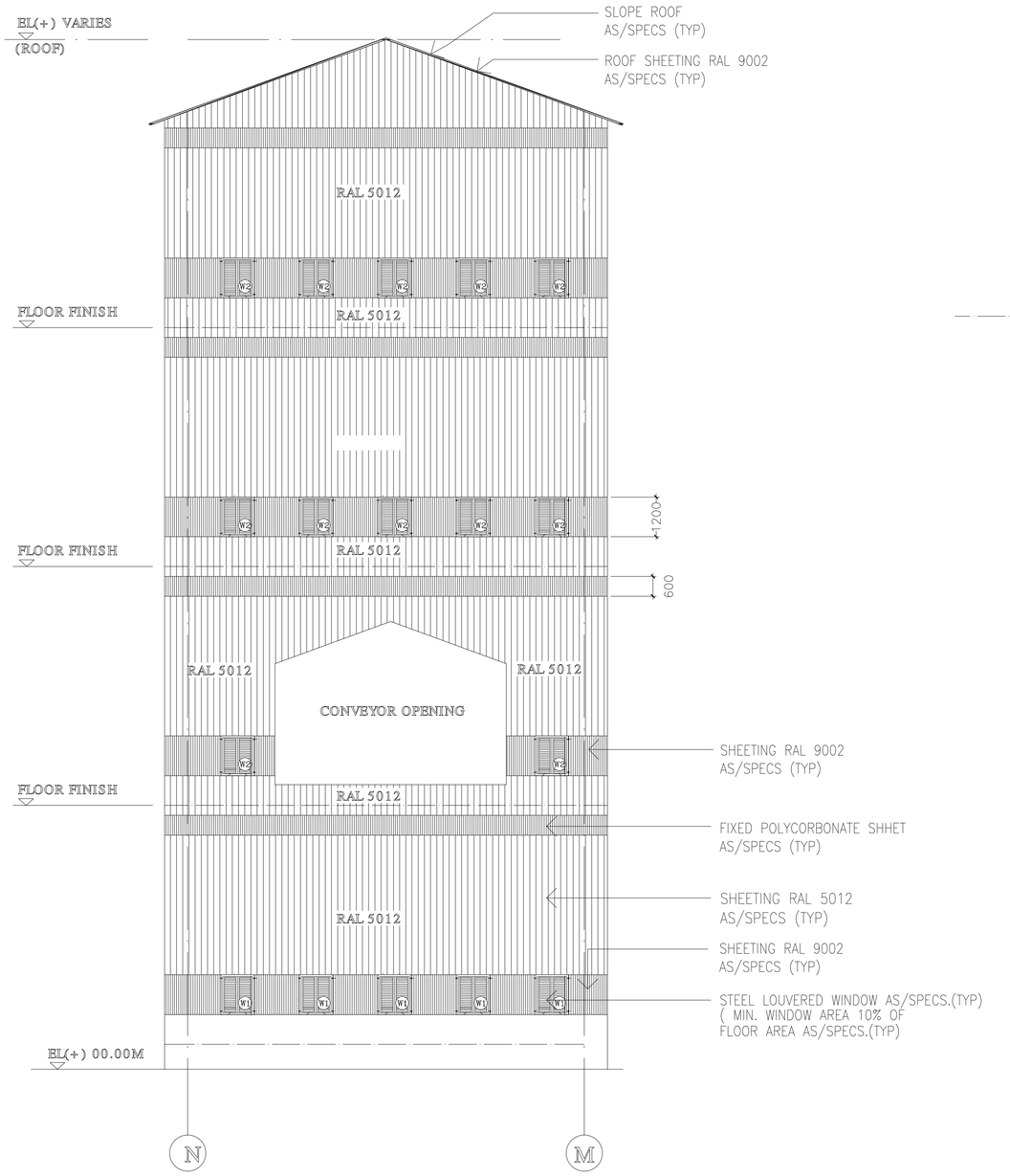
FOR TENDER PURPOSE ONLY

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
P	16.10.20	ISSUED FOR TENDER PURPOSE ONLY	RP	GC	UPT

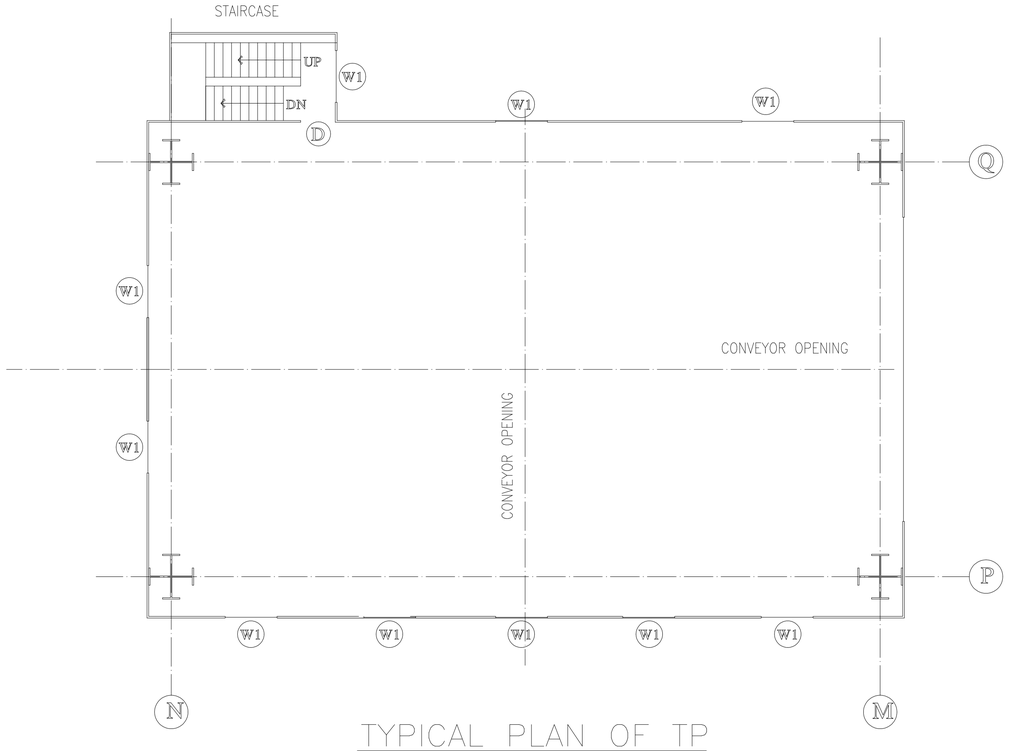
	TALCHER FERTILIZER LIMITED
	PROJECTS & DEVELOPMENT INDIA LIMITED NOIDA
REV.	P
SHEET :	2 OF 4
SCALE :	
DWG. NO :	PC183-1000-0101
FILE :	PC183-1000-0101_RP

PROJECT : INTEGRATED COAL BASED FERTILISER COMPLEX, AT TALCHER, ANGUL DISTRICT, ODISHA (INDIA)

TITLE : COAL, PETCOKE & LIMESTONE HANDLING
GENERAL ARRANGEMENT AND SECTIONAL DETAIL OF TRACK HOPPER & TUNNEL



TYPICAL ELEVATION OF TP



TYPICAL PLAN OF TP

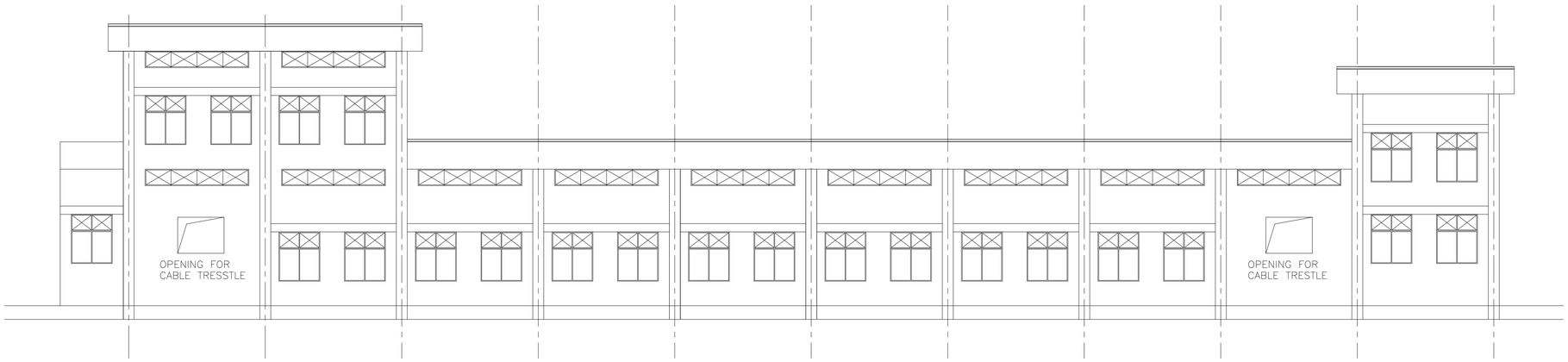
- TYPICAL ARCHITECTURAL DETAILS AS SHOWN IN THE DRAWING ARE INDICATIVE ONLY AND FOR TENDER PURPOSE ONLY.
- THE ELEVATION HEIGHT, NUMBER OF BAYS, NUMBER OF FLOORS, SIZE OF BUILDING, NO. OF STAIRCASES, NO. OF ROLLING SHUTTERS, OPENING FOR CONVEYORS, ETC. IS SHOWN IN THE DRAWING ARE INDICATIVE ONLY AND FOR TENDER PURPOSE ONLY.
- THE WORKS SHALL BE CARRIED OUT AS PER THE RELEASED FOR CONSTRUCTION DRAWINGS DURING DETAIL ENGINEERING STAGE.

1. ALL DIMENSIONS ARE IN MM AND LEVELS ARE IN METRES.
2. TYPICAL 750 MM WIDE PLINTH PROTECTION SHALL BE PROVIDED ALLROUND THE BUILDING AS PER TECHNICAL SPECIFICATIONS.
3. ALL PAINTING, FLOORING AND ALLIED WORKS, INTERNAL AND EXTERNAL FINISHES ETC. SHALL BE AS PER TECHNICAL SPECIFICATIONS.
4. READ THIS DRAWING IN CONJUNCTION WITH RELEVANT MECH. DRGS.

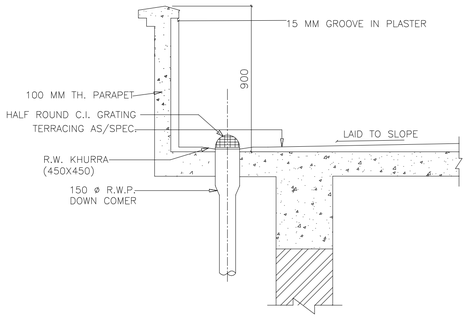
FOR TENDER PURPOSE ONLY

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
P	16.10.20	ISSUED FOR TENDER PURPOSE ONLY	RP	GC	UPT

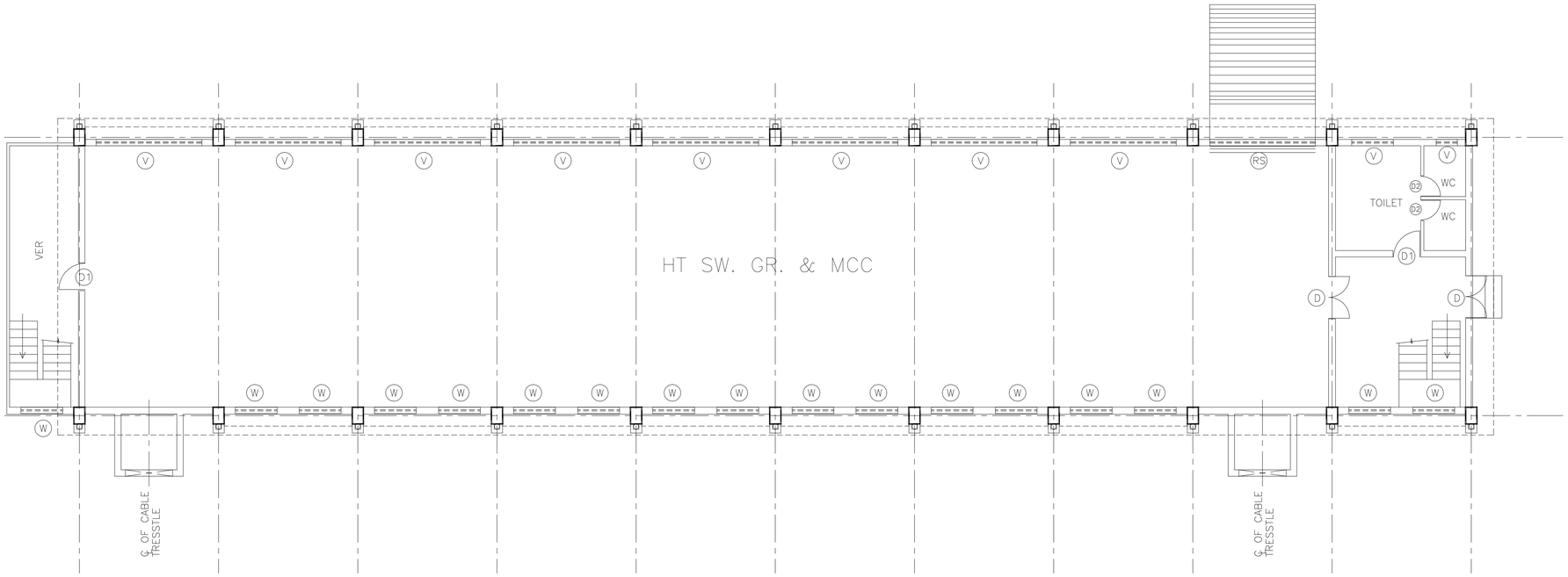
	TALCHER FERTILIZER LIMITED
	PROJECTS & DEVELOPMENT INDIA LIMITED NOIDA
REV.	P
SHEET	3 OF 4
SCALE	
DWG. NO	PC183-1000-0101
FILE	PC183-1000-0101_RP
PROJECT	INTEGRATED COAL BASED FERTILISER COMPLEX, AT TALCHER, ANGUL DISTRICT, ODISHA (INDIA)
TITLE	COAL, PETCOKE & LIMESTONE HANDLING TYPICAL ARCHITECTURAL DETAILS OF TP'S



TYPICAL ELEVATION OF MCC ROOM



TYPICAL GUTTER DETAIL



TYPICAL PLAN OF MCC ROOM

- TYPICAL ARCHITECTURAL DETAILS AS SHOWN IN THE DRAWING ARE INDICATIVE ONLY AND FOR TENDER PURPOSE ONLY.
- THE ELEVATION HEIGHT, NUMBER OF BAYS, NUMBER OF FLOORS, SIZE OF BUILDING, NO. OF STAIRCASES ETC. IS SHOWN IN THE DRAWING ARE INDICATIVE ONLY AND FOR TENDER PURPOSE ONLY.
- THE WORKS SHALL BE CARRIED OUT AS PER THE RELEASED FOR CONSTRUCTION DRAWINGS DURING DETAIL ENGINEERING STAGE.

1. ALL DIMENSIONS ARE IN MM AND LEVELS ARE IN METRES.
2. TYPICAL 750 MM WIDE PLINTH PROTECTION SHALL BE PROVIDED ALLROUND THE BUILDING AS PER TECHNICAL SPECIFICATIONS.
3. ALL PAINTING, FLOORING AND ALLIED WORKS, INTERNAL AND EXTERNAL FINISHES ETC. SHALL BE AS PER TECHNICAL SPECIFICATIONS.
4. READ THIS DRAWING IN CONJUNCTION WITH RELEVANT MECH. DRGS.

FOR TENDER PURPOSE ONLY

REV.	DATE	DESCRIPTION	PPD.	CKD.	APPD.
P	16.10.20	ISSUED FOR TENDER PURPOSE ONLY	RP	GC	UPT

TALCHER FERTILIZER LIMITED

PROJECTS & DEVELOPMENT INDIA LIMITED
NOIDA

REV. P
SHEET : 4 OF 4
SCALE :
DWG. NO : PC183-1000-0101
FILE : PC183-1000-0101_RP

PROJECT : INTEGRATED COAL BASED FERTILISER COMPLEX, AT TALCHER, ANGUL DISTRICT, ODISHA (INDIA)

TITLE : COAL, PETCOKE & LIMESTONE HANDLING
CONTROL & MCC ROOM TYPICAL ARCHITECTURAL DETAILS

SECTION VI– 3.4

DESIGN PHILOSOPHY

FOR

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

ANNEXURE- I - SOIL INVESTIGATION REPORT

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TABLE OF CONTENT

INTRODUCTION

M/s Swayin & Associates has awarded to conduct the Soil Investigation Works, Survey works of coal gasification & ammonia urea plant, Talcher, Odisha, India for M/s Talcher Fertilizers Limited for the proposed construction structures, Industrial plant, Building, Boundary wall etc. located at Talcher in Odisha. This report provides the results of the geotechnical investigation conducted at proposed CMD & CGU area of Talcher for TFL.

The geotechnical Investigation was completed and provides accurate detailed data of soil conditions of Proposed CMD & CGU Area at Talcher under Talcher Fertilizers limited.

Through correspondence with the WUHUAN ENGINEERING CO., LTD. The investigation was intended to assist in determining the most appropriate method for the development of construction structures, Industrial plant, Building, Boundary wall etc.

The work was completed in accordance with the proposal as per LOI No: WUHUAN/SWAYIN/SOIL/TFL/2020: DTD.03.01.2020.

This report has been prepared specifically and solely for the project described herein. It contains the Geotechnical Investigation and provides the observations and Recommendations for the proposed CMD & CGU Unit at Talcher, Odisha under M/s Talcher Fertilizers limited.

1. GENERAL INFORMATION ABOUT THE FIELD INVESTIGATION, INCLUDING EQUIPMENTS, METHODS, PERSONNEL, COMMENTS:

a) General Data:

Name of Owner: M/s Talcher Fertilizers Limited.

Name of Contractor: M/s Wuhan Engineering Co., ltd.

Name of Sub Contractor: M/s Swayin& Associates.

Name of Project: Detailed soil Investigation Works, Survey works of coal gasification & ammonia urea plant, Talcher, Odisha, India.

LOI No: WUHUAN/SWAYIN/SOIL/TFL/2020: DTD.03.01.2020

Description of Work: To execute/ providing services for soil investigation & allied works at TFL's Coal gasification, CMD, Ammonia & Urea unit in Talcher.

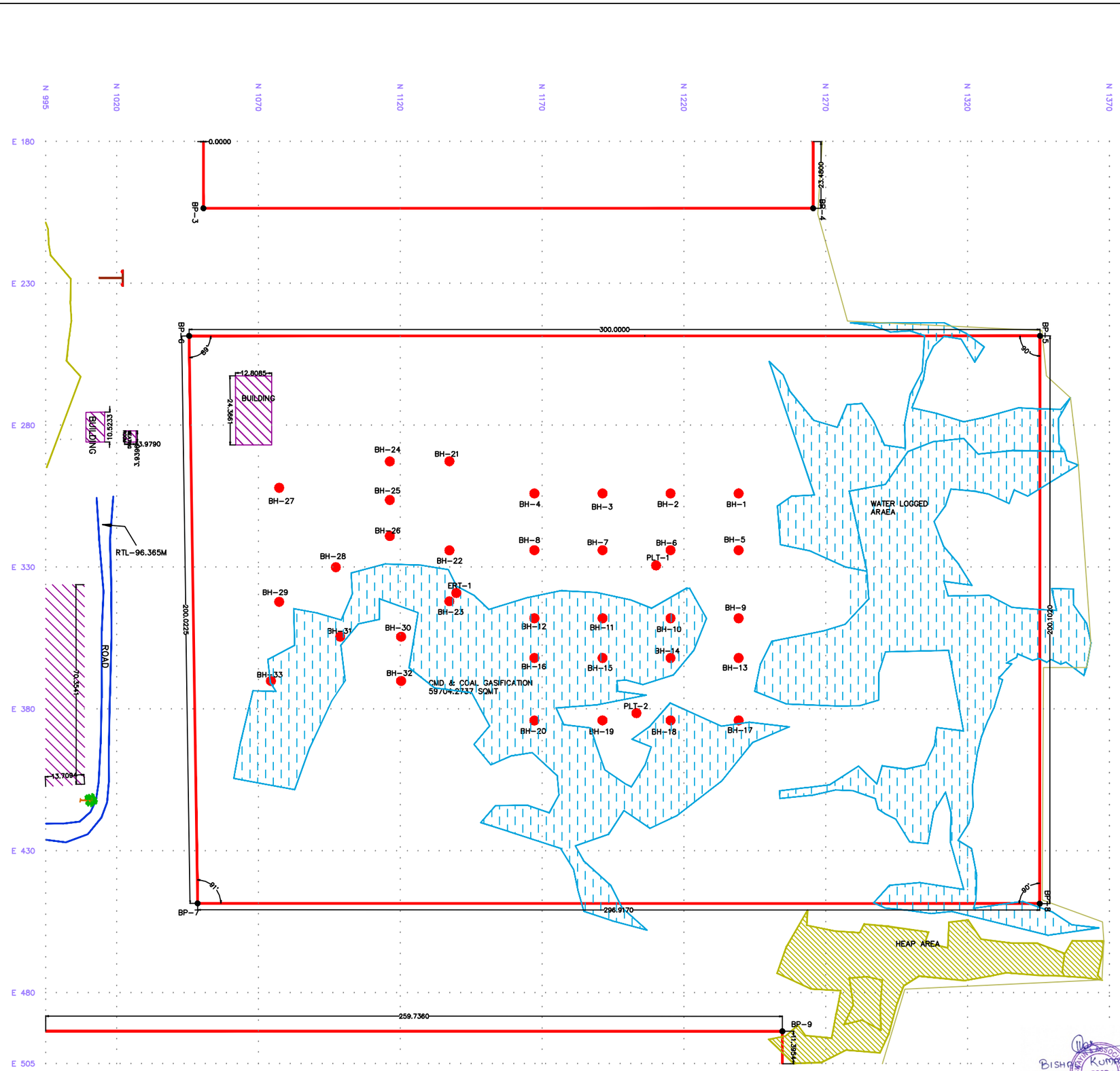
LIST OF EQUIPMENTS / PERSONNEL

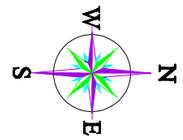
List of Equipments:

S No.	Name of the Equipments	Quantity
1.	8 HP Engine (Kirloskar)	03 no's
2.	8 HP Engine (Mahaveer)	01 no
3.	Tractor-Mounted Boring Rig	01 no
4.	Core Barrel (0.5, 1.0, 1.5mtr) NX-size Double tube	Each 05 no's
5.	Casing 4" dia.	15 no's
6.	Drilling Rod	200mtr
7.	Split Spoon Sampler	05 no's& extra 3 no's Available at site.
8.	UDS Tube	As per required
9.	UDS Lifter	05 no's
10.	Core Box	As per required
11.	SPT Hammer (63.5 kg)	05 no's
12.	Diamond Bit (NX Size)	As required
13.	TC Bit (NX Size)	As required
14.	Guide Rod	05 no's
15.	Water Pump	05 no's
16.	Hose pipe with football	05 no's
17.	Delivery pipe	05 set's
18.	Chhuri	08 no's
19.	Tool Kits	05 no's

List of Responsible Person for the Project:

S No.	Name of Personnel	Designation
1.	Shri.SambhunathSwayin	Managing Partner
2.	Mr.DharmaTeja Annam	Technical Manager
3.	Mr.Sukant Swain	Project Manager
4.	Mr.BibhuRanjanBaliarsingh	Asst. Technical Manager
5.	Mr.Deepak Kumar Sahoo	Civil Engineer
6.	Mr.SashankarDhali	Site Engineer
7.	Mr.BiswajitSahoo	Site Engineer
8.	Mr.BhabhenHalder	Site Engineer
9.	Mr.Sudev Pal	Surveyor
10.	Mr.Rajesh Das	Asst. Surveyor
11.	Duryodhan Pradhan	Site Supervisor
12.	Vijay Kumar	Site Supervisor
13.	Mr.Bijay Kumar Behera	Lab. Technician
14.	Mr.Sudhir Kumar Rout	Lab. Technician
15.	Ms.ManjulataNayak	Draftsman
16.	Mrs.Lija Rani Sethy	Draftsman





LEGENDS:-

PROPOSED BOUNDARY	
BOUNDARY POINT	
ROAD	
BUILDING	
BORE HOLE POINT	
POND/WATER LOGGED AREA	
HEAP AREA	

CO-ORDINATES OF BOREHOLE:

CO-ORDINATES OF BORE HOLE			
BH	EASTING	NORTHING	R.L 'm'
BH-1	304.000	1239.300	95.439
BH-2	304.000	1215.300	95.211
BH-3	304.000	1191.300	95.075
BH-4	304.000	1167.300	95.229
BH-5	324.000	1239.300	95.474
BH-6	324.000	1215.300	95.208
BH-7	324.000	1191.300	95.195
BH-8	324.000	1167.300	95.326
BH-9	348.000	1239.300	95.333
BH-10	348.000	1215.300	95.093
BH-11	348.000	1191.300	94.692
BH-12	348.000	1167.300	94.794
BH-13	362.000	1239.300	95.118
BH-14	362.000	1215.300	94.798
BH-15	362.000	1191.300	94.762
BH-16	362.000	1167.300	94.737
BH-17	384.000	1239.311	95.063
BH-18	384.000	1215.311	94.912
BH-19	384.000	1191.289	95.252
BH-20	384.056	1167.289	94.786
BH-21	292.665	1137.335	96.458
BH-22	324.050	1137.342	95.249
BH-23	342.000	1137.300	95.025
BH-24	292.700	1116.308	96.387
BH-25	306.300	1116.308	94.898
BH-26	319.000	1116.302	95.302
BH-27	302.000	1077.300	96.479
BH-28	330.000	1097.289	95.361
BH-29	342.200	1077.300	95.172
BH-30	354.501	1120.300	95.38
BH-31	354.501	1098.800	94.978
BH-32	370.100	1120.300	95.35
BH-33	370.100	1074.399	95.065
PLT-1	313.954	1179.194	95.22
PLT-2	375.03	1203.258	94.969
ERT-1	342.00	1137.30	95.025

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

CLIENT	TALCHER FERTILIZERS LIMITED (TFL)	
CONTRACTOR	WUHUAN ENGG. CO., LTD.	
TITLE	LOCATION PLAN	
PROJECT	DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.	
PREPARED BY	SWAYIN & ASSOCIATES 77, SATYA NAGAR, BHUBANESWAR PH-(91-0674)2570015/2572971/2570458	
SCALE:	DRAWING. NO.	REV
1:1000	B/SA/TFL/LOCATION PLAN DWG.	0

BISHNU KUMAR DAS. MTECH (GEOTECH)

LOCATION DETAILS

SL No.	Location	Type of BH	BH No.	DOS	DOC	Depth of BH (mtr.)	UTM Coordinates		RL (mtr.)	GWT (mtr.)
							Easting	Northing		
1.	CMD & Coal Gasification Area	A	BH-01	09.02.20	13.02.20	27.88	304.000	1239.300	95.439	0.75
2.		C	BH-02	08.02.20	11.02.20	17.62	304.000	1215.300	95.211	1.54
3.		A	BH-03	09.02.20	11.02.20	26.00	304.000	1191.300	95.075	1.30
4.		A	BH-04	09.02.20	12.02.20	25.06	304.000	1167.300	95.229	1.75
5.		C	BH-05	12.02.20	13.02.20	17.59	324.000	1239.300	95.474	1.60
6.		A	BH-06	13.02.20	16.02.20	27.74	324.000	1215.300	95.208	1.65
7.		A	BH-07	03.02.20	06.02.20	26.50	324.000	1191.300	95.195	1.58
8.		C	BH-08	09.02.20	11.02.20	16.82	324.000	1167.300	95.326	1.68
9.		C	BH-09	13.02.20	14.02.20	18.23	348.000	1239.300	95.333	1.70
10.		A	BH-10	14.02.20	23.02.20	26.90	348.000	1251.300	95.093	1.54
11.		C	BH-11	17.02.20	18.02.20	20.84	348.000	1191.300	94.692	1.05
12.		A	BH-12	14.02.20	17.02.20	26.00	348.000	1167.300	94.794	0.60
13.		C	BH-13	17.02.20	18.02.20	18.43	362.000	1239.300	95.118	1.60
14.		C	BH-14	18.02.20	20.02.20	20.31	362.000	1251.300	94.798	1.30
15.		A	BH-15	20.02.20	23.02.20	27.40	362.000	1191.300	94.762	0.00
16.		C	BH-16	18.02.20	20.02.20	19.84	362.000	1167.300	94.737	1.60
17.		A	BH-17	19.02.20	21.02.20	27.14	384.000	1239.311	95.063	1.58
18.		C	BH-18	17.02.20	19.02.20	18.52	384.000	1215.311	94.912	1.60
19.		C	BH-19	16.02.20	17.02.20	18.48	384.000	1191.289	95.252	0.60
20.		A	BH-20	20.02.20	23.02.20	28.50	384.056	1167.289	94.786	0.10

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

SL No.	Location	Type of BH	BH No.	DOS	DOC	Depth of BH (mtr.)	UTM Coordinates		RL (mtr.)	GWT (mtr.)
							Easting	Northing		
21.	CMD & Coal Gasification Area	C	BH-21	10.02.20	12.02.20	15.00	292.665	1137.335	96.458	1.90
22.		C	BH-22	01.02.20	02.02.20	21.00	324.050	1137.342	95.249	1.65
23.		C	BH-23	13.02.20	14.02.20	18.49	342.000	1137.300	95.025	1.60
24.		C	BH-24	16.02.20	17.02.20	17.82	292.700	1116.308	96.387	1.95
25.		A	BH-25	02.02.20	08.02.20	30.00	306.300	1116.308	94.898	1.95
26.		C	BH-26	30.01.20	31.01.20	18.00	319.000	1116.302	95.302	2.00
27.		C	BH-27	15.02.20	16.02.20	17.87	302.000	1077.300	96.479	1.68
28.		C	BH-28	28.01.20	30.01.20	22.50	330.000	1097.289	95.361	2.00
29.		C	BH-29	03.02.20	07.02.20	16.50	342.200	1077.300	95.172	1.60
30.		C	BH-30	25.01.20	01.02.20	17.80	354.501	1120.300	95.380	1.90
31.		C	BH-31	17.01.20	27.01.20	27.50	354.501	1098.800	94.978	1.95
32.		C	BH-32	16.01.20	24.01.20	22.00	370.100	1120.300	95.350	1.40
33.		C	BH-33	28.01.20	01.02.20	16.69	370.100	1074.399	95.065	1.95
34		-	PLT-01	12.05.20	13.05.20	1.80	313.954	1179.194	95.220	1.58
35		-	PLT-02	08.05.20	09.05.20	1.80	375.030	1203.258	94.969	1.00
36		-	ERT-01	13.05.20	13.05.20	-	342.000	1137.300	95.025	-

* RL – Reduced Level, which also refers Natural Ground Level (NGL) of particular position.

*GWT–Ground Water Table.

* DOS – Date of Start.

* DOC – Date of Completion.

Geological Information:

Talcher also named as City of Black Diamond or Coal City of Odisha is one of the fastest growing industrial and coal hubs in the state. Because of its huge coal reserves, the city has been ranked among the highest in terms of GDP in Odisha. It is also one of the 4 sub-divisions of Angul district in the Indian state of Odisha. Situated on the right bank of the river Brahmani, it is one of the fastest growing industrial and mining complexes of the country. The city is surrounded by the coalfields under MCL (Mahanadi Coalfields Limited) and has three Mega Power plants like NTPC, TTPS. Jindal power plant (FCIL), set up **Talcher** Unit over an area of 902 acre in the district of Angul, **Odisha** which is located about 126 km away from **Bhubaneswar** to produce urea using coal as feed stock. ... 1980 with Ammonia and Urea production capacity of 900 and 1500 Tons per day respectively.The “Talcher Fertilizers Limited” (TFL), a consortium of four state-run companies GAIL, CIL, RCF and FCIL was established in December 2014 to revive the Talcher unit. Joint Venture Company was incorporated on 27.10.2015 with contributing equity of GAIL, CIL and RCF being 29.67% each while FCIL retaining 10.99% equity. Projects & Development India Limited (PDIL) is the PMC for the project.

History:

A legend states that Talcher was founded in the 12th century by one of four brothers belonging to the Kachwaha Rajput dynasty of Jaipur who were on a pilgrimage to Puri; during the same journey another brother became the ruler of Bonai State and two others were killed.At the time of the British Raj Talcher was one among the 26 feudatory states of Odisha.The state's accession to the Indian Union was signed by its last ruler Hrudaya Chandra Dev Birabar on 1 January 1948.

Population Density:

As of 2011 India census, Talcher had a population of 40,841 . Males constitute 55% of the population and females 45%. Talcher has an average literacy rate of 75%, higher than the national average of 59.5%: male literacy is 80%, and female literacy is 62%. In Talcher, 12% of the population is under 6 years of age.

Climate:

The Talcherlies on 92m above sea level Talcher's climate is classified as tropical. The summers are much rainier than the winters in Talcher. According to Köppen and Geiger, this climate is classified as Aw. The average annual temperature is 27.0 °C | 80.7 °F in Talcher. About 1307 mm | 51.5 inch of precipitation falls annually.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	20.9	23.4	27.9	31.8	33.5	31.4	28.4	28.2	28.5	26.9	23.3	20.3
Min. Temperature (°C)	14	16.4	20.6	24.9	27	26.6	25.4	25.3	25.2	22.8	17.6	13.6
Max. Temperature (°C)	27.8	30.5	35.2	38.8	40	36.3	31.4	31.2	31.8	31.1	29	27.1
Avg. Temperature (°F)	69.6	74.1	82.2	89.2	92.3	88.5	83.1	82.8	83.3	80.4	73.9	68.5
Min. Temperature (°F)	57.2	61.5	69.1	76.8	80.6	79.9	77.7	77.5	77.4	73.0	63.7	56.5
Max. Temperature (°F)	82.0	86.9	95.4	101.8	104.0	97.3	88.5	88.2	89.2	88.0	84.2	80.8
Precipitation / Rainfall (mm)	10	31	32	33	50	195	293	327	224	90	19	3

Potential geology Hazards

The Project site dose not posses any type of Potential geological hazards.

Site Surface Description:

- According to the Topography of site location (CMD & Coal gasification unit) the terrain was observed to be Sub-undulated to flat terrain.
- Due to the recent rain fall, the site location posses some patches of water logging with the depth of water 30cm around.

Description of above ground Obstructions:

- Since the above ground surface was leveled, there is no presence of above ground obstacles except some patches of water logging due to difference in ground levels.

b) Subsurface Conditions:

- As per the scope and contract conditions 33 no's of Boreholes were executed in this CMD & Coal Gasification unit and corresponding RL (in mtr) were recorded and tabulated in location details and log sheets.
- Center to Center distance between proposed BH positions was around 20-25m and since the BH'S were executed at closely spaced, there is no difference in soil strata inside boreholes.

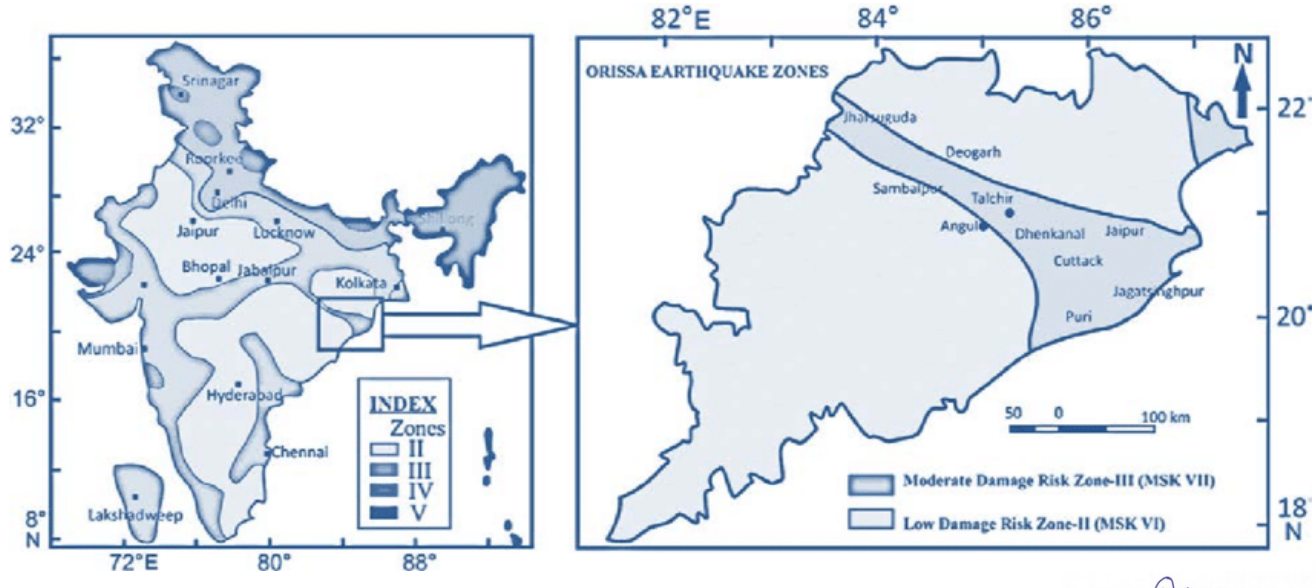
- The top surface layer consists of clayey sand which is dense to very dense in condition upto an average depth of 3.00m. Mostly the ground water table was encountered in the top surface layer.
- Underlain the top layer, there is a presence of compact clay with 'N' value greater than 100. The condition of soil strata is very hard upto an average depth of 6.50m followed by weathered Rock, Sandstone & Claystone.
- Difference in soil strata w.r. to ground levels and water table has been represented in a profile manner (please refer sub-soil profile)

Analysis & Discussion of Chemical Nature:

- Ground water quality is accessed on the basis of water samples collected from site. As per analysis of Ground water from the test results sulphate content is less than 400 mg/l and chloride content is less than 500 mg/l, hence the ground water may be used for construction purpose.
- The chemical analysis test result reveals that the sub-soil/ground water is not aggressive against chemical attack on sub-structures. Hence, no special precautions/remedial measures are required for underground reinforced concrete structure, steel or any other building material.

Seismic Hazard:

- As per seismic hazard map of India (refer figure below), the project site (Talcher, Odisha) lies in Moderate Damage Risk Zone-III.
- As per IS:1893 the type of soil encountered in project site is Type-I (Rock or Hard Soil Strata) as per Figure-2.



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SCOPE OF WORK

The Geo-Technical Investigation consists of advancement of 33 boreholes at proposed CMD & Coal Gasification Unit. The boreholes were drilled upto required depths as per contract requirement and based on the level of the founding in which the foundations for the proposed structures & sub-structures, leading to their economical and safe design.

The Scope of work for the Field Investigation was as follows:

1. Advancement of 33 boreholes at the specified locations as per the tender terms & conditions.
2. Record the soil conditions encountered in the boreholes.
3. Conducting Standard Penetration test (SPT), collection of undisturbed (UDS) &disturbed (DS) soil samples from boreholes.
4. Conducting other allied activities of Soil Investigation as per tender requirement.
5. Conducting laboratory test on collected soil samples as per Bill of Quantities proposed.
6. Analysis of Field and laboratory tests data and provide geotechnical characterization of the soils encountered.
7. Preparation & Submission of the Geotechnical Investigation report, with appropriate descriptions of the existing Soil encountered in the boreholes advanced for the investigation and provide recommendations with respect to the implications for construction of Buildings and Structures etc., in CMD & Coal Gasification Unit.

EXPLORATION TECHNIQUE

i. Soil exploration was conducted with 150mm dia. boreholes. The bore were done with Rotary calyx technique as per IS 1892-1962. The top of the borehole is taken from the actual bed level at the time of boring. Standard Penetration tests were conducted at every required interval using Standard split spoon sampler driven by a 63.5 kg hammer with free fall height of 750 mm as per IS 2131-1963. The results are recorded and represented graphically in logs of boreholes. Undisturbed & disturbed sample were collected in plastic bags for visual inspection and classification of strata from all the layers as recorded in log sheets of boreholes.

ii. Collection representative undisturbed/disturbed soil samples from the exploratory boreholes for carrying out detailed laboratory analysis, which would help finalization of design soil parameters and foundation type.

iii. Carrying out standard penetration tests as per the provisions laid down in IS:2131-1981 in the holes and subsequently maintaining penetration chart depth-wise upto the test depth in each of the 1 nos. Exploratory bore holes at locations.

BORING METHOD

Boreholes were dug in CMD Areas are as per direction of Engineer-in-charge.
The boreholes of 150mm dia. in soil & rocky strata upto the desired depth are indicating in borelog data sheet.
The boring was done by using Rotary calyx core drilling 04 no's & Tractor mount 01 no.
The drilling was stopped on reaching the specified depth within the layer.

CORE DRILLING (as per IS 6926:1996)

Core drilling was done where the formation encountered is too hard to be sampled by any soil sampling methods. The switching over from soil sampling method to core drilling should be normally done in accordance with the guidelines given in IS-2131:1981 and IS-2132:1986. However, the final decision should be taken by the geologist and engineer-in-charge of the site.
Casing was seated on bedrock or in a firm formation to prevent travelling of the borehole and to prevent loss of drilling fluid. Surface of the rock or hard formation at the bottom of the casing, was leveled, when necessary, using the appropriate bits. The core drilling may be carried out by an NX-size double-

tube swivel-type core barrel approved by the engineer-in-charge. Core drilling was continued until core blockage occurs or until the net length of the core barrel has been drilled in.

The recovered core was placed in the core box with the upper (surface) end of the core. at the upper-left corner of the core box. The cores with proper markings is placed into core boxes at appropriate spacing's, with blocks. Soft or friable cores, or those which change materially upon drying, was wrapped in plastic film or seal in wax, or both as required by the engineer. Spacer blocks or slug properly marked are used to indicate any noticeable gap in recovered cores which might indicate a change or void in the formation. The fractured, bedded and/or jointed pieces of the core should be reassembled in the sequential order of their recovery before keeping the same in the core box.

Core drilling was stopped when soft materials are encountered that produce less than 50 percent recovery. If necessary, samples of soft materials was taken as per IS-2131:1981 and IS-2132:1986 in consultation with geologist or engineer-in-charge. Diamond core drilling was resumed when hard formation is again encountered.

Sub-surface structures, including the dip of strata, the occurrence of seams, fissures, cavities and broken areas are among the most important items to be detected and described. Special care was taken to obtain and record information about these features. The core samples was properly logged into the cores boxes as per IS 1892:1979.

FIELD TEST

1. Standard Penetration Tests (as per IS.2131)

These tests were conducted by using split spoon sampler, which consists of a driving shoe, a split-barrel of circular cross-section which is longitudinally split into two parts and a coupling. IS: 2131-1981 gives the standard for carrying out the test.

Procedure:

1. The borehole is advanced to the required depth and the bottom cleaned.
2. The split-spoon sampler, attached to standard drill rods of required length is lowered into the borehole and rested at the bottom
3. The split-spoon sampler is driven into the soil for a distance of 750mm by blows of a drop hammer (monkey) of 63.5 kg falling vertically and freely from a height of 750 mm. The number of blows required to penetrate every 150 mm is recorded while driving the sampler. The number of blows required for the last 300 mm of penetration is added together and recorded as the N value at that particular depth of the borehole. The number of blows required to effect the first 150mm of penetration, called the seating drive, is disregarded.
4. The split-spoon sampler is then withdrawn and is detached from the drill rods. The split-barrel is disconnected from the cutting shoe and the coupling. The soil sample collected inside the split barrel is carefully collected so as to preserve the natural moisture content and transported to the laboratory for tests. Sometimes, a thin liner is inserted within the split-barrel so that at the end of the SPT, the liner containing the soil sample is sealed with molten wax at both its ends before it is taken away to the laboratory.5. The SPT is carried out at every 0.75 m vertical intervals in a borehole. This can be increased to 1.50 m if the depth of borehole is large. Due to the presence of boulders or rocks, it may not be possible to drive the sampler to a distance of 450 mm. In such a case, the N value can be recorded for the first 300 mm penetration. The boring log shows refusal and the test is halted if
   a) 50 blows are required for any 150mm penetration b) 100 blows are required for 300m penetration
   c) 10 successive blows produce no advance.

2. Undisturbed Sample (as per IS - 2132)

In each borehole undisturbed sample(UDS) shall be collected at regular intervals of 3m .The starting depth of collecting UDS shall be either 2.5m (where starting depth of SPT is 1m) or 1m (where starting depth of SPT is 2.5m) depth below ground level. The starting depth shall be staggered in alternate boreholes. Undisturbed samples shall be of 100mm diameter and 450mm length. Samples shall be collected in such a manner that the structure of soil and its moisture content do not get altered. The specification for the accessories required for sampling and the sampling procedure shall conform to IS:1892 and IS:2132.

3. Disturbed Samples

Representative disturbed sample obtained from boring at every 1.5m interval in depth or change in stratum shall be placed in suitable sampling covers labeled properly for onward transmission to the laboratory. This sample shall be sent to the laboratory immediately after the boring is completed. All SPT samples shall also be similarly preserved.

4. Plate Load Test Procedure (AS PER IS 1888-1982)

Two no's of Electrical Resistivity test were conducted in the field at CMD Area to determine the resistance to flow of an electric current through the sub surface material at interval of ground surface.

5.0 Electrical Resistivity Test (IS: 3043, 1966)

One no of Electrical Resistivity test was conducted in the field at CMD Area by Electrical resistivity method to determine the resistance to flow of an electric current through the sub surface material at interval of ground surface.

LABORATORY TESTING TECHNIQUE (AS PER IS)

The soil samples collected from the boreholes were tested in the laboratory and the field tests conducted at the site. The following tests were conducted.

a. Moisture content (IS - 2720 Pt. II)

Natural Moisture contents were obtained by oven drying method and the results are tabulated in Annexure-A.

b. Bulk and dry density

The bulk and dry density with saturated and buoyant density of samples are tabulated.

c. Grain Size Distribution (IS - 2720 Pt. IV)

Both sieve size analysis and hydrometer analysis were conducted on different sample sand the findings are tabulated. Grain size classification scale confirms Indian Bureau of Standards (IS:1498).

d. Specific Gravity (IS-2720 Pt.III-2)

Specific gravity values were obtained by pycnometer method/Density Bottle method and the results are tabulated.

e. Atterberg's Limits (IS - 2720 Pt. V)

The consistency limits are the water contents at which the soil mass passes from one state to another. The soil mass interaction has four states of consistency limits. The Atterberg's limits useful for engineering purposes are Liquid Limit &Plastic Limit, which are tabulated along with other index properties.

f. Direct Shear Tests - IS 2720 (Part XIII)

These tests were done on identical sandy samples by shear box apparatus which was an undrained test. Shearing force was applied by increasing the successive load until the failure takes place. The plane of shear failure was determined & the graph is attached.

g. Tri-axial Shear Test (IS - 2720 Pt.XII)

This test was done by triaxial apparatus on all undisturbed &remolded soil samples of cylindrical shape, subjected to direct stress acting in three mutually perpendicular direction viz. Major principal stress in vertical direction and minor principal stress failure is determined. This test gives more accurate & precise result of C & Φ due to uniform stress distribution of fluid from the empirical formula

($\sigma 1 = \sigma 3 \tan 2\Phi + 2c \tan \Phi$).

h. Void Ratio (IS-2386 Pt.III-1963)

The percentage of voids shall be calculated as follows:

Percentage of voids = (V_v/V_s)

where, V_v = Volume of Void Space ; V_s =Volume of Solids.

i. Unconfined Compression Tests (IS-2720 Pt.-X)

This was generally performed on selected cohesive soil depends on shear characteristic of the soil which can be determined from the unconfined compression test result. Effective stress parameters (C & Φ) were determined from the failure envelope.

j. Permeability Test (IS-2720 Pt.-17)

This test is to determine the permeability (hydraulic conductivity) of a sandy soil by the constant head test method.

Permeability (or hydraulic conductivity) refers to the ease with which water can flow through a soil. This property is necessary for the calculation of seepage through earth dams or under- sheet pile walls, the calculation of the seepage rate from waste storage facilities (landfills, ponds, etc.), and the calculation of the rate of settlement of clayey soil deposits.

k. Water content of Rock (IS-13030-1991)

Water contents of rock test were obtained in our laboratory by oven drying method and the results are tabulated.

l. Density of Rock (IS-13030-1991

The density test of rock was obtained in our laboratory and the results are tabulated.

m. Porosity of Rock (IS-13030-1991

The Porosity test of rock was obtained in our laboratory and the results are tabulated.

n. Permeability of Rock (IS-5229-1-1985

The Permeability test of rock was obtained in our laboratory and the results are tabulated.

o. UCS Test of Rock (IS-9143-1-1979

The Unconfined Compressive Strength test of rock was obtained in our laboratory and the results are tabulated.

p. Mohr's Scale of hardness Test of Rock (IS-13630-13-2006

The Mohr's Scale of hardness test of rock was obtained in our laboratory and the results are tabulated.

q. Shear Strength Test of Rock (IS-1121-IV-1974

The Shear Strength test of rock was obtained in our laboratory and the results are tabulated.

r. Mineralogical & Petro logical Test of Rock (IS-2386-8-1963

The Mineralogical & Petro logical Test rock was obtained in our laboratory and the results are tabulated.

CHEMICAL ANALYSIS OF WATER

a. pH Tests- IS 3025 (Pt.-11)

The pH value of water was determined as per IS code 3025 Part-11 and results are tabulated.

b. Chloride Tests- IS 3025 (Pt.-32)

The chloride content was tested in our laboratory as per IS code 3025 Part-32 and results are tabulated.

c. Sulphate Tests- IS 3025 (Pt.-24)

The sulphate content was tested in our laboratory as per IS code 3025 Part-24 and results are tabulated.

d. Carbonate Tests- IS 3025 (Pt.-51)

The Carbonate content was tested in our laboratory as per IS code 3025 Part-51 and results are tabulated.

e. Magnesium Test-IS 3025 (Pt.-46)

The Magnesium content was tested in our laboratory as per IS code 3025 Part-46 and results are tabulated.

f. Ammonium Test-IS 3025 (Pt.-34)

The Ammonium content was tested in our laboratory as per IS code 3025 Part-34 and results are tabulated.

DESIGN PARAMETERS

- Since the project site is having uniform Sub-Soil stratification, for CGU area boreholes grouped into two zones viz., Zone-01 (BH-01 to BH-14 & BH-16 to BH-33) & Zone-02 (BH-15). Based on bore logs, Field & Laboratory Test results, the following Design Soil Profile has been used for the analysis of Open Foundation and Pile Foundations:

ZONE-01(BH-01 to 14 & BH-16 to 33)

Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	DensityY_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Clayey Sand	NGL to 3.15	39 to 83	3.15	0.10	23	31	1.90
2	Compact Clay	3.15 to 6.51	96 to >100	3.36	0.52	2	43	1.79
3	Weathered Rock (Clay stone)	6.51 to 10.64	>100	4.13	Completely Weathered (Sedimentary Rock)			
4	Sandstone	10.64 to 16.92	>100	6.28	Completely to Moderately Weathered (Sedimentary Rock)			
5	Clay stone	16.92 to 21.55	>100	4.63	Highly to completely Weathered (Sedimentary Rock)			

* Table 1.1

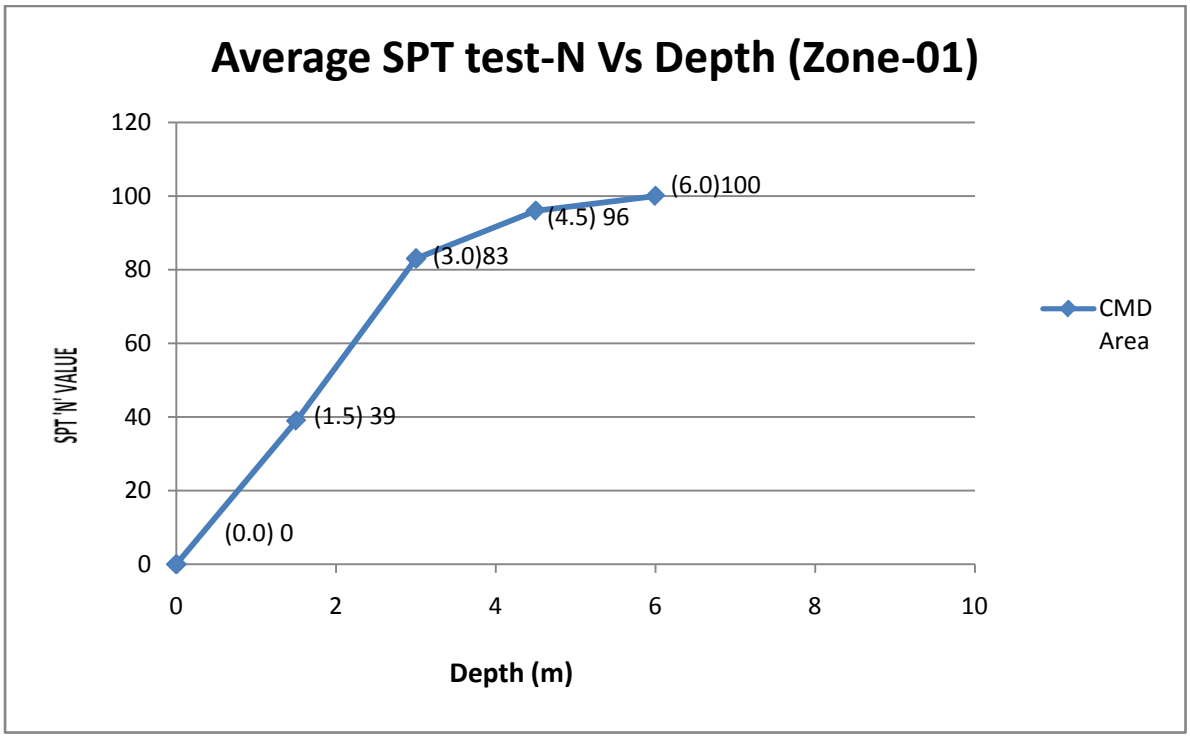
ZONE-02 (BH-15)

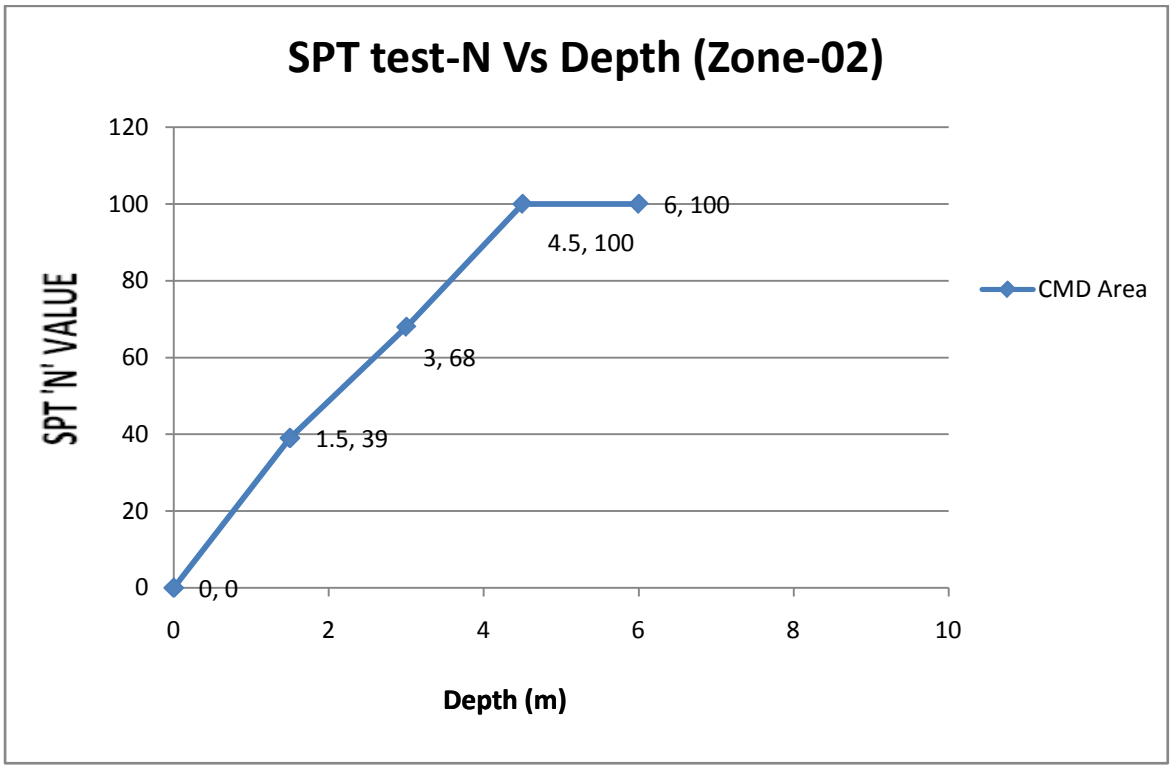
Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	DensityY_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Clayey Sand	NGL to 3.00	39 to 68	3.00	0.11	22	32	1.93
2	Compact Clay	3.00 to 8.00	>100	5.00	0.54	0	41	1.78
3	Weathered Rock (Clay stone)	8.00 to 17.90	>100	9.90	Highly to Moderately Weathered (Sedimentary Rock)			
4	Clay stone	17.90 to 27.40	>100	9.50	Completely Weathered (Sedimentary Rock)			

* Table 1.2

Note:

Rock classification is based on RQD % of rock.


Average SPT test-N Vs Depth (Zone-01)
120
100
80
60
40
20
0
SPT 'N' VALUE
0
2
4
6
8
10
Depth (m)
(0.0) 0
(1.5) 39
(3.0)83
(4.5) 96
(6.0)100
CMD Area


SPT test-N Vs Depth (Zone-02)
120
100
80
60
40
20
0
SPT 'N' VALUE
0
2
4
6
8
10
Depth (m)
0, 0
1.5, 39
3, 68
4.5, 100
6, 100
CMD Area

ANALYSIS OF STRATUM

LOCATION: (CMD & Coal Gasification Unit Area)

Zone-01

BH-01 to 14 & BH-16 to 33

Stratum	Average Depth Range (max21.55m)	'N' Value	Type of soil	State
I	0.00-3.15	39 to 83	Clayey sand	Dense to Very Dense
II	3.15-6.51	96 to >100	Compact clay	Very Hard
III	6.51-10.64	>100	Weathered Rock	Sedimentary Rock
IV	10.64-16.92	>100	Sand stone	Sedimentary Rock
V	16.92-21.55	>100	Clay stone	Sedimentary Rock

Zone-02

BH-15

Stratum	Average Depth Range (max27.40m)	'N' Value	Type of soil	State
I	0.00-3.00	39 to 68	Clayey sand	Dense to Very Dense
II	3.00 - 8.00	>100	Compact clay	Very Hard
III	8.00 - 17.90	>100	Weathered Rock	Sedimentary Rock
V	17.90 - 27.40	>100	Clay stone	Sedimentary Rock

COEFFICIENT FRICTION BETWEEN SOIL AND CONCRETE FOUNDATION:

Location-CMD & CGU Area

Zone-01

(BH-01 to 14 & 16 to 33)

Description of Strata	Coefficient of friction (μ)	
	Minimum	Maximum
Clayey sand	0.35	0.45
Compact clay	0.30	0.35
Weathered Rock/ Sand stone/ Clay stone	0.65	0.70

Zone-02

(BH-15)

Description of Strata	Coefficient of friction (μ)	
	Minimum	Maximum
Clayey sand	0.35	0.45
Compact clay	0.30	0.35
Weathered Rock/ Clay stone	0.65	0.70

DYNAMIC PROPERTIES OF SOIL

POISSON'S RATIO- (μ)

Poisson's ratio is worked out from lateral strain (E_3) to axial strain (E_1) by Triaxial Compression Test apparatus on soil sample of cylindrical shape, subjected to direct acting in three mutually perpendicular direction viz, major principal stress in vertical direction and minor principal stress in lateral direction by fluid pressure and the plane shear failure is determined and test result is tabuled.

Poisson's ratio (μ) = E_3/ E_1

MODULUS OF ELASTICITY-(E)

Modulus of elasticity is obtained from the formula given below;

$$\delta L = PL_0/A_0E$$

$$E = PL_0/(A_0 \times \delta L)$$

SHEAR MODULUS-(G)

Shear Modulus is determined as per IS code 5249:1992 and result is tabulated.

$$G = E/2(1+\mu)$$

BULK MODULUS-(B)

(From Soil mechanics by T.William Lambe & Robert V.Whitman)

$$B = E/3(1-2E)$$

BH No:-15

Parameter	Results
Poisson's Ratio(μ)	0.32
Modulus of Elasticity (E) in kg/cm^2	640.00
Shear Modulus (G) in kg/cm^2	245.59
Bulk Modulus (B) in kg/cm^2	593.01

SHEAR WAVE VELOCITY)

The Shear Wave Velocity at site is 1050 m/s.

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.1, the following are the analysis of safe bearing capacity in open foundation:

Zone-01(BH No: 01 to 14 & 16 to 33)

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
CMD & Coal Gasification Unit (Zone-01)	1.50	Up to 3.0	30.94	40.03	64.05	120.10
		>3.0 to <6.0	33.55	36.72	58.75	110.16
	2.00	Up to 3.0	36.30	37.42	59.87	112.26
		>3.0 to <6.0	38.56	33.89	54.22	101.67
	3.00	Up to 3.0	47.46	39.02	62.44	117.07
		>3.0 to <6.0	48.85	34.37	55.00	103.12
	4.00	Up to 3.0	25.66	31.35	50.16	94.04
		>3.0 to <6.0	24.49	29.63	47.40	88.88
	5.00	Up to 3.0	27.39	25.70	41.12	77.10
		>3.0 to <6.0	25.05	25.25	40.41	75.76

* Table No. 1.3

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ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.1, the following are the analysis of safe bearing capacity in open foundation:

BH No: 01 to 14 & 16 to 33

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
CMD & Coal Gasification Unit (Zone-01)	1.50	5 x 1	25.82	56.37	90.19	169.10
		10 x 2	26.02	38.92	62.27	116.76
		15 x 3	27.20	36.09	57.74	108.27
		20 x 4	28.92	35.49	56.78	106.47
		25 x 5	30.78	34.83	55.74	104.50
		30 x 6	32.71	43.07	68.91	129.20
	2.00	5 x 1	31.70	45.81	73.29	137.42
		10 x 2	30.65	35.23	56.37	105.70
		15 x 3	31.67	32.65	52.25	97.96
		20 x 4	33.22	31.92	51.06	95.75
		25 x 5	34.97	31.18	49.89	93.55
		30 x 6	36.83	38.46	61.53	115.38
	3.00	5 x 1	44.58	31.25	50.00	93.75
		10 x 2	40.86	35.97	57.56	107.92
		15 x 3	41.00	33.35	53.36	100.06
		20 x 4	42.10	31.67	50.68	95.02
		25 x 5	43.59	30.69	49.11	92.08
		30 x 6	45.27	37.61	60.18	112.84
	4.00	5 x 1	27.38	28.70	45.93	86.11
		10 x 2	21.75	30.79	49.27	92.38
		15 x 3	19.93	27.92	44.68	83.77
		20 x 4	19.06	26.52	42.43	79.56
		25 x 5	18.57	25.43	40.69	76.30
		30 x 6	18.27	30.78	49.24	92.33
	5.00	5 x 1	30.64	25.68	41.09	77.05
		10 x 2	23.58	25.79	41.79	77.38
		15 x 3	21.28	24.35	38.96	73.06
		20 x 4	20.17	22.49	35.98	67.47
		25 x 5	19.54	21.58	34.53	64.75
		30 x 6	19.14	25.92	41.48	77.77

* Table No. 1.4

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Mat Foundation:

BH No: 01 to 14 & 16 to 33

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
CMD & Coal Gasification Unit (Zone-01)	1.50	6 x 6	35.03	44.98	71.96
		10 x 10	41.30	42.65	68.25
		15 x 15	49.40	40.88	65.41
		20 x 20	57.58	39.65	63.44
		25 x 25	65.79	38.55	61.68
		30 x 30	74.03	37.55	60.08
		12 x 6	31.62	43.94	70.31
		20 x 10	36.25	42.08	67.33
		30 x 15	42.29	40.64	65.02
		40 x 20	48.41	39.47	63.15
		50 x 25	54.56	38.42	61.46
		60 x 30	60.73	37.44	59.90
	2.00	6 x 6	39.96	40.94	65.51
		10 x 10	46.05	38.21	61.14
		15 x 15	54.06	36.45	58.32
		20 x 20	62.20	35.17	56.27
		25 x 25	70.39	34.16	54.65
		30 x 30	78.60	33.24	53.19
		12 x 6	36.51	39.52	63.24
		20 x 10	40.97	37.52	60.03
		30 x 15	46.92	36.04	57.66
		40 x 20	53.00	34.96	55.93
		50 x 25	59.13	34.00	54.39
		60 x 30	65.28	33.11	52.98
	3.00	6 x 6	50.02	41.78	66.76
		10 x 10	55.68	37.46	59.94
		15 x 15	63.47	35.09	56.15
		20 x 20	71.50	33.45	53.52
		25 x 25	79.62	32.12	51.39
		30 x 30	87.80	30.97	49.56
		12 x 6	46.51	39.47	63.15
		20 x 10	50.54	36.42	58.27
		30 x 15	56.28	34.45	55.13
		40 x 20	62.25	33.00	52.80
		50 x 25	68.32	31.83	50.92
		60 x 30	74.42	30.79	49.26

* Table No. 1.5

BISHOW KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES BHUBANESWAR-17 SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Mat Foundation:

BH No: 01 to 14 & 16 to 33

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
CMD & Coal Gasification Unit (Zone-01)	4.00	6 x 6	23.53	35.27	56.43
		10 x 10	22.81	31.17	49.86
		15 x 15	22.66	28.40	45.44
		20 x 20	22.76	26.82	42.91
		25 x 25	22.95	25.57	40.92
		30 x 30	23.19	24.52	39.23
		12 x 6	21.81	33.00	52.80
		20 x 10	21.10	29.64	47.43
		30 x 15	20.90	27.70	44.33
		40 x 20	20.93	26.33	42.13
		50 x 25	21.05	25.20	40.33
		60 x 30	21.21	24.24	38.73
	5.00	6 x 6	24.67	30.26	48.41
		10 x 10	23.70	26.15	41.84
		15 x 15	23.43	23.39	37.43
		20 x 20	23.46	21.69	34.70
		25 x 25	23.62	20.45	32.71
		30 x 30	23.84	19.42	31.07
		12 x 6	22.90	27.76	44.41
		20 x 10	21.96	24.74	39.58
		30 x 15	21.65	22.58	36.13
		40 x 20	21.62	21.19	33.90
		50 x 25	21.72	20.07	32.12
		60 x 30	21.85	19.12	30.60

* Table No. 1.6

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.2, the following are the analysis of safe bearing capacity in open foundation:

Zone-02

BH No: 15

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
CMD & Coal Gasification Unit (Zone-02)	1.50	Up to 3.0	29.91	39.58	63.34	118.75
		>3.0 to <6.0	32.24	36.27	58.03	108.80
	2.00	Up to 3.0	34.91	39.08	62.53	117.24
		>3.0 to <6.0	36.90	35.14	56.22	105.41
	3.00	Up to 3.0	45.33	52.60	84.15	157.79
		>3.0 to <6.0	46.47	47.00	75.21	141.01
	4.00	Up to 3.0	23.98	43.56	69.70	130.69
		>3.0 to <6.0	22.23	42.01	67.21	126.03
	5.00	Up to 3.0	25.57	35.09	56.15	105.27
		>3.0 to <6.0	23.35	35.25	56.40	105.76

* Table No. 1.7

ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.2, the following are the analysis of safe bearing capacity in open foundation:

BH No: 15

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
CMD & Coal Gasification Unit (Zone-02)	1.50	5 x 1	25.08	51.69	82.70	155.07
		10 x 2	24.92	37.04	59.26	111.12
		15 x 3	26.12	35.68	57.09	107.05
		20 x 4	27.66	34.75	55.60	104.24
		25 x 5	29.35	34.41	55.05	103.22
		30 x 6	31.10	42.74	68.38	128.22
	2.00	5 x 1	30.62	42.69	68.31	128.08
		10 x 2	29.43	34.27	54.84	102.82
		15 x 3	30.30	34.10	54.57	120.31
		20 x 4	31.67	32.77	52.43	98.31
		25 x 5	33.25	32.33	51.73	97.00
		30 x 6	34.93	40.07	64.11	120.21
	3.00	5 x 1	42.73	28.70	45.93	86.11
		10 x 2	38.98	41.20	65.92	123.59
		15 x 3	38.99	44.95	71.92	134.86
		20 x 4	39.94	43.01	68.82	129.03
		25 x 5	41.26	41.97	67.15	125.91
		30 x 6	42.77	51.79	82.86	155.37
	4.00	5 x 1	25.66	28.70	45.93	86.11
		10 x 2	20.36	43.97	70.35	131.91
		15 x 3	18.64	38.80	62.09	116.41
		20 x 4	17.81	37.29	59.67	111.88
		25 x 5	17.34	36.07	57.70	108.20
		30 x 6	17.06	43.99	70.39	131.98
	5.00	5 x 1	28.69	28.70	45.93	86.11
		10 x 2	22.05	35.02	56.03	105.06
		15 x 3	19.88	33.25	53.20	99.76
		20 x 4	18.83	31.06	49.69	93.17
		25 x 5	18.23	30.13	48.21	90.39
		30 x 6	17.85	36.67	58.67	110.01

* Table No. 1.8

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Mat Foundation:

BH No: 15

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
CMD & Coal Gasification Unit (Zone-02)	1.50	6 x 6	33.58	44.64	71.42
		10 x 10	39.27	43.03	68.84
		15 x 15	46.65	41.95	67.12
		20 x 20	54.12	41.33	66.13
		25 x 25	61.61	40.81	65.30
		30 x 30	69.13	40.34	64.54
		12 x 6	30.35	43.61	69.78
		20 x 10	34.55	42.45	67.91
		30 x 15	40.05	41.70	66.72
		40 x 20	45.63	41.15	65.84
		50 x 25	51.25	40.67	65.07
		60 x 30	56.88	40.22	64.35
	2.00	6 x 6	38.15	42.66	68.26
		10 x 10	43.68	40.49	64.79
		15 x 15	50.97	39.26	62.82
		20 x 20	58.40	38.49	61.58
		25 x 25	65.87	37.96	60.74
		30 x 30	73.37	37.50	59.99
		12 x 6	34.90	41.18	65.89
		20 x 10	38.94	39.76	63.61
		30 x 15	44.35	38.82	62.11
		40 x 20	49.89	38.26	61.21
		50 x 25	55.48	37.78	60.45
		60 x 30	61.10	37.35	59.76
	3.00	6 x 6	47.52	57.45	91.92
		10 x 10	52.62	52.59	84.15
		15 x 15	59.71	50.17	80.28
		20 x 20	67.02	48.68	77.89
		25 x 25	74.44	47.55	76.08
		30 x 30	81.89	46.60	74.55
		12 x 6	44.19	54.35	86.95
		20 x 10	47.82	51.13	81.80
		30 x 15	53.03	49.26	78.82
		40 x 20	58.47	48.03	76.84
		50 x 25	64.00	47.11	75.38
		60 x 30	69.58	46.32	74.11

* Table No. 1.9

BISHOW KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES 171 SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Mat Foundation:

BH No: 15

Location	Depth in 'm'	Width of Footing in 'm' (L x B)	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
CMD & Coal Gasification Unit (Zone-02)	4.00	6 x 6	21.82	50.41	80.66
		10 x 10	21.11	45.54	72.86
		15 x 15	20.93	42.44	67.91
		20 x 20	20.97	40.95	65.52
		25 x 25	21.11	39.87	63.79
		30 x 30	21.29	38.98	62.37
		12 x 6	20.22	47.17	75.47
		20 x 10	19.52	43.32	69.31
		30 x 15	19.30	41.40	66.24
		40 x 20	19.32	40.21	64.33
		50 x 25	19.37	39.29	62.87
		60 x 30	19.50	38.54	61.66
	5.00	6 x 6	22.83	42.80	68.48
		10 x 10	21.88	37.97	60.76
		15 x 15	21.58	35.07	56.10
		20 x 20	21.57	33.51	53.62
		25 x 25	21.67	32.52	52.03
		30 x 30	21.83	31.73	50.76
		12 x 6	21.17	39.26	62.81
		20 x 10	20.27	35.92	57.48
		30 x 15	19.94	33.85	54.16
		40 x 20	19.88	32.74	52.39
		50 x 25	19.93	31.93	51.08
		60 x 30	20.03	31.25	50.00

ALLOWABLE BEARING CAPACITY FROM PLATE LOAD TEST

Location	PLT No	Depth in (m)	Plate Size (m)	Footing size (m)	Allowable pressure from PLT graph(when st=25mm) For 25mm
CMD & Coal Gasification Unit	01	1.80	0.50	1	69.25
				2	47.85
				3	41.35
				4	38.65
				5	35.24
	02	1.80	0.50	1	63.25
				2	44.50
				3	39.25
				4	35.02
				5	32.24

* Table No. 1.11

- The Recommended value for the foundation at a depth

  1.80 m depth footing size 3 x 3 is 40.30 T/m^2 for 25 mm settlement.

  As per Client required

  2.00 m depth footing size 3 x 3 is 44.78 T/m^2 for 25 mm settlement

  2.50 m depth footing size 3 x 3 is 55.97 T/m^2 for 25 mm settlement

ANALYSIS OF LOAD CAPACITIES IN PILE FOUNDATION

BORED CAST IN-SITU PILE:

- The recommended Pile Capacity of bored cast-in-situ RCC Piles for different length and diameters shall be as follows:
- Pile cut-off level is considered as 2.00m below Natural Ground Level (NGL)
- Since the soil strata in this location (CMD & Coal Gasification Unit) has been possess Zone-01 the top soil as Clayey Sand (Dense in Nature) followed by Compact Clay and Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.12)
- Since the soil strata in this location (CMD & Coal Gasification Unit) has been possess Zone-02 the top soil as Clayey Sand (Dense in Nature) followed by Compact Clay and Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.13)

Zone-01(BH-01 to 14 & 16 to 33)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	8.00	301.74	100.76	8.80
0.50		342.27	114.32	9.78
0.60		427.53	142.83	11.74
0.75		565.92	189.14	14.67
0.80		614.85	205.52	15.65

* Table No. 1.12

Zone-02

(BH-15)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	8.00	295.46	100.24	8.80
0.50		334.71	113.74	9.78
0.60		417.05	142.14	11.74
0.75		550.19	188.28	14.67
0.80		597.14	204.60	15.65

* Table No. 1.13

DISCUSSION AND CONCLUSION

Based on the field and laboratory test results and the given recommendations the following are summarized:

- Since the project CMD & CGU site is having uniform Sub-Soil stratification, boreholes has been grouped in two zones viz., Zone-1 (BH-01 to 14 & 16 to 33) & Zone-2 (BH-15). Based on bore logs, Field & Laboratory Test results, the following Design Soil Profile has been used for the analysis of Open Foundation and Pile Foundations.

General Observation opinion:

- For CMD & CGU area in Zone-01 the top surface layer consists of Clayey sand which is dense to very dense in condition up to an average depth of 3.15m. Mostly the ground water table was encountered at a depth 1.25m to 2.25m.
- Undulation the top layer, there is a presence of compact clay with 'N' value greater than 100. The condition of soil strata is very hard upto an average depth of 6.55m followed by weathered Rock, Sand stone & Clay stone.
- For CMD & CGU area in Zone-02 the top surface layer consists of Clayey sand which is dense to very dense in condition up to an average depth of 3.15m.
- Undulation the top layer, there is a presence of compact clay with 'N' value greater than 100. The condition of soil strata is very hard upto an average depth of 6.55m followed by weathered Rock & Clay stone.
- Difference in soil strata w.r.to ground levels and water table has been represented in a profile manner (please refer sub-soil profile).
- At project site, it is observed that Sedimentary Rocks composition of Clay stone and Sandstone at deeper depths is present.
- From the analysis of rock tests, it is noted that moderate weathering is formed at entire area with sandstone (fine grained) followed by clay stone.
- Details of rock test details have been given in Annexure-B of the report.

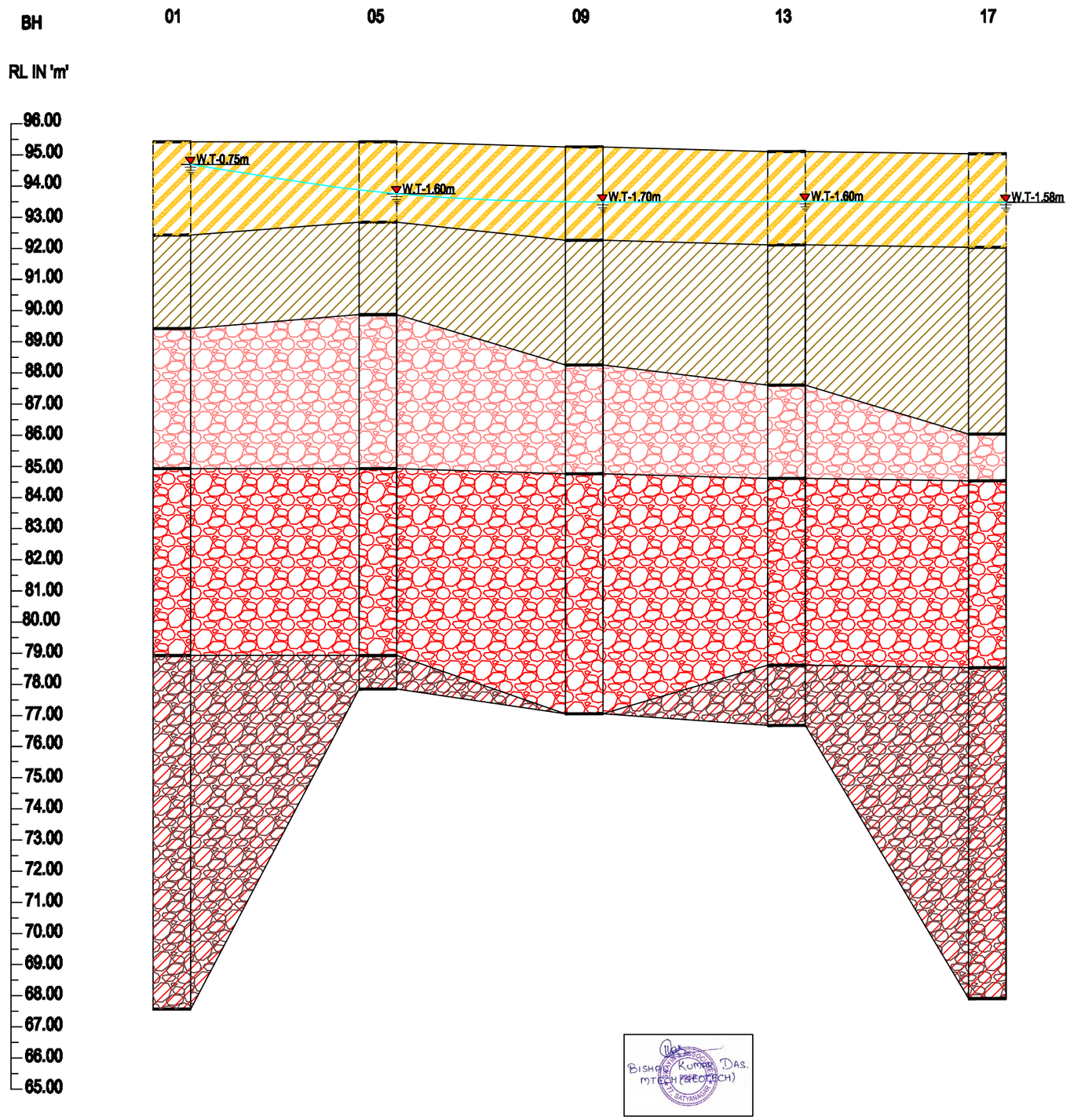
Recommendations for Foundation consideration:

- For lightly loaded structures in Zone-01(i.e., for structure loading upto 47 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.3
- For lightly loaded structures in Zone-02(i.e., for structure loading upto 45 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.7
- For heavy loaded structures i.e. Pile foundation please refer TABLE:- 1.12 & 1.13
- From the test results being performed (in-situ and laboratory), it is clear that there is no requirement of soil improvement in the site location. Moreover, the project site is not prone to liquefaction zone.

Suitability of the soils to be used as fill material:

- As per the laboratory test results the soil present at site location is clayey sand with slight plasticity. So it is recommended to use excavated soil as back filling material followed with layer to layer compaction upto maximum density.
- Since they will exhibit slight to no plasticity the soils can be compacted to fairly good compaction and provides good backfill and foundation support.
- For CMD & CGU Area the natural ground water table is available at minimum depth of 1.25m to maximum 2.25m.

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
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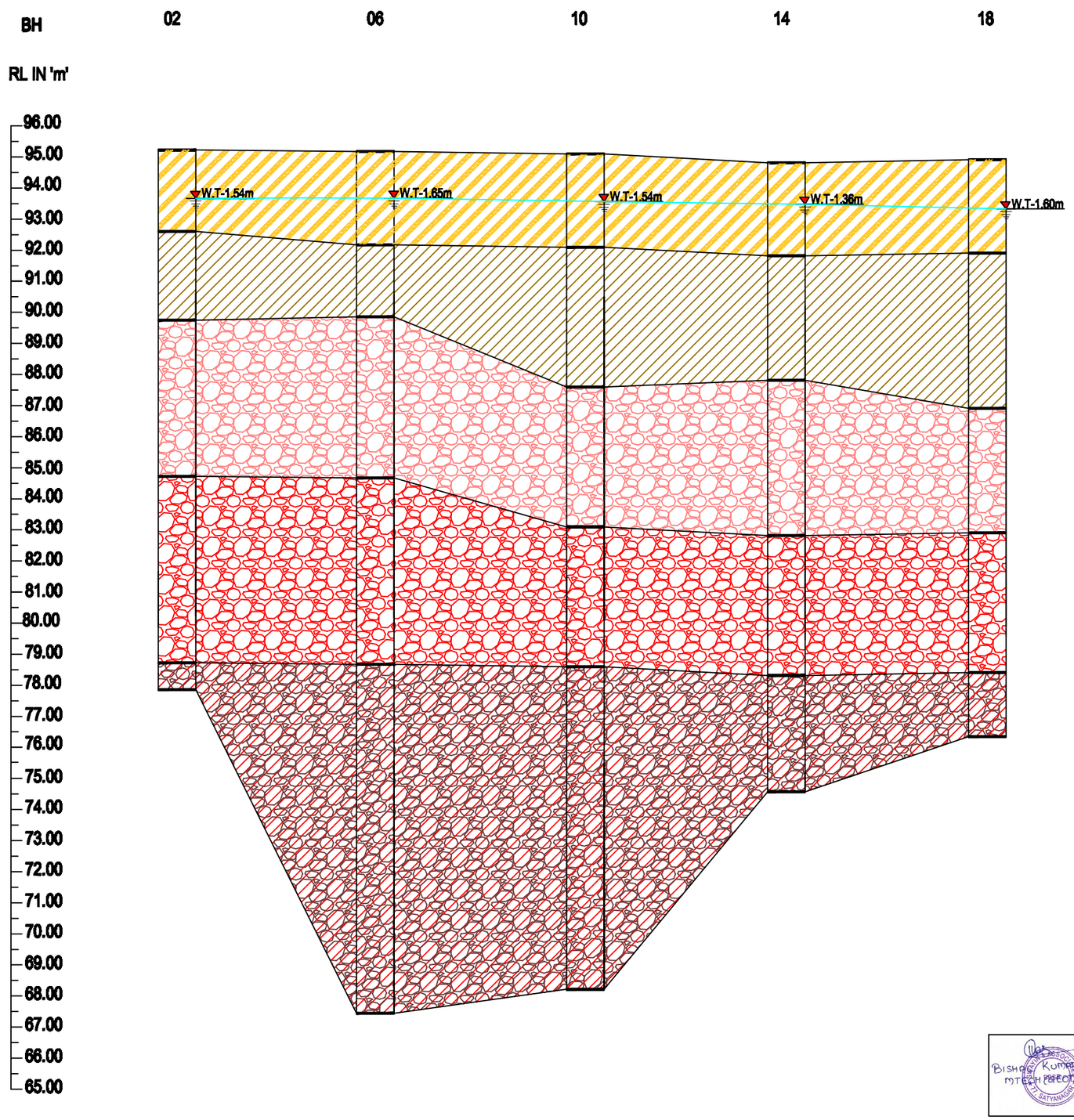
LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	01 TO 17

SUB-SOIL & CROSS PROFILE



BISHNU KUMAR DAS. M.TECH (GEOTECH)

LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

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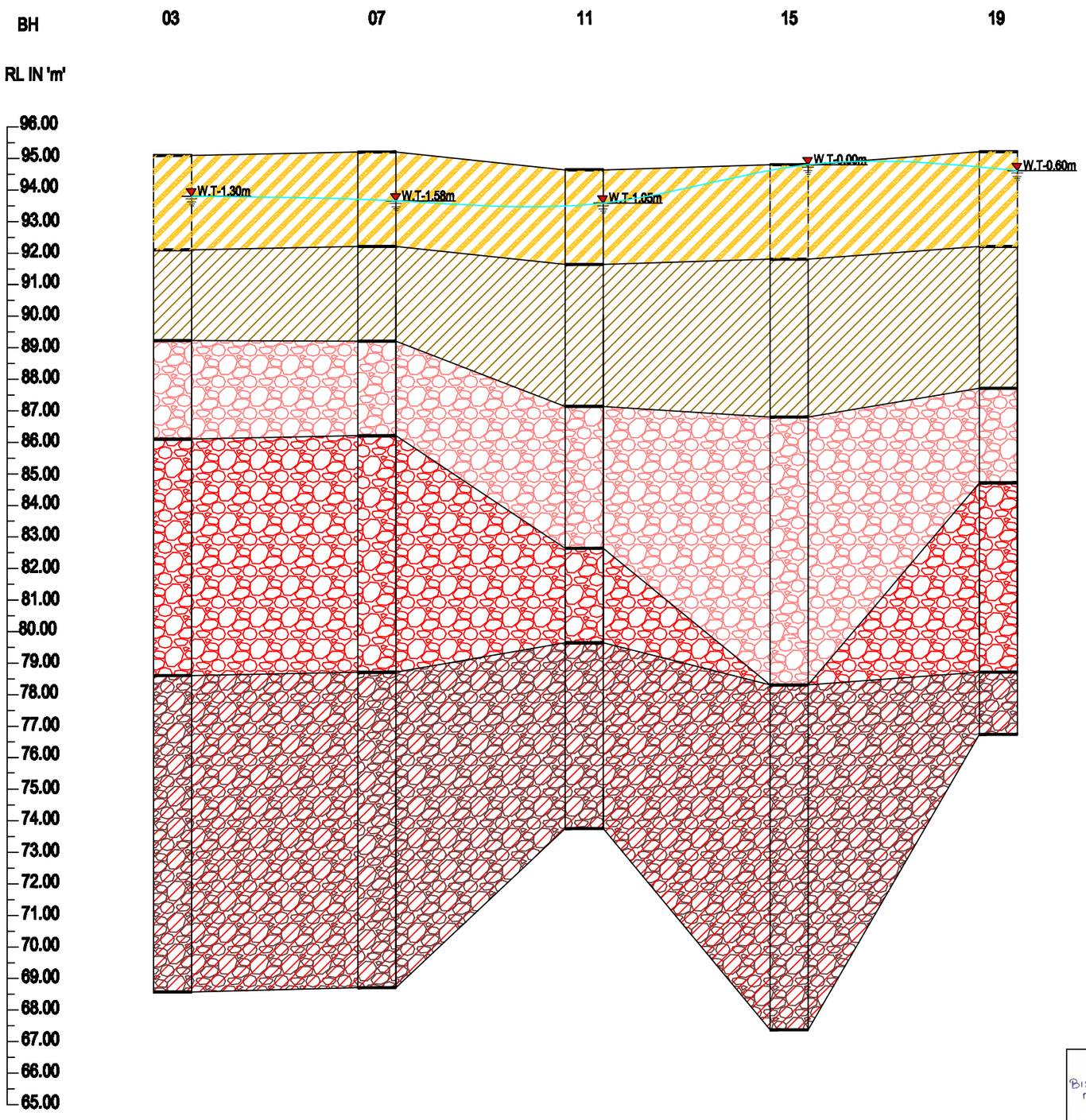
LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	02 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

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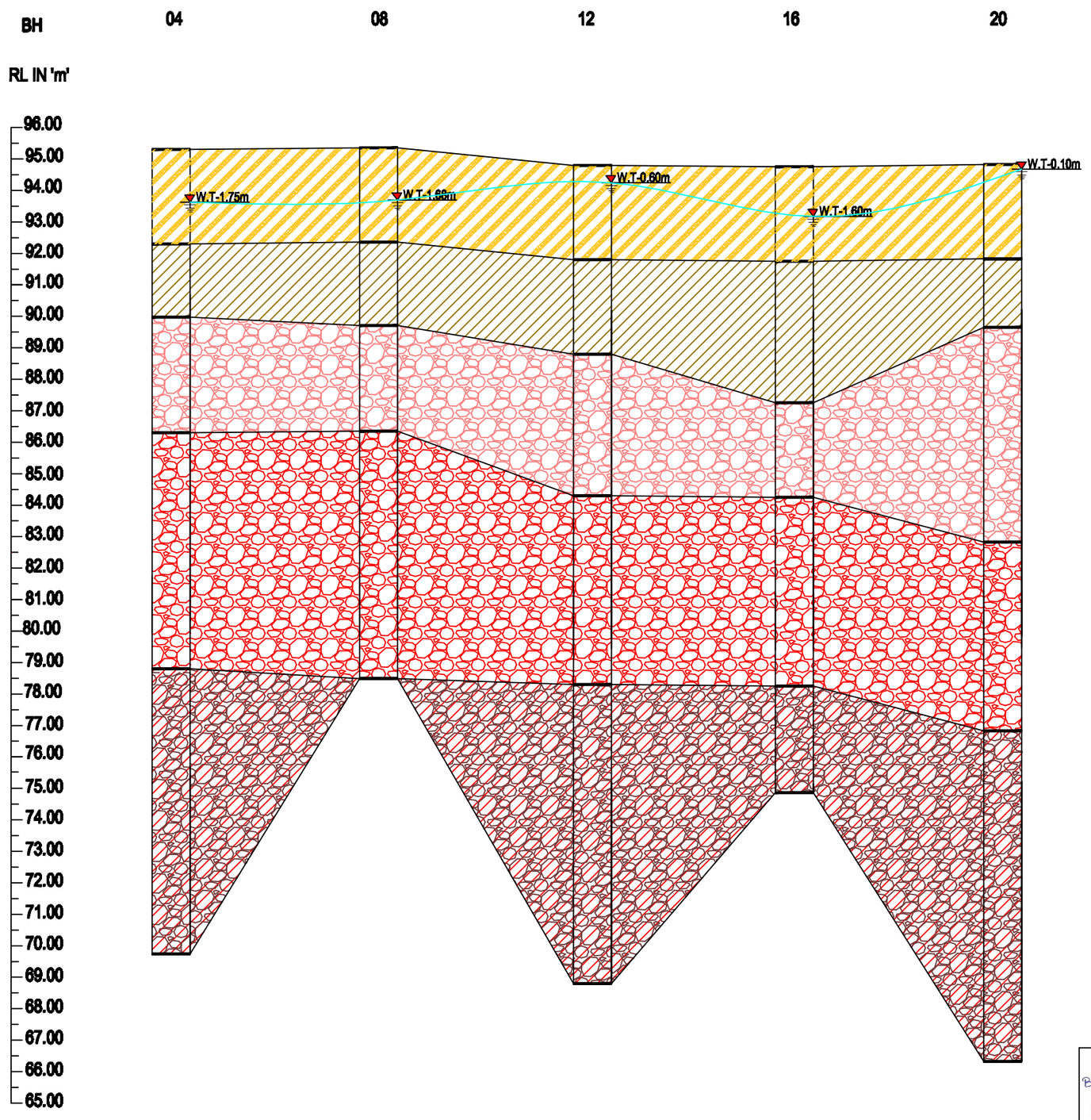
LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	03 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

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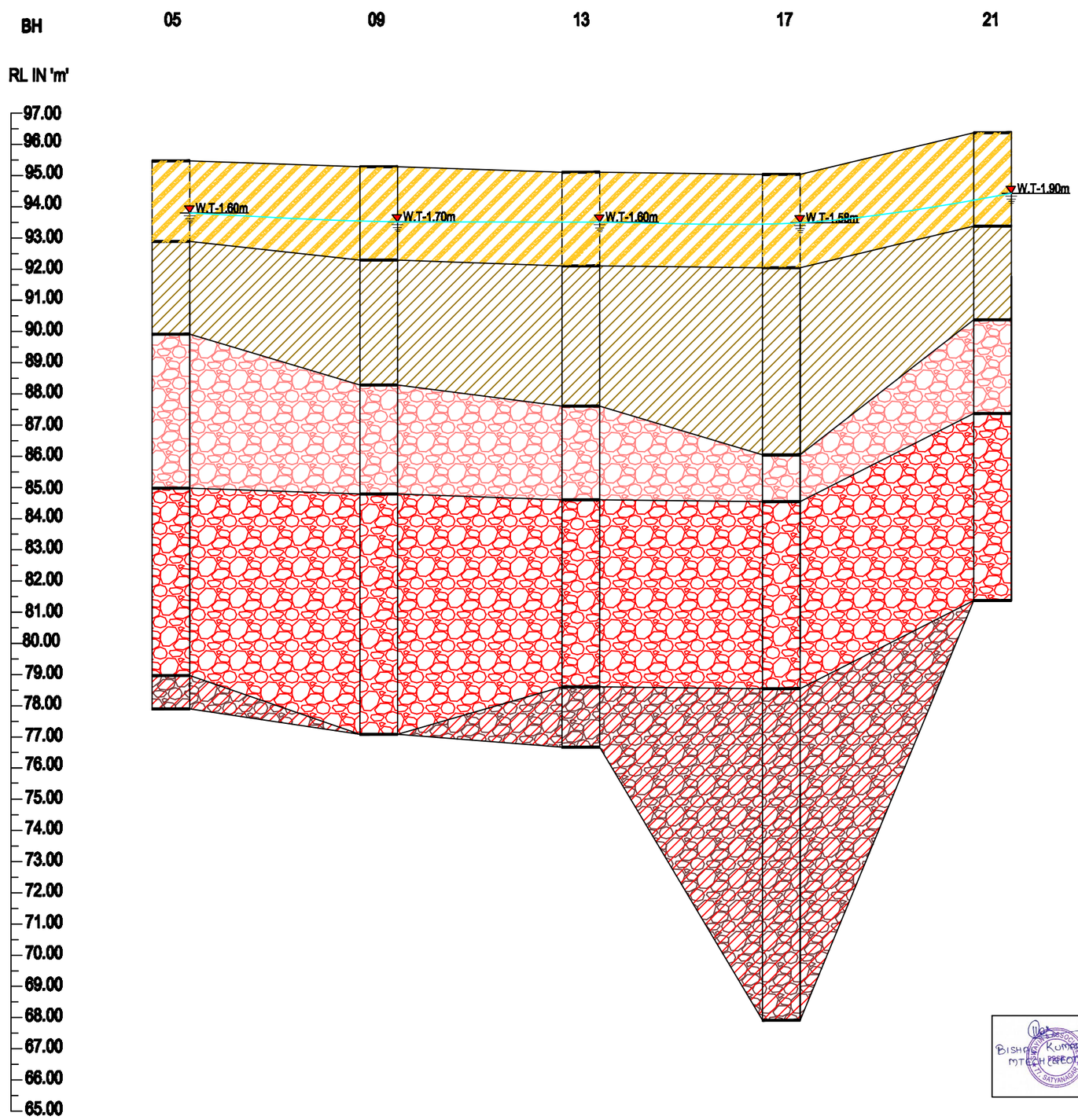
BISHNU KUMAR DAS. M.TECH (GEOTECH)

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	04 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

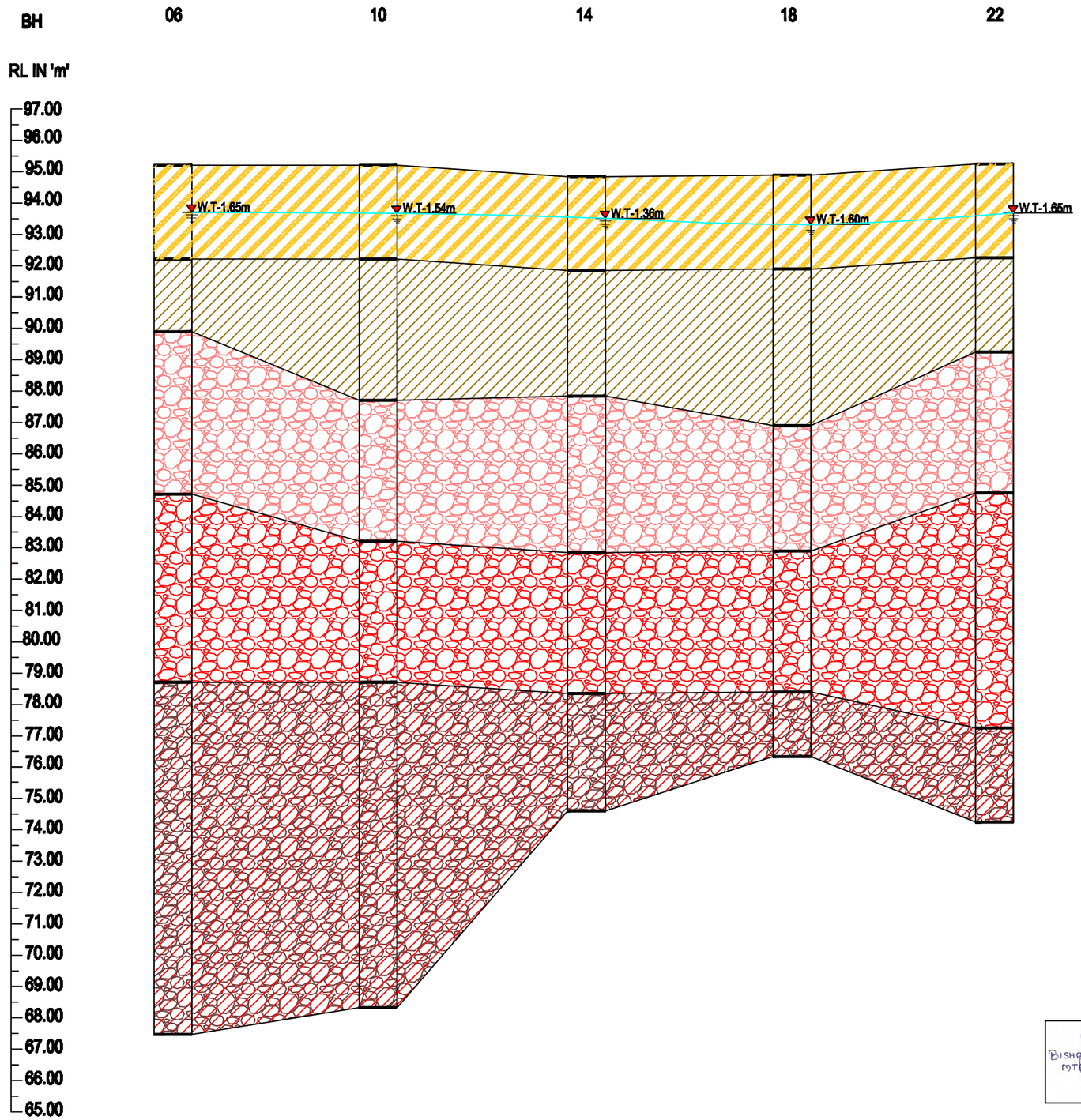
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	05 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

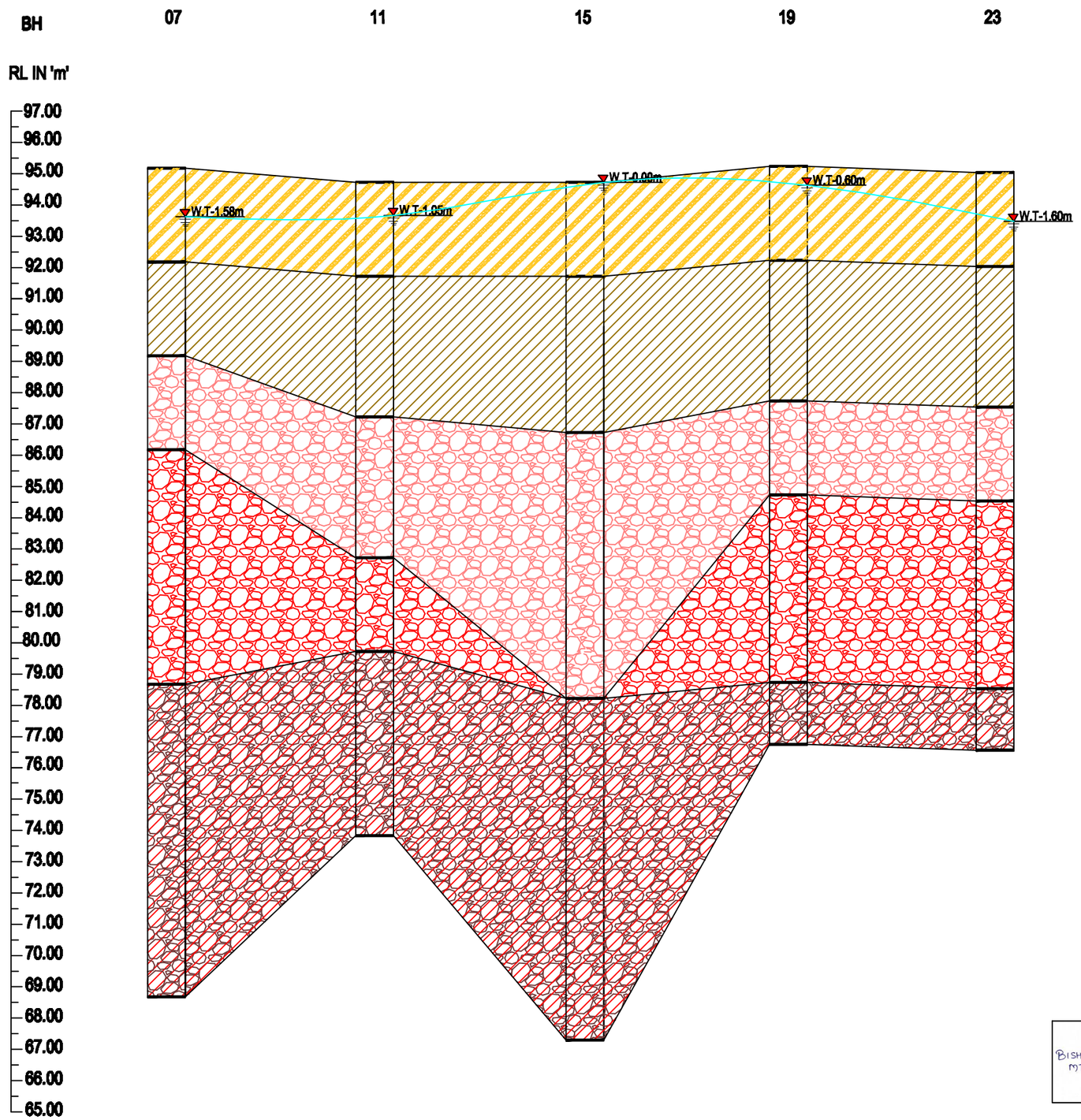
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	06 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : TALCHER FERTILIZERS LIMITED (TFL)

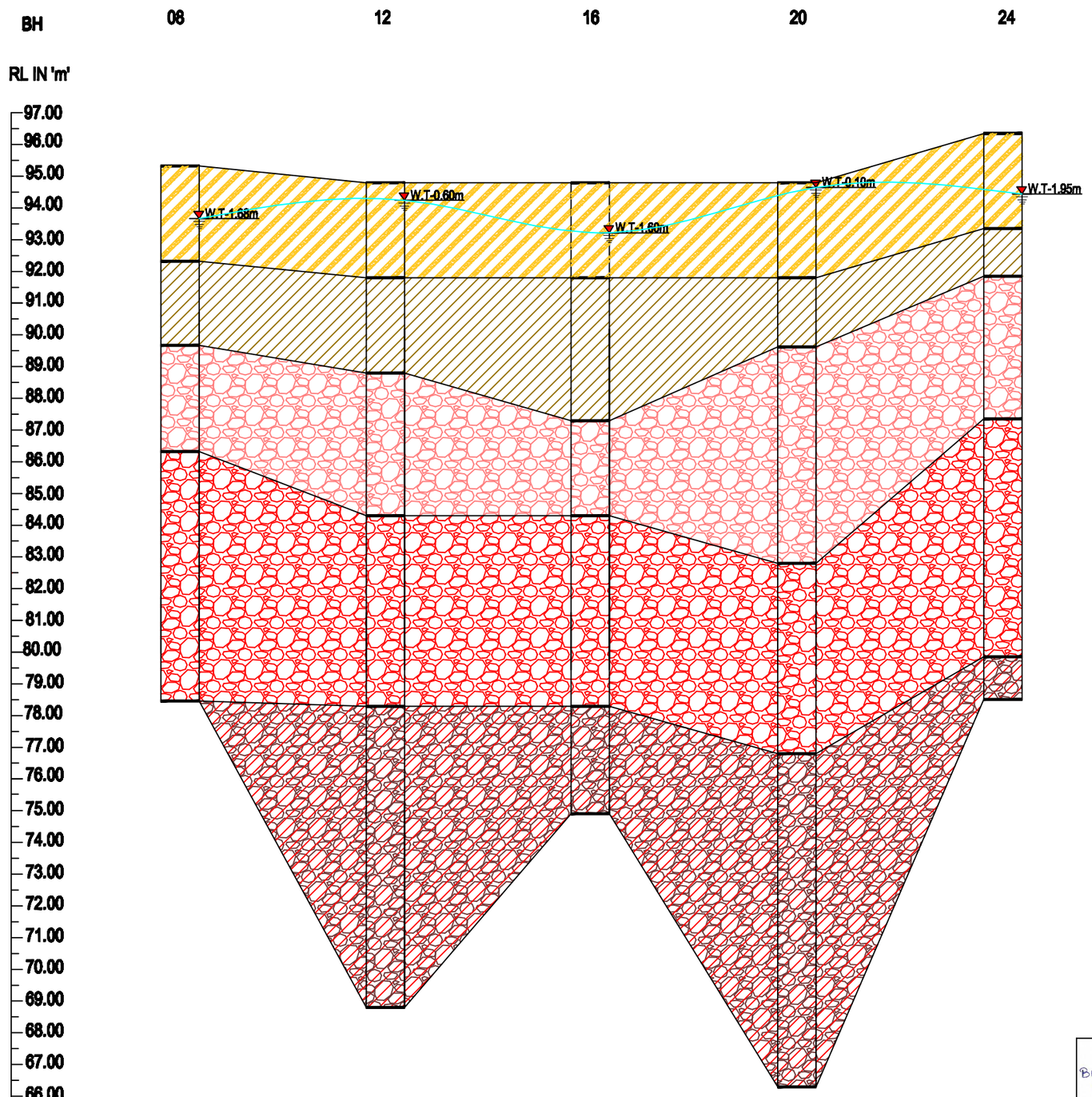
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	07 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

BISHNU PRASAD KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES PLOT NO.77, SATYANAGAR

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

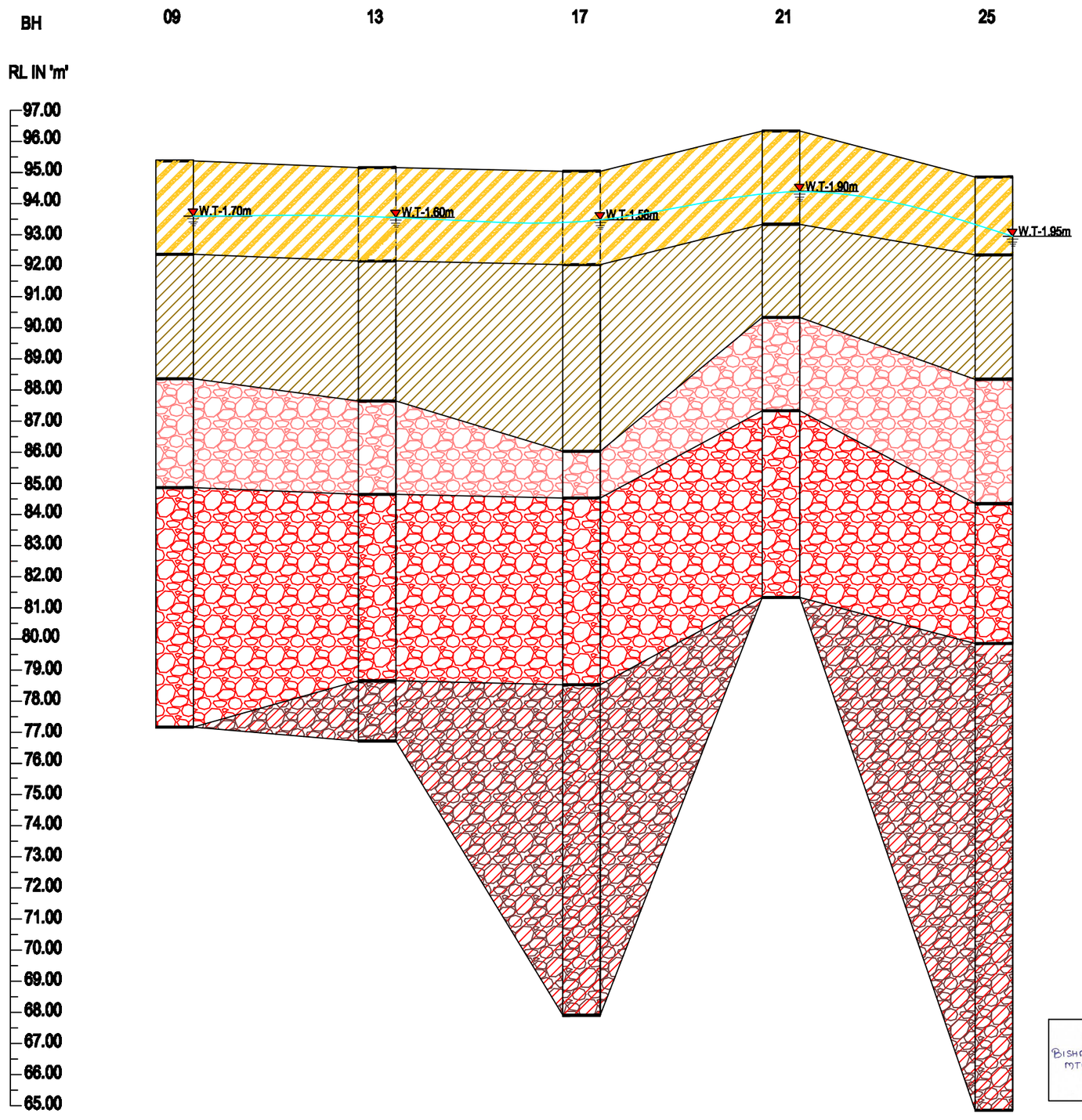
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	08 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

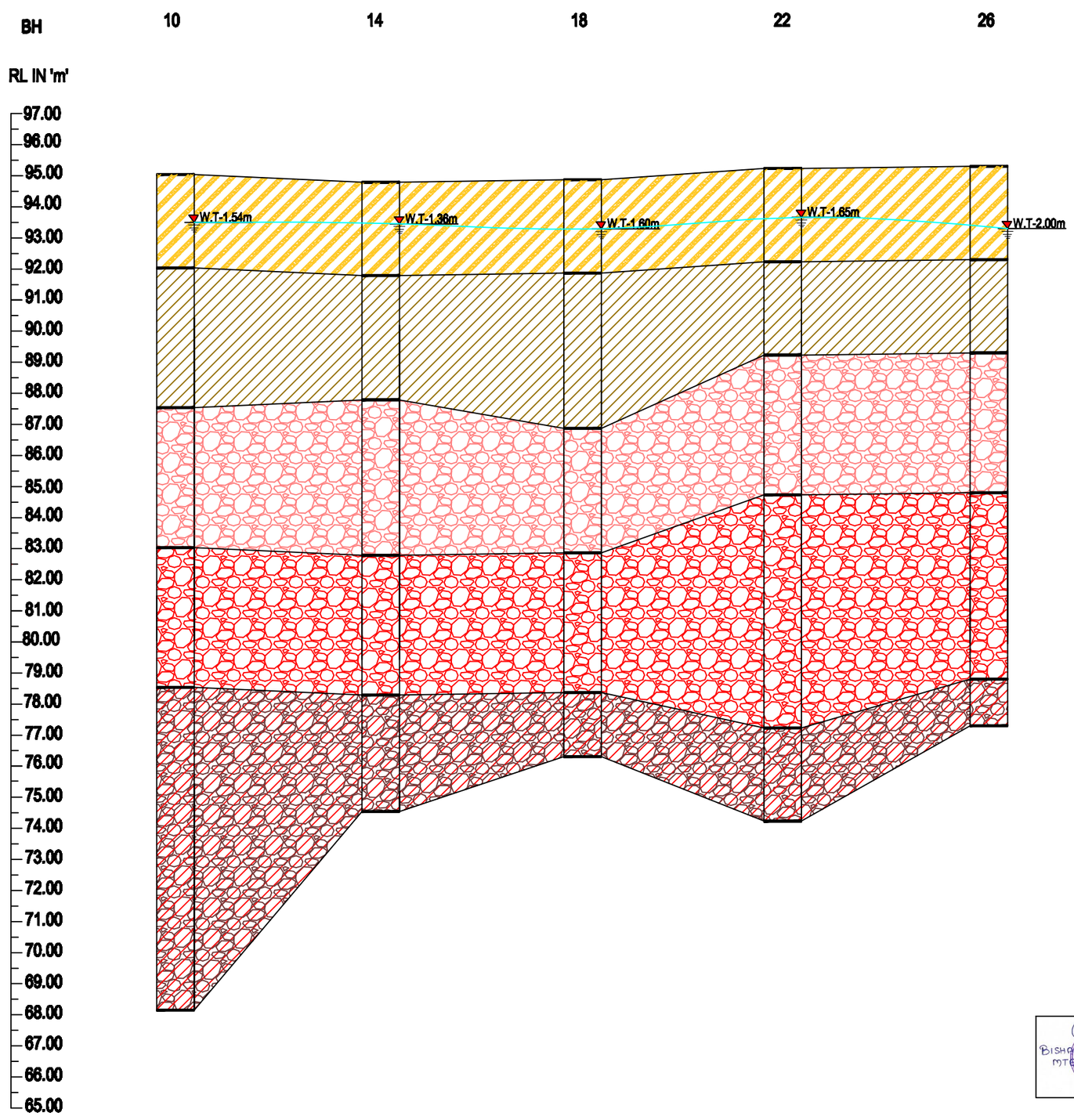
INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

BISHNU KUMAR DAS. M.TECH (GEOTECH)

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	09 TO 17

SUB-SOIL & CROSS PROFILE



BISHNU KUMAR DAS. M.TECH (GEOTECH) 77, SATYANAGAR

LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

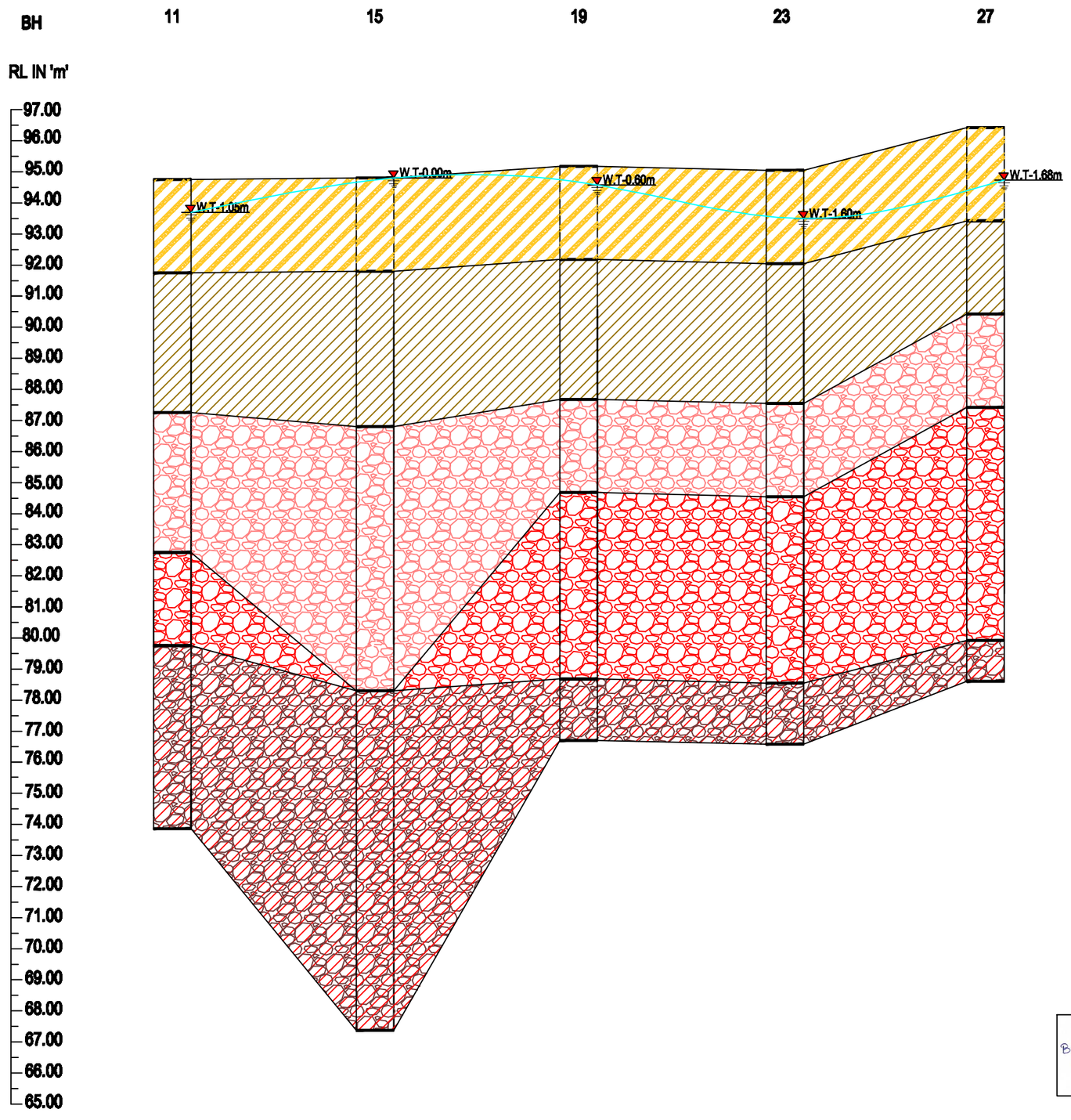
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	10 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

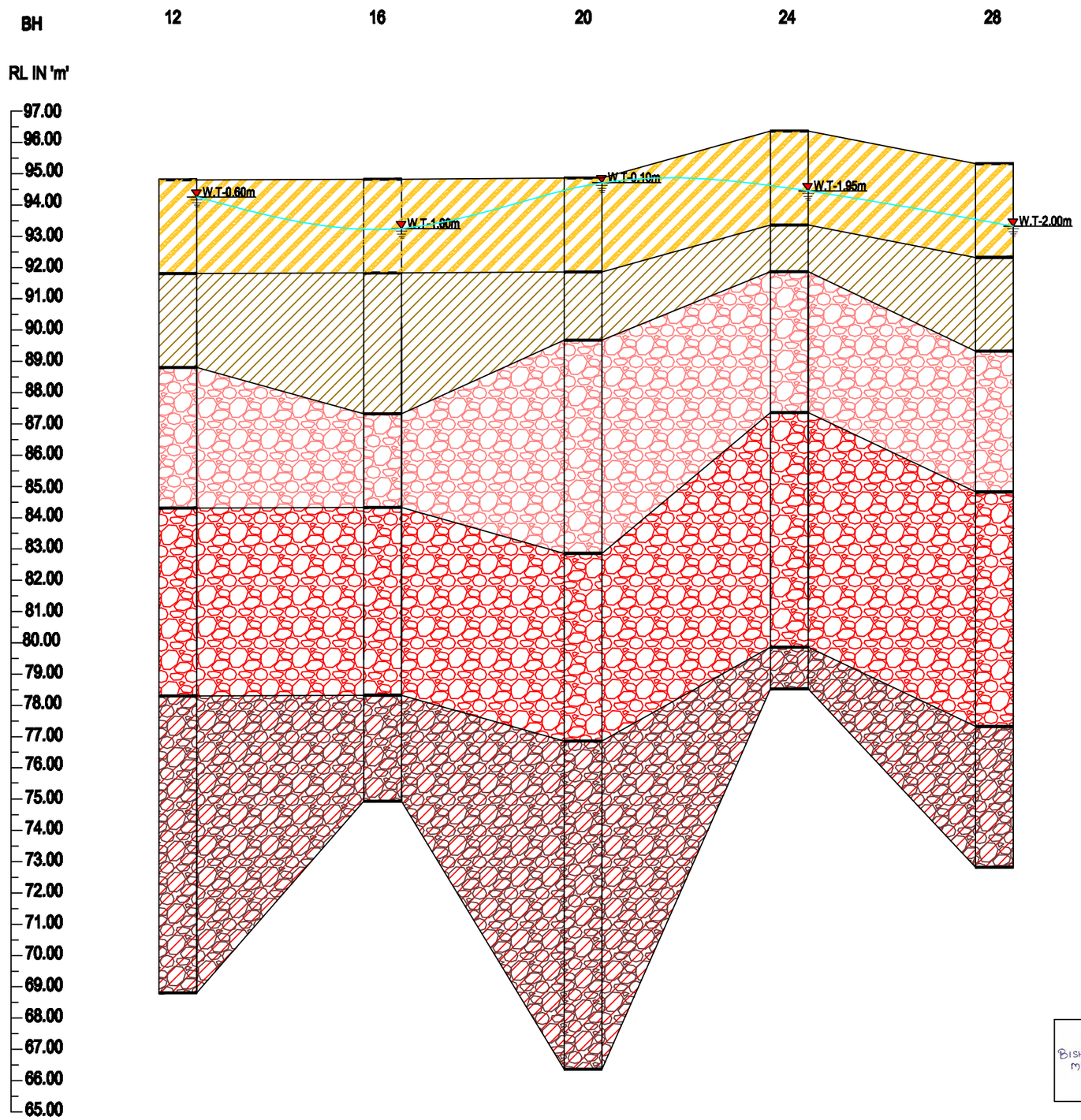
INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

BISHNU KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES 77, SATYANAGAR

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	11 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

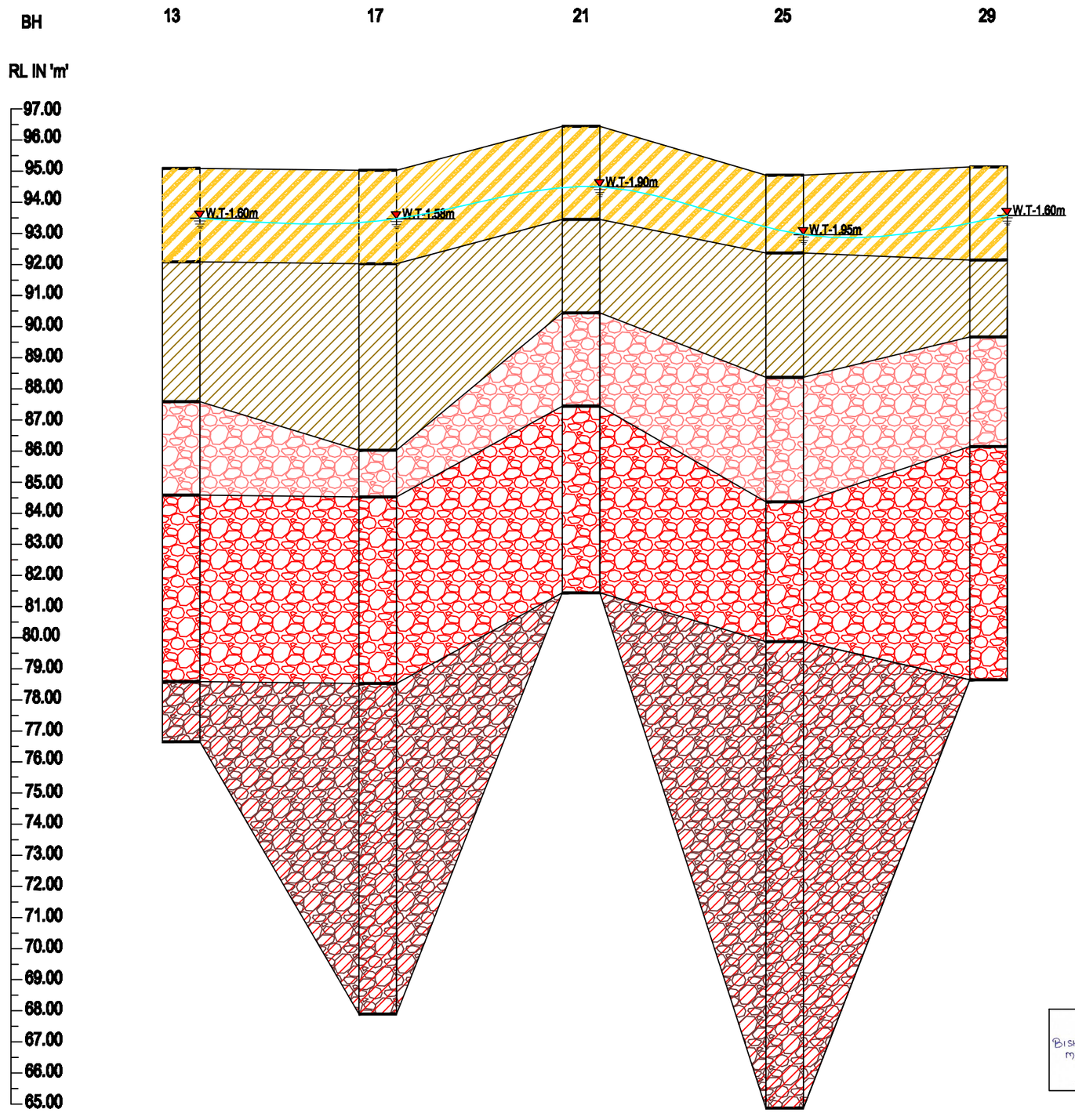
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	12 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
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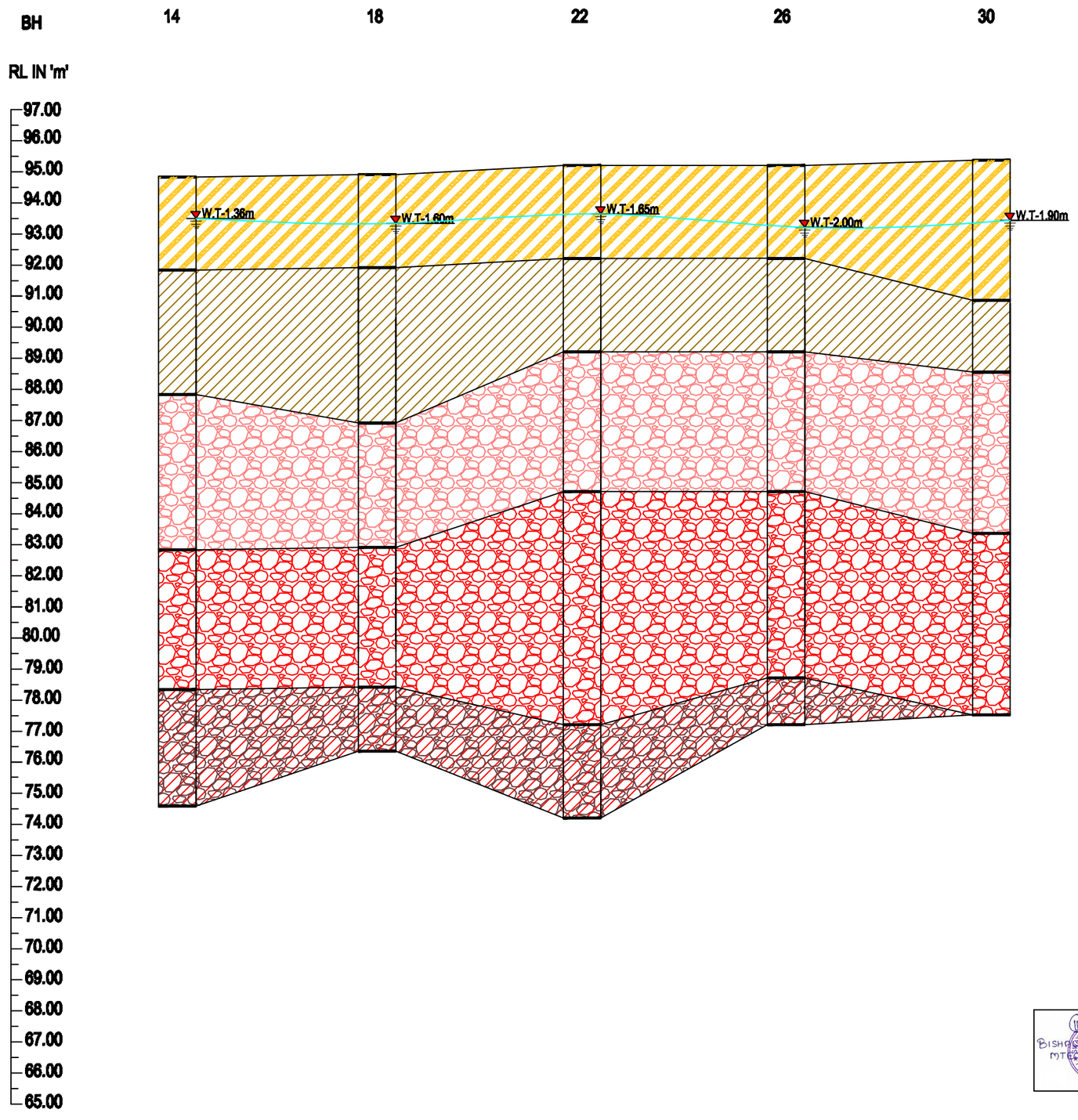
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	13 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

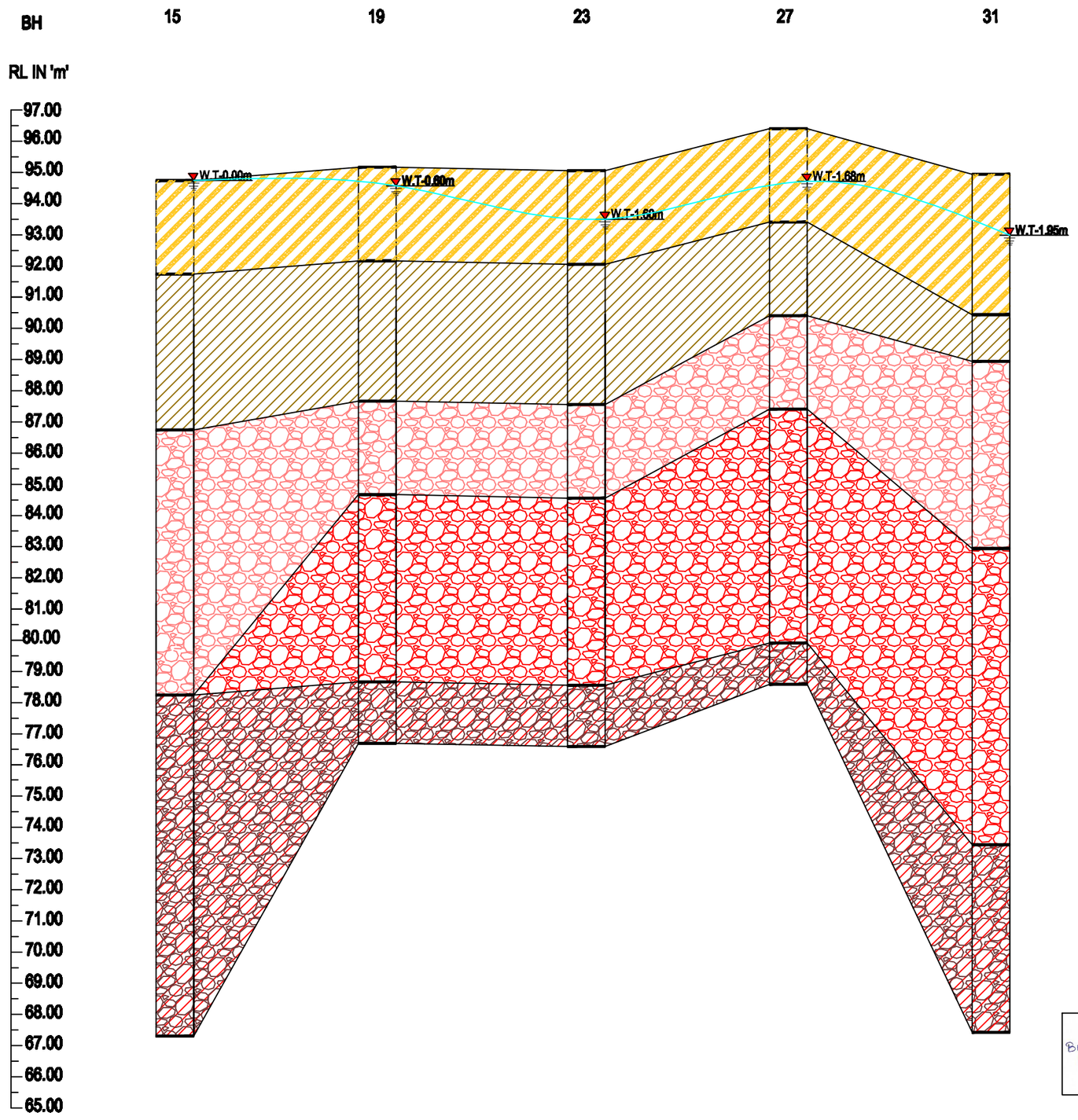
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	14 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : TALCHER FERTILIZERS LIMITED (TFL)

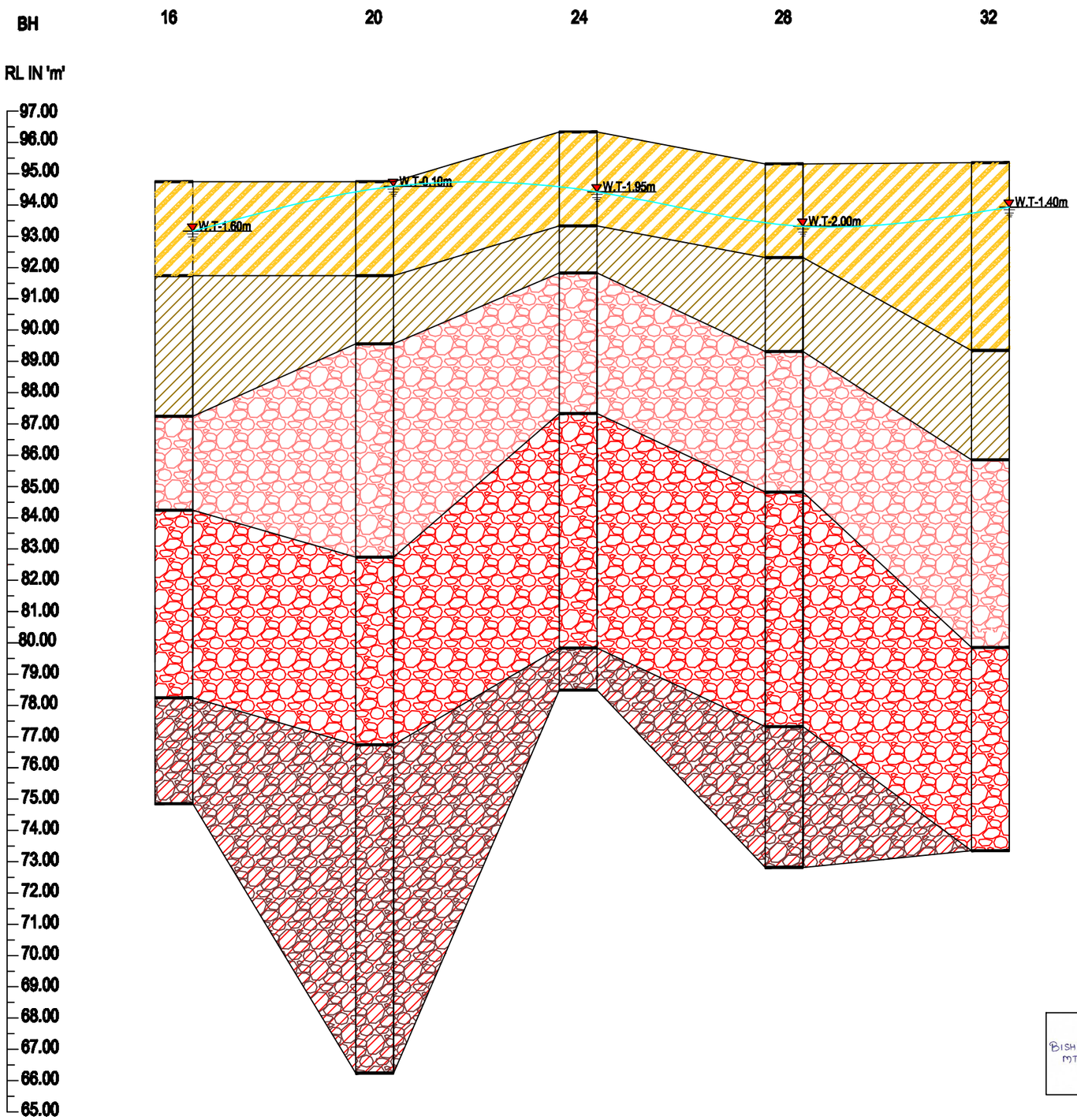
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	15 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

BISHAL KUMAR DAS. MTECH (GEOTECH)

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

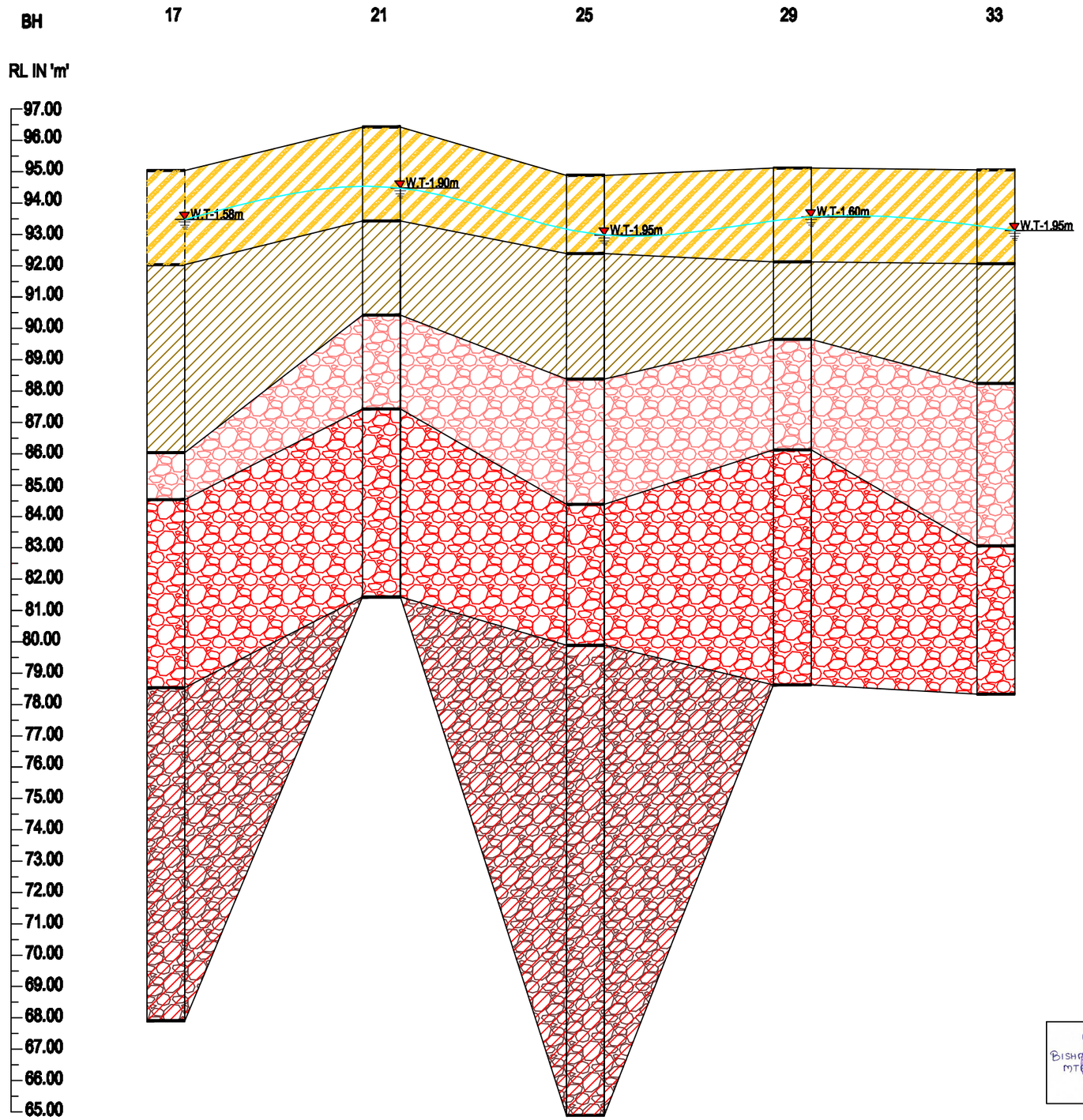
CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	16 TO 17

SUB-SOIL & CROSS PROFILE



LEGEND:

1	WATER TABLE	
2	CLAYEY SAND (DENSE)	
3	COMPACTED CLAY	
4	WEATHERED ROCK (CLAYSTONE)	
5	SANDSTONE	
6	CLAYSTONE	

NOTE : ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE.

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

CLIENT : Talcher Fertilizers — TALCHER FERTILIZERS LIMITED (TFL)

CONTRACTOR : WUHUAN ENGG. CO., LTD.

INVESTIGATED AND PREPARED BY :-

SWAYIN & ASSOCIATES .
77, SATYA NAGAR, BHUBANESWAR
PH-(0674) 2570015,2572971

LOCATION	CMD AREA	BH NO
TITLE	SUB-SOIL & CROSS PROFILE	17 TO 17

SWAYIN & ASSOCIATES

77, SATYANAGAR, BHUBANESWAR

Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.88 m	BORE HOLE NO: – 01 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 13.02.2020	CO–ORDINATES: E : 304.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.439 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.75m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
					1.50		43	SPT	01			
			2.00		2.00			UDS	No Recovery			
		3.00	3.00		3.00		>100	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		6.00	6.00		6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		7.00									
					7.50			CS	01	32	NIL	
			8.00									
			9.00		9.00			CS	02	28	NIL	
			10.00									
		10.50			10.50			CS	03	46	18	
			11.00									
SAND STONE	SEDIMENTARY		12.00		12.00			CS	04	58	29	
			13.00									
					13.50			CS	05	56	33	
			14.00									
		15.00	15.00		15.00			CS	06	62	43	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SA

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE REC

BISHNU KUMER DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES SATYANAGAR

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 14	No. of Water Sample : 01
	No. of SPT: 04	

SWAYIN & ASSOCIATES

77, SATYANAGAR, BHUBANESWAR

Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.88 m	BORE HOLE NO: – 01 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 13.02.2020	CO–ORDINATES: E : 304.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.439 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.75m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	62	43	
		16.50	16.00		16.50			CS	07	57	27	
			17.00									
			18.00		18.00			CS	08	60	34	
			19.00									
			20.00		19.50			CS	09	37	18	
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	10	41	16	
			22.00									
			23.00		22.50			CS	11	53	18	
			24.00		24.00			CS	12	58	16	
			25.00									
			26.00		25.50			CS	13	59	22	
			27.00									
BH TERMINATED AT DEPTH 27.88M		27.88	28.00		27.88			CS	14	60	28	
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

BISHNU KUMAR DAS. MTECH (GEOTECH) SWAYIN ASSOCIATES 77, SATYANAGAR

No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 14 No. of SPT: 04	No. of Vane Shear Test : NIL No. of Water Sample : 01

SWAYIN & ASSOCIATES

77, SATYANAGAR, BHUBANESWAR

Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.62 m	BORE HOLE NO: – 02 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 08.02.2020	COMPLETED ON: 11.02.2020	CO–ORDINATES: E : 304.000 m, N : 1215.300 m / GROUND LEVEL: RL– 95.211 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.54m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00 – 1.00 – 2.00		1.50		42	SPT	01			▽
COMPACTED CLAY	CI	2.60	3.00 – 4.00 – 5.00		3.00		>100	SPT	02			
					4.50		>100	SPT	03			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY	5.50	6.00 – 7.00 – 8.00 – 9.00 – 10.00		6.00		>100	SPT	04			
					7.50			CS	01	28	13	
					9.00			CS	02	43	16	
SAND STONE	SEDIMENTARY	10.50	11.00 – 12.00 – 13.00 – 14.00 – 15.00		10.50			CS	03	60	13	
					12.00			CS	04	58	28	
					13.50			CS	05	70	38	
					15.00			CS	06	64	37	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMP

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVE

BISHNU KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES SATYANAGAR

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 04	

SWAYIN & ASSOCIATES

77, SATYANAGAR, BHUBANESWAR

Web Site : www.swayinassociates.com

BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING
DIA OF HOLE:	150 mm
DEPTH:	17.62 m
COMMENCED ON: 08.02.2020	COMPLETED ON: 11.02.2020
WATER TABLE :1.54m	

CLIENT: TALCHER FERTILIZERS LIMITED (TFL)		CONTRACTOR: WUHUAN ENGG. CO., LTD.	
BORE HOLE NO: – 02	SHEET NO: – 02	JOB NO: – TLD/2020–03	
CO–ORDINATES: E : 304.000 m N : 1215.300 m	GROUND LEVEL: RL– 95.211 M	LOCATION: – CMD AREA	TYPE : – C

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	62	37	
			16.00		16.50			CS	07	68	35	
CLAY STONE		16.50	17.00									
BH TERMINATED AT DEPTH 17.62M		17.48	18.00		17.62			CS	08	69	36	
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST W– WATER SAMPI

▽–WATER LEVEL P–PENETROMETRE TEST, V– VANE SHEAR TEST C–CORE RECOVEI

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No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 14 No. of SPT: 04	No. of Vane Shear Test : NIL No. of Water Sample : 01

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.00 m	BORE HOLE NO: – 03 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 11.02.2020	CO–ORDINATES: E : 304.000 m, N : 1191.300 m / GROUND LEVEL: RL– 95.075 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.30m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00		1.50		40	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		82	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		5.80	6.00		6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		7.00		7.50			CS	01	13	NIL	
			8.00									
		9.00	9.00		9.00			CS	02	22	NIL	
			10.00		10.50			CS	03	28	13	
			11.00									
SAND STONE	SEDIMENTARY		12.00		12.00			CS	04	54	22	
			13.00		13.50			CS	05	62	43	
			14.00									
		15.00	15.00		15.00			CS	06	66	43	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 14	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.54 m	BORE HOLE NO: –03 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 11.02.2020	CO–ORDINATES: E : 304.000 m, N : 1191.300 m / GROUND LEVEL: RL– 95.075 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE :1.30m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	66	43	
		16.50	16.00		16.50			CS	07	68	45	
			17.00									
			18.00		18.00			CS	08	54	32	
			19.00									
			20.00		19.50			CS	09	58	28	
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	10	28	15	
			22.00									
			23.00		22.50			CS	11	39	17	
			24.00		24.00			CS	12	44	22	
			25.00									
					25.50			CS	13	55	24	
BH TERMINATED AT DEPTH 26.00M		26.00	26.00		26.00			CS	14	58	17	
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 14	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	25.06 m	BORE HOLE NO: – 04 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 12.02.2020	CO–ORDINATES: E : 304.000 m, N : 1167.300 m / GROUND LEVEL: RL– 95.229 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.75m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
					1.50		42	SPT	01			
			2.00		2.00			UDS	01			
COMPACTED CLAY	CI	3.00	3.00		3.00		>100	SPT	02			
			4.00									
					4.50		>100	SPT	03			
			5.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY	5.30	6.00		6.00		>100	SPT	04			
			7.00									
					7.50			CS	01	18	NIL	
			8.00									
		9.00	9.00		9.00			CS	02	25	NIL	
			10.00									
					10.50			CS	03	34	13	
			11.00									
SAND STONE	SEDIMENTARY		12.00		12.00			CS	04	58	35	
			13.00									
					13.50			CS	05	68	39	
			14.00									
		15.00	15.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 12	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	25.06 m	BORE HOLE NO: –04 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 12.02.2020	CO–ORDINATES: E : 304.000 m, N : 1167.300 m / GROUND LEVEL: RL– 95.229 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE :1.75m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00									
			16.00									
		16.50			16.50			CS	06	69	45	
			17.00									
			18.00		18.00			CS	07	72	49	
			19.00									
					19.50			CS	08	54	27	
			20.00									
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	09	60	36	
			22.00									
					22.50			CS	10	62	38	
			23.00									
			24.00		24.00			CS	11	68	53	
			25.00									
BH TERMINATED AT DEPTH 25.06M		25.06			25.06			CS	12	63	37	
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

BISHNU KUMAR DAS. M.TECH (GEOTECH) SWAYIN ASSOCIATES 77, SATYANAGAR

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 12	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.59 m	BORE HOLE NO: – 05 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 12.02.2020	COMPLETED ON: 13.02.2020	CO–ORDINATES: E : 324.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.474 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00		1.50		41	SPT	01			
			2.00									
		2.60	3.00		3.00		>100	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		5.60	6.00		6.00		>100	SPT	04			
			7.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY				7.50			CS	01	16	NIL	
			8.00									
			9.00		9.00			CS	02	28	13	
			10.00									
		10.50			10.50			CS	03	33	NIL	
			11.00									
			12.00		12.00			CS	04	64	29	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	05	67	37	
			14.00									
		15.00	15.00		15.00			CS	06	52	33	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.59 m	BORE HOLE NO: – 05 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 12.02.2020	COMPLETED ON: 13.02.2020	CO–ORDINATES: E : 324.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.474 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	52	33	
CLAY STONE	SEDIMENTARY	16.50	16.00		16.50			CS	07	57	28	
BH TERMINATED AT DEPTH 17.59M	SEDIMENTARY	17.59	17.00		17.59			CS	08	55	29	
			18.00									
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.74 m	BORE HOLE NO: – 06 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 13.02.2020	COMPLETED ON: 16.02.2020	CO–ORDINATES: E : 324.000 m, N : 1215.300 m / GROUND LEVEL: RL– 95.208 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.65m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00		1.50		47	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		>100	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		5.30										
			6.00		6.00		>100	SPT	04			
			7.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY				7.50		>100	SPT	05			
			8.00									
			9.00		9.00			CS	01	18	NIL	
			10.00									
		10.50			10.50			CS	02	28	NIL	
			11.00									
			12.00		12.00			CS	03	25	NIL	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	47	23	
			14.00									
		15.00	15.00		15.00			CS	05	68	36	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

BISHNU KUMAR DAS. MTECH (GEOTECH) SWAYIN ASSOCIATES SATYANAGAR

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.74 m	BORE HOLE NO: –06 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 13.02.2020	COMPLETED ON: 16.02.2020	CO–ORDINATES: E : 324.000 m, N : 1215.300 m / GROUND LEVEL: RL– 95.208 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE :1.65m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	68	36	
		16.50	16.00		16.50			CS	06	72	43	
			17.00									
			18.00		18.00			CS	07	54	23	
			19.00									
			20.00		19.50			CS	08	48	15	
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	09	56	23	
			22.00									
			23.00		22.50			CS	10	48	17	
			24.00		24.00			CS	11	43	12	
			25.00									
			26.00		25.50			CS	12	48	20	
			27.00									
BH TERMINATED AT DEPTH 27.74M		27.74	28.00		27.74			CS	13	55	22	
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

BISHNU KUMAR DAS. MTECH (GEOTECH) SWAYIN ASSOCIATES PVT. LTD. SATYANAGAR

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.50 m	BORE HOLE NO: – 07 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 03.02.2020	COMPLETED ON: 20.02.2020	CO–ORDINATES: E : 324.000 m, N : 1191.300 m / GROUND LEVEL: RL– 95.195 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.58m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00 – 3.00		1.50		41	SPT	01			▽
					3.00		63	SPT	02			
COMPACTED CLAY	CI	3.00	3.00 – 6.00		4.50		>100	SPT	03			
					6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY	6.00	6.00 – 9.00		7.50			CS	01	15	NIL	
					9.00			CS	02	42	17	
SAND STONE	SEDIMENTARY	9.00	9.00 – 15.00		10.50			CS	03	60	38	
					12.00			CS	04	64	42	
					13.50			CS	05	50	36	
					15.00			CS	06	59	38	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 14	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.50 m	BORE HOLE NO: – 07 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 03.02.2020	COMPLETED ON: 20.02.2020	CO–ORDINATES: E : 324.000 m, N : 1191.300 m / GROUND LEVEL: RL– 95.195 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.58m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
	SEDIMENTARY	15.00	15.00		15.00			CS	06	59	38	
SAND STONE			16.00									
		16.50			16.50			CS	07	59	34	
			17.00									
					17.54			CS	08	68	25	
			18.00									
			19.00		19.00			CS	09	70	37	
			20.00									
			21.00									
CLAY STONE	SEDIMENTARY				20.50			CS	10	56	26	
			22.00									
					22.50			CS	11	53	28	
			23.00									
					23.50			CS	12	48	23	
			24.00									
			25.00		25.00			CS	13	51	23	
			26.00									
BH TERMINATED AT DEPTH 26.50M		26.50			26.50			CS	14	52	22	
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 14	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	16.82 m	BORE HOLE NO: – 08 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 11.02.2020	CO–ORDINATES: E : 324.000 m, N : 1167.300 m / GROUND LEVEL: RL– 95.326 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.68m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00		1.50		48	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		88	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		5.70										
			6.00		6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		7.00		7.50			CS	01	17	NIL	
		9.00	9.00		9.00			CS	02	28	10	
			10.00		10.50			CS	03	60	34	
			11.00									
SAND STONE	SEDIMENTARY		12.00		12.00			CS	04	62	38	
			13.00		13.50			CS	05	69	42	
			14.00									
		15.00	15.00		15.00			CS	06	82	53	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	16.82 m	BORE HOLE NO: – 08 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 09.02.2020	COMPLETED ON: 11.02.2020	CO–ORDINATES: E : 324.000 m, N : 1167.300 m / GROUND LEVEL: RL– 95.326 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.68m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	82	53	
			16.00		16.50			CS	07	74	44	
BH TERMINATED AT DEPTH 16.82M		16.82	17.00									
			18.00									
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.23 m	BORE HOLE NO: – 09 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 13.02.2020	COMPLETED ON: 14.02.2020	CO–ORDINATES: E : 348.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.333 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.70m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		45	SPT	01			
			1.00									
			2.00									
		3.00	3.00		3.00		>100	SPT	02			
			4.00									
COMPACTED CLAY	CI				4.50		>100	SPT	03			
			5.00									
			6.00		6.00		>100	SPT	04			
		7.00	7.00									
					7.50		>100	SPT	05			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	01	28	11	
			10.00									
		10.50			10.50			CS	02	42	14	
			11.00									
			12.00		12.00			CS	03	48	25	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	65	28	
			14.00									
		15.00	15.00		15.00			CS	05	62	31	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.23 m	BORE HOLE NO: – 09 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 13.02.2020	COMPLETED ON: 14.02.2020	CO–ORDINATES: E : 348.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.333 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.70m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	62	31	
			16.00		16.50			CS	06	53	23	
BH TERMINATED AT DEPTH 18.23M		18.23	17.00		18.00			CS	07	37	20	
			18.00									
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.90 m	BORE HOLE NO: – 10 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 14.02.2020	COMPLETED ON: 23.02.2020	CO–ORDINATES: E : 348.000 m, N : 1215.300 m / GROUND LEVEL: RL– 95.093 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.54m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00		1.50		41	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		81	SPT	02			
			4.00									
					4.50		>100	SPT	03			
COMPACTED CLAY	CI		5.00									
			6.00		6.00		>100	SPT	04			
			7.00									
		7.50			7.50		>100	SPT	05			
			8.00									
			9.00		9.00			CS	01	27	NIL	
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		10.00									
					10.50			CS	02	28	10	
			11.00									
		12.00	12.00		12.00			CS	03	48	19	
			13.00									
SAND STONE	SEDIMENTARY				13.50			CS	04	67	41	
			14.00									
		15.00	15.00		15.00			CS	05	76	43	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.90 m	BORE HOLE NO: –10 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 14.02.2020	COMPLETED ON: 23.02.2020	CO–ORDINATES: E : 348.000 m, N : 1215.300 m / GROUND LEVEL: RL– 95.093 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE :1.54m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	76	43	
		16.50	16.00		16.50			CS	06	81	46	
			17.00									
			18.00		18.00			CS	07	61	40	
			19.00									
			20.00		19.50			CS	08	60	37	
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	09	58	29	
			22.00									
			23.00		22.50			CS	10	63	31	
			24.00		24.00			CS	11	48	26	
			25.00									
			26.00		25.50			CS	12	55	28	
					26.50			CS	13	57	29	
BH TERMINATED AT DEPTH 26.90M		26.90	27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

BISHNU KUMAR DAS. M.TECH (GEOTECH) SWAYIN ASSOCIATES PVT. LTD. SATYANAGAR

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	20.84 m	BORE HOLE NO: – 11 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 17.02.2020	COMPLETED ON: 18.02.2020	CO–ORDINATES: E : 348.000 m, N : 1191.300 m / GROUND LEVEL: RL– 94.692 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.05m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
			2.00		1.50		40	SPT	01			
		3.00	3.00		3.00		81	SPT	02			
			4.00									
					4.50		>100	SPT	03			
VERY COMPACTED CLAY	CI		5.00									
			6.00		6.00		>100	SPT	04			
			7.00									
		7.50			7.50		>100	SPT	05			
			8.00									
			9.00		9.00			CS	01	27	NIL	
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		10.00									
					10.50			CS	02	38	NIL	
			11.00									
		12.00	12.00		12.00			CS	03	54	NIL	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	58	NIL	
			14.00									
		15.00	15.00		15.00			CS	05	68	NIL	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

BISHNU KUMAR DAS. MTECH (GEOTECH) SWAYIN ASSOCIATES SATYANAGAR

No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 09 No. of SPT: 05	No. of Vane Shear Test : NIL No. of Water Sample : 01

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	20.84 m	BORE HOLE NO: – 11 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 17.02.2020	COMPLETED ON: 18.02.2020	CO–ORDINATES: E : 348.000 m, N : 1191.300 m / GROUND LEVEL: RL– 94.692 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.05m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAY STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	68	NIL	
			16.00		16.50			CS	06	72	37	
			17.00		18.00			CS	07	76	39	
			18.00		19.50			CS	08	70	42	
			19.00									
			20.00									
BH TERMINATED AT DEPTH 20.84M		20.84	21.00		20.84			CS	09	44	21	
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 09	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.00 m	BORE HOLE NO: – 12 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 14.02.2020	COMPLETED ON: 17.02.2020	CO–ORDINATES: E : 348.000 m, N : 1167.300 m / GROUND LEVEL: RL– 94.794 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
					1.50		33	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		75	SPT	02			
			4.00									
COMPACTED CLAY	CI				4.50		>100	SPT	03			
			5.00									
		6.00	6.00		6.00		>100	SPT	04			
			7.00									
					7.50		>100	SPT	05			
			8.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		9.00		9.00			CS	01	28	NIL	
			10.00									
		10.50			10.50			CS	02	39	20	
			11.00									
			12.00		12.00			CS	03	39	16	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	46	21	
			14.00									
		15.00	15.00		15.00			CS	05	68	33	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 12	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	26.00 m	BORE HOLE NO: –12 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 14.02.2020	COMPLETED ON: 17.02.2020	CO–ORDINATES: E : 348.000 m, N : 1167.300 m / GROUND LEVEL: RL– 94.794 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	68	33	
		16.50	16.00		16.50			CS	06	62	27	
			17.00									
			18.00		18.00			CS	07	55	30	
			19.00									
			20.00		19.50			CS	08	28	NIL	
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	09	39	15	
			22.00									
			23.00		22.50			CS	10	54	28	
			24.00									
			25.00		24.50			CS	11	50	17	
BH TERMINATED AT DEPTH 26.00M		26.00	26.00		26.00			CS	12	57	23	
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 12	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.43 m	BORE HOLE NO: –13 / SHEET NO: –01	JOB NO: –TLD/2020–03
COMMENCED ON: 17.02.2020	COMPLETED ON: 18.02.2020	CO–ORDINATES: E : 362.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.118 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		43	SPT	01			
			1.00									
			2.00									
		3.00	3.00		3.00		>100	SPT	02			
			4.00									
					4.50		>100	SPT	03			
COMPACTED CLAY	CI		5.00									
			6.00		6.00		>100	SPT	04			
			7.00									
		7.50			7.50		>100	SPT	05			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	01	37	NIL	
			10.00									
		10.50			10.50			CS	02	39	17	
			11.00									
			12.00		12.00			CS	03	54	22	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	45	24	
			14.00									
		15.00	15.00		15.00			CS	05	51	28	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.43 m	BORE HOLE NO: –13 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 17.02.2020	COMPLETED ON: 18.02.2020	CO–ORDINATES: E : 362.000 m, N : 1239.300 m / GROUND LEVEL: RL– 95.118 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	51	28	
			16.00									
CLAY STONE	SEDIMENTARY	16.50	17.00		16.50			CS	06	65	31	
			18.00		18.00			CS	07	62	33	
BH TERMINATED AT DEPTH 18.43M		18.43	19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	20.31 m	BORE HOLE NO: –14 / SHEET NO: –01	JOB NO: –TLD/2020–03
COMMENCED ON: 18.02.2020	COMPLETED ON: 20.02.2020	CO–ORDINATES: E : 362.000 m, N : 1215.300 m / GROUND LEVEL: RL– 94.798 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.36m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		37	SPT	01			▽
			1.00									
			2.00									
		3.00	3.00		3.00		94	SPT	02			
			4.00									
COMPACTED CLAY	CI				4.50		>100	SPT	03			
			5.00									
			6.00		6.00		>100	SPT	04			
		7.00	7.00		7.50		>100	SPT	05			
			8.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		9.00		9.00			CS	01	29	12	
			10.00		10.50			CS	02	36	15	
			11.00									
		12.00	12.00		12.00			CS	03	48	20	
SAND STONE	SEDIMENTARY		13.00		13.50			CS	04	25	11	
			14.00									
		15.00	15.00		15.00			CS	05	64	30	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	20.31m	BORE HOLE NO: –14 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 18.02.2020	COMPLETED ON: 20.02.2020	CO–ORDINATES: E : 362.000 m, N : 1215.300 m / GROUND LEVEL: RL– 94.798 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.36m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	64	30	
		16.50	16.00									
			17.00		16.50			CS	06	31	16	
CLAY STONE	SEDIMENTARY		18.00		18.00			CS	07	52	24	
			19.00									
BH TERMINATED AT DEPTH 20.31M		20.31	20.00		20.00			CS	08	42	20	
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.40 m	BORE HOLE NO: –15 / SHEET NO: –01	JOB NO: –TLD/2020–03
COMMENCED ON: 20.02.2020	COMPLETED ON: 23.02.2020	CO–ORDINATES: E : 362.000 m, N : 1191.300 m / GROUND LEVEL: RL– 94.762 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.00m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
					1.50		39	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		68	SPT	02			
			4.00									
					4.50		>100	SPT	03			
			5.00									
COMPACTED CLAY	CI											
			6.00		6.00		>100	SPT	04			
			7.00									
					7.50		>100	SPT	05			
		8.00	8.00									
			9.00		9.00		>100	SPT	06			
			10.00									
					10.50			CS	01	26	NIL	
			11.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		12.00		12.00			CS	02	58	28	
			13.00									
					13.50			CS	03	74	44	
			14.00									
		15.00	15.00		15.00			CS	04	82	55	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 12	No. of Water Sample : 01
	No. of SPT: 06	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.40m	BORE HOLE NO: –15 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 20.02.2020	COMPLETED ON: 23.02.2020	CO–ORDINATES: E : 362.000 m, N : 1191.300 m / GROUND LEVEL: RL– 94.762 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.00m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY	15.00	15.00		15.00			CS	04	82	55	
			16.00									
		16.90	17.00		16.50			CS	05	86	58	
			18.00		18.00			CS	06	70	42	
			19.00									
			20.00		19.50			CS	07	52	18	
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	08	54	20	
			22.00									
			23.00		22.50			CS	09	44	16	
			24.00		24.00			CS	10	49	15	
			25.00									
			26.00		25.50			CS	11	56	19	
			27.00		27.00			CS	12	58	21	
BH TERMINATED AT DEPTH 27.40M		27.40			27.40							
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAM

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOV

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 12	No. of Water Sample : 01
	No. of SPT: 06	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	19.84m	BORE HOLE NO: – 16 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 18.02.2020	COMPLETED ON: 20.02.2020	CO–ORDINATES: E : 362.000 m, N : 1167.300 m / GROUND LEVEL: RL– 94.737 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		43	SPT	01			
			1.00									
			2.00									
		3.00	3.00		3.00		81	SPT	02			
			4.00									
					4.50		>100	SPT	03			
COMPACTED CLAY	CI		5.00									
			6.00		6.00		>100	SPT	04			
			7.00									
		7.50			7.50		>100	SPT	05			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	01	19	NIL	
			10.00									
		10.50			10.50			CS	02	21	NIL	
			11.00									
			12.00		12.00			CS	03	42	20	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	68	27	
			14.00									
		15.00	15.00		15.00			CS	05	71	38	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	19.84m	BORE HOLE NO: –16 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 18.02.2020	COMPLETED ON: 20.02.2020	CO–ORDINATES: E : 362.000 m, N : 1167.300 m / GROUND LEVEL: RL– 94.737 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	71	38	
		16.50	16.00		16.50			CS	06	53	13	
CLAY STONE	SEDIMENTARY		17.00		18.00			CS	07	56	16	
			18.00		19.50			CS	08	58	20	
BH TERMINATED AT DEPTH 19.84M		19.84	19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 08 No. of SPT: 05	No. of Vane Shear Test : NIL No. of Water Sample : 01

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.14 m	BORE HOLE NO: –17 / SHEET NO: –01	JOB NO: –TLD/2020–03
COMMENCED ON: 19.02.2020	COMPLETED ON: 21.02.2020	CO–ORDINATES: E : 384.000 m, N : 1239.311 m / GROUND LEVEL: RL– 95.063 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE :1.58m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
					1.50		42	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		>100	SPT	02			
			4.00									
					4.50		>100	SPT	03			
			5.00									
COMPACTED CLAY	CI		6.00		6.00		>100	SPT	04			
			7.00									
					7.50		>100	SPT	05			
			8.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY	9.00	9.00		9.00			CS	01	34	10	
			10.00									
		10.50			10.50			CS	02	36	13	
			11.00									
			12.00		12.00			CS	03	41	15	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	52	36	
			14.00									
		15.00	15.00		15.00			CS	05	78	53	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.14 m	BORE HOLE NO: –17 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 19.02.2020	COMPLETED ON: 21.02.2020	CO–ORDINATES: E : 384.000 m, N : 1239.311 m / GROUND LEVEL: RL– 95.063 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE :1.58m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	78	53	
		16.50	16.00		16.50			CS	06	73	55	
			17.00									
			18.00		18.00			CS	07	58	20	
			19.00									
			20.00		19.50			CS	08	49	18	
CLAY STONE	SEDIMENTARY		21.00		21.00			CS	09	64	34	
			22.00									
			23.00		22.50			CS	10	59	28	
			24.00		24.00			CS	11	55	28	
			25.00									
			26.00		25.50			CS	12	56	25	
BH TERMINATED AT DEPTH 27.14M		27.14	27.00		27.00			CS	13	54	24	
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.52 m	BORE HOLE NO: –18 / SHEET NO: –01	JOB NO: –TLD/2020–03
COMMENCED ON: 17.02.2020	COMPLETED ON: 19.02.2020	CO–ORDINATES: E : 384.000 m, N : 1215.311 m / GROUND LEVEL: RL– 94.912 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		33	SPT	01			▽
			1.00									
			2.00									
		3.00	3.00		3.00		83	SPT	02			
			4.00									
					4.50		>100	SPT	03			
			5.00									
COMPACTED CLAY	CI		6.00		6.00		>100	SPT	04			
			7.00									
					7.50		>100	SPT	05			
		8.00	8.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		9.00		9.00			CS	01	13	NIL	
			10.00									
					10.50			CS	02	19	NIL	
			11.00									
		12.00	12.00		12.00			CS	03	38	15	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	54	26	
			14.00									
		15.00	15.00		15.00			CS	05	68	32	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.52 m	BORE HOLE NO: –18 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 17.02.2020	COMPLETED ON: 19.02.2020	CO–ORDINATES: E : 384.000 m, N : 1215.311 m / GROUND LEVEL: RL– 94.912 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	68	32	
		16.50	16.50		16.50			CS	06	48	23	
CLAY STONE	SEDIMENTARY		17.00									
			18.00		18.00			CS	07	52	25	
BH TERMINATED AT DEPTH 18.52M		18.52	19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.48 m	BORE HOLE NO: –19 / SHEET NO: –01	JOB NO: –TLD/2020–03
COMMENCED ON: 16.02.2020	COMPLETED ON: 17.02.2020	CO–ORDINATES: E : 384.000 m, N : 1191.289 m / GROUND LEVEL: RL– 95.252 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 0.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
			2.00		1.50		43	SPT	01			
		3.00	3.00		3.00		81	SPT	02			
			4.00									
			5.00		4.50		>100	SPT	03			
COMPACTED CLAY	CI		6.00		6.00		>100	SPT	04			
			7.00									
		7.50	7.50		7.50		>100	SPT	05			
			8.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		9.00		9.00			CS	01	25	10	
			10.00									
		10.50	10.50		10.50			CS	02	33	11	
			11.00									
			12.00		12.00			CS	03	55	24	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	59	20	
			14.00									
		15.00	15.00		15.00			CS	05	63	21	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 07 No. of SPT: 05	No. of Vane Shear Test : NIL No. of Water Sample : 01

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.48 m	BORE HOLE NO: –19 / SHEET NO: –02	JOB NO: –TLD/2020–03
COMMENCED ON: 16.02.2020	COMPLETED ON: 17.02.2020	CO–ORDINATES: E : 384.000 m, N : 1191.289 m / GROUND LEVEL: RL– 95.252 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 0.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	63	21	
			16.00									
		16.50			16.50			CS	06	48	23	
CLAY STONE	SEDIMENTARY		17.00									
			18.00									
BH TERMINATED AT DEPTH 18.48M		18.48			18.48			CS	07	59	24	
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMP

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	28.50 m	BORE HOLE NO: – 20 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 20.02.2020	COMPLETED ON: 23.02.2020	CO–ORDINATES: E : 384.056 m, N : 1167.289 m / GROUND LEVEL: RL– 94.786 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.10m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
					1.50		40	SPT	01			
			2.00		2.00			UDS	01			
		3.00	3.00		3.00		81	SPT	02			
COMPACTED CLAY	CI		4.00									
					4.50		>100	SPT	03			
		5.20	5.00									
			6.00		6.00		>100	SPT	04			
			7.00									
					7.50		>100	SPT	05			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	01	38	13	
			10.00									
					10.50			CS	02	40	15	
			11.00									
		12.00	12.00		12.00			CS	03	69	48	
			13.00									
SAND STONE	SEDIMENTARY				13.50			CS	04	73	54	
			14.00									
		15.00	15.00		15.00			CS	05	84	58	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 14	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	28.50 m	BORE HOLE NO: – 20 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 20.02.2020	COMPLETED ON: 23.02.2020	CO–ORDINATES: E : 384.056 m, N : 1167.289 m / GROUND LEVEL: RL– 94.786 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 0.10m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
		15.00	15.00		15.00			CS	05	84	58	
SAND STONE	SEDIMENTARY		16.00		16.50			CS	06	85	56	
		18.00	17.00		18.00			CS	07	72	48	
			18.00		19.50			CS	08	64	33	
			19.00									
			20.00		21.00			CS	09	52	31	
			21.00		22.50			CS	10	54	28	
			22.00									
			23.00		24.00			CS	11	56	29	
CLAY STONE	SEDIMENTARY		24.00		25.50			CS	12	56	28	
			25.00									
			26.00		27.00			CS	13	57	25	
			27.00									
			28.00		28.50			CS	14	59	25	
BH TERMINATED AT DEPTH 28.50M		28.50	29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: 01	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 14	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	15.00 m	BORE HOLE NO: – 21 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 10.02.2020	COMPLETED ON: 12.02.2020	CO–ORDINATES: E : 292.665 m, N : 1137.335 m / GROUND LEVEL: RL– 96.458 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.90m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		45	SPT	01			
			1.00									
			2.00									
		3.00	3.00		3.00		>100	SPT	02			
COMPACTED CLAY	CI		4.00									
					4.50		>100	SPT	03			
			5.00									
		6.00	6.00		6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		7.00									
					7.50		>100	SPT	05			
			8.00									
		9.00	9.00		9.00			CS	01	48	23	
			10.00									
					10.50			CS	02	86	45	
			11.00									
SAND STONE	SEDIMENTARY		12.00		12.00			CS	03	84	42	
			13.00									
					13.50			CS	04	84	41	
			14.00									
BH TERMINATED AT DEPTH 15.00M		15.00	15.00		15.00			CS	05	75	42	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 05 No. of SPT: 05	No. of Vane Shear Test : NIL No. of Water Sample : 01

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	21.00 m	BORE HOLE NO: – 22 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 01.02.2020	COMPLETED ON: 02.02.2020	CO–ORDINATES: E : 324.050 m, N : 1137.342 m / GROUND LEVEL: RL– 95.249 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.65m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
			2.00		1.50		42	SPT	01			
		3.00	3.00		3.00		80	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		6.00	6.00		6.00		>100	SPT	04			
			7.00									
					7.50			CS	01	18	NIL	
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	02	22	NIL	
			10.00									
		10.50			10.50			CS	03	60	46	
			11.00									
			12.00		12.00			CS	04	62	47	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	05	98	78	
			14.00									
		15.00	15.00		15.00			CS	06	49	24	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 10	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	21.00 m	BORE HOLE NO: – 22 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 01.02.2020	COMPLETED ON: 02.02.2020	CO–ORDINATES: E : 324.050 m, N : 1137.342 m / GROUND LEVEL: RL– 95.249 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.65m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	49	24	
			16.00		16.50			CS	07	29	20	
			17.00									
CLAY STONE	SEDIMENTARY	18.00	18.00		18.00			CS	08	57	NIL	
			19.00									
			20.00		19.50			CS	09	96	25	
BH TERMINATED AT DEPTH 21.00M		21.00	21.00		21.00			CS	10	72	44	
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMP

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVE

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 10	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.49 m	BORE HOLE NO: – 23 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 13.02.2020	COMPLETED ON: 14.02.2020	CO–ORDINATES: E : 342.000 m, N : 1137.300 m / GROUND LEVEL: RL– 95.025 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		38	SPT	01			▽
			1.00									
			2.00									
		3.00	3.00		3.00		80	SPT	02			
			4.00									
					4.50		>100	SPT	03			
COMPACTED CLAY	CI		5.00									
			6.00		6.00		>100	SPT	04			
			7.00									
		7.50			7.50		>100	SPT	05			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	01	29	NIL	
			10.00									
		10.50			10.50			CS	02	37	13	
			11.00									
			12.00		12.00			CS	03	48	22	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	04	58	20	
			14.00									
		15.00	15.00		15.00			CS	05	57	24	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.49 m	BORE HOLE NO: – 23 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 13.02.2020	COMPLETED ON: 14.02.2020	CO–ORDINATES: E : 342.000 m, N : 1137.300 m / GROUND LEVEL: RL– 95.025 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	57	24	
			16.00									
		16.50			16.50			CS	06	56	25	
CLAY STONE	SEDIMENTARY		17.00									
			18.00		18.00			CS	07	64	32	
BH TERMINATED AT DEPTH 18.49M		18.49										
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.82 m	BORE HOLE NO: – 24 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 16.02.2020	COMPLETED ON: 17.02.2020	CO–ORDINATES: E : 292.700 m, N : 1116.308 m / GROUND LEVEL: RL– 96.387 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.95m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		42	SPT	01			
COMPACTED CLAY	CI	3.00	3.00		3.00		>100	SPT	02			
		4.50	4.50		4.50		>100	SPT	03			
			6.00		6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		7.00		7.50			CS	01	30	NIL	
		9.00	9.00		9.00			CS	02	38	NIL	
			10.00		10.50			CS	03	64	28	
SAND STONE	SEDIMENTARY		11.00									
			12.00		12.00			CS	04	72	54	
			13.00		13.50			CS	05	63	29	
			14.00									
		15.00	15.00		15.00			CS	06	54	27	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.82 m	BORE HOLE NO: – 24 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 16.02.2020	COMPLETED ON: 17.02.2020	CO–ORDINATES: E : 292.700 m, N : 1116.308 m / GROUND LEVEL: RL– 96.387 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.95m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	54	27	
CLAY STONE	SEDIMENTARY	16.50	16.00		16.50			CS	07	58	25	
BH TERMINATED AT DEPTH 17.82M		17.82	17.00		17.82			CS	08	53	24	
			18.00									
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	30.00 m	BORE HOLE NO: – 25 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 02.02.2020	COMPLETED ON: 08.02.2020	CO–ORDINATES: E : 306.300 m, N : 1116.308 m / GROUND LEVEL: RL– 94.898 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.95m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
			2.00		1.50		46	SPT	01			
		2.50	3.00		3.00		>100	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
			6.00		6.00		>100	SPT	04			
		6.50	7.00									
					7.50		>100	SPT	05			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	01	28	NIL	
			10.00									
		10.50	11.00		10.50			CS	02	52	28	
SAND STONE	SEDIMENTARY		12.00		12.00			CS	03	58	35	
			13.00									
			14.00		13.50			CS	04	62	43	
		15.00	15.00		15.00			CS	05	68	45	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 15	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	30.00 m	BORE HOLE NO: – 25 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 02.02.2020	COMPLETED ON: 08.02.2020	CO–ORDINATES: E : 306.300 m, N : 1116.308 m / GROUND LEVEL: RL– 94.898 M	LOCATION: – CMD AREA / TYPE : – A
WATER TABLE : 1.95m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
		15.00	15.00		15.00			CS	05	68	45	
			16.00		16.50			CS	06	54	23	
			17.00									
			18.00		18.00			CS	07	49	20	
			19.00									
			20.00		19.50			CS	08	51	23	
			21.00		21.00			CS	09	53	22	
			22.00									
					22.50			CS	10	48	15	
CLAY STONE	SEDIMENTARY		23.00									
			24.00		24.00			CS	11	42	16	
			25.00									
					25.50			CS	12	54	22	
			26.00									
			27.00		27.00			CS	13	68	33	
			28.00									
					28.50			CS	14	51	25	
			29.00									
BH TERMINATED AT DEPTH 30.00M		30.00	30.00		30.00			CS	15	68	35	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 15	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.00 m	BORE HOLE NO: – 26 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 30.01.2020	COMPLETED ON: 31.01.2020	CO–ORDINATES: E : 319.000 m, N : 1116.302 m / GROUND LEVEL: RL– 95.302 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 2.00m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
			2.00		1.50		40	SPT	01			
		3.00	3.00		3.00		>100	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		6.00	6.00		6.00		>100	SPT	04			
			7.00									
					7.50		>100	SPT	05			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
			9.00		9.00			CS	01	20	NIL	
			10.00									
		10.50			10.50			CS	02	38	22	
			11.00									
			12.00		12.00			CS	03	58	24	
			13.00									
					13.50			CS	04	69	45	
			14.00									
		15.00	15.00		15.00			CS	05	74	52	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	18.00 m	BORE HOLE NO: – 26 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 30.01.2020	COMPLETED ON: 31.01.2020	CO–ORDINATES: E : 319.000 m, N : 1116.302 m / GROUND LEVEL: RL– 95.302 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 2.00m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY	15.00	15.00		15.00			CS	05	74	52	
CLAY STONE	SEDIMENTARY	16.50	16.00		16.50			CS	06	46	16	
BH TERMINATED AT DEPTH 18.00M		18.00	17.00		18.00			CS	07	48	18	
			18.00									
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.87 m	BORE HOLE NO: – 27 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 15.02.2020	COMPLETED ON: 16.02.2020	CO–ORDINATES: E : 302.000 m, N : 1077.300 m / GROUND LEVEL: RL– 96.479 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.68m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00		1.50		45	SPT	01			
			2.00									
		3.00	3.00		3.00		>100	SPT	02			
VERY COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		6.00	6.00		6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		7.00									
			8.00		7.50			CS	01	37	20	
		9.00	9.00		9.00			CS	02	39	17	
			10.00									
			11.00		10.50			CS	03	52	23	
SAND STONE	SEDIMENTARY		12.00		12.00			CS	04	68	29	
			13.00									
			14.00		13.50			CS	05	72	38	
		15.00	15.00		15.00			CS	06	68	28	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 08 No. of SPT: 04	No. of Vane Shear Test : NIL No. of Water Sample : 01

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.87 m	BORE HOLE NO: – 27 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 15.02.2020	COMPLETED ON: 16.02.2020	CO–ORDINATES: E : 302.000 m, N : 1077.300 m / GROUND LEVEL: RL– 96.479 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.68m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	68	28	
CLAY STONE	SEDIMENTARY	16.50	16.00		16.50			CS	07	58	21	
BH TERMINATED AT DEPTH 17.87M		17.87	17.00		17.87			CS	08	63	27	
			18.00									
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	22.50 m	BORE HOLE NO: – 28 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 28.01.2020	COMPLETED ON: 30.01.2020	CO–ORDINATES: E : 330.000 m, N : 1097.289 m / GROUND LEVEL: RL– 95.361 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 2.00m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		32	SPT	01			▽
			1.00									
			2.00									
		3.00	3.00		3.00		>100	SPT	02			
COMPACTED CLAY	CI		4.00									
					4.50		>100	SPT	03			
			5.00									
		6.00	6.00		6.00		>100	SPT	04			
			7.00									
					7.50			CS	01	39	NIL	
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		8.00									
					9.00			CS	02	60	26	
			9.00									
			10.00									
		10.50			10.50			CS	03	69	33	
			11.00									
			12.00		12.00			CS	04	78	45	
SAND STONE	SEDIMENTARY		13.00									
					13.50			CS	05	85	50	
			14.00									
		15.00	15.00		15.00			CS	06	91	61	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 11	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	22.50 m	BORE HOLE NO: – 28 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 28.01.2020	COMPLETED ON: 30.01.2020	CO–ORDINATES: E : 330.000 m, N : 1097.289 m / GROUND LEVEL: RL– 95.361 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 2.00m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	91	61	
			16.00		16.50			CS	07	90	56	
			17.00									
		18.00	18.00		18.00			CS	08	92	58	
CLAY STONE	SEDIMENTARY		19.00		19.50			CS	09	67	28	
			20.00									
			21.00		21.00			CS	10	68	36	
			22.00									
BH TERMINATED AT DEPTH 22.50M		22.50	22.50		22.50			CS	11	70	38	
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 11	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	16.50 m	BORE HOLE NO: – 29 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 03.02.2020	COMPLETED ON: 07.02.2020	CO–ORDINATES: E : 342.200 m, N : 1077.300 m / GROUND LEVEL: RL– 95.172 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.60m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
			2.00		1.50		47	SPT	01			
		3.00	3.00		3.00		58	SPT	02			
COMPACTED CLAY	CI		4.00									
			5.00		4.50		>100	SPT	03			
		5.50										
			6.00		6.00		>100	SPT	04			
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		7.00									
					7.50			CS	01	37	NIL	
		9.00	9.00		9.00			CS	02	42	NIL	
			10.00									
					10.50			CS	03	54	23	
			11.00									
SAND STONE	SEDIMENTARY		12.00		12.00			CS	04	68	32	
			13.00									
					13.50			CS	05	70	45	
			14.00									
		15.00	15.00		15.00			CS	06	65	29	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 04	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING
DIA OF HOLE:	150 mm
DEPTH:	16.50 m
COMMENCED ON: 03.02.2020	COMPLETED ON: 07.02.2020
WATER TABLE :1.60m	

CLIENT: TALCHER FERTILIZERS LIMITED (TFL)		CONTRACTOR: WUHUAN ENGG. CO., LTD.	
BORE HOLE NO: – 29	SHEET NO: – 02	JOB NO: – TLD/2020–03	
CO–ORDINATES: E : 342.200 m N : 1077.300 m	GROUND LEVEL: RL– 95.172 M	LOCATION: – CMD AREA	TYPE : – C

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	06	65	29	
BH TERMINATED AT DEPTH 16.50M		16.50	16.00 17.00 18.00 19.00 20.00 21.00 22.00 23.00 24.00 25.00 26.00 27.00 28.00 29.00 30.00		16.50			CS	07	58	36	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST W– WATER SAMPI

▽–WATER LEVEL P–PENETROMETRE TEST, V– VANE SHEAR TEST C–CORE RECOVEI

No. of disturbed sample: NIL No. of Large diameter sample: NIL	No. of Undisturbed sample: NIL No. of CORE: 07 No. of SPT: 04	No. of Vane Shear Test : NIL No. of Water Sample : 01

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.80 m	BORE HOLE NO: – 30 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 25.01.2020	COMPLETED ON: 01.02.2020	CO–ORDINATES: E : 354.501 m, N : 1120.300 m / GROUND LEVEL: RL– 95.380 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.90m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00		1.50		27	SPT	01			
			2.00									
			3.00		3.00		44	SPT	02			
			4.00									
COMPACTED CLAY	CI	4.50	5.00		4.50		98	SPT	03			
			6.00		6.00		>100	SPT	04			
		6.80	7.00									
					7.50		>100	SPT	05			
			8.00									
			9.00		9.00			CS	01	40	NIL	
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		10.00		10.50			CS	02	45	NIL	
			11.00									
		12.00	12.00		12.00			CS	03	47	25	
			13.00									
SAND STONE	SEDIMENTARY				13.50			CS	04	52	27	
			14.00									
		15.00	15.00		15.00			CS	05	60	29	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	17.80 m	BORE HOLE NO: – 30 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 25.01.2020	COMPLETED ON: 01.02.2020	CO–ORDINATES: E : 354.501 m, N : 1120.300 m / GROUND LEVEL: RL– 95.380 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE :1.90m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	60	29	
			16.00		16.50			CS	06	69	37	
BH TERMINATED AT DEPTH 17.80M		17.80	17.00		17.80			CS	07	74	53	
			18.00									
			19.00									
			20.00									
			21.00									
			22.00									
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 07	No. of Water Sample : 01
	No. of SPT: 05	

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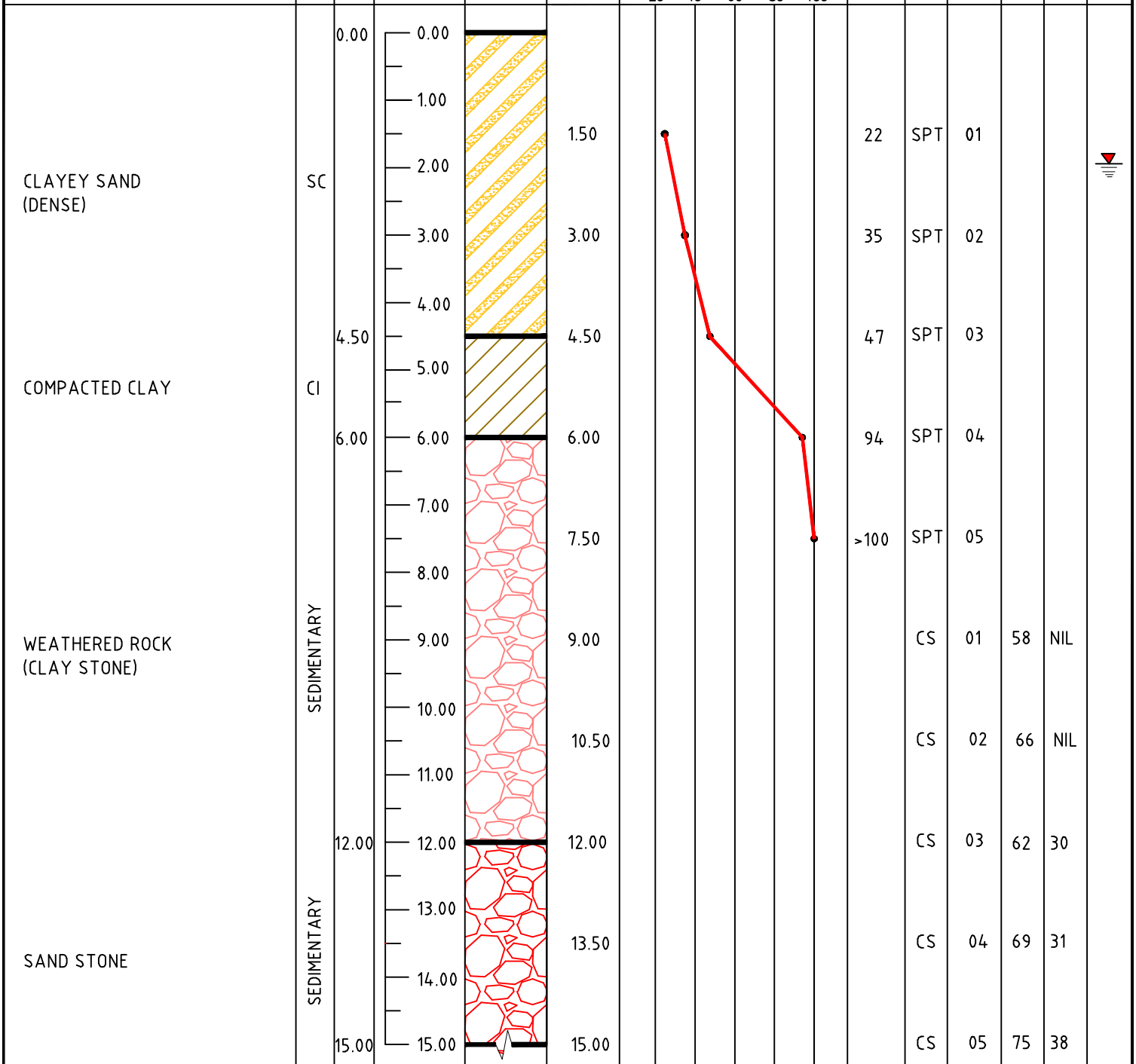
BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.50 m	BORE HOLE NO: – 31 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 17.01.2020	COMPLETED ON: 27.01.2020	CO–ORDINATES: E : 354.501 m, N : 1098.800 m / GROUND LEVEL: RL– 94.978 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.95m			



LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	27.50 m	BORE HOLE NO: – 31 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 17.01.2020	COMPLETED ON: 27.01.2020	CO–ORDINATES: E : 354.501 m, N : 1098.800 m / GROUND LEVEL: RL– 94.978 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.95m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	75	38	
			16.00									
			17.00		17.00			CS	06	70	76	
			18.00		18.50			CS	07	56	23	
			19.00									
			20.00		20.00			CS	08	58	42	
			21.00									
CLAY STONE	SEDIMENTARY	21.50	22.00		21.50			CS	09	56	22	
			23.00		23.00			CS	10	66	31	
			24.00									
			25.00		24.50			CS	11	67	59	
			26.00		26.00			CS	12	61	41	
			27.00									
BH TERMINATED AT DEPTH 27.54M		27.54	28.00		27.54			CS	13	86	33	
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 13	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	22.00 m	BORE HOLE NO: – 32 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 16.01.2020	COMPLETED ON: 24.01.2020	CO–ORDINATES: E : 370.100 m, N : 1120.300 m / GROUND LEVEL: RL– 95.350 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.40m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00		1.50		19	SPT	01			
			1.00		2.00			DS	01			
			2.00		3.00		27	SPT	02			
			3.00		4.50		35	SPT	03			
			4.00		6.00		96	SPT	04			
		6.00	5.00		7.50		>100	SPT	05			
VERY COMPACTED CLAY	CI		6.00		9.00		>100	SPT	06			
			7.00		10.50			CS	01	46	NIL	
			8.00		12.50			CS	02	60	NIL	
			9.00		14.00			CS	03	62	35	
		9.50	10.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		11.00									
			12.00									
			13.00									
			14.00									
		15.00	15.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 06	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	22.00	BORE HOLE NO: – 32 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 16.01.2020	COMPLETED ON: 24.01.2020	CO–ORDINATES: E : 370.100 m, N : 1120.300 m / GROUND LEVEL: RL– 95.350 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.40m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY	15.00	15.00		15.50			CS	04	53	31	
		15.50	16.00									
			17.00		17.00			CS	05	48	30	
			18.00									
SAND STONE	SEDIMENTARY		18.50		18.50			CS	06	50	36	
			19.00									
			20.00		20.00			CS	07	56	46	
			21.00									
BH TERMINATED AT DEPTH 22.00M		22.00	22.00		22.00			CS	08	98	78	
			23.00									
			24.00									
			25.00									
			26.00									
			27.00									
			28.00									
			29.00									
			30.00									

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 08	No. of Water Sample : 01
	No. of SPT: 06	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	16.69 m	BORE HOLE NO: – 33 / SHEET NO: – 01	JOB NO: – TLD/2020–03
COMMENCED ON: 28.01.2020	COMPLETED ON: 01.02.2020	CO–ORDINATES: E : 370.100 m, N : 1074.399 m / GROUND LEVEL: RL– 95.065 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.95m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
CLAYEY SAND (DENSE)	SC	0.00	0.00									
			1.00									
			2.00		1.50		34	SPT	01			
		3.00	3.00		3.00		65	SPT	02			
			4.00									
COMPACTED CLAY	CI		5.00		4.50		90	SPT	03			
			6.00		6.00		>100	SPT	04			
		6.80	7.00		7.50		>100	SPT	05			
			8.00									
WEATHERED ROCK (CLAY STONE)	SEDIMENTARY		9.00		9.00			CS	01	42	NIL	
			10.00									
			11.00		10.50			CS	02	41	23	
		12.00	12.00		12.00			CS	03	40	23	
SAND STONE	SEDIMENTARY		13.00		13.50			CS	04	52	37	
			14.00									
		15.00	15.00		15.00			CS	05	71	54	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

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No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 06	No. of Water Sample : 01
	No. of SPT: 05	

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BORELOG DATA SHEET

NAME OF PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER.

TYPE OF BORING:	ROTARY CALYX DRILLING		
DIA OF HOLE:	150 mm	CLIENT: TALCHER FERTILIZERS LIMITED (TFL)	CONTRACTOR: WUHUAN ENGG. CO., LTD.
DEPTH:	16.69 m	BORE HOLE NO: – 33 / SHEET NO: – 02	JOB NO: – TLD/2020–03
COMMENCED ON: 28.01.2020	COMPLETED ON: 01.02.2020	CO–ORDINATES: E : 370.100 m, N : 1074.399 m / GROUND LEVEL: RL– 95.065 M	LOCATION: – CMD AREA / TYPE : – C
WATER TABLE : 1.95m			

DESCRIPTION OF STRATA	IS CLASSIFICATION	CHANGE OF STRATA IN MTRS.	DEPTH IN MTRS.	SYMBOL	SAMPLE DEPTH IN MTRS.	GRAPHICAL REPRESENTATION OF 'N' VALUES (20 40 60 80 100)	"N" VALUES	SAMPLE TYPE	SAMPLE REF NO.	CORE RECOVERY %	RQD %	G.W.L OBSER
SAND STONE	SEDIMENTARY	15.00	15.00		15.00			CS	05	71	54	
BH TERMINATED AT DEPTH 16.69M		16.69	16.00, 17.00, 18.00, 19.00, 20.00, 21.00, 22.00, 23.00, 24.00, 25.00, 26.00, 27.00, 28.00, 29.00, 30.00		16.69			CS	06	73	52	

LEGEND: –

UDS–UNDISTURBED SAMPLE, DS– DISTURBED SAMPLE, SPT–STANDARD PENETRATION TEST, W– WATER SAMPI

▽–WATER LEVEL, P–PENETROMETRE TEST, V– VANE SHEAR TEST, C–CORE RECOVEI

No. of disturbed sample: NIL	No. of Undisturbed sample: NIL	No. of Vane Shear Test : NIL
No. of Large diameter sample: NIL	No. of CORE: 06	No. of Water Sample : 01
	No. of SPT: 05	

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TRIAL PIT-01

LOCATION :- CMD AREA
CO-ORDINATES-313.954 N-1179.194
PROJECT:- DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER, ODISHA, INDIA.

TP:-01
TOTAL DEPTH:1.80M
R.L:-95.220

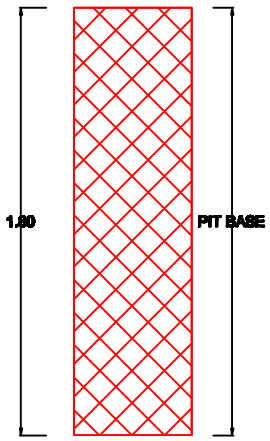
DATE OF START :-12.05.2020
DATE OF COMP. :- 12.05.2020

SCALE IN METRES	STRATA DEPTH	STRATA SYMBOL	SAMPLE DEPTH (M)	SAMPLE TYPE	SAMPLE No.
0.00	0.00	3.00 S / 3.00 W / 3.00 N / 3.00 E			
1.00			1.00	UDS	01
1.80			1.60	DS	01
		3.00 / 3.00 / 3.00 / 3.00			

LEGEND:-

1) CLAYEY SAND

2) WATER TABLE-1.58 M



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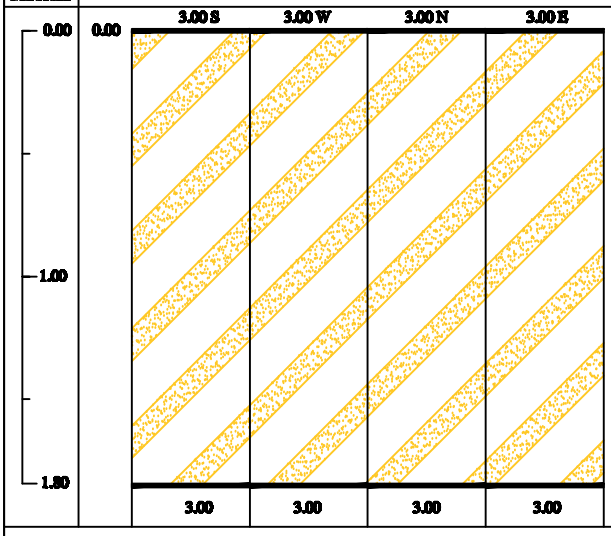
TRIAL PIT-02

LOCATION :- CMD AREA
CO-ORDINATES-375.030 N-1203.258
PROJECT:- DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER, ODISHA, INDIA.

TP:-01
TOTAL DEPTH:1.80M
R.L:-94.969

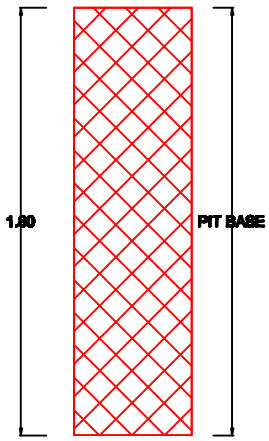
DATE OF START :-08.05.2020
DATE OF COMP. :- 08.05.2020



LEGEND:-

1) CLAYEY SAND

2) WATER TABLE-1.00 M



BISHNU KUMAR DAS.
MTECH (GEOTECH)

ANNEXURE - A SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Location	Borehole No	Depth in Mtrs	Type of Sample	IS Classification (IS:1498-1970)	Density in gm/cc		Water Content (%) (IS:2720 Pt-II)	Particle Size (%) (IS:2720 Pt-IV)			Atterberg's Limits (IS:2720 Pt-V)			Specific gravity (IS:2720 Pt-III_2)	Triaxial Shear Test (UU) (IS:2720 Pt-12)		Direct Shear Test (IS:2720 Pt-13)		Consolidation Test (IS:2720 Pt-15)		Void Ratio	UCS in kg/cm2 (IS:2720 Pt-10)	Permeability Test (IS:2720 Pt-17)	Modulus of Elasticity (E) Kg/cm^2
					Bulk	Dry		Gravel	Sand	Silt & Clay	LL	PL	PI		C in kg/cm^2	ø in degree	C in kg/cm^2	ø in degree	Cc	Mv (cm2/kg)				
CMD & CGU AREA	BH-01	1.5	SPT	SC	1.86	1.537	21	0	56	44	-	-	-	2.67	-	-	0.10	23	0.065	0.000095	-	9.20	-	189.26
		3.0	SPT	CI	1.78	1.348	32	-	-	-	45	21	24	2.65	-	-	-	-	-	-	0.97	-	-	-
		4.5	SPT	CI	-	-	-	0	9	91	-	-	-	-	0.53	0	-	-	-	-	-	-	1.082×10^{-7}	-
		6.0	SPT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	324.27
	BH-02	1.5	SPT	SC	-	-	-	0	58	42	31	20	11	2.66	-	-	-	-	-	-	-	-	-	186.00
		3.0	SPT	CI	-	-	-	0	8	92	42	20	22	-	-	-	-	-	0.178	0.00025	-	13.33	-	269.21
		4.5	SPT	CI	1.75	1.346	30	-	-	-	-	-	-	2.64	0.51	0	-	-	-	-	0.96	-	-	324.27
	BH-03	2.0	UDS	SC	1.89	1.549	22	0	55	45	33	21	12	2.67	-	-	0.12	20	-	-	-	6.93	0.960×10^{-4}	179.47
		3.0	SPT	CI	1.77	1.321	34	-	-	-	46	22	24	-	0.54	0	-	-	-	-	-	-	-	-
		4.5	SPT	CI	-	-	-	0	7	93	-	-	-	2.65	-	-	-	-	-	-	0.99	12.98	-	-
	BH-04	2.0	UDS	SC	1.87	1.558	20	0	57	43	31	19	12	2.68	-	-	0.13	19	-	-	-	6.67	0.984×10^{-4}	186.00
		3.0	SPT	CI	-	-	-	-	-	-	43	20	23	-	0.52	0	-	-	-	-	-	-	-	324.27
		4.5	SPT	CI	1.80	1.353	33	0	6	94	-	-	-	2.65	-	-	-	-	-	-	0.96	-	-	-
	BH-05	1.5	SPT	SC	-	-	-	0	60	40	-	-	-	2.67	-	-	0.09	25	0.062	0.000092	-	7.47	-	182.73
		3.0	SPT	CI	1.78	1.338	33	-	-	-	45	22	23	2.65	-	-	-	-	-	-	0.98	-	-	324.27
		4.5	SPT	CI	-	-	-	0	9	91	-	-	-	2.64	0.55	0	-	-	-	-	-	-	1.054×10^{-7}	-
	BH-06	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	202.31
		2.0	UDS	SC	1.88	1.541	22	0	56	44	33	21	12	2.66	-	-	0.07	26	-	-	-	6.80	0.889×10^{-4}	-
		3.0	SPT	CI	1.80	1.353	33	-	-	-	43	20	23	-	0.52	0	-	-	0.175	0.00027	-	-	-	-
		4.5	SPT	CI	-	-	-	0	6	94	-	-	-	2.65	-	-	-	-	-	-	0.96	13.33	-	324.27
	BH-07	1.5	SPT	SC	1.90	1.545	23	-	-	-	30	20	10	2.67	-	-	0.10	25	-	-	-	5.47	-	182.73
		4.5	SPT	CI	-	-	-	0	9	91	-	-	-	2.64	0.50	0	-	-	-	-	-	-	-	324.27

BISHAL KUMAR DAS. MTECH (GEOTECH)

CLIENT: TALCHER FERTILIZERS LIMITED

CONTRACTOR: WUHUAN ENGINEERING CO., LTD.

SUB CONTRACTOR: SWAYIN & ASSOCIATES.

JOB No. TLD/2020-03

ANNEXURE - A SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Location	Borehole No	Depth in Mtrs	Type of Sample	IS Classification (IS:1498-1970)	Density in gm/cc		Water Content (%) (IS:2720 Pt-II)	Particle Size (%) (IS:2720 Pt-IV)			Atterberg's Limits (IS:2720 Pt-V)			Specific gravity (IS:2720 Pt-III_2)	Triaxial Shear Test (UU) (IS:2720 Pt-12)		Direct Shear Test (IS:2720 Pt-13)		Consolidation Test (IS:2720 Pt-15)		Void Ratio	UCS in kg/cm2 (IS:2720 Pt-10)	Permeability Test (IS:2720 Pt-17)	Modulus of Elasticity (E) Kg/cm^2
					Bulk	Dry		Gravel	Sand	Silt & Clay	LL	PL	PI		C in kg/cm^2	ø in degree	C in kg/cm^2	ø in degree	Cc	Mv (cm2/kg)				
CMD & CGU AREA	BH-08	1.5	SPT	SC	1.87	1.545	21	0	57	43	-	-	-	2.68	-	-	-	-	-	-	-	-	-	205.58
		3.0	SPT	CI	-	-	-	0	6	94	45	22	23	-	0.53	0	-	-	-	-	-	-	-	-
		4.5	SPT	CI	1.75	1.346	30	-	-	-	-	-	-	2.64	-	-	-	-	-	-	0.96	-	-	324.27
	BH-09	1.5	SPT	SC	1.87	1.545	21	0	62	38	-	-	-	-	-	-	0.10	23	0.063	0.000096		6.00	-	195.79
		4.5	SPT	SC	1.89	1.524	24	-	-	-	31	20	11	2.67	-	-	-	-	-	-	-	-	-	-
		6.0	SPT	CI	1.79	1.336	34	-	-	-	44	21	23	2.64	-	-	-	-	-	-	0.98	-	-	324.27
	BH-10	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	182.73
		2.0	UDS	SC	1.93	1.544	25	0	60	40	33	21	12	2.65	-	-	0.11	21	-	-	0.72	-	0.875×10^{-4}	-
		4.5	SPT	CI	-	-	-	0	8	92	-	-	-	2.66	-	-	-	-	-	-	-	-	-	324.27
		6.0	SPT	CI	1.80	1.353	33	-	-	-	-	-	-	-	0.51	0	-	-	-	-	-	-	-	-
	BH-11	1.5	SPT	SC	1.92	1.587	21	-	-	-	30	21	9	-	-	-	-	-	-	-	-	-	-	179.47
		3.0	SPT	CI	1.79	1.356	32	-	-	-	45	21	24	-	-	-	-	-	0.176	0.00026	-	-	-	-
		6.0	SPT	CI	-	-	-	-	-	-	-	-	-	2.68	0.49	1	-	-	-	-	-	-	-	324.27
	BH-12	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	156.63
		2.0	UDS	SC	1.90	1.532	24	0	59	41	31	20	11	2.66	-	-	0.09	24	-	-	0.74	7.20	0.902×10^{-4}	-
		4.5	SPT	CI	-	-	-	0	7	93	42	20	22	-	-	-	-	-	-	-	-	-	-	-
		6.0	SPT	CI	1.82	1.348	35	-	-	-	-	-	-	2.65	0.52	0	-	-	-	-	0.97	-	-	324.27
	BH-13	1.5	SPT	SC	-	-	-	0	56	44	-	-	-	2.67	-	-	-	-	0.067	0.000098	-	5.73	-	189.26
		4.5	SPT	CI	1.77	1.351	31	-	-	-	-	-	-	2.64	0.51	0	-	-	-	-	0.95	-	-	-
		6.0	SPT	CI	-	-	-	0	8	92	40	19	21	-	-	-	-	-	-	-	-	-	-	324.27
	BH-14	1.5	SPT	SC	-	-	-	0	61	39	30	21	9	-	-	-	-	-	-	-	-	-	-	169.68
		4.5	SPT	CI	-	-	-	0	8	92	-	-	-	2.65	-	-	-	-	-	-	-	-	-	324.27

BISHNU KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES SATYANAGAR

ANNEXURE - A SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Location	Borehole No	Depth in Mtrs	Type of Sample	IS Classification (IS:1498-1970)	Density in gm/cc		Water Content (%) (IS:2720 Pt-II)	Particle Size (%) (IS:2720 Pt-IV)			Atterberg's Limits (IS:2720 Pt-V)			Specific gravity (IS:2720 Pt-III_2)	Triaxial Shear Test (UU) (IS:2720 Pt-12)		Direct Shear Test (IS:2720 Pt-13)		Consolidation Test (IS:2720 Pt-15)		Void Ratio	UCS in kg/cm2 (IS:2720 Pt-10)	Permeability Test (IS:2720 Pt-17)	Modulus of Elasticity (E) Kg/cm^2
					Bulk	Dry		Gravel	Sand	Silt & Clay	LL	PL	PI		C in kg/cm^2	ø in degree	C in kg/cm^2	ø in degree	Cc	Mv (cm2/kg)				
CMD & CGU AREA	BH-15	1.5	SPT	SC	1.92	1.536	25	-	-	-	-	-	-	2.67	-	-	0.11	24	-	-	-	-	-	176.21
		2.0	UDS	SC	1.93	1.532	26	0	57	43	32	21	11	2.66	-	-	0.11	22	-	-	0.74	8.27	-	-
		3.0	SPT	CI	-	-	-	0	7	93	-	-	-		0.54	0	-	-	0.173	0.00023	-	9.07	-	-
		6.0	SPT	CI	1.78	1.359	31	-	-	-	-	-	-	2.65	-	-	-	-	-	-	0.95	-	-	-
		7.5	SPT	CI	-	-	-	-	-	-	41	20	21		0.54	4	-	-	-	-	-	-	-	324.27
	BH-16	1.5	SPT	SC	-	-	-	0	60	40	30	20	10	-	-	-	-	-	-	-	-	-	-	189.26
		4.5	SPT	CI	1.80	1.38	30	-	-	-	43	20	23	-	-	-	-	-	-	-	-	-	-	-
		6.0	SPT	CI	-	-	-	0	6	94	-	-	-	2.64	0.55	5	-	-	-	-	-	-	-	324.27
	BH-17	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	186.00
		2.0	UDS	SC	1.94	1.58	23	0	61	39	31	21	10	2.67	-	-	0.08	26	-	-	0.69	6.67	0.765×10^{-4}	-
		4.5	SPT	CI	1.77	1.34	32	-	-	-	-	-	-	2.64	-	-	-	-	-	-	0.97	-	-	324.27
		6.0	SPT	CI	-	-	-	0	10	90	-	-	-	-	0.48	2	-	-	-	-	-	-	-	-
	BH-18	1.5	SPT	SC	1.90	1.56	22	0	58	42	-	-	-	2.66	-	-	-	-	-	-	0.71	4.40	-	156.63
		4.5	SPT	CI	1.80	1.35	33	-	-	-	42	20	22	-	0.52	0	-	-	-	-	-	-	-	-
		6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	324.27
		7.5	SPT	CI	-	-	-	0	9	91	-	-	-	2.65	-	-	-	-	-	-	-	-	-	-
	BH-19	1.5	SPT	SC	1.88	1.54	22	-	-	-	29	20	9	2.66	-	-	-	-	-	-	-	-	-	189.26
		4.5	SPT	CI	-	-	-	0	8	92	-	-	-	-	0.51	0	-	-	-	-	-	12.65	-	324.27
	BH-20	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	179.47
		2.0	UDS	SC	1.91	1.54	24	0	56	44	31	20	11	2.67	-	-	0.10	21	0.066	0.000094	0.73	6.67	0.816×10^{-4}	-
		3.0	SPT	CI	-	-	-	0	10	90	-	-	-	-	0.53	0	-	-	-	-	-	-	-	-
		4.5	SPT	CI	1.79	1.36	32	-	-	-	-	-	-	2.64	-	-	-	-	-	-	0.95	-	-	324.27
	BH-21	1.5	SPT	SC	1.92	1.54	25	-	-	-	-	-	-	2.67	-	-	-	-	-	-	0.74	6.00	-	195.79
		3.0	SPT	CI	1.79	1.37	31	-	-	-	43	21	22	2.64	-	-	-	-	-	-	0.93	-	-	324.27
		4.5	SPT	CI	-	-	-	0	9	91	-	-	-	-	-	-	-	-	-	-	-	-	1.067×10^{-7}	-

BISHAL KUMAR DAS. MTECH (GEOTECH)

ANNEXURE - A SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Location	Borehole No	Depth in Mtrs	Type of Sample	IS Classification (IS:1498-1970)	Density in gm/cc		Water Content (%) (IS:2720 Pt-II)	Particle Size (%) (IS:2720 Pt-IV)			Atterberg's Limits (IS:2720 Pt-V)			Specific gravity (IS:2720 Pt-III_2)	Triaxial Shear Test (UU) (IS:2720 Pt-12)		Direct Shear Test (IS:2720 Pt-13)		Consolidation Test (IS:2720 Pt-15)		Void Ratio	UCS in kg/cm2 (IS:2720 Pt-10)	Permeability Test (IS:2720 Pt-17)	Modulus of Elasticity (E) Kg/cm^2
					Bulk	Dry		Gravel	Sand	Silt & Clay	LL	PL	PI		C in kg/cm^2	ø in degree	C in kg/cm^2	ø in degree	Cc	Mv (cm2/kg)				
CMD & CGU AREA	BH-22	1.5	SPT	SC	-	-	-	-	-	-	31	21	10	-	-	-	0.10	23	-	-	-	-	-	186.00
		3.0	SPT	CI	1.81	1.35	34	-	-	-	-	-	-	2.65	-	-	-	-	-	-	0.96	-	-	-
		4.5	SPT	CI	-	-	-	0	8	92	-	-	-	-	-	-	-	-	-	-	-	-	-	324.27
	BH-23	1.5	SPT	SC	1.90	1.53	24	0	55	45	31	20	11	2.66	-	-	-	-	-	-	0.74	5.07	-	172.94
		4.5	SPT	CI	-	-	-	0	7	93	42	20	22	-	-	-	-	-	-	-	-	-	-	324.27
		6.0	SPT	CI	1.82	1.35	35	-	-	-	-	-	-	2.65	0.52	0	-	-	0.175	0.00025	0.97	-	-	-
	BH-24	1.5	SPT	SC	1.91	1.57	22	0	59	41	30	21	9	2.66	-	-	-	-	-	-	-	5.60	-	186.00
		3.0	SPT	CI	1.80	1.34	34	-	-	-	44	21	23	-	-	-	-	-	-	-	-	-	-	324.27
	BH-25	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	199.05
		2.0	UDS	SC	1.93	1.56	24	0	57	43	33	21	12	2.66	-	-	0.09	23	-	-	0.71	7.60	0.877×10^{-4}	-
		3.0	SPT	CI	-	-	-	0	8	92	40	19	21	-	-	-	-	-	-	-	-	-	-	-
		4.5	SPT	CI	1.77	1.33	33	-	-	-	-	-	-	2.64	0.53	0	-	-	-	-	0.98	-	-	-
		6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	324.27
	BH-26	1.5	SPT	SC	-	-	-	0	61	39	-	-	-	-	-	-	-	-	-	-	-	8.00	-	-
		3.0	SPT	CI	1.80	1.36	32	-	-	-	-	-	-	2.65	-	-	-	-	-	-	0.94	-	-	-
		4.5	SPT	CI	-	-	-	0	9	91	-	-	-	-	0.50	0	-	-	-	-	-	-	-	-
	BH-27	1.5	SPT	SC	-	-	-	0	60	40	-	-	-	2.67	-	-	0.09	25	0.063	0.000097	-	7.47	-	195.79
		3.0	SPT	CI	1.78	1.34	33	-	-	-	45	22	23	2.65	-	-	-	-	-	-	0.98	-	-	-
		4.5	SPT	CI	-	-	-	0	9	91	-	-	-	-	0.55	0	-	-	-	-	-	-	1.054×10^{-7}	-
		6.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	324.27
	BH-28	1.5	SPT	SC	1.93	1.58	22	-	-	-	32	21	11	-	-	-	0.11	21	-	-	-	-	-	153.37
		3.0	SPT	CI	1.79	1.37	31	-	-	-	44	21	23	2.65	-	-	-	-	-	-	0.94	-	-	324.27
		4.5	SPT	CI	-	-	-	0	7	93	-	-	-	-	0.51	0	-	-	-	-	-	-	-	-

BISHWAJIT KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES PVT. LTD. SATYANAGAR

Talcher Fertilizers

PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER, ODISHA, INDIA.

CLIENT: TALCHER FERTILIZERS LIMITED

CONTRACTOR: WUHUAN ENGINEERING CO., LTD.

SUB CONTRACTOR: SWAYIN & ASSOCIATES.

JOB No. TLD/2020-03

ANNEXURE - A SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Location	Borehole No	Depth in Mtrs	Type of Sample	IS Classification (IS:1498-1970)	Density in gm/cc		Water Content (%) (IS:2720 Pt-II)	Particle Size (%) (IS:2720 Pt-IV)			Atterberg's Limits (IS:2720 Pt-V)			Specific gravity (IS:2720 Pt-III_2)	Triaxial Shear Test (UU) (IS:2720 Pt-12)		Direct Shear Test (IS:2720 Pt-13)		Consolidation Test (IS:2720 Pt-15)		Void Ratio	UCS in kg/cm2 (IS:2720 Pt-10)	Permeability Test (IS:2720 Pt-17)	Modulus of Elasticity (E) Kg/cm^2
					Bulk	Dry		Gravel	Sand	Silt & Clay	LL	PL	PI		C in kg/cm^2	ø in degree	C in kg/cm^2	ø in degree	Cc	Mv (cm2/kg)				
CMD & CGU AREA	BH-29	1.5	SPT	SC	-	-	-	0	62	38	-	-	-	-	-	-	-	-	-	-	-	6.27	-	202.31
		4.5	SPT	CI	-	-	-	0	10	90	40	19	21	-	-	-	-	-	0.174	0.00024	-	-	-	324.27
	BH-30	1.5	SPT	SC	1.94	1.56	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		3.0	SPT	SC	-	-	-	0	59	41	-	-	-	-	-	-	0.09	22	-	-	-	-	-	192.52
		4.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	339.36
		6.0	SPT	CI	1.80	1.35	33	-	-	-	-	-	-	2.64	0.53	0	-	-	-	-	0.95	-	-	-
	BH-31	1.5	SPT	SC	-	-	-	0	61	39	-	-	-	-	-	-	-	-	0.064	0.000093	-	2.93	-	-
		3.0	SPT	SC	1.90	1.56	22	-	-	-	30	20	10	-	-	-	-	-	-	-	-	-	-	163.16
		4.5	SPT	CI	-	-	-	0	8	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		6.0	SPT	CI	1.77	1.36	30	-	-	-	-	-	-	2.65	0.50	0	-	-	-	-	0.95	-	1.071 x 10^{-7}	305.92
	BH-32	3.0	SPT	SC	1.89	1.56	21	-	-	-	-	-	-	2.67	-	-	-	-	-	-	0.71	-	-	137.05
		4.5	SPT	SC	-	-	-	0	60	40	-	-	-	-	-	-	-	-	-	-	-	4.67	-	-
		6.0	SPT	SC	-	-	-	-	-	-	31	21	10	-	-	-	-	-	-	-	-	-	-	-
		7.5	SPT	CI	1.78	1.36	31	-	-	-	-	-	-	2.64	-	-	-	-	0.177	0.00025	0.94	-	-	324.27
		9.0	SPT	CI	-	-	-	0	7	93	-	-	-	-	0.52	0	-	-	-	-	-	13.33	-	-
	BH-33	1.5	SPT	SC	-	-	-	0	62	38	-	-	-	2.66	-	-	0.08	26	-	-	-	4.53	-	159.89
		4.5	SPT	CI	1.77	1.36	30	-	-	-	-	-	-	2.64	-	-	-	-	-	-	0.94	-	-	-
		6.0	SPT	CI	-	-	-	0	9	91	44	21	23	-	-	-	-	-	-	-	-	-	-	293.68

BISHWAJIT KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES

CALCULATION FOR VOID RATIO

Example for some Boreholes

1) **For BH-01**

Depth:-3.00m

Specific gravity: 2.65

Dry Density: 1.35

Void Ratio (e_0) = (2.65/1.35)-1

= 0.97

2) **For BH-10**

Depth:-2.00m

Specific gravity: 2.65

Dry Density: 1.54

Void Ratio (e_0) = (2.65/1.54)-1

= 0.72

3) **For BH-15**

Depth:-6.00m

Specific gravity: 2.65

Dry Density: 1.36

Void Ratio (e_0) = (2.65/1.36)-1

= 0.95

4) **For BH-20**

Depth:-2.00m

Specific gravity: 2.67

Dry Density: 1.54

Void Ratio (e_0) = (2.67/1.54)-1

= 0.73

5) **For BH-25**

Depth:-2.00m

Specific gravity: 2.66

Dry Density: 1.56

Void Ratio (e_0) = (2.66/1.56)-1

= 0.71

6) **For BH-30**

Depth:- 6.00m

Specific gravity: 2.64

Dry Density: 1.35

Void Ratio (e_0) = (2.64/1.35)-1

= 0.95

7) **For BH-33**

Depth:- 4.50m

Specific gravity: 2.64

Dry Density: 1.36

Void Ratio (e_0) = (2.64/1.36)-1

= 0.94

BISHO KUMAR DAS. M.TECH (GEOTECH)

ANNEXURE-B (ANALYSIS OF ROCK PROPERTIES)

Borehole No.		1	1	1	2
Depth (in mtr)		10.50	15.00	27.88	9
Core Piece No		3	6	14	2
RQD (%)		18	43	28	16
Density (g/cc)		2.48	2.57	2.48	2.47
Water content		0.11	0.036	0.096	0.097
Porosity		6.21	11.42	6.12	6.11
Permeability		1.64×10^{-8}	2.45×10^{-7}	2.17×10^{-8}	1.67×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		108.96	240.16	149.26	104.45
Point Load Test (kg/cm^2)		4.54	10.56	4.95	4.60
Weatherability		Completely Weathered(Grade-V)	Highly Weathered(Grade-IV)	Highly Weathered (Grade-IV)	Completely Weathered(Grade-V)
Term		Weak	Strong	Weak to Strong	Weak
Mohr's Scale of Hardness		3	5	3	3
Cohesion and angle of internal friction	Shear Strength, C	16.42 kg/cm^2	15.65 kg/cm^2	19.58 kg/cm^2	17.20 kg/cm^2
	ϕ	18°	30°	16^o	18°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with $20^0$to 35^0 dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 25° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with $20^0$to 35^0 dip
Corrosivity		Moderately to Mildy Corrosive	Mildy Corrosive	Moderately to Mildy Corrosive	Moderately to Mildy Corrosive
The rock deformability characteristics		Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation :V to IV Description of Rock : Very Poor to Poor	Quality of Deformation :V Description of Rock : Very Poor

BISHWAJIT KUMAR DAS. M.TECH (GEOTECH) SWAYIN ASSOC. 12 SATYANAGAR

Borehole No.		2	2	3	3
Depth (in mtr)		13.50	17.48	16.50	25.50
Core Piece No		5	8	7	13
RQD (%)		38	36	45	24
Density (g/cc)		2.57	2.49	2.56	2.48
Water content		0.042	0.10	0.033	0.087
Porosity		9.96	5.97	11.96	6.02
Permeability		1.85×10^{-7}	1.64×10^{-8}	2.64×10^{-7}	2.54×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		274.62	160.54	240.46	141.15
Point Load Test (kg/cm^2)		12.9	5.14	10.59	5.02
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered(Grade-IV)	Highly Weathered (Grade-IV)	Completely Weathered (Grade-V)
Term		Strong	Strong	Weak to Strong	Strong to Weak
Mohr's Scale of Hardness		5	3.5	5	3.5
Cohesion and angle of internal friction	Shear Strength, C	18.86 kg/cm^2	21.54 kg/cm^2	13.64 kg/cm^2	15.65 kg/cm^2
	ϕ	33°	15°	28^0	18°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 20° dip
Corrosivity		Moderately Corrosive	Moderately Corrosive	Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation : V to IV Description of Rock : Very Poor to Poor	Quality of Deformation : IV to V Description of Rock : Very Poor to Poor

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

Borehole No.		4	4	5	5
Depth (in mtr)		13.50	21.00	9	13.50
Core Piece No		5	10	2	5
RQD (%)		39	36	13	37
Density (g/cc)		2.58	2.47	2.43	2.58
Water content		0.041	0.091	0.085	0.043
Porosity		10.25	5.96	5.65	10.28
Permeability		1.95×10^{-7}	1.74×10^{-8}	2.14×10^{-8}	1.98×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		284.31	148.92	82.47	282.62
Point Load Test (kg/cm^2)		8.67	6.56	3.63	12.45
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Completely Weathered(Grade-V)	Highly Weathered (Grade-IV)
Term		Weak to Strong	Strong	Weak	Strong
Mohr's Scale of Hardness		5	4	3	5
Cohesion and angle of internal friction	Shear Strength, C	19.15 kg/cm^2	20.78 kg/cm^2	17.88 kg/cm^2	20.15 kg/cm^2
	ϕ	33°	16^0	11^0	33°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 35^0 dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip
Corrosivity		Moderately Corrosive	Moderately Corrosive	Moderately to Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation : V to IV Description of Rock : Very Poor to Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation : IV Description of Rock : Poor

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Borehole No.		5	6	6	7
Depth (in mtr)		17.59	16.50	25.50	9.00
Core Piece No		8	06	12	2
RQD (%)		29	43	20	17
Density (g/cc)		2.48	2.58	2.42	2.48
Water content		0.091	0.038	0.12	0.078
Porosity		6.07	12.06	5.02	6.12
Permeability		3.14×10^{-8}	2.57×10^{-7}	2.54×10^{-8}	2.04×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		152.12	218.59	168.12	102.11
Point Load Test (kg/cm^2)		6.7	9.62	5.15	4.67
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Completely Weathered(Grade-V)	Completely Weathered(Grade-V)
Term		Strong	Weak to Strong	Weak	Weak
Mohr's Scale of Hardness		3	4	3	3
Cohesion and angle of internal friction	Shear Strength, C	20.85 kg/cm^2	12.75 kg/cm^2	22.11 kg/cm^2	18.66 kg/cm^2
	ϕ	15°	28^0	15°	16°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 25° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 20° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 35^0 dip
Corrosivity		Moderately Corrosive	Mildy Corrosive	Moderately Corrosive	Moderately to Mildy Corrosive
The rock deformability characteristics		Quality of Deformation :IV Description of Rock :Poor	Quality of Deformation : V to IV Description of Rock : Very Poor to Poor	Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation :V Description of Rock : Very Poor

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Borehole No.		7	7	8	8
Depth (in mtr)		12.00	22.50	9.00	16.50
Core Piece No		04	11	2	7
RQD (%)		42	28	10	44
Density (g/cc)		2.59	2.49	2.47	2.57
Water content		0.041	0.094	0.081	0.032
Porosity		11.45	5.95	5.24	12.12
Permeability		2.37×10^{-7}	2.64×10^{-8}	1.15×10^{-8}	2.54×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		228.74	154.50	92.54	221.45
Point Load Test (kg/cm^2)		10.07	6.80	4.07	7.98
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV	Completely Weathered(Grade-V)	Highly Weathered (Grade-IV)
Term		Strong	Strong to Weak	Weak	Strong
Mohr's Scale of Hardness		5	3.0	3.0	4
Cohesion and angle of internal friction	Shear Strength, C	16.45 kg/cm^2	21.12 kg/cm^2	16.10 kg/cm^2	12.15 kg/cm^2
	ϕ	30°	16°	17°	27°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with25° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 45^0 dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip
Corrosivity		Mildy Corrosive	Moderately Corrosive	Moderately to Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation : IV to V Description of Rock : Poor to Very Poor	Quality of Deformation : V Description of Rock : Very Poor	Quality of Deformation : IV to III Description of Rock : Poor to Fair

BISHNU KUMAR DAS. MTECH (GEOTECH)

Borehole No.		9	9	10	10
Depth (in mtr)		10.50	15.00	12.00	16.50
Core Piece No		2	5	3	06
RQD (%)		14	31	19	46
Density (g/cc)		2.48	2.58	2.46	2.58
Water content		0.084	0.034	0.095	0.044
Porosity		5.21	10.95	5.85	12.10
Permeability		1.11×10^{-8}	1.98×10^{-7}	1.54×10^{-8}	2.25×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		98.88	226.45	110.45	228.31
Point Load Test (kg/cm^2)		3.87	9.97	4.86	10.05
Weatherability		Completely Weathered (Grade-V)	Highly Weathered (Grade-IV)	Completely Weathered (Grade-V)	Highly Weathered (Grade-IV)
Term		Weak	Strong	Weak	Strong
Mohr's Scale of Hardness		3	4.5	3	5
Cohesion and angle of internal friction	Shear Strength, C	12.00 kg/cm^2	15.45 kg/cm^2	15.95 kg/cm^2	12.45 kg/cm^2
	ϕ	13°	30°	18°	27°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 30^0dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with $20^0$to 35^0	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip
Corrosivity		Moderately to Mildy Corrosive	Mildy Corrosive	Moderately to Mildy Corrosive	Mildy Corrosive
The rock deformability characteristics		Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation : IV to V Description of Rock : Poor to Very Poor	Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation : IV Description of Rock : Poor

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Borehole No.		10	11	12	12
Depth (in mtr)		19.50	19.50	10.50	15.00
Core Piece No		8	08	02	05
RQD (%)		42	42	20	33
Density (g/cc)		2.47	2.46	2.47	2.57
Water content		0.098	0.096	0.085	0.045
Porosity		6.05	5.68	5.58	10.84
Permeability		3.18×10^{-8}	3.25×10^{-8}	1.74×10^{-8}	2.16×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		156.25	156.18	107.42	240.62
Point Load Test (kg/cm^2)		5.02	6.88	4.73	10.6
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Completely Weathered(Grade-V)	Highly Weathered (Grade-IV)
Term		Strong to Weak	Strong to Weak	Weak	Weak to Strong
Mohr's Scale of Hardness		3	3	3	4
Cohesion and angle of internal friction	Shear Strength, C	19.42 kg/cm^2	20.42 kg/cm^2	15.35 kg/cm^2	16.25 kg/cm^2
	ϕ	13°	14°	15°	25°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Continuous Fractures	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 25° dip
Corrosivity		Moderately Corrosive	Moderately Corrosive	Moderately to Mildy Corrosive	Moderately to Mildy Corrosive
The rock deformability characteristics		Quality of Deformation :IV to V Description of Rock :Poor to Very Poor	Quality of Deformation :IV to V Description of Rock : Poor to Very Poor	Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation : V to IV Description of Rock : Very Poor to Poor

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Borehole No.		12	13	13	13
Depth (in mtr)		22.50	10.50	13.50	18.00
Core Piece No		10	2	4	7
RQD (%)		28	17	24	33
Density (g/cc)		2.5	2.45	2.54	2.48
Water content		0.094	0.089	0.051	0.11
Porosity		5.86	5.75	10.42	6.07
Permeability		3.25×10^{-8}	2.55×10^{-8}	1.81×10^{-7}	1.58×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		150.84	103.55	265.48	158.42
Point Load Test (kg/cm^2)		6.64	4.56	8.05	6.97
Weatherability		Highly Weathered (Grade-IV)	Completely Weathered(Grade-V)	Completely Weathered(Grade-V)	Highly Weathered (Grade-IV)
Term		Strong to Weak	Weak	Weak - Strong	Strong
Mohr's Scale of Hardness		3	3	4	3
Cohesion and angle of internal friction	Shear Strength, C	20.44 kg/cm^2	18.87 kg/cm^2	15.64 kg/cm^2	20.59 kg/cm^2
	ϕ	16°	16°	26°	16°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 25° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 35° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 25° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip
Corrosivity		Moderately Corrosive	Moderately to Mildy Corrosive	Moderately to Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation: IV to V Description of Rock: Very Poor	Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation :V to IV Description of Rock : Very Poor to Poor	Quality of Deformation : IV Description of Rock : Poor

BISHNU KUMAR DAS. M.TECH (GEOTECH)

Borehole No.		14	14	14	15
Depth (in mtr)		12.00	15.00	18.00	13.50
Core Piece No		3	5	7	03
RQD (%)		20	30	24	
Density (g/cc)		2.46	2.56	2.47	
Water content		0.075	0.041	0.10	
Porosity		6.01	10.95	6.15	
Permeability		1.054×10^{-8}	2.15×10^{-7}	3.14×10^{-8}	
Unconfined Compressive Strength (kg/cm^2)		93.15	234.65	142.96	215.42
Point Load Test (kg/cm^2)		4.35	10.33	6.29	
Weatherability		Completely Weathered (Grade-V)	Highly Weathered (Grade-IV)	Completely Weathered (Grade-V)	
Term		Weak	Weak to Strong	Weak	
Mohr's Scale of Hardness		3	4	3.5	
Cohesion and angle of internal friction	Shear Strength, C	15.02 kg/cm^2	16.62 kg/cm^2	18.45 kg/cm^2	
	ϕ	15°	28°	15°	
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Continuous Fractures	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	
Corrosivity		Moderately to Mildy Corrosive	Mildy Corrosive	Moderately to Mildy Corrosive	
The rock deformability characteristics		Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation : V to IV Description of Rock : Very Poor to Poor	Quality of Deformation :V Description of Rock : Very Poor	

BISHWA KUMAR DAS. MTECH (GEOTECH)

Borehole No.		15	15	16	16
Depth (in mtr)		16.50	27.00	15.00	19.50
Core Piece No		05	12	5	8
RQD (%)		58	21	38	20
Density (g/cc)		2.52	2.48	2.56	2.48
Water content		0.085	0.094	0.038	0.085
Porosity		5.58	6.10	11.80	5.54
Permeability		1.65×10^{-8}	2.54×10^{-8}	2.41×10^{-7}	1.31×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		218.48	124.15	218.41	142.21
Point Load Test (kg/cm^2)		9.62	5.46	9.62	5.02
Weatherability		Moderately Weathered (Grade-III)	Completely Weathered(Grade-V)	Highly Weathered (Grade-IV)	Completely Weathered (Grade-V)
Term		Strong	Weak	Weak to Strong	Weak
Mohr's Scale of Hardness		4	3	4.0	3.5
Cohesion and angle of internal friction	Shear Strength, C	14.38 kg/cm^2	16.72 kg/cm^2	13.25 kg/cm^2	22.87 kg/cm^2
	ϕ	26°	18°	26°	16°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with $20^0$to 35^0	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 20^0dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip
Corrosivity		Moderately to Mildy Corrosive	Moderately Corrosive	Mildly Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation: IV-III Description of Rock : Poor-Fair	Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation : V to IV Description of Rock : Very Poor to Poor	Quality of Deformation :V Description of Rock : Very Poor

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Borehole No.		17	17	17	18
Depth (in mtr)		10.50	16.50	27.00	12
Core Piece No		2	6	13	3
RQD (%)		13	55	24	15
Density (g/cc)		2.47	2.59	2.48	2.48
Water content		0.095	0.038	0.098	0.085
Porosity		5.65	10.84	6.08	5.17
Permeability		1.25×10^{-8}	2.48×10^{-7}	3.54×10^{-8}	1.14×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		94.65	262.48	143.65	100.15
Point Load Test (kg/cm^2)		4.16	11.5	4.84	4.41
Weatherability		Completely Weathered(Grade-V)	Moderately Weathered (Grade-III)	Completely Weathered (Grade-V)	Completely Weathered (Grade-V)
Term		Weak	Weak toStrong	Strong to Weak	Weak
Mohr's Scale of Hardness		3	4	3	3
Cohesion and angle of internal friction	Shear Strength, C	12.65 kg/cm^2	13.54 kg/cm^2	18.65 kg/cm^2	12.75 kg/cm^2
	ϕ	13°	26°	14°	13°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 30° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures Closely with 30° dip
Corrosivity		Moderately to Mildy Corrosive	Mildy Corrosive	Moderately Corrosive	Moderately to Mildy Corrosive
The rock deformability characteristics		Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation: V to III Description of Rock: Very Poor to Fair	Quality of Deformation: IV to V Description of Rock: Very Poor to Poor	Quality of Deformation: V Description of Rock: Very Poor

BISHWAJIT KUMAR DAS. M.TECH (GEOTECH)

Borehole No.		18	18	19	19
Depth (in mtr)		15.00	18.00	10.50	13.50
Core Piece No		5	7	2	4
RQD (%)		32	25	11	26
Density (g/cc)		2.58	2.48	2.48	2.58
Water content		0.042	0.094	0.081	0.038
Porosity		10.86	5.95	6.14	10.92
Permeability		2.19×10^{-7}	3.45×10^{-8}	1.05×10^{-8}	2.28×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		228.55	147.52	99.19	220.45
Point Load Test (kg/cm^2)		10.06	6.49	4.36	9.71
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered(Grade-IV)	Completely Weathered (Grade-V)	Highly Weathered (Grade-IV)
Term		Strong to Weak	Strong	Weak	Strong
Mohr's Scale of Hardness		4	3	3	4
Cohesion and angle of internal friction	Shear Strength, C	16.54 kg/cm^2	20.55 kg/cm^2	15.22 kg/cm^2	16.65 kg/cm^2
	ϕ	29°	16°	18°	29°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 25° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 45^0dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip
Corrosivity		Mildy Corrosive	Moderately Corrosive	Moderately to Mildy Corrosive	Mildy Corrosive
The rock deformability characteristics		Quality of Deformation: IV to V Description of Rock: Very Poor to Poor	Quality of Deformation: IV Description of Rock:Poor	Quality of Deformation: V Description of Rock: Very Poor	Quality of Deformation:V to IV Description of Rock: Very Poor to Poor

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Borehole No.		19	20	20	20
Depth (in mtr)		18.48	10.50	15.00	28.50
Core Piece No		7	2	5	14
RQD (%)		24	15	58	25
Density (g/cc)		2.49	2.46	2.60	2.5
Water content		0.085	0.084	0.039	0.095
Porosity		6.23	5.94	12.24	6.12
Permeability		2.59×10^{-8}	2.08×10^{-8}	2.46×10^{-7}	3.54×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		143.92	101.45	262.85	148.54
Point Load Test (kg/cm^2)		6.34	4.46	11.57	5.01
Weatherability		Completely Weathered (Grade-V)	Completely Weathered (Grade-V)	Moderately Weathered (Grade-III)	Highly Weathered (Grade-IV)
Term		Weak	Weak	Strong	Strong
Mohr's Scale of Hardness		3	3	5	3
Cohesion and angle of internal friction	Shear Strength, C	15.75 kg/cm^2	18.54 kg/cm^2	12.75 kg/cm^2	20.24 kg/cm^2
	ϕ	18°	16°	27°	16°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 20° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 35^{0}dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 25° dip
Corrosivity		Moderately Corrosive	Moderately Corrosive	Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation: V Description of Rock: Very Poor	Quality of Deformation: V Description of Rock: Very Poor	Quality of Deformation: IV to III Description of Rock: Poor to Fair	Quality of Deformation: IV Description of Rock: Poor

BISHNU KUMAR DAS.
MTECH (GEOTECH)

Borehole No.		21	21	22	22
Depth (in mtr)		9.00	15.00	15.00	21.00
Core Piece No		2	6	6	10
RQD (%)		23	42	24	44
Density (g/cc)		2.46	2.58	2.54	2.49
Water content		0.096	0.044	0.051	0.095
Porosity		5.97	11.75	10.42	5.85
Permeability		1.74×10^{-8}	2.65×10^{-7}	1.81×10^{-7}	1.74×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		112.92	218.25	265.48	162.54
Point Load Test (kg/cm^2)		4.97	9.61	8.05	7.16
Weatherability		Completely Weathered (Grade-V)	Highly Weathered (Grade-IV)	Completely Weathered (Grade-V)	Highly Weathered (Grade-IV)
Term		Weak	Strong	Strong to Weak	Strong
Mohr's Scale of Hardness		3	5	4	4
Cohesion and angle of internal friction	Shear Strength, C	15.95 kg/cm^2	12.75 kg/cm^2	15.64 kg/cm^2	20.24 kg/cm^2
	ϕ	18°	38°	26°	16°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with $20^0$to 35^0	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 25° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with30° dip
Corrosivity		Moderately to Mildy Corrosive	Mildy Corrosive	Moderately to Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation: V Description of Rock: Very Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation : III to V Description of Rock : Fair to Very Poor	Quality of Deformation: IV Description of Rock: Poor

BISHWANATH KUMAR DAS. MTECH (GEOTECH)

Borehole No.		23	23	23	24
Depth (in mtr)		10.50	16.50	18.00	15.00
Core Piece No		2	6	7	6
RQD (%)		13	25	32	27
Density (g/cc)		2.48	2.54	2.49	2.57
Water content		0.078	0.047	0.098	0.038
Porosity		5.98	10.82	6.07	11.25
Permeability		1.01×10^{-8}	2.28×10^{-7}	1.75×10^{-8}	2.18×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		105.12	218.42	155.62	221.78
Point Load Test (kg/cm^2)		4.35	9.9	6.85	8.24
Weatherability		Completely Weathered(Grade-V)	Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Highly Weathered (Grade-III)
Term		Weak	Weak to Strong	Strong	Strong
Mohr's Scale of Hardness		3	4	3	4.5
Cohesion and angle of internal friction	Shear Strength, C	15.28 kg/cm^2	15.84 kg/cm^2	20.95 kg/cm^2	16.25 kg/cm^2
	ϕ	18°	28°	15°	29°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 45° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip
Corrosivity		Moderately to Mildy Corrosive	Mildy Corrosive	Moderately Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation: IV Description of Rock: Very Poor	Quality of Deformation :V to IV Description of Rock : Very Poor to Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation: III to IV Description of Rock: Fair to Poor

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Borehole No.		24	25	25	25
Depth (in mtr)		17.82	10.50	15.00	30.00
Core Piece No		8	2	5	15
RQD (%)		24	28	45	35
Density (g/cc)		2.47	2.49	2.58	2.49
Water content		0.088	0.096	0.034	0.099
Porosity		6.09	6.28	12.25	6.03
Permeability		2.51×10^{-8}	3.15×10^{-8}	2.55×10^{-7}	1.61×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		140.12	152.15	223.31	158.42
Point Load Test (kg/cm^2)		6.17	6.70	9.83	6.97
Weatherability		Completely Weathered (Grade-V)	Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)
Term		Weak	Strong	Strong	Weak to Strong
Mohr's Scale of Hardness		3	4	5	3.5
Cohesion and angle of internal friction	Shear Strength, C	15.75 kg/cm^2	20.55 kg/cm^2	12.55 kg/cm^2	21.15 kg/cm^2
	ϕ	18°	16°	27°	15°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with20° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 25° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip
Corrosivity		Moderately Corrosive	Moderately Corrosive	Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation :V Description of Rock : Very Poor	Quality of Deformation :IV Description of Rock :Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation : V to IV Description of Rock : Very Poor to Poor

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Borehole No.		26	26	26	27
Depth (in mtr)		10.50	15.00	18.00	9.00
Core Piece No		2	5	7	2
RQD (%)		22	52	18	17
Density (g/cc)		2.46	2.58	2.46	2.42
Water content		0.096	0.047	0.082	0.081
Porosity		5.98	11.98	5.94	5.98
Permeability		1.68×10^{-8}	2.55×10^{-7}	2.05×10^{-8}	2.21×10^{-8}
Unconfined Compressive Strength (kg/cm^2)		114.82	242.36	104.45	87.11
Point Load Test (kg/cm^2)		5.05	10.67	4.68	3.64
Weatherability		Completely Weathere (Grade-V)	Moderately Weathered (Grade-III)	Completely Weathered(Grade-V)	Completely Weathered(Grade-V)
Term		Weak	Strong	Weak	Weak
Mohr's Scale of Hardness		3	5	3	3
Cohesion and angle of internal friction	Shear Strength , C	16.85 kg/cm^2	13.15 kg/cm^2	17.85 kg/cm^2	18.1 kg/cm^2
	ϕ	18°	26°	17°	11°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with $20^0$to 35^0	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 35^0 dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Fractures closely with 35^0 dip
Corrosivity		Moderately to Mildy Corrosive	Mildy Corrosive	Moderately to Mildy Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation: V Description of Rock: Very Poor	Quality of Deformation : IV to III Description of Rock : Poor to Fair	Quality of Deformation: V Description of Rock: Very Poor	Quality of Deformation :V Description of Rock : Very Poor

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Borehole No.		27	27	28	28
Depth (in mtr)		13.50	17.87	10.50	15.00
Core Piece No		5	8	3	6
RQD (%)		38	27	33	61
Density (g/cc)		2.58	2.48	2.49	2.59
Water content		0.039	0.094	0.094	0.038
Porosity		10.85	5.95	5.95	11.45
Permeability		2.27×10^{-7}	3.45×10^{-8}	1.75×10^{-8}	2.38×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		218.75	151.64	156.84	256.31
Point Load Test (kg/cm^2)		9.63	6.68	6.90	11.29
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Moderately Weathered (Grade-III)
Term		Weak to Strong	Strong	Strong	Strong
Mohr's Scale of Hardness		5	3	3	5
Cohesion and angle of internal friction	Shear Strength, C	17.15 kg/cm^2	20.45 kg/cm^2	20.15 kg/cm^2	12.75 kg/cm^2
	ϕ	28°	16°	16°	29°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with25° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip
Corrosivity		Mildy Corrosive	Moderately Corrosive	Moderately Corrosive	Mildy Corrosive
The rock deformability characteristics		Quality of Deformation :V to IV Description of Rock : Very Poor to Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation :IV to III Description of Rock : Poor to Fair

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

Borehole No.		28	29	30	30
Depth (in mtr)		22.50	13.50	12.00	17.80
Core Piece No		11	5	3	7
RQD (%)		38	45	25	53
Density (g/cc)		2.48	2.60	2.49	2.60
Water content		0.098	0.033	0.077	0.042
Porosity		6.08	12.08	5.97	11.82
Permeability		3.54×10^{-8}	2.68×10^{-7}	2.56×10^{-8}	2.48×10^{-7}
Unconfined Compressive Strength (kg/cm^2)		143.65	223.64	142.62	228.52
Point Load Test (kg/cm^2)		4.84	9.85	6.28	10.06
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Moderately Weathered (Grade-III)
Term		Strong	Weak to Strong	Strong	Strong
Mohr's Scale of Hardness		3	5	3	5
Cohesion and angle of internal friction	Shear Strength, C	18.65 kg/cm^2	12.30 kg/cm^2	17.28 kg/cm^2	11.85 kg/cm^2
	ϕ	14°	27°	17°	29°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 20° dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip
Corrosivity		Moderately Corrosive	Mildy Corrosive	Moderately Corrosive	Mildy Corrosive
The rock deformability characteristics		Quality of Deformation : IV Description of Rock : Poor	Quality of Deformation : V to IV Description of Rock : Very Poor to Po	Quality of Deformation: IV Description of Rock: Poor	Quality of Deformation: IV to III Description of Rock: Poor to Fair

BISHNU KUMAR DAS. MTECH (GEOTECH)

Borehole No.		31	31	31	32
Depth (in mtr)		12.00	20.00	24.50	14.00
Core Piece No		3	8	11	3
RQD (%)		30	42	59	35
Density (g/cc)		2.48	2.57	2.47	2.48
Water content		0.089	0.038	0.096	0.098
Porosity		5.25	11.25	6.18	5.75
Permeability		1.41 x 10^{-8}	2.18 x 10-7	3.34 x 10^{-8}	1.78 x 10^{-8}
Unconfined Compressive Strength (kg/cm^2)		146.35	221.78	141.86	158.62
Point Load Test (kg/cm^2)		6.44	8.24	6.24	6.98
Weatherability		Highly Weathered (Grade-IV)	Highly Weathered (Grade-IV)	Moderately Weathered (Grade-III)	Highly Weathered (Grade-IV)
Term		Strong	Strong	Strong	Strong
Mohr's Scale of Hardness		3	4.5	4	3
Cohesion and angle of internal friction	Shear Strength, C	15.85 kg/cm^2	16.25 kg/cm2	18.17 kg/cm^2	20.42 kg/cm^2
	ϕ	18°	29°	15°	16°
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Fractures closely with 20^0 to 35^0 dip	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 35° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Moderate spaced Fractures with 30° dip
Corrosivity		Moderately Corrosive	Mildy Corrosive	Moderately Corrosive	Moderately Corrosive
The rock deformability characteristics		Quality of Deformation :IV Description of Rock :Poor	Quality of Deformation: IV to III Description of Rock: Poor to Fair	Quality of Deformation : III to IV Description of Rock : Fair to Poor	Quality of Deformation : IV Description of Rock : Poor

BISHWANATH KUMAR DAS. M.TECH (GEOTECH)

Borehole No.		32	33	33	
Depth (in mtr)		22.00	12.00	15.00	
Core Piece No		8	3	5	
RQD (%)		78	23	54	
Density (g/cc)		2.59	2.48	2.60	
Water content		0.034	0.082	0.031	
Porosity		11.74	6.21	11.45	
Permeability		2.65×10^{-7}	6.54×10^{-8}	2.48×10^{-7}	
Unconfined Compressive Strength (kg/cm^2)		241.48	110.48	245.65	
Point Load Test (kg/cm^2)		10.63	4.35	10.82	
Weatherability		Moderately Weathered (Grade-III)	Completely Weathered(Grade-V)	Moderately Weathered (Grade-III)	
Term		Strong	Weak	Strong	
Mohr's Scale of Hardness		5	3	5	
Cohesion and angle of internal friction	Shear Strength, C	12.05 kg/cm^2	14.22 kg/cm^2	12.45 kg/cm^2	
	ϕ	30°	12°	30°	
Mineralogical and Petrological composition		Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	Type of Rock: Sedimentary Rock Classification: Claystone Group: Argillaceous Composition: Hard Clays Continuous Fractures	Type of Rock: Sedimentary Rock Classification: Sandstone Group: Arenaceous (Sandy) Composition: Fine Grained Sands Moderate spaced Fractures with 15° dip	
Corrosivity		Mildy Corrosive	Moderately to Mildy Corrosive	Mildy Corrosive	
The rock deformability characteristics		Quality of Deformation : IV to III Description of Rock : Poor to Fair	Quality of Deformation: V Description of Rock: Very Poor	Quality of Deformation: IV to III Description of Rock: Poor to Fair	

BISHWAJIT KUMAR DAS, M.TECH (GEOTECH)

Table 12.5

Geomechanical classification of jointed rock masses

Class No. and its description	1	2	3	4	5
	Very good	good	Fair	Poor	Very Poor
Rock Quality R.Q.D.(%)	90–100	75–90	50–75	25–50	< 25
Weath-ering	Unwea-thered	Slightly Weath-ered	Modera-tely weathe-red	Highly weath-ered	Comple-tely weath-ered

REFERENCE:-

* For Rock classification reference is taken from “ENGINEERING CLASSIFICATIONS OF ROCK MASS-Dr P. Verma.

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ANNEXURE-C (ANALYSIS OF CHEMICAL PROPERTIES OF WATER SAMPLES)

S No.	Borehole No.	pH	Chloride	Hardness	Sulphate	Carbondioxide	Ammonia	Magnesium
1	BH-1	7.20	92.65	262.15	133.26	0.83	0.35	6.24
2	BH-3	7.15	97.335	258.78	127.65	0.86	0.24	5.31
3	BH-7	7.25	90.15	252.14	129.13	0.91	0.51	6.52
4	BH-10	7.17	92.54	261.94	130.54	0.95	0.12	5.98
5	BH-15	7.21	93.87	253.39	131.216	0.83	0.35	6.48
6	BH-19	7.34	95.48	260.43	132.285	0.94	0.25	6.12
7	BH-22	7.24	98.12	256.15	129.223	0.85	0.19	5.05
8	BH-25	7.13	94.92	253.65	127.245	1.01	0.33	4.67
9	BH-28	7.37	90.69	257.15	129.31	0.92	0.42	6.15
10	BH-30	7.23	95.46	263.48	130.345	0.8	0.26	6.55
11	BH-32	7.42	97.43	254.16	132.247	0.97	0.25	5.97
12	BH-33	7.32	95.34	259.94	131.354	0.81	0.21	5.48

- All test results are mentioned in mg/l except for pH.
- Ground water quality is accessed on the basis of water samples collected from site. Since the test results are in permissible limits, ground water of project site can be used for construction.

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ANNEXURE-D (ANALYSIS OF CHEMICAL PROPERTIES OF SOIL SAMPLES)

S No.	Borehole No.	Depth in 'm'	Chloride (%)	Sulphate (%)
1	BH-1	1.50	0.15	0.12
2	BH-2	4.50	0.17	0.14
3	BH-5	1.50	0.16	0.15
4	BH-9	3.00	0.21	0.12
5	BH-11	3.00	0.18	0.11
6	BH-13	4.50	0.15	0.16
7	BH-16	1.50	0.20	0.14
8	BH-19	3.00	0.23	0.16
9	BH-22	1.50	0.17	0.15
10	BH-25	1.50	0.22	0.15
11	BH-28	3.00	0.23	0.14
12	BH-32	4.50	0.19	0.13

ANNEXURE-E (ANALYSIS OF CHEMICAL PROPERTIES OF ROCK SAMPLES)

S No.	Borehole No.	Depth in 'm'	Chloride (%)	Sulphate (%)
1	BH-2	16.50	0.045	0.022
2	BH-5	18.50	0.042	0.031
3	BH-6	21.00	0.050	0.028
4	BH-8	13.50	0.048	0.029
5	BH-11	16.50	0.046	0.033
6	BH-15	15.00	0.057	0.024
7	BH-21	18.50	0.053	0.031
8	BH-23	18.50	0.051	0.032
9	BH-25	13.50	0.048	0.029
10	BH-28	15.00	0.058	0.023
11	BH-30	21.00	0.061	0.031
12	BH-33	18.50	0.047	0.030

BISHOW KUMAR DAS. MTECH (GEOTECH)

PLATE LOAD TEST RESULTS & GRAPHS

PLATE LOAD TEST PROCEDURE (AS PER IS 1888-1982)

a) PLATE SIZE AND THICKNESS:

The square plates used are of 0.50m was used for the Test.

b) TEST PIT:

Test was conducted at depths of 1.80m Below Ground Level after proper leveling. The top surface was finished and leveled properly.

c) PLACING OF TEST PLATE:

The plate was bedded to the soil by spreading fine sand carefully leveled and set horizontally at the bottom of the pit. At the commencement of the test the seating load of 10.00 kg/cm^2 at the plate level was applied.

d) METHOD OF LISTING:

Loading is applied by the method consisting of a hydraulic jack. The loading system is adequate to ensure that the test can be carried up to the specified limit. A ball and socket arrangement was inserted suitably in the assembly so as to allow the plate to rotate while keeping the direction of the load vertical throughout. Hydraulic jack with a load gauge attachment applied the loading increment.

e) LOAD INCREMENTS:

The numbers of loading increments were decided on the basis of ultimate bearing Capacity according to clause no. 4.6 of IS 1888.

f) SETTLEMENT AND OBSERVATION:

Settlement was recorded with two dial gauges of 30mm range and least count of 0.01 mm placed diagonally opposite on the test plate. Settlement was observed for each increment of load after an interval of 1, 2.25, 4, 6.25, 9, 16, 25min. the average of two dial-gauge readings were considered. The next load increment was applied when the rate of settlement is less than 0.02 mm/ min.

PLATE LOAD TEST REPORT

Client: TALCHER FERTILIZERS LIMITED	DOS: 12.05.2020
Co-ordinate: E-324.10 N-1214.80	DOC: 13.05.2020
Size of the plate: 500 mm x 500 mm x 25mm	Location:-CMD Area
Plate Loading Test No. 01	Depth of Testing: 1.80m
RL-95.210m	

Sl No:	Date	Time	Pressure at plate level	Load Intensity	Dial Gauge Readings		Settelment in mm		Remarks.
					D1	D2	Average	Net	
1	2	3	4	5	6	7	8	9	10
1	12.05.2020	1.30 PM	10kg/cm²	40.00KN/m2					
2		1.31 PM			2.29	2.41	2.35	2.35	
3		1.32 PM			2.30	2.42	2.36	2.36	
4		1.34 PM			2.31	2.44	2.38	2.38	
5		1.36 PM			2.33	2.45	2.39	2.39	
6		1.39 PM			2.36	2.47	2.42	2.42	
7		1.46 PM			2.37	2.49	2.43	2.43	
8		1.55 PM			2.46	2.50	2.48	2.48	
9		2.30 PM			3.61	3.90	3.76	3.76	
10	12.05.2020	2.35 PM	20 kg/cm²	80.00KN/m2					
11		2.36 PM			5.06	5.10	5.08	5.08	
12		2.37 PM			5.07	5.12	5.10	5.10	
13		2.39 PM			5.10	5.13	5.12	5.12	
14		2.41 PM			5.14	5.19	5.17	5.17	
15		2.44 PM			5.15	5.20	5.18	5.18	
16		2.51 PM			5.19	5.25	5.22	5.22	
17		3.00 PM			5.45	5.49	5.47	5.47	
18		3.35 PM			5.83	5.63	5.73	5.73	
19	12.05.2020	3.40 PM	40 kg/cm²	160.00KN/m2					
20		3.41 PM			7.81	7.65	7.73	7.73	
21		3.42 PM			7.82	7.66	7.74	7.74	
22		3.44 PM			7.83	7.67	7.75	7.75	
23		3.46 PM			7.84	7.69	7.77	7.77	
24		3.49 PM			7.85	7.70	7.78	7.78	
25		3.56 PM			7.86	7.75	7.81	7.81	
26		4.05 PM			7.88	7.76	7.82	7.82	
27		4.40 PM			7.96	7.87	7.92	7.92	

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PLATE LOAD TEST REPORT

Client: TALCHER FERTILIZERS LIMITED	DOS: 12.05.2020
Co-ordinate: E-324.10 N-1214.80	DOC: 13.05.2020
Size of the plate: 500 mm x 500 mm x 25mm	Location:-CMD Area
Plate Loading Test No. 01	Depth of Testing: 1.80m
RL-95.210m	

Sl No:	Date	Time	Pressure at plate level	Load Intensity	Dial Gauge Readings		Settelment in mm		Remarks.
					D1	D2	Average	Net	
1	2	3	4	5	6	7	8	9	10
28	12.05.2020	4.45 PM	60 kg/cm²	240.00KN/m2					
29		4.46 PM			8.68	8.65	8.67	8.67	
30		4.47 PM			8.71	8.68	8.70	8.70	
31		4.49 PM			8.76	8.70	8.73	8.73	
32		4.51 PM			8.79	8.75	8.77	8.77	
33		4.54 PM			8.84	8.87	8.86	8.86	
34		5.01 PM			8.89	9.01	8.95	8.95	
35		5.10 PM			9.10	9.16	9.13	9.13	
36		5.45 PM			10.50	10.46	10.48	10.48	
37	12.05.2020	5.50 PM	80 kg/cm²	320.00KN/m2					
38		5.51 PM			11.55	11.51	11.53	11.53	
39		5.52 PM			11.56	11.53	11.55	11.55	
40		5.54 PM			11.58	11.54	11.56	11.56	
41		5.56 PM			11.61	11.56	11.59	11.59	
42		5.59 PM			11.63	11.59	11.61	11.61	
43		6.06 PM			11.68	11.63	11.66	11.66	
44		6.15 PM			11.70	11.65	11.68	11.68	
45		6.50 PM			11.71	11.68	11.70	11.70	
46	12.05.2020	6.55 PM	120 kg/cm²	480.00KN/m2					
47		6.56 PM			13.16	13.42	13.29	13.29	
48		6.57 PM			13.18	13.43	13.31	13.31	
49		6.59 PM			13.20	13.46	13.33	13.33	
50		7.01 PM			13.21	13.48	13.35	13.35	
51		7.04 PM			13.23	13.49	13.36	13.36	
52		7.11 PM			13.26	13.52	13.39	13.39	
53		7.20 PM			13.29	13.53	13.41	13.41	
54		7.55 PM			13.36	13.57	13.47	13.47	

BISHAL KUMAR DAS. M.TECH (GEOTECH)

PLATE LOAD TEST REPORT

Client: TALCHER FERTILIZERS LIMITED	DOS: 12.05.2020
Co-ordinate: E-324.10 N-1214.80	DOC: 13.05.2020
Size of the plate: 500 mm x 500 mm x 25mm	Location:-CMD Area
Plate Loading Test No. 01	Depth of Testing: 1.80m
RL-95.210m	

Sl No:	Date	Time	Pressure at plate level	Load Intensity	Dial Gauge Readings		Settelment in mm		Remarks.
					D1	D2	Average	Net	
1	2	3	4	5	6	7	8	9	10
55	12.05.2020	8.00 PM	160 kg/cm²	640.00KN/m2					
56		8.01 PM			15.28	15.35	15.32	15.32	
57		8.02 PM			15.30	15.38	15.34	15.34	
58		8.04 PM			15.35	15.45	15.40	15.40	
59		8.06 PM			15.42	15.51	15.47	15.47	
60		8.09 PM			15.52	15.61	15.57	15.57	
61		8.16 PM			15.92	15.98	15.95	15.95	
62		8.25 PM			16.39	16.56	16.48	16.48	
63		9.00 PM			16.63	16.69	16.66	16.66	
64	12.05.2020	9.05 PM	200 kg/cm²	800.00KN/m2					
65		9.06 PM			20.32	20.25	20.29	20.29	
66		9.07 PM			20.38	20.29	20.34	20.34	
67		9.09 PM			20.40	20.36	20.38	20.38	
68		9.11 PM			20.52	20.43	20.48	20.48	
69		9.14 PM			20.59	20.47	20.53	20.53	
70		9.21 PM			20.67	20.59	20.63	20.63	
71		9.30 PM			20.91	20.87	20.89	20.89	
72		10.05 PM			21.12	21.07	21.10	21.10	
73	09.05.2020	10.10 PM	230 kg/cm²	920.00KN/m2					
74		10.11 PM			22.10	22.05	22.08	22.08	
75		10.12 PM			22.12	22.09	22.11	22.11	
76		10.14 PM			22.15	22.10	22.13	22.13	
77		10.16 PM			22.21	22.19	22.20	22.20	
78		10.19 PM			22.30	22.26	22.28	22.28	
79		10.26 PM			22.45	22.31	22.38	22.38	
80		10.35 PM			22.61	22.57	22.59	22.59	
81		11.00 PM			22.84	22.78	22.81	22.81	

BISHAL KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES BBSR

PLATE LOAD TEST REPORT

Client: TALCHER FERTILIZERS LIMITED	DOS: 12.05.2020
Co-ordinate: E-324.10 N-1214.80	DOC: 13.05.2020
Size of the plate: 500 mm x 500 mm x 25mm	Location:-CMD Area
Plate Loading Test No. 01	Depth of Testing: 1.80m
RL-95.210m	

Sl No:	Date	Time	Pressure at plate level	Load Intensity	Dial Gauge Readings		Settelment in mm		Remarks.
					D1	D2	Average	Net	
1	2	3	4	5	6	7	8	9	10
82	13.05.2020	6.00 AM	200 kg/cm²	800.00KN/m2	21.52	21.48	21.50	21.50	
83		6.15 AM	150 kg/cm²	600.00KN/m2	18.44	18.20	18.32	18.32	
84		6.30 AM	100 kg/cm²	400.00KN/m2	15.90	15.60	15.75	15.75	
85		6.45 AM	50 kg/cm²	200.00 KN/m2	13.82	13.79	13.81	13.81	
86		7.00 AM	0 kg/cm²	0.00 KN/m2	12.62	12.52	12.57	12.57	

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

PLATE LOAD TEST REPORT

Client: TALCHER FERTILIZERS LIMITED	DOS: 08.05.2020
Co-ordinate: E-384.00 N-1172.289	DOC: 09.05.2020
Size of the plate: 500 mm x 500 mm x 25mm	Location:- CMD Area
Plate Loading Test No. 02	Depth of Testing: 1.80m
RL-95.036M	

Sl No:	Date	Time	Pressure at plate level	Load Intensity	Dial Gauge Readings		Settelment in mm		Remarks.
					D1	D2	Average	Net	
1	2	3	4	5	6	7	8	9	10
1	08.05.2020	6.15 PM	5kg/cm2	20.00KN/m2					
2		6.16 PM			0.58	0.56	0.57	0.57	
3		6.17 PM			0.59	0.57	0.58	0.58	
4		6.19 PM			0.61	0.58	0.60	0.60	
5		6.21 PM			0.62	0.59	0.61	0.61	
6		6.24 PM			0.64	0.59	0.62	0.62	
7		6.31 PM			0.67	0.62	0.65	0.65	
8		6.40 PM			1.09	0.92	1.01	1.01	
9		7.15 PM			1.32	1.23	1.28	1.28	
10	08.05.2020	7.20 PM	10kg/cm²	40.00KN/m2					
11		7.21 PM			2.21	2.40	2.31	2.31	
12		7.22 PM			2.23	2.41	2.32	2.32	
13		7.24 PM			2.25	2.41	2.33	2.33	
14		7.26 PM			2.26	2.43	2.35	2.35	
15		7.29 PM			2.26	2.45	2.36	2.36	
16		7.36 PM			2.27	2.46	2.37	2.37	
17		7.45 PM			2.28	2.48	2.38	2.38	
18		8.20 PM			2.29	2.50	2.40	2.40	
19	08.05.2020	8.25 PM	20kg/cm²	80.00KN/m2					
20		8.26 PM			2.95	3.29	3.12	3.12	
21		8.27 PM			2.98	3.31	3.15	3.15	
22		8.29 PM			3.16	3.33	3.25	3.25	
23		8.31 PM			3.19	3.35	3.27	3.27	
24		8.34 PM			3.21	3.40	3.31	3.31	
25		8.41 PM			3.50	3.60	3.55	3.55	
26		8.50 PM			4.20	4.10	4.15	4.15	
27		9.25 PM			4.39	4.19	4.29	4.29	

BISHWA KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES PVT. LTD. SATYANAGAR

PLATE LOAD TEST REPORT

Client: TALCHER FERTILIZERS LIMITED	DOS: 08.05.2020
Co-ordinate: E-384.00 N-1172.289	DOC: 09.05.2020
Size of the plate: 500 mm x 500 mm x 25mm	Location:- CMD Area
Plate Loading Test No. 02	Depth of Testing: 1.80m
RL-95.036M	

Sl No:	Date	Time	Pressure at plate level	Load Intensity	Dial Gauge Readings		Settelment in mm		Remarks.
					D1	D2	Average	Net	
1	2	3	4	5	6	7	8	9	10
28	08.05.2020	9.30 PM	40 kg/cm²	160.00KN/m2					
29		9.31 PM			6.95	7.00	6.98	6.98	
30		9.32 PM			6.98	7.02	7.00	7.00	
31		9.34 PM			7.00	7.04	7.02	7.02	
32		9.36 PM			7.05	7.06	7.06	7.06	
33		9.39 PM			7.11	7.15	7.13	7.13	
34		9.46 PM			7.14	7.19	7.17	7.17	
35		9.55 PM			7.22	7.28	7.25	7.25	
36		10.30 PM			7.37	7.48	7.43	7.43	
37	08.05.2020	10.35 PM	60 kg/cm²	240.00KN/m2					
38		10.36 PM			8.35	8.51	8.43	8.43	
39		10.37 PM			8.36	8.52	8.44	8.44	
40		10.39 PM			8.37	8.53	8.45	8.45	
41		10.41 PM			8.40	8.58	8.49	8.49	
42		10.44 PM			8.55	8.64	8.60	8.60	
43		10.51 PM			8.62	8.69	8.66	8.66	
44		11.00 PM			8.84	8.92	8.88	8.88	
45		11.35 PM			9.02	9.08	9.05	9.05	
46	08.05.2020	11.40 PM	80 kg/cm²	320.00KN/m2					
47		11.41 PM			10.83	11.01	10.92	10.92	
48		11.42 PM			10.86	11.09	10.98	10.98	
49		11.44 PM			10.99	11.20	11.10	11.10	
50		11.46 PM			11.06	11.25	11.16	11.16	
51		11.49 PM			11.11	11.30	11.21	11.21	
52		11.56 PM			11.19	11.42	11.31	11.31	
53	09.05.20	12.05 AM			11.29	11.53	11.41	11.41	
54		12.40 AM			11.54	11.64	11.59	11.59	

BISHNU KUMAR DAS. MTECH (GEOTECH)

PLATE LOAD TEST REPORT

Client: TALCHER FERTILIZERS LIMITED	DOS: 08.05.2020
Co-ordinate: E-384.00 N-1172.289	DOC: 09.05.2020
Size of the plate: 500 mm x 500 mm x 25mm	Location:- CMD Area
Plate Loading Test No. 02	Depth of Testing: 1.80m
RL-95.036M	

Sl No:	Date	Time	Pressure at plate level	Load Intensity	Dial Gauge Readings		Settelment in mm		Remarks.
					D1	D2	Average	Net	
1	2	3	4	5	6	7	8	9	10
55	09.05.2020	12.45 AM	100 kg/cm²	400.00KN/m2					
56		12.46 AM			13.40	13.53	13.47	13.47	
57		12.47 AM			13.42	13.55	13.49	13.49	
58		12.49 AM			13.46	13.59	13.53	13.53	
59		12.51 AM			13.48	13.60	13.54	13.54	
60		12.54 AM			13.50	13.61	13.56	13.56	
61		01.01 AM			13.56	13.68	13.62	13.62	
62		01.10 AM			13.58	13.72	13.65	13.65	
63		01.45 PM			13.94	14.01	13.98	13.98	
64	09.05.2020	01.50 AM	150 kg/cm²	600.00KN/m2					
65		01.51 AM			15.29	15.40	15.35	15.35	
66		01.52 AM			15.30	15.41	15.36	15.36	
67		01.54 AM			15.32	15.43	15.38	15.38	
68		01.56 AM			15.36	15.45	15.41	15.41	
69		01.59 AM			15.37	15.46	15.42	15.42	
70		02.06 AM			15.39	15.49	15.44	15.44	
71		02.15 AM			15.44	15.54	15.49	15.49	
72		02.50 AM			16.52	16.68	16.60	16.60	
73	09.05.2020	02.55 AM	220 kg/cm²	880.00KN/m2					
74		02.56 AM			18.02	18.09	18.06	18.06	
75		02.57 AM			18.04	18.11	18.08	18.08	
76		02.59 AM			18.05	18.12	18.09	18.09	
77		03.01 AM			18.10	18.19	18.15	18.15	
78		03.04 AM			18.12	18.20	18.16	18.16	
79		03.11 AM			18.16	18.23	18.20	18.20	
80		03.20 AM			18.31	18.48	18.40	18.40	
81		03.55 AM			18.71	18.85	18.78	18.78	

BISHWAJIT KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES 171 SATYANAGAR

Load Intensity calculation for PLT

Size of the Plate = (0.50 x 0.50) m

= 0.25 m^2

Pressure applied on Plate in 1st stage = 10 kg/cm^2

Load Intensity = Applied Pressure on plate / Size of the Plate

= (10/0.25) = 40 Kn/m^2

PLATE LOAD TEST NO - PLT-01

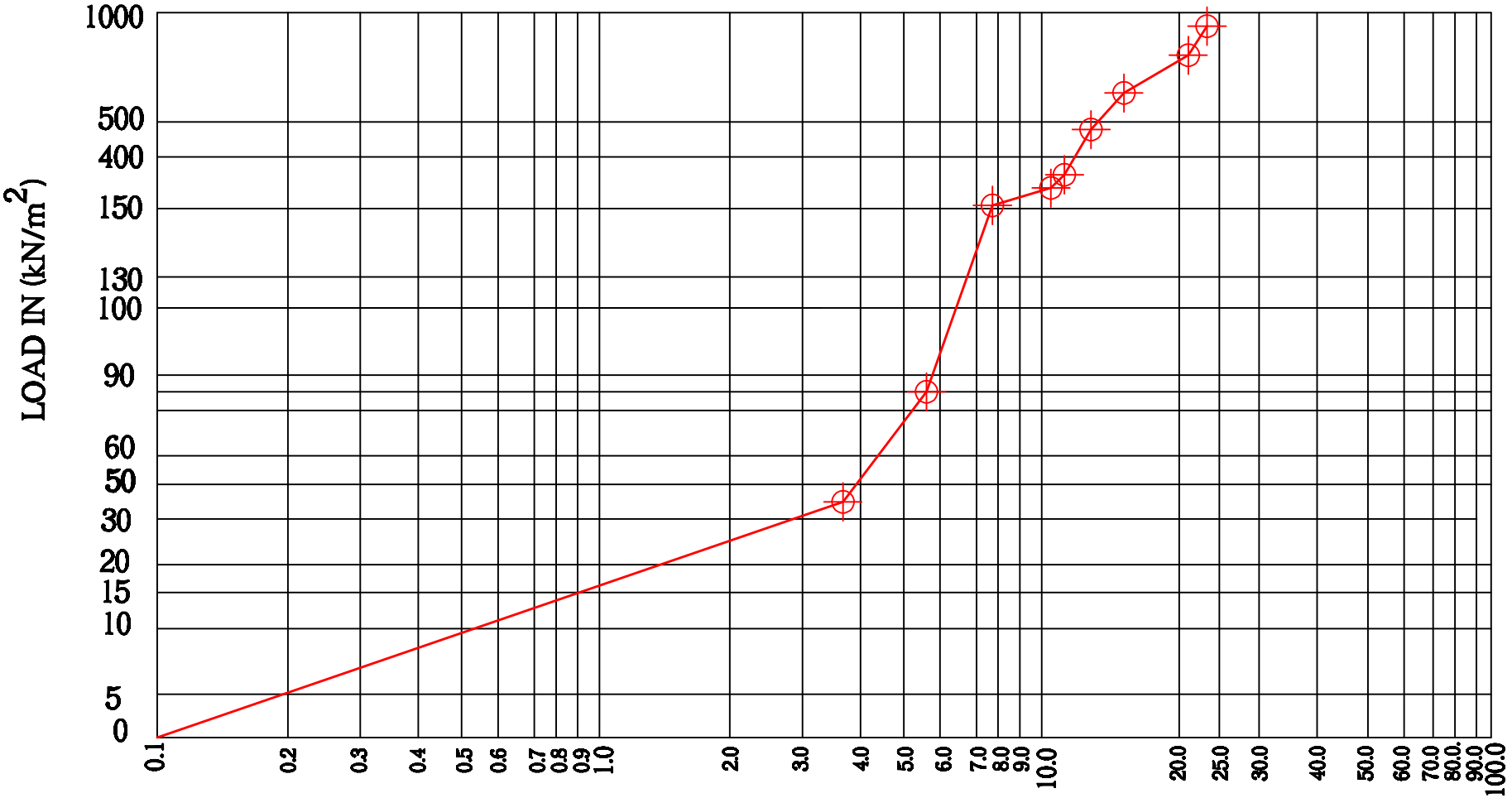
DEPTH - 1.80M

CLIENT : TFL (TALCHER FERTILIZERS LIMITED)

CO-ORDINATE: E-313.954, N- 1179.194

RL - 95.220M

SIZE OF THE PLATE :- 500mm X 500mm



LOAD-SETTLEMENT CURVE (LOG-LOG SCALE)

LOAD TEST NO - PLT-02

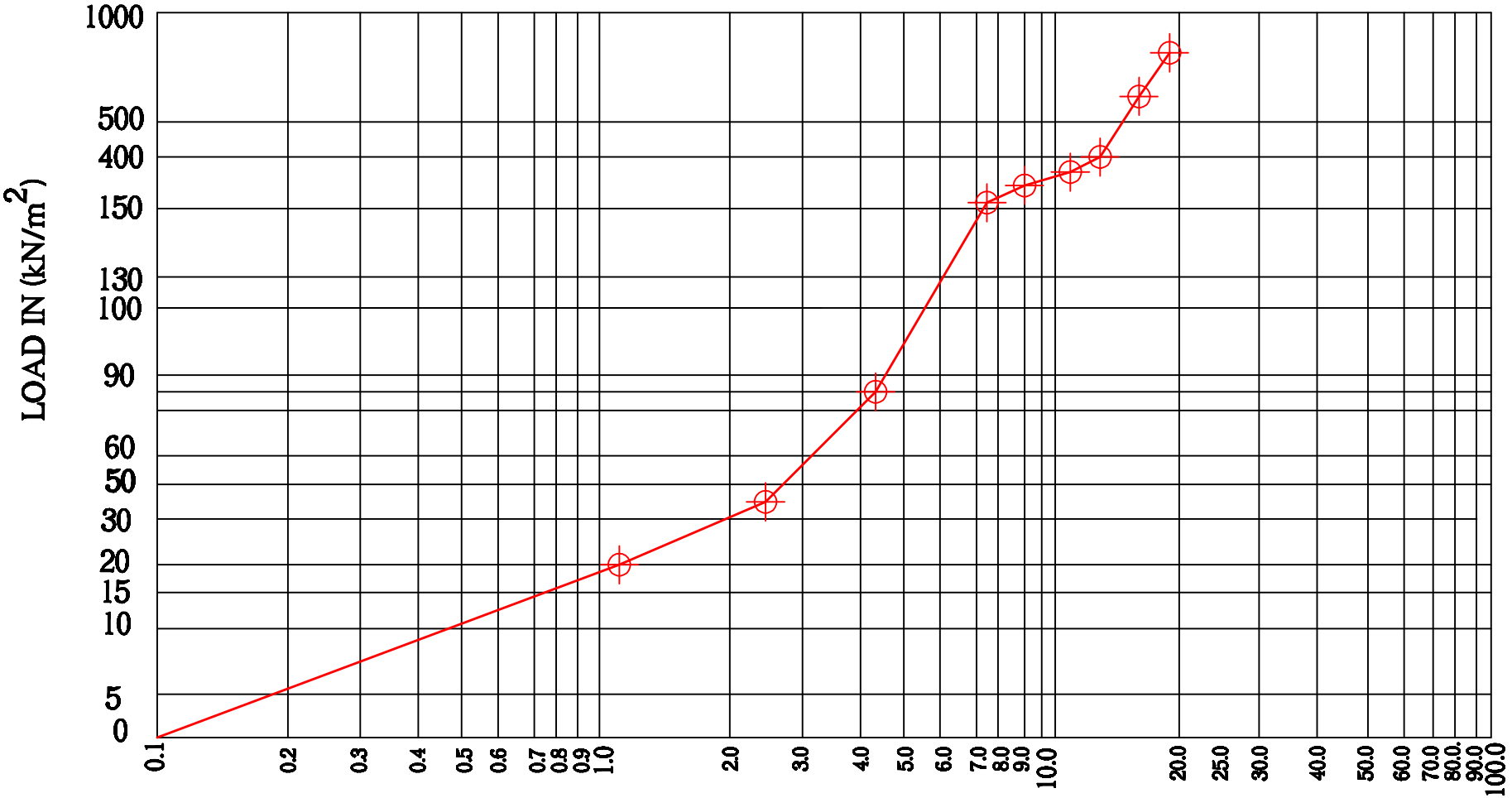
DEPTH - 1.80M

CLIENT : TFL (TALCHER FERTILIZERS LIMITED)

CO-ORDINATE: E-375.030, N- 1203.258

RL - 94.969M

SIZE OF THE PLATE :- 500mm X 500mm



LOAD-SETTLEMENT CURVE (LOG-LOG SCALE)

ERT TEST RESULTS & GRAPHS

SCOPE OF WORK

The scope of work in brief involved in the above studies included-

• Soil Resistivity survey at Spacing of 100cm, 200cm, 400cm, 600cm, 800cm and 1000cm at each location.

CORROSION SURVEY

METHODOLOGY:

Corrosion Survey:

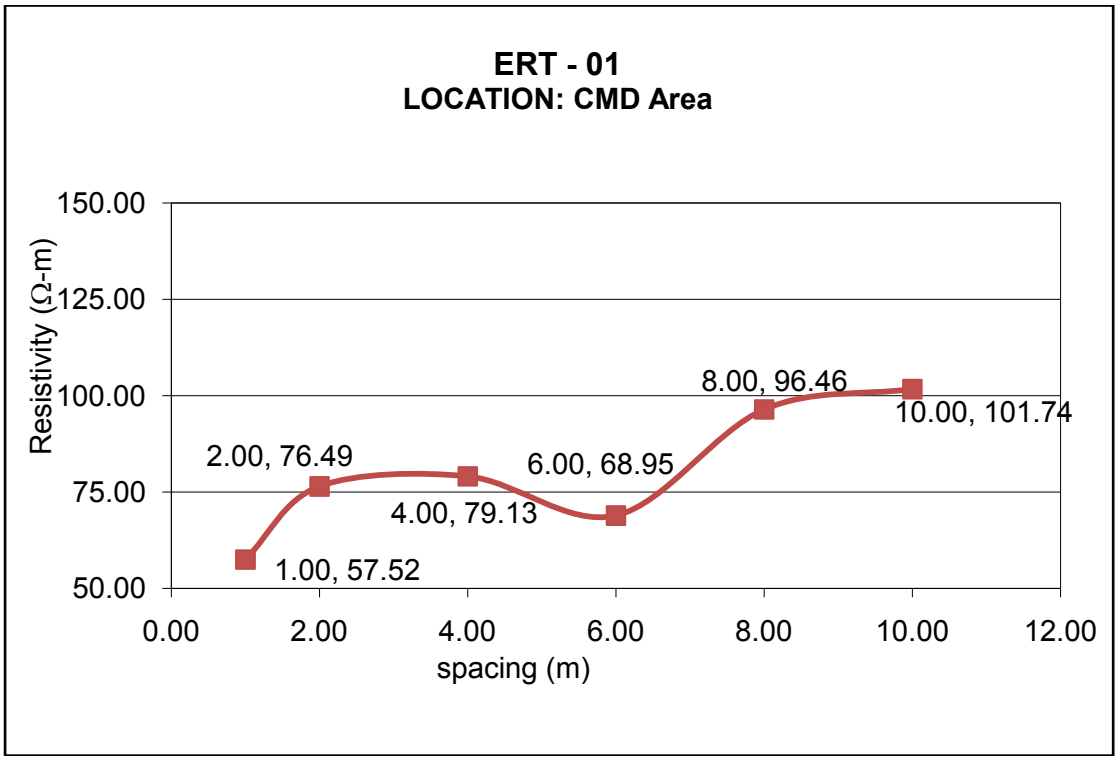
- Method -- Wenner Configuration
- Electrode Spacing -- 50cm, 100 cm, 200cm, 300cm, 400cm and 500cm at each location(Care has to be taken while taking readings)

INSTRUMENT USED & PROCEDURE

Digital Soil Resistivity Meter	:	01 No.
Make	:	Electronic Devices, Panki, and Kanpur.
Least Count	:	0.01 Ohm.
Method	:	Werner configuration
Electrode spacing	:	100cm, 200cm, 400cm, 600cm, 800cm and 1000cm at each location.

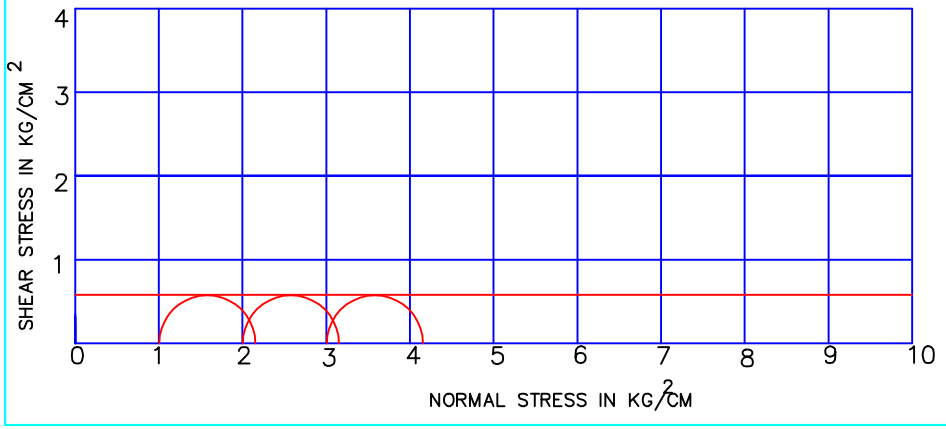
TABULATION OF ELECTRICAL RESISTIVITY TEST RESULTS

S No.	ERT No.	Date	Location	Spacing in mtr.	Resistance in Ω	Resistivity in Ω-m (ρ=2πaR)
1		2	3	5	6	7
1	1	13.05.20	CMD AREA	1.00	9.16	57.52
				2.00	6.09	76.49
				4.00	3.15	79.13
				6.00	1.83	68.95
				8.00	1.92	96.46
				10.00	1.62	101.74



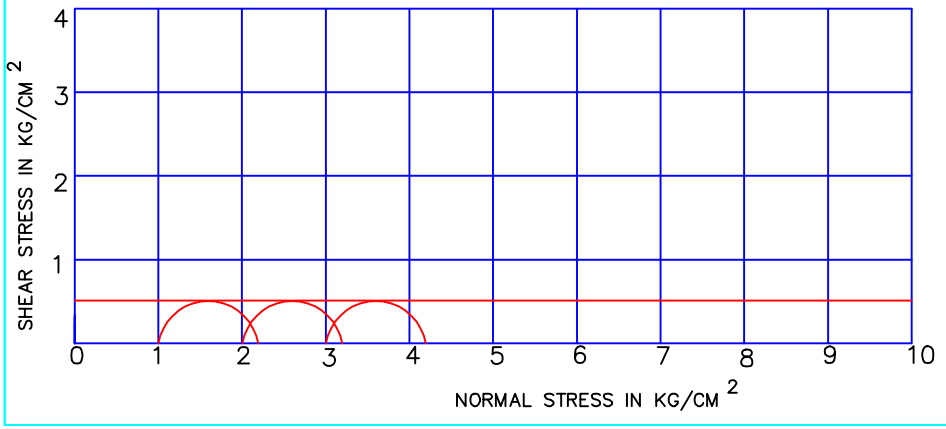
LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-01

C=0.53KG/CM^2
Ø=0°



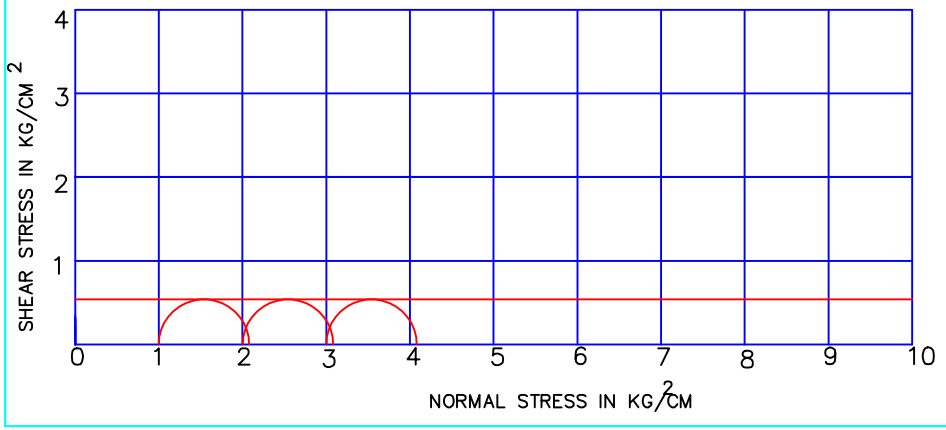
LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-02

C=0.51KG/CM^2
Ø=0°



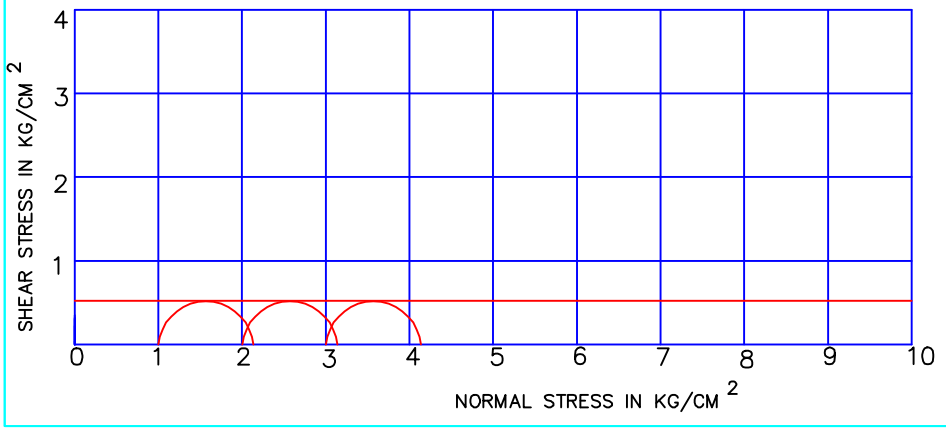
LOCATION:-CMD AREA
DEPTH :-3.00M.
BH-03

C=0.54KG/CM^2
Ø=0°



LOCATION:-CMD AREA
DEPTH :-3.00M.
BH-04

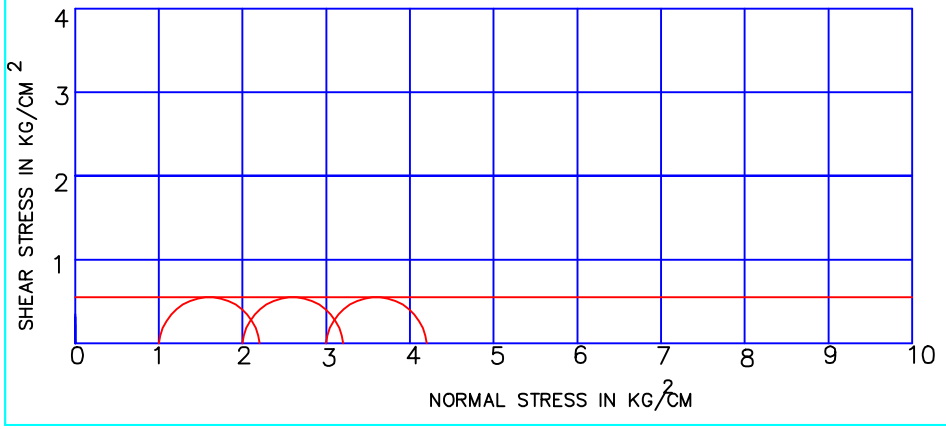
C=0.52KG/CM^2
Ø=0°



BISHWAJIT KUMAR DAS.
MTECH (GEOTECH)

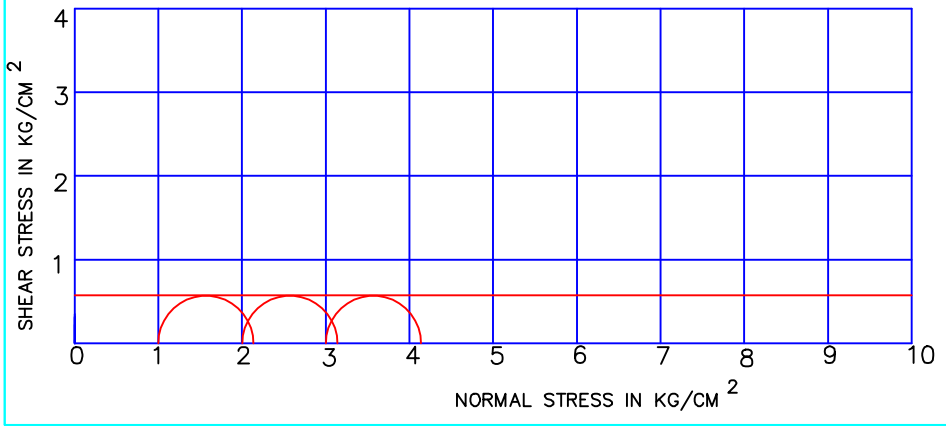
LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-05

C=0.55KG/CM^2
Ø=0°



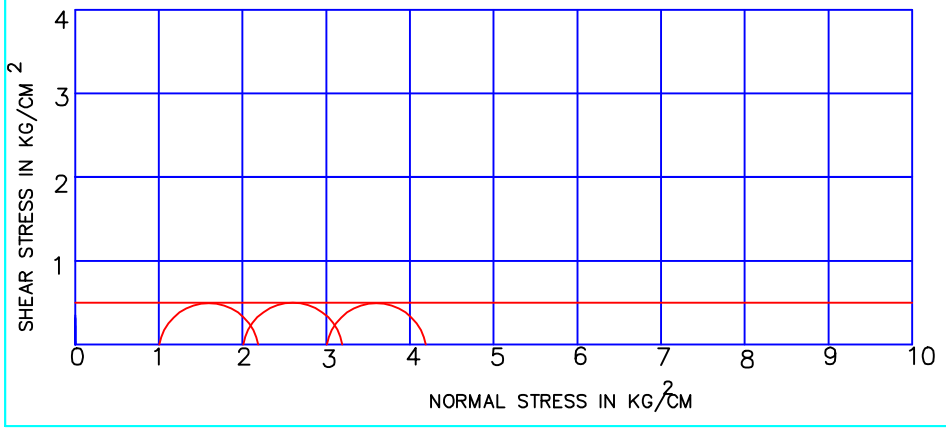
LOCATION:-CMD AREA
DEPTH :-3.00M.
BH-06

C=0.52KG/CM^2
Ø=0°



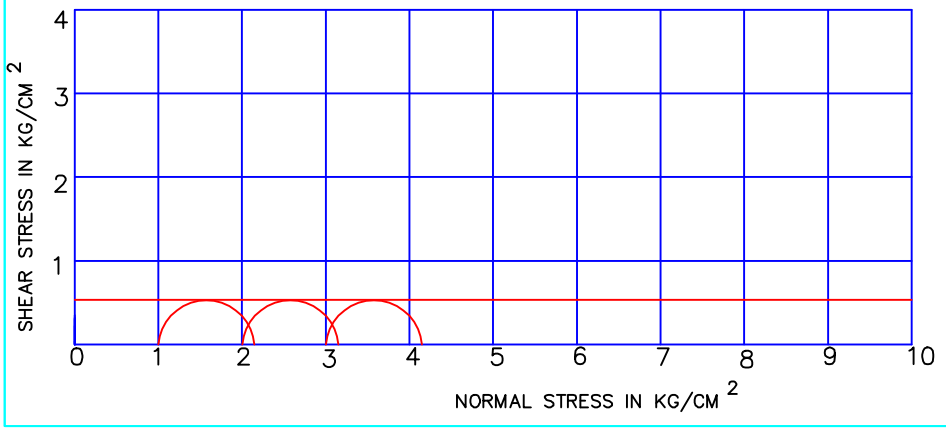
LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-07

C=0.50KG/CM^2
Ø=0°



LOCATION:-CMD AREA
DEPTH :-3.00M.
BH-08

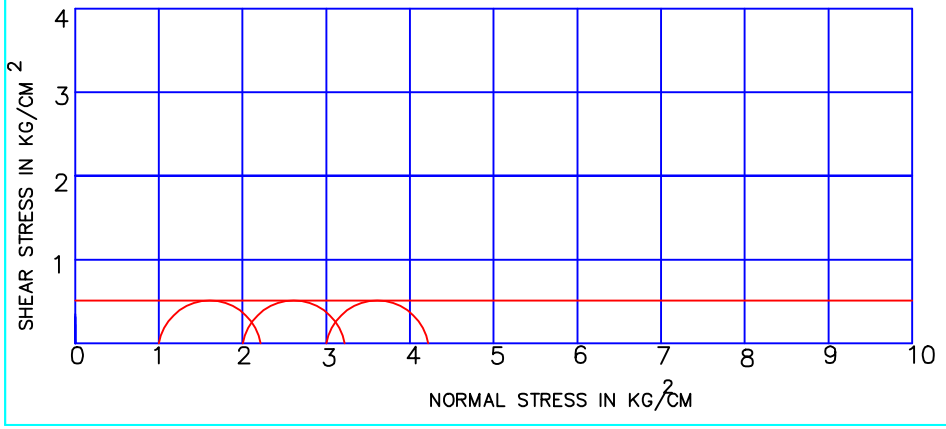
C=0.53KG/CM^2
Ø=0°



BISHAL KUMAR DAS.
MTECH (GEOTECH)

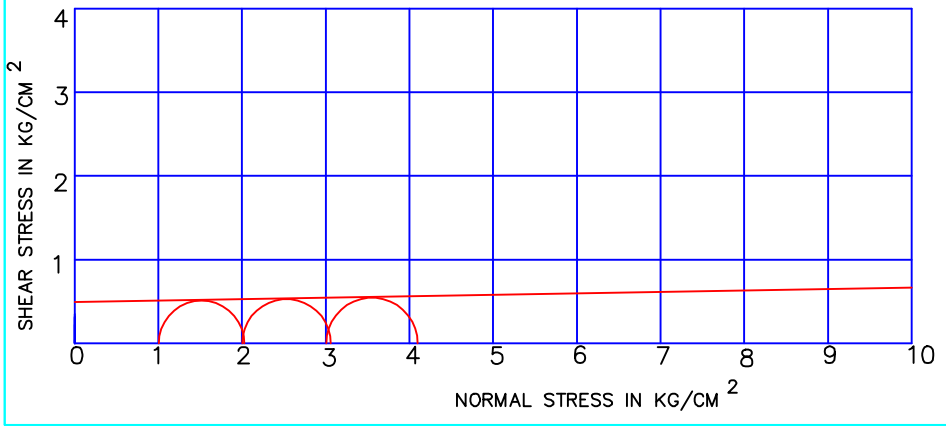
LOCATION:-CMD AREA
DEPTH :-6.00M.
BH-10

C=0.51KG/CM^2
Ø=0°



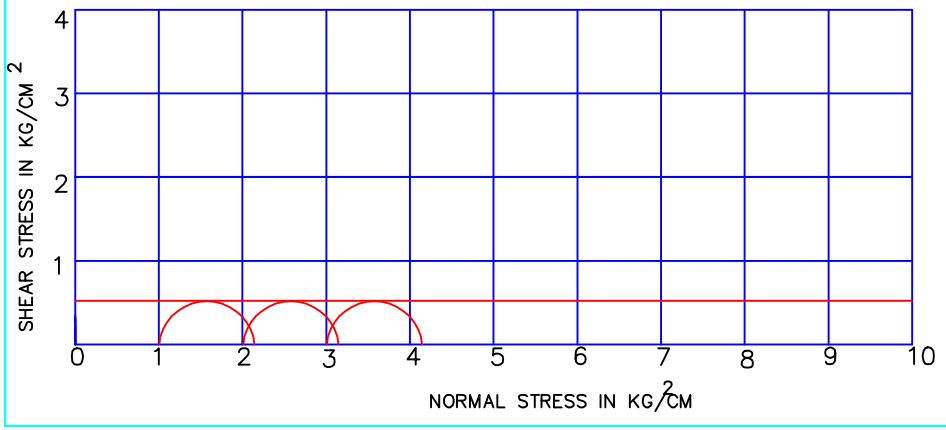
LOCATION:-CMD AREA
DEPTH :-6.00M.
BH-11

C=0.49KG/CM^2
Ø=1°



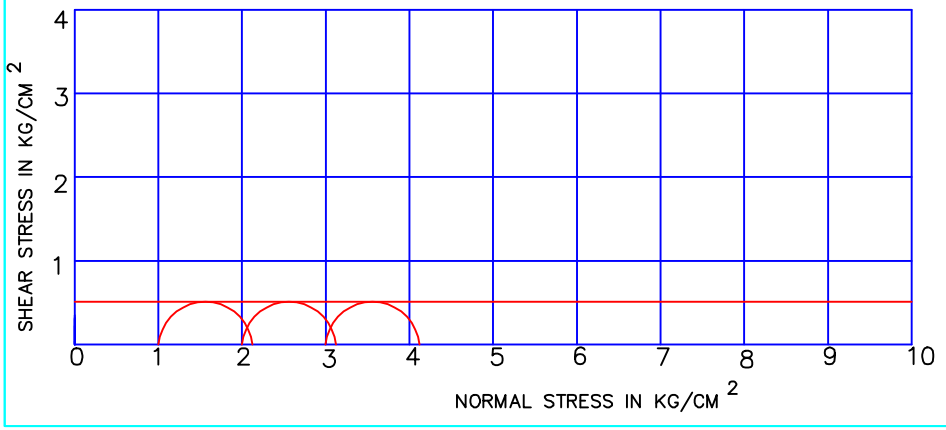
LOCATION:-CMD AREA
DEPTH :-6.00M.
BH-12

C=0.52KG/CM^2
Ø=0°



LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-13

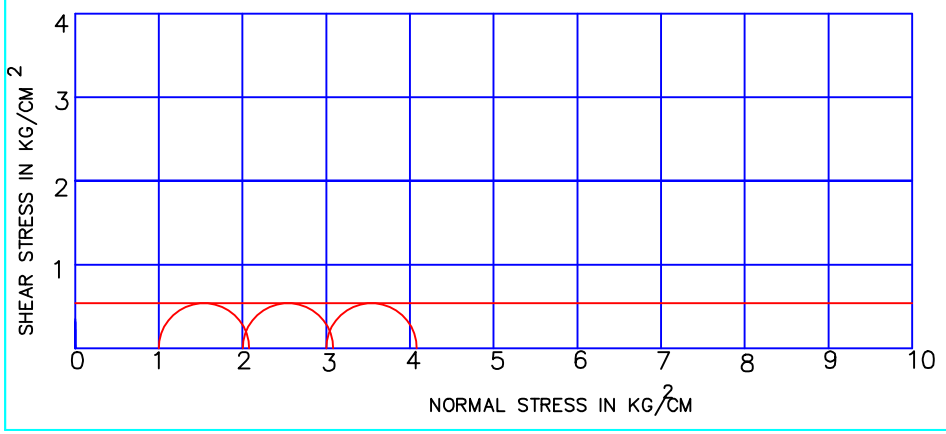
C=0.51KG/CM^2
Ø=0°



BISHAL KUMAR DAS.
MTECH (GEOTECH)

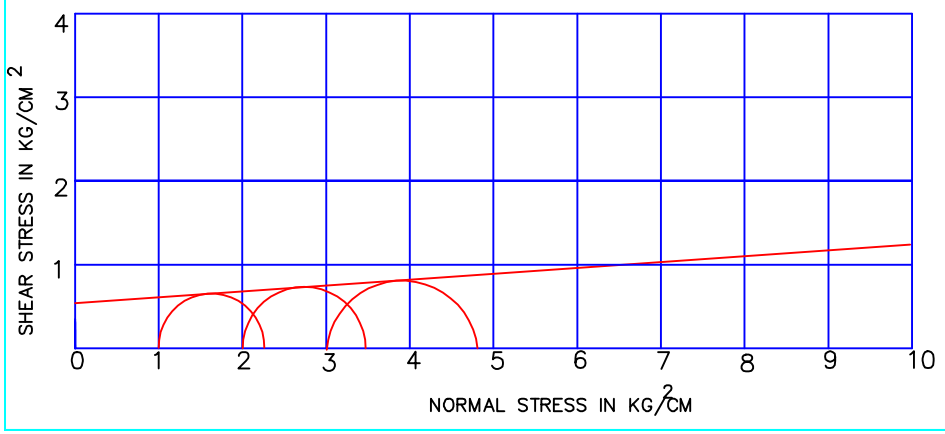
LOCATION:-CMD AREA
DEPTH :-3.00M.
BH-15

C=0.54KG/CM^2
Ø=0°



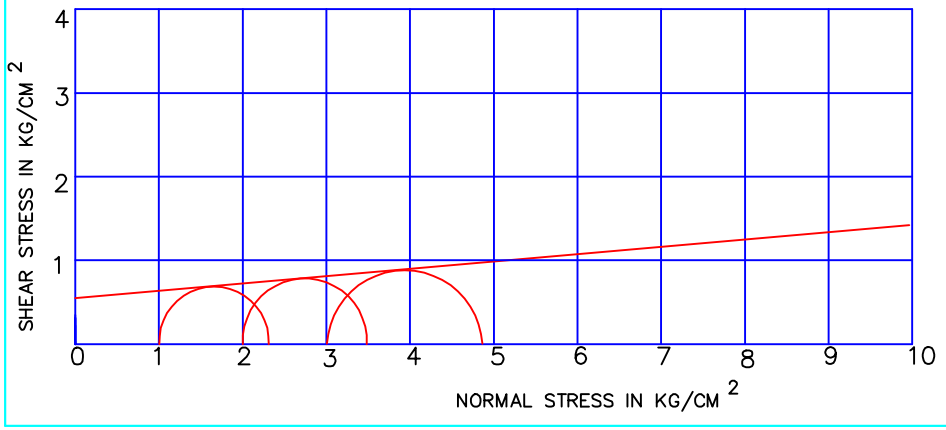
LOCATION:-CMD AREA
DEPTH :-7.50M.
BH-15

C=0.54KG/CM^2
Ø=4°



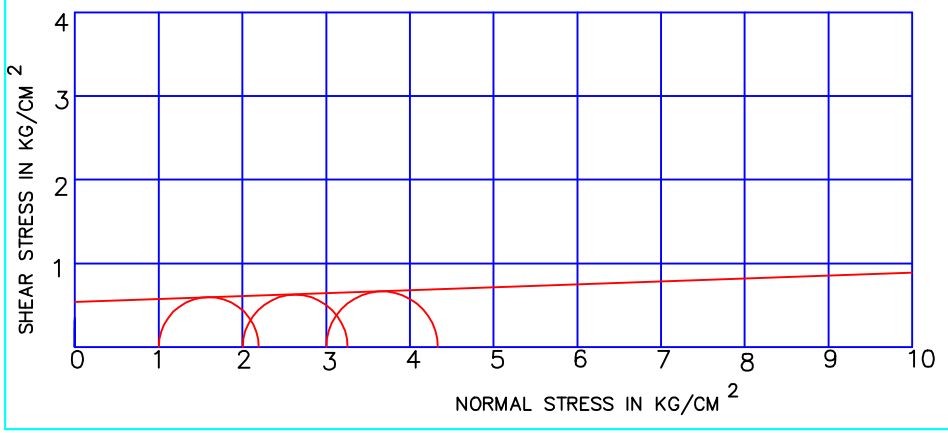
LOCATION:-CMD AREA
DEPTH :-6.00M.
BH-16

C=0.55KG/CM^2
Ø=5°



LOCATION:-CMD AREA
DEPTH :-6.00M.
BH-17

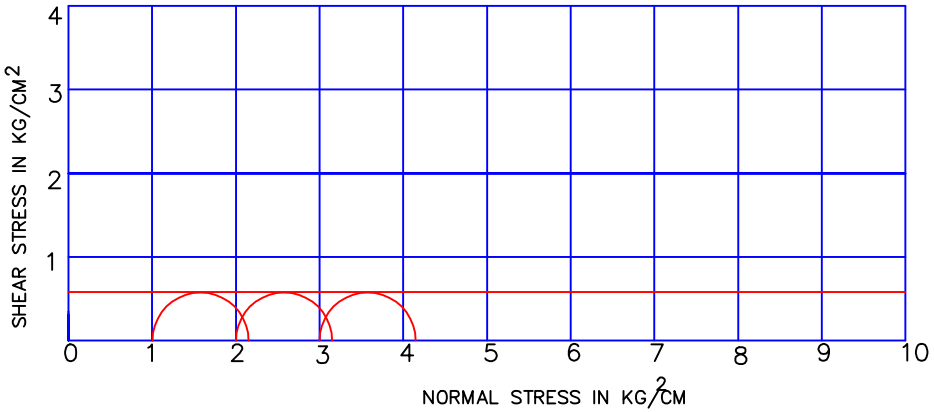
C=0.48KG/CM^2
Ø=2°



BISHOW KUMAR DAS.
MTECH (GEOTECH)

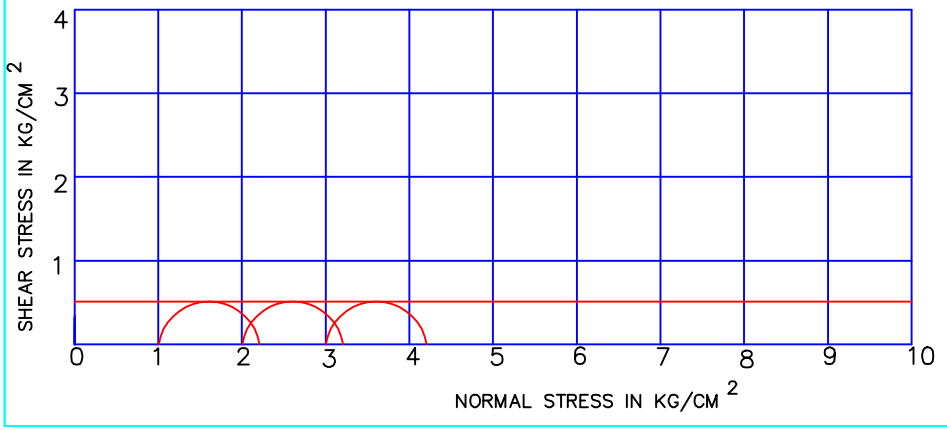
LOCATION: –CMD AREA
DEPTH : –4.50M.
BH–18

C=0.52KG/CM^2
Ø=0°



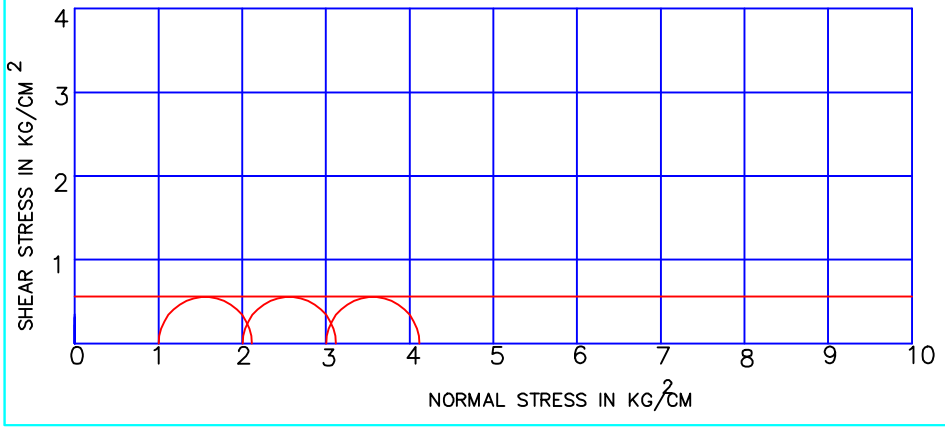
LOCATION: –CMD AREA
DEPTH : –4.50M.
BH–19

C=0.51KG/CM^2
Ø=0°



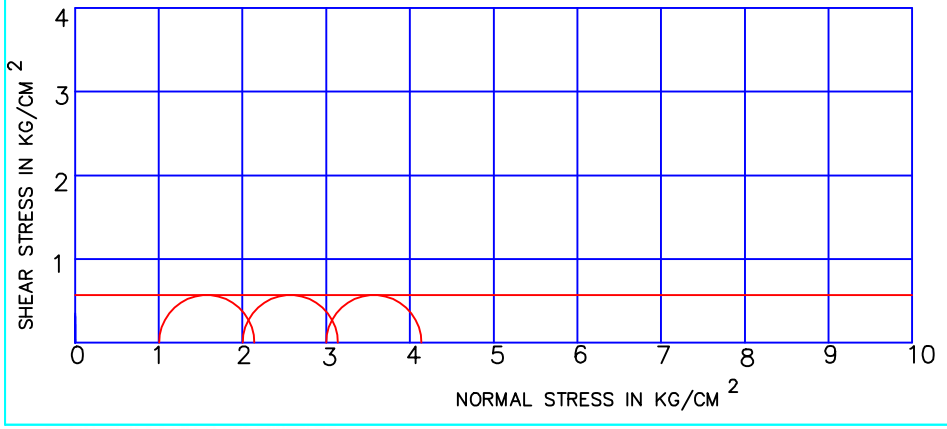
LOCATION: –CMD AREA
DEPTH : –3.00M.
BH–20

C=0.53KG/CM^2
Ø=0°



LOCATION: –CMD AREA
DEPTH : –6.00M.
BH–23

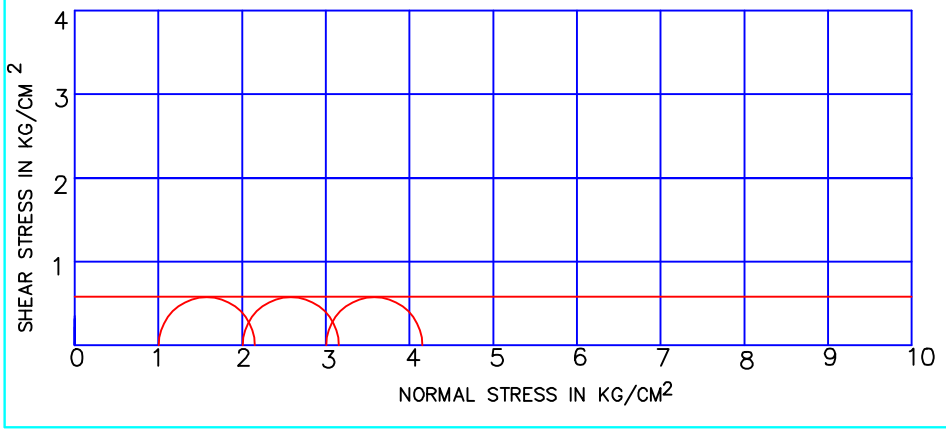
C=0.52KG/CM^2
Ø=0°



BISHWAJIT KUMAR DAS.
M.TECH (GEOTECH)
SWAYIN & ASSOCIATES
T.L. SATYANAGAR

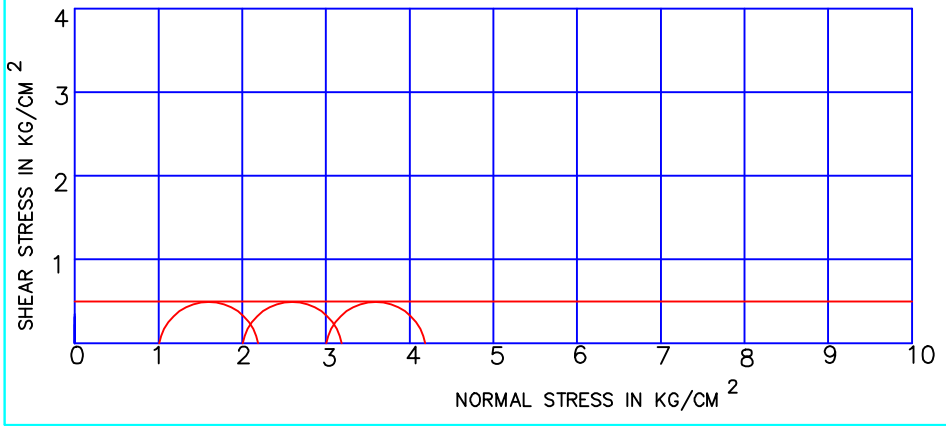
LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-25

C=0.53KG/CM^2
Ø=0°



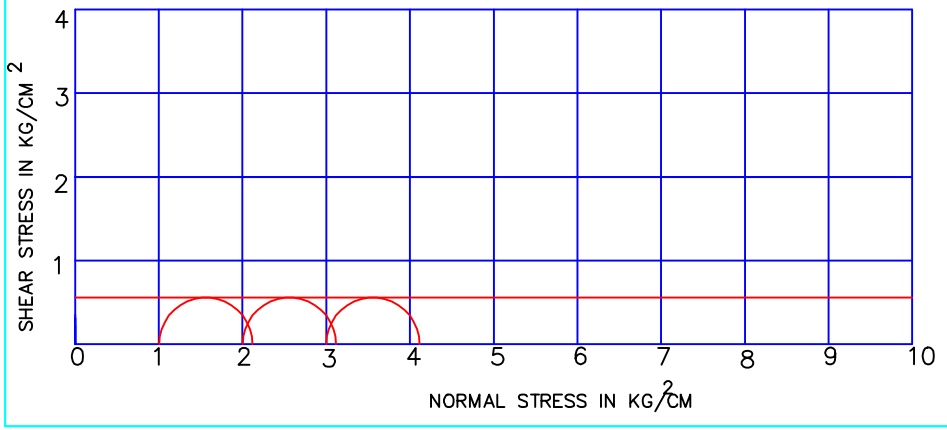
LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-26

C=0.50G/CM^2
Ø=0°



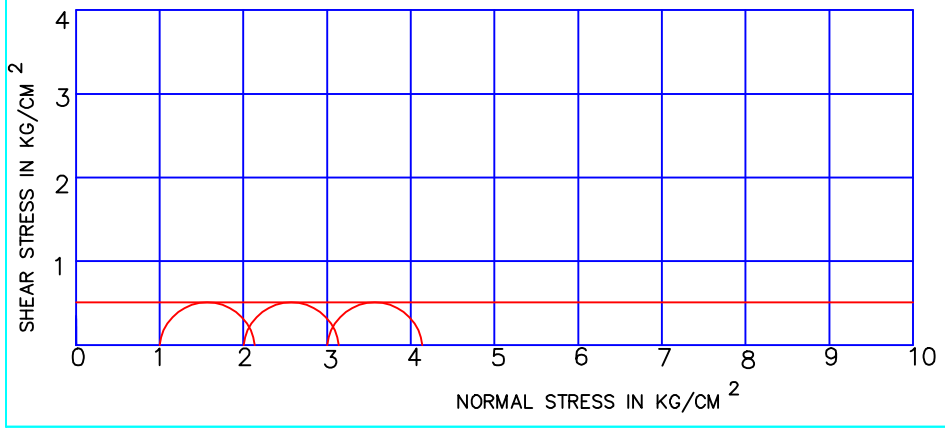
LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-27

C=0.55KG/CM^2
Ø=0°



LOCATION:-CMD AREA
DEPTH :-4.50M.
BH-28

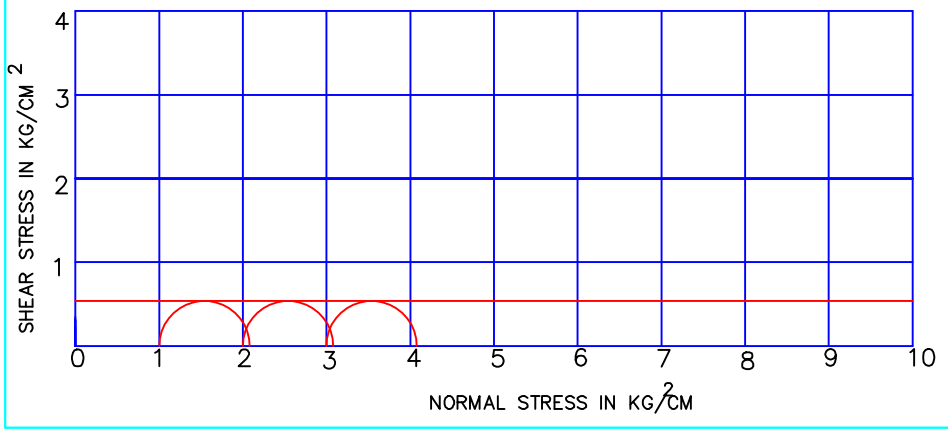
C=0.51KG/CM^2
Ø=0°



BISHAL KUMAR DAS.
MTECH (GEOTECH)

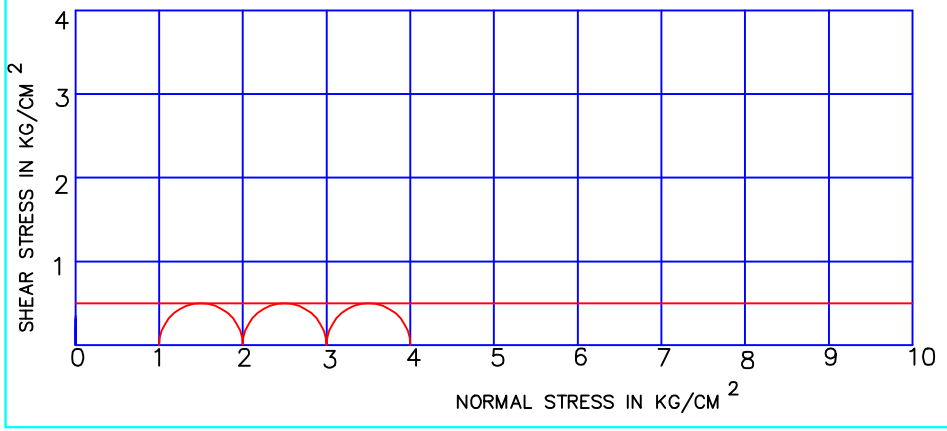
LOCATION:-CMD AREA
DEPTH :-6.00M.
BH-30

C=0.53KG/CM^2
Ø=0°



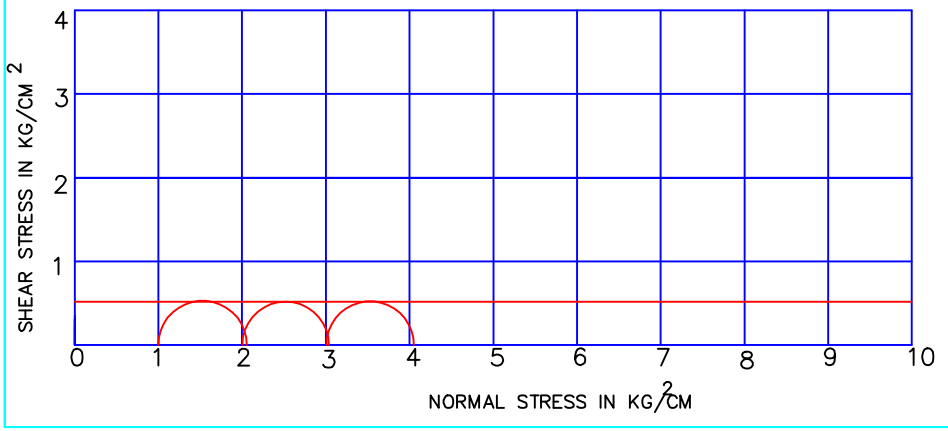
LOCATION:-CMD AREA
DEPTH :-6.00M.
BH-31

C=0.50KG/CM^2
Ø=0°



LOCATION:-CMD AREA
DEPTH :-9.00M.
BH-32

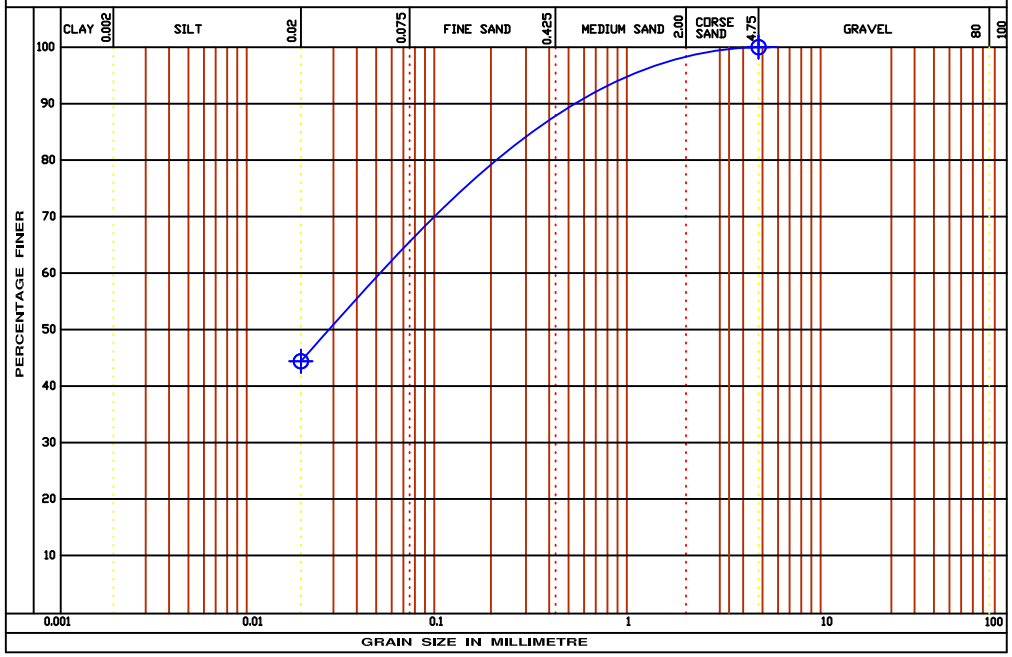
C=0.52KG/CM^2
Ø=0°



BISHAL KUMAR DAS.
MTECH (GEOTECH)
SWAYIN ASSOCIATES
T. SATYANAGAR

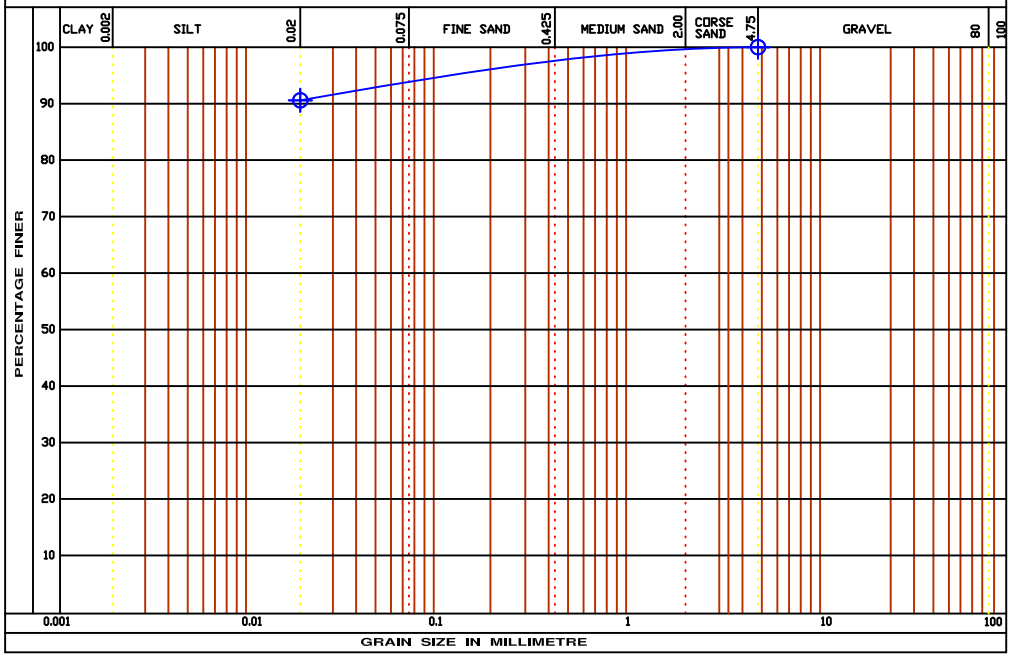
LOCATION - CMD AREA
DEPTH-1.50M
B.H NO:- 01

GRAIN SIZE DISTRIBUTION CURVE



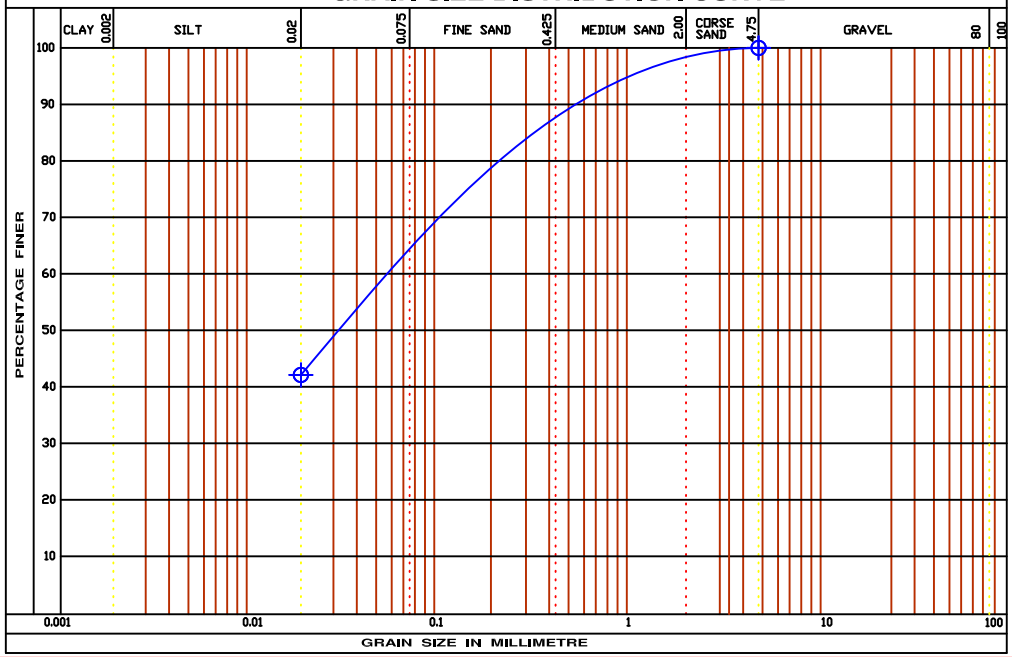
LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 01

GRAIN SIZE DISTRIBUTION CURVE



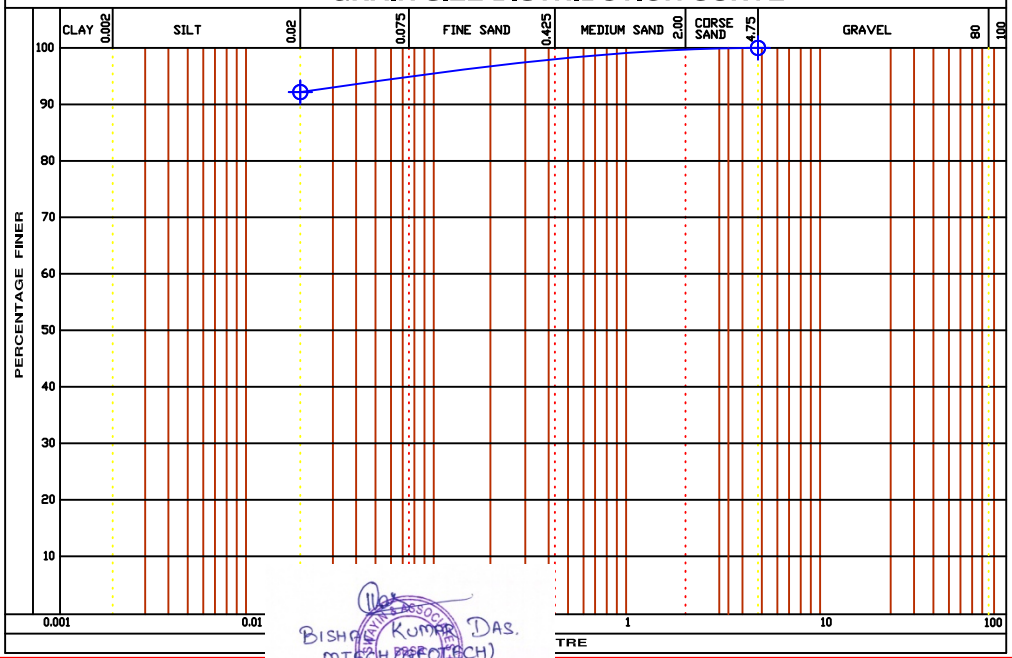
LOCATION - CMD AREA
DEPTH-1.50M
B.H NO:- 02

GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-3.00M
B.H NO:- 02

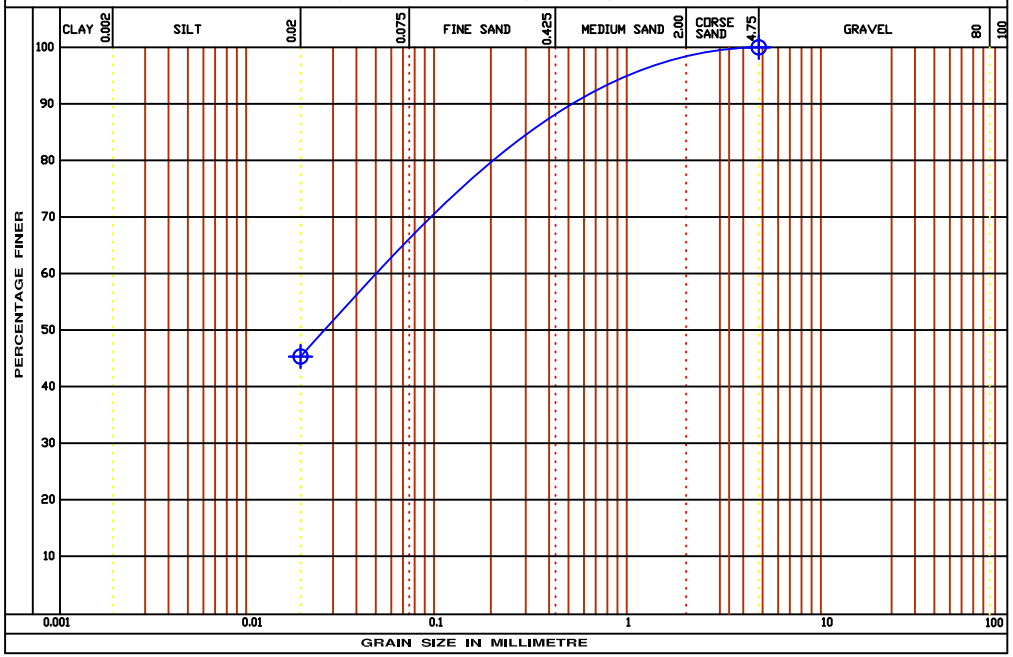
GRAIN SIZE DISTRIBUTION CURVE



BISHO KUMAR DAS.
MTECH (GEOTECH)

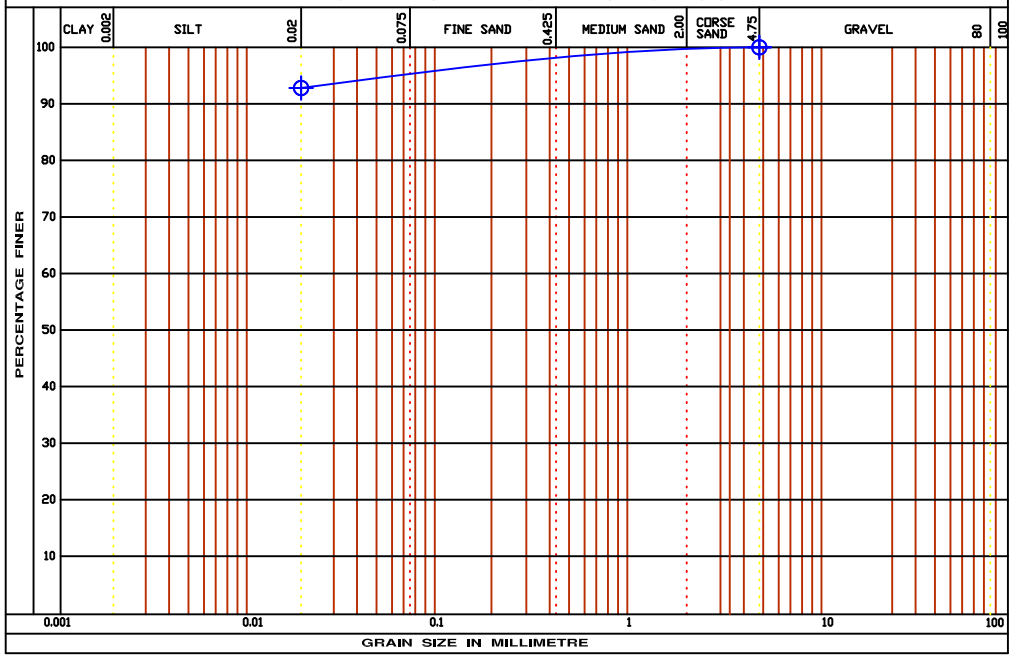
LOCATION - CMD AREA
DEPTH-2.00M
B.H NO:- 03

GRAIN SIZE DISTRIBUTION CURVE



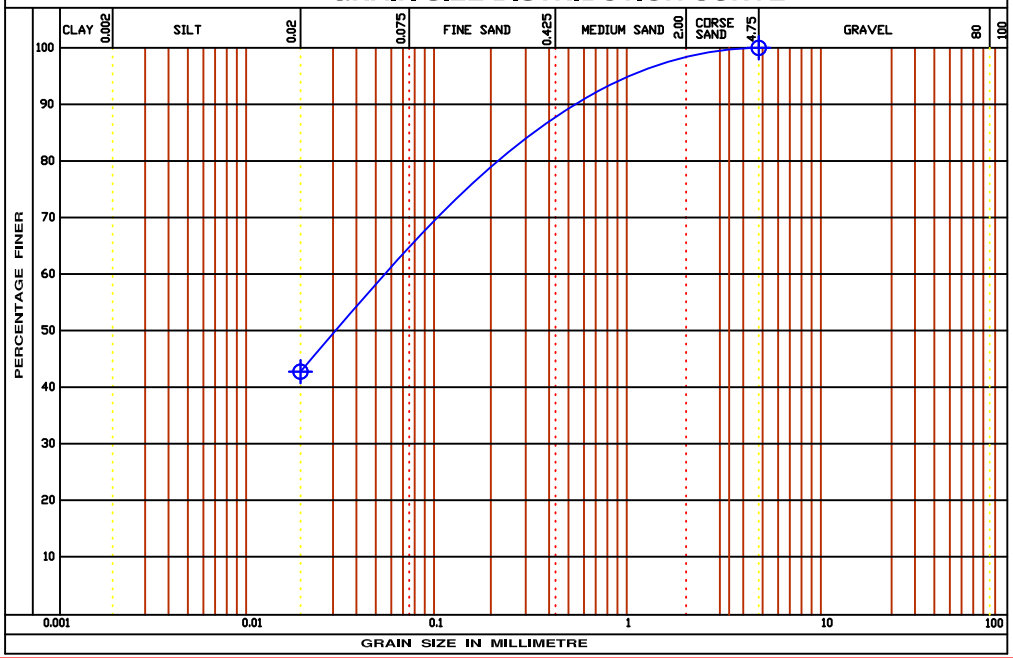
LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 03

GRAIN SIZE DISTRIBUTION CURVE



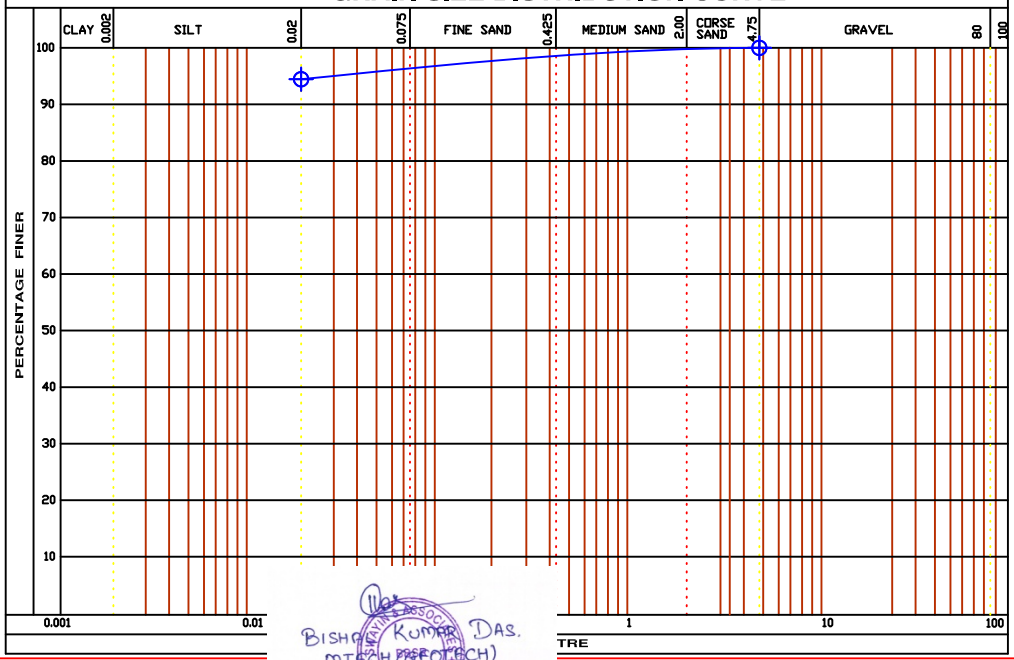
LOCATION - CMD AREA
DEPTH-2.00M
B.H NO:- 04

GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 04

GRAIN SIZE DISTRIBUTION CURVE

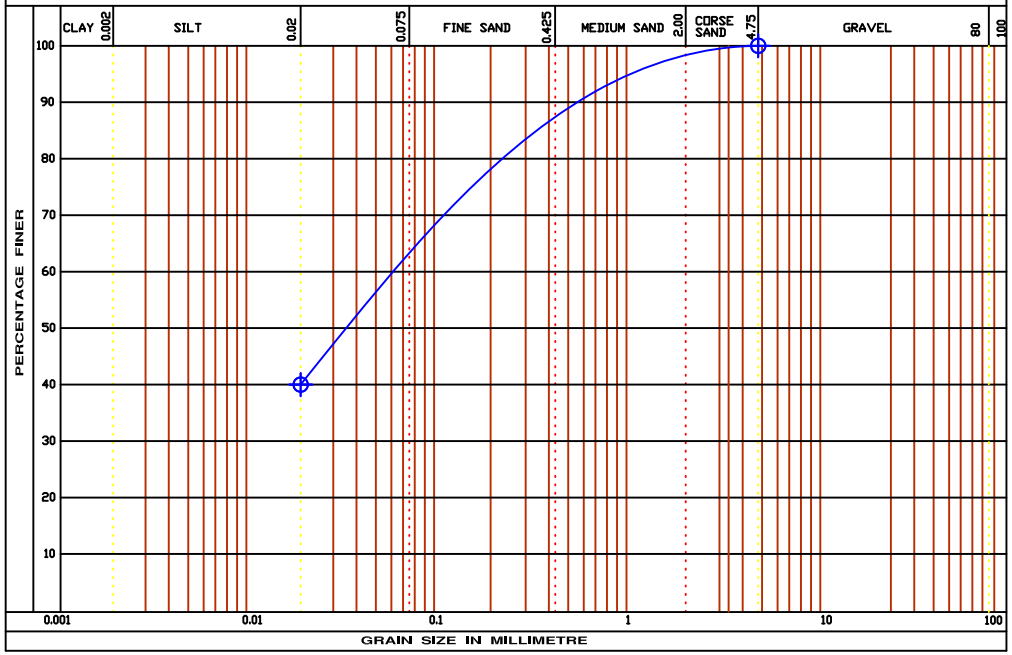


BISHWAJIT KUMAR DAS.
M.TECH (GEOTECH)
SWAYIN & ASSOCIATES
77, SATYANAGAR

LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 05

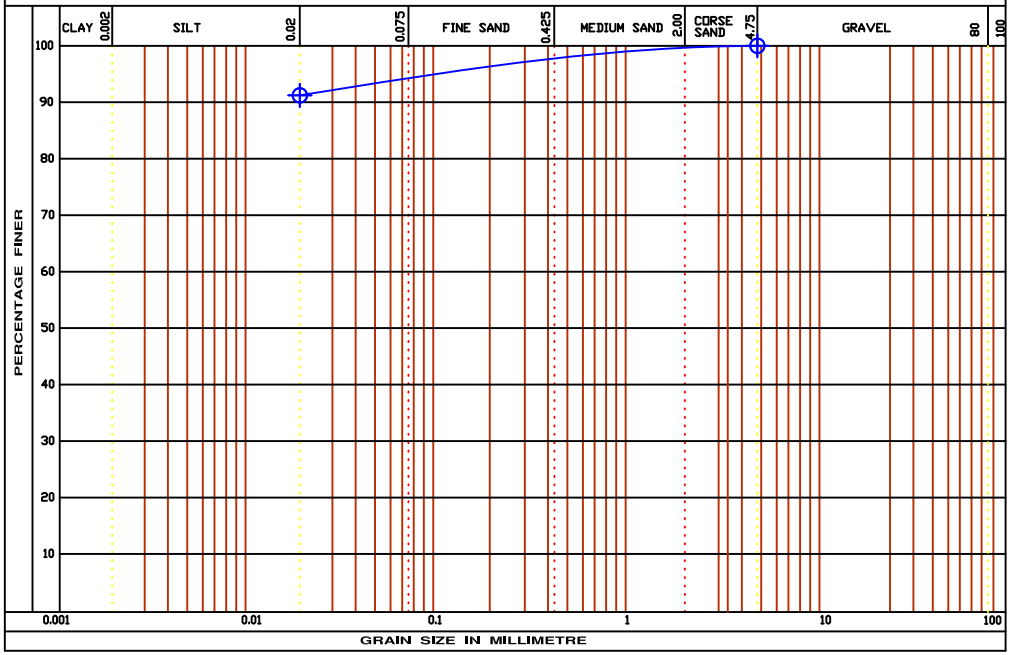
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 05

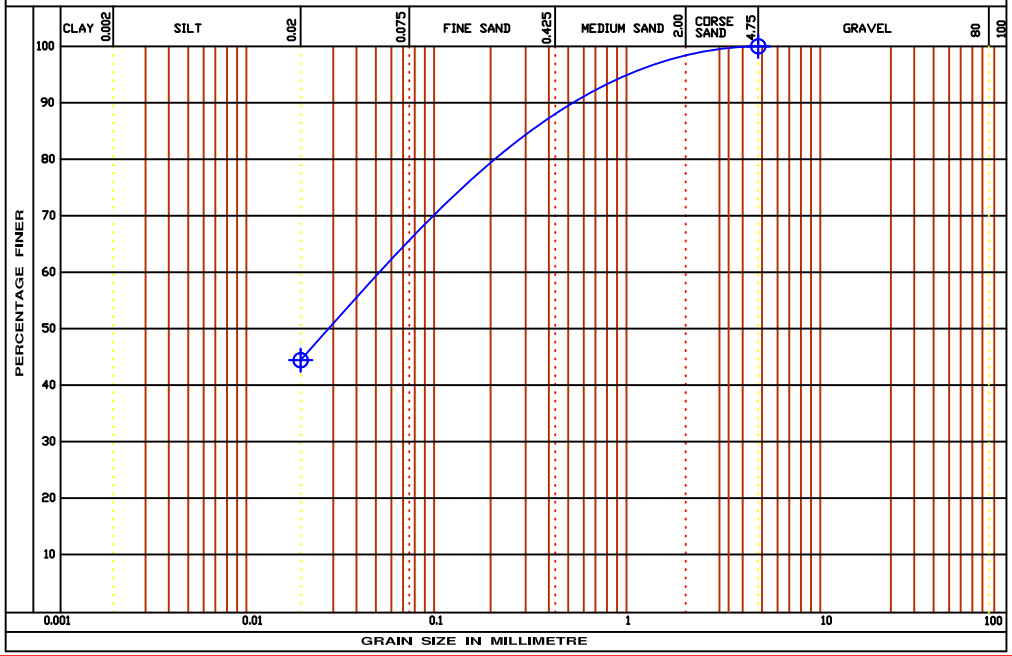
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-2.00M

B.H NO:- 06

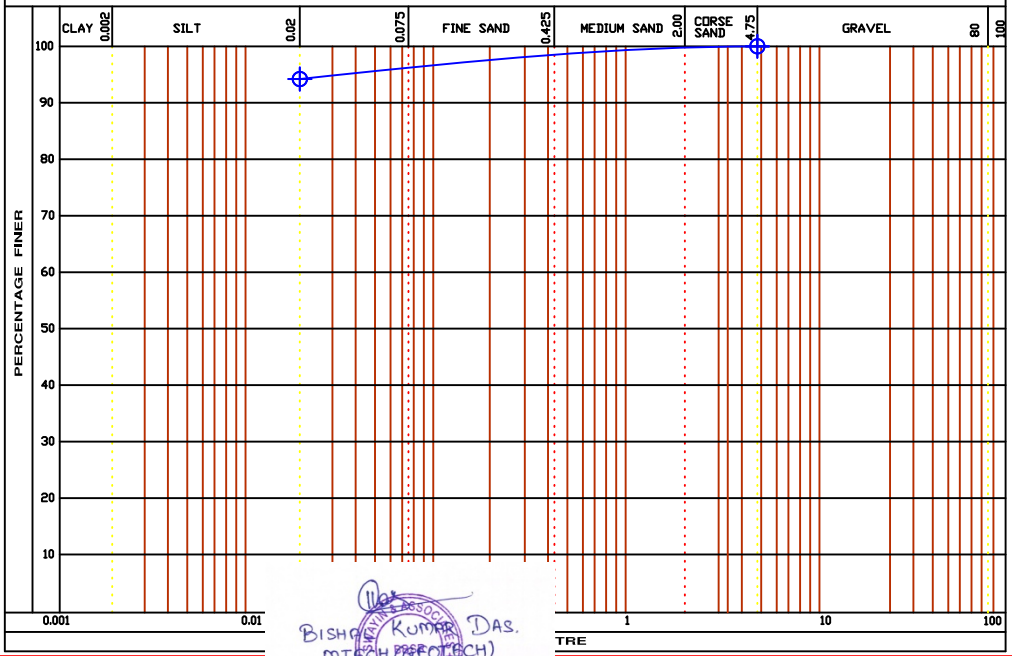
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 06

GRAIN SIZE DISTRIBUTION CURVE

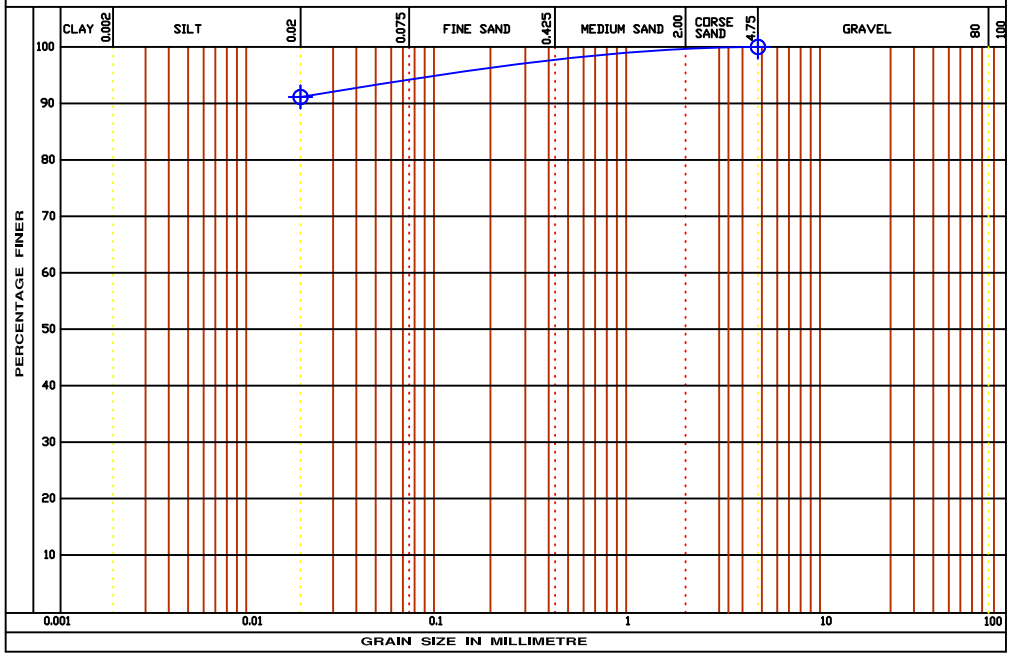


BISHO KUMAR DAS.
MTECH (GEOTECH)

LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 07

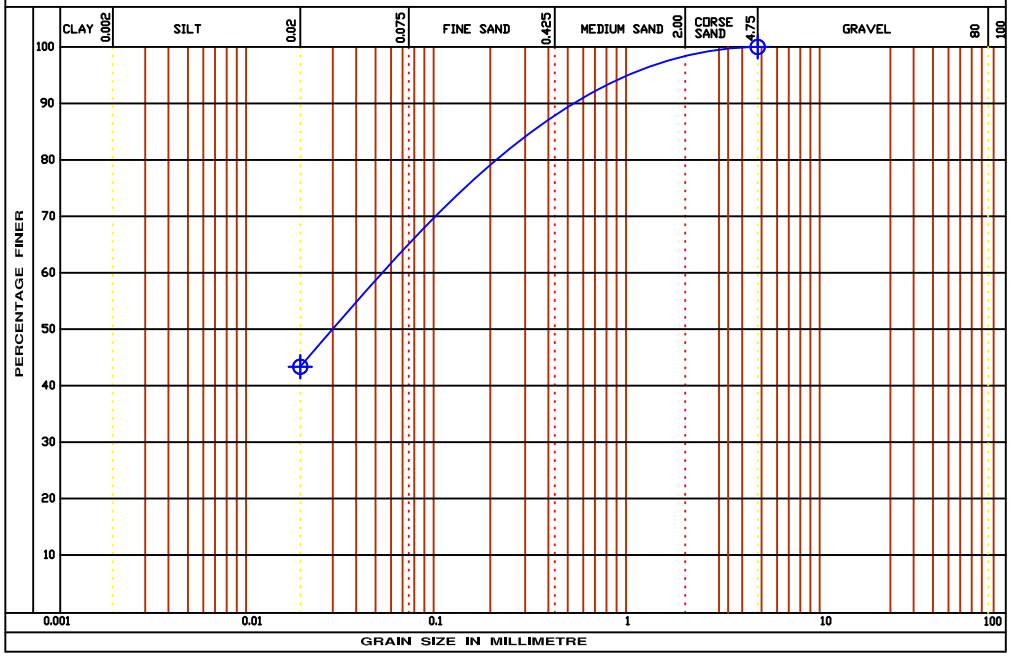
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 08

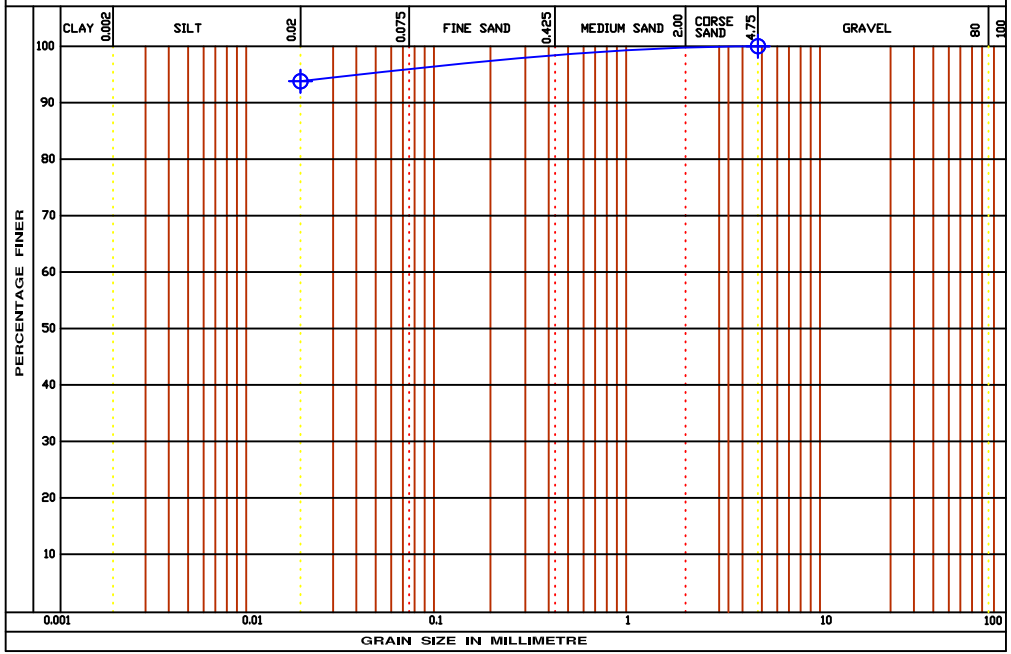
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-3.00M

B.H NO:- 08

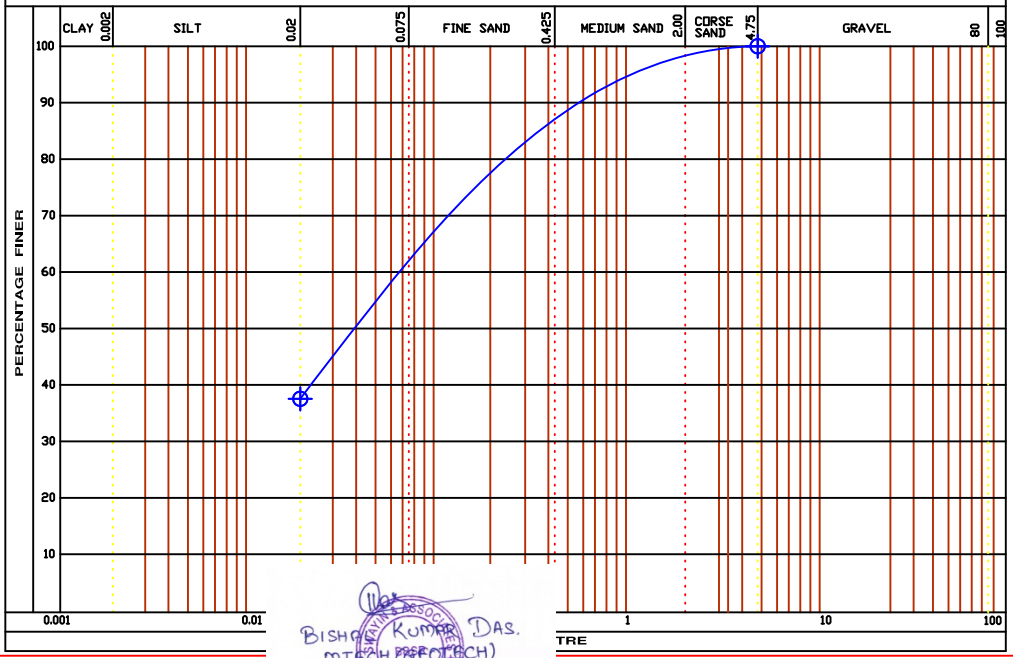
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

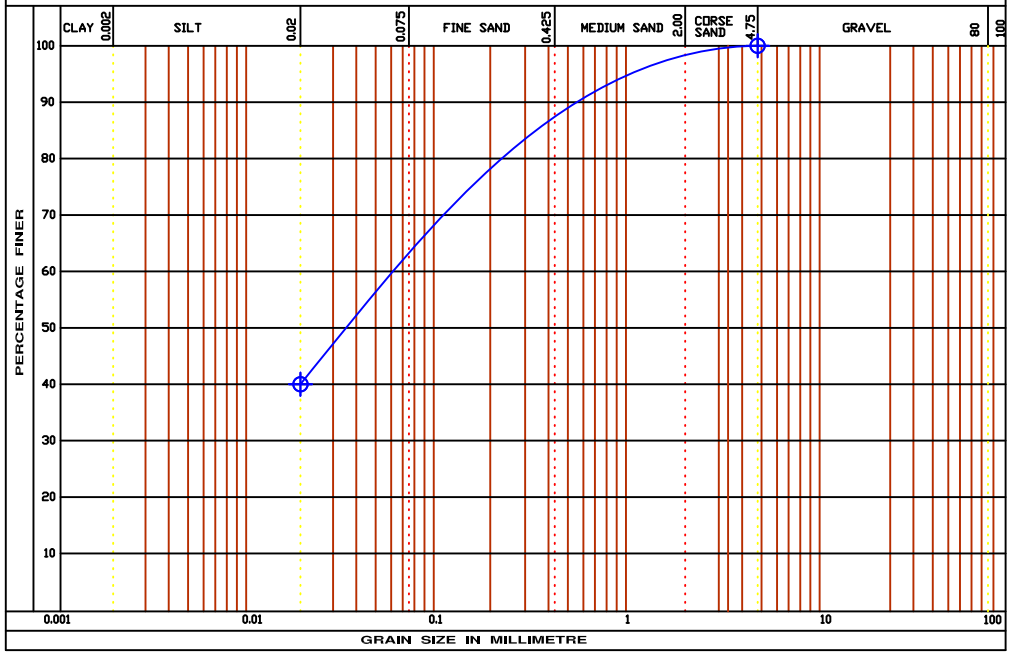
B.H NO:- 09

GRAIN SIZE DISTRIBUTION CURVE

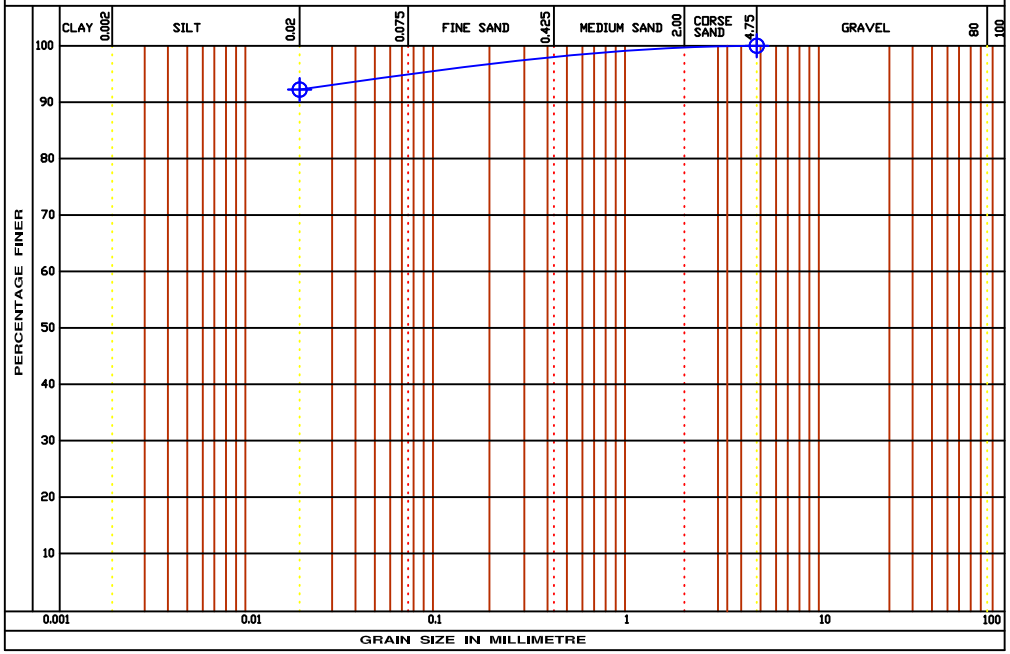


BISHO KUMAR DAS.
MTECH (GEOTECH)

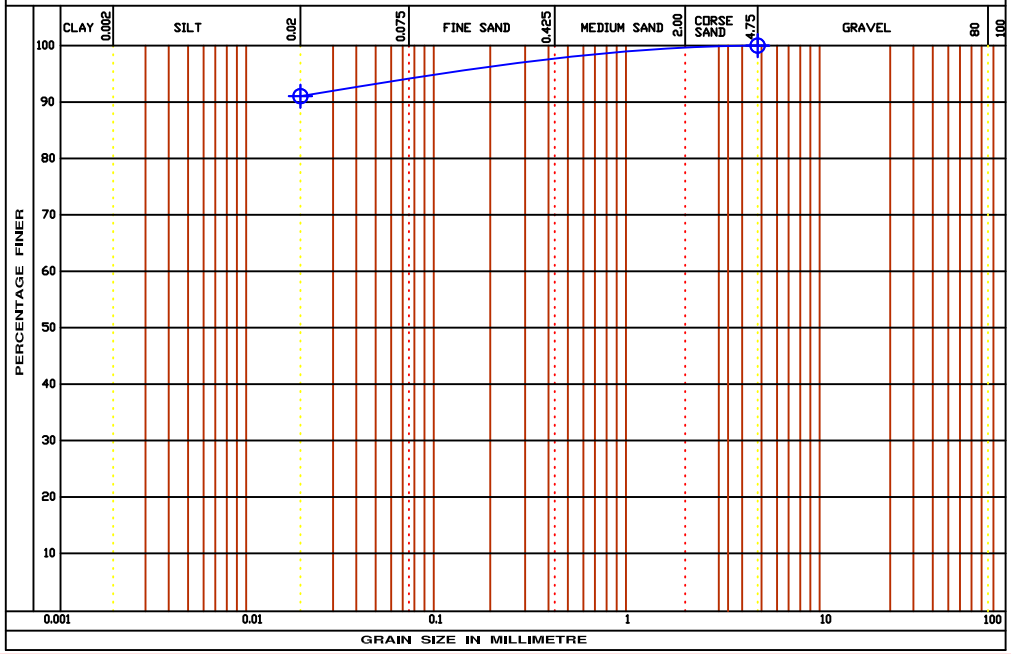
LOCATION - CMD AREA
DEPTH-2.00M
B.H NO:- 10
GRAIN SIZE DISTRIBUTION CURVE



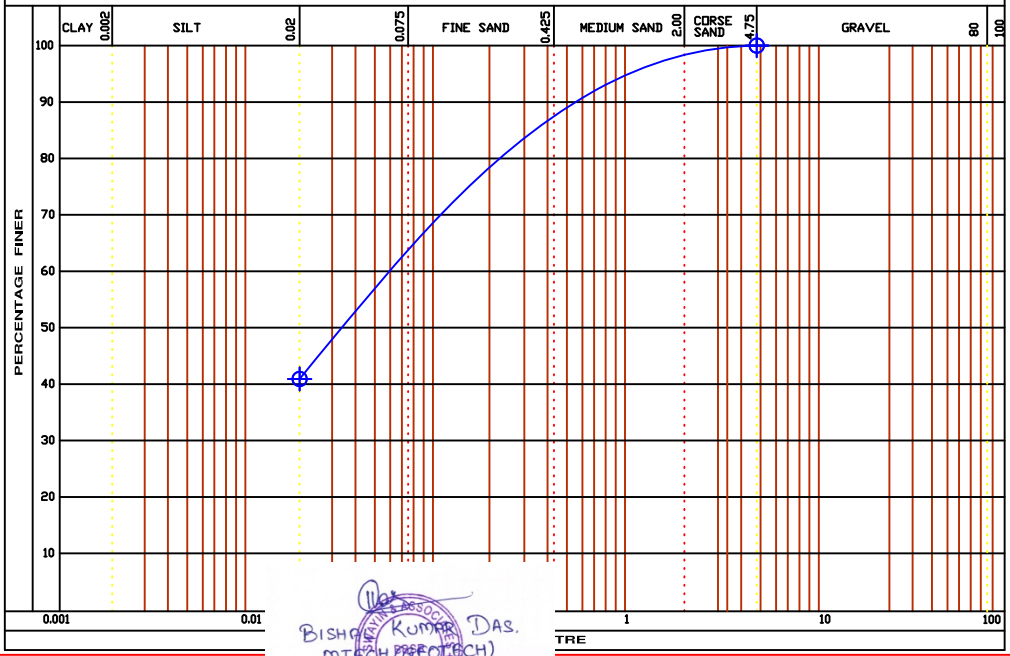
LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 10
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 11
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-2.00M
B.H NO:- 12
GRAIN SIZE DISTRIBUTION CURVE

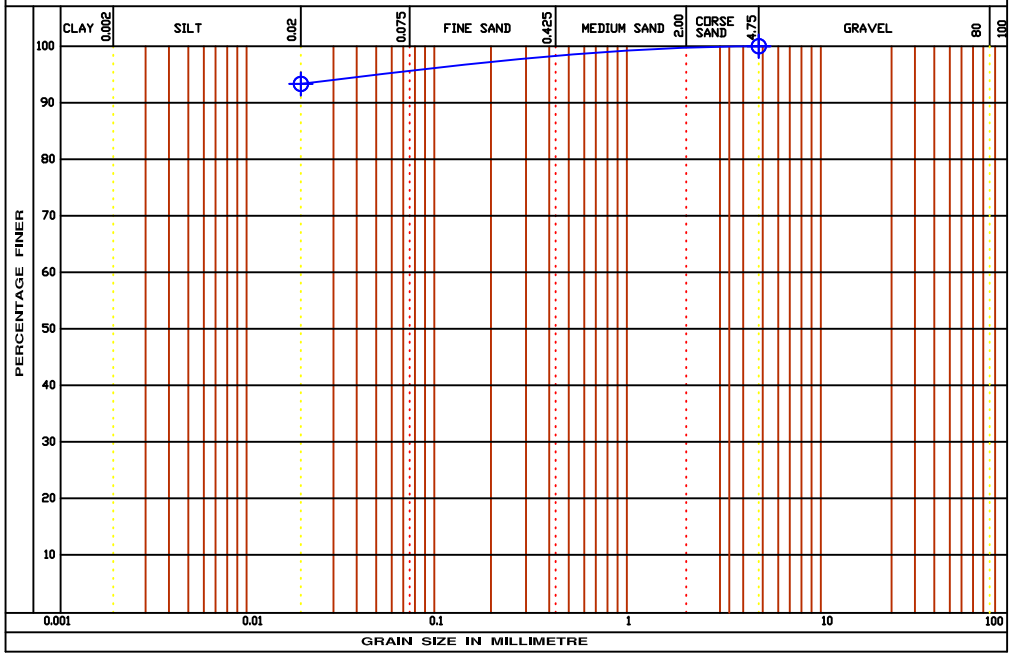


BISHO KUMAR DAS.
MTECH (GEOTECH)

LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 12

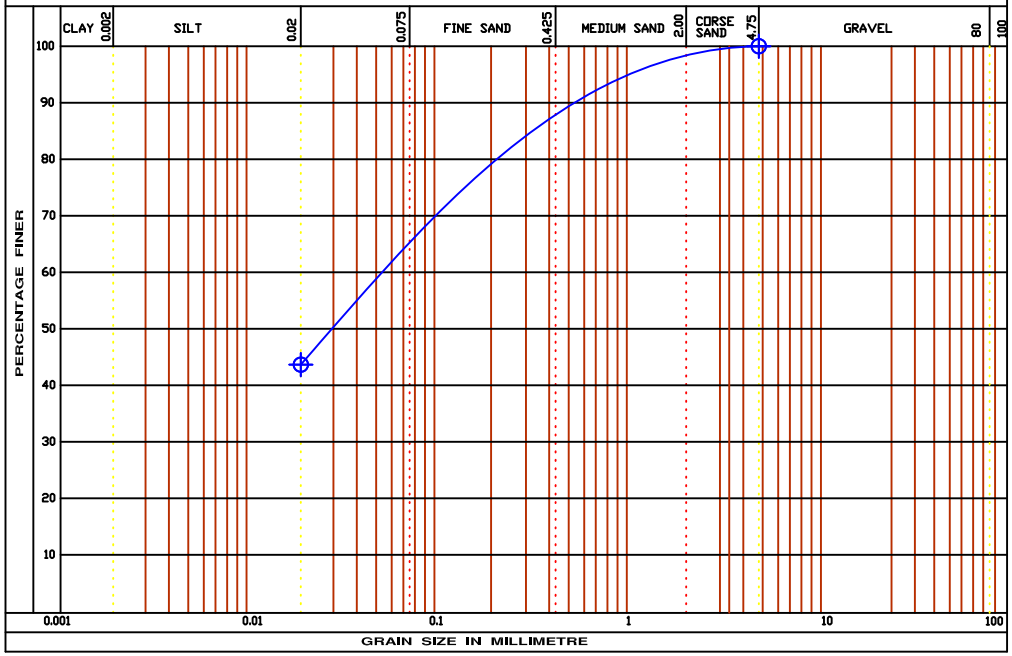
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 13

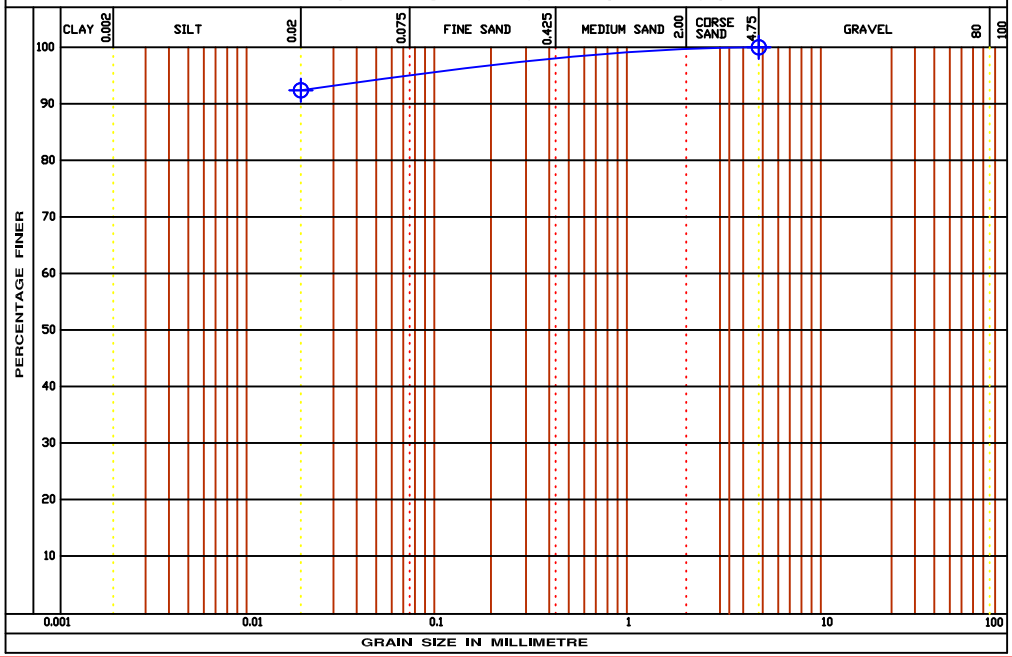
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-6.00M

B.H NO:- 13

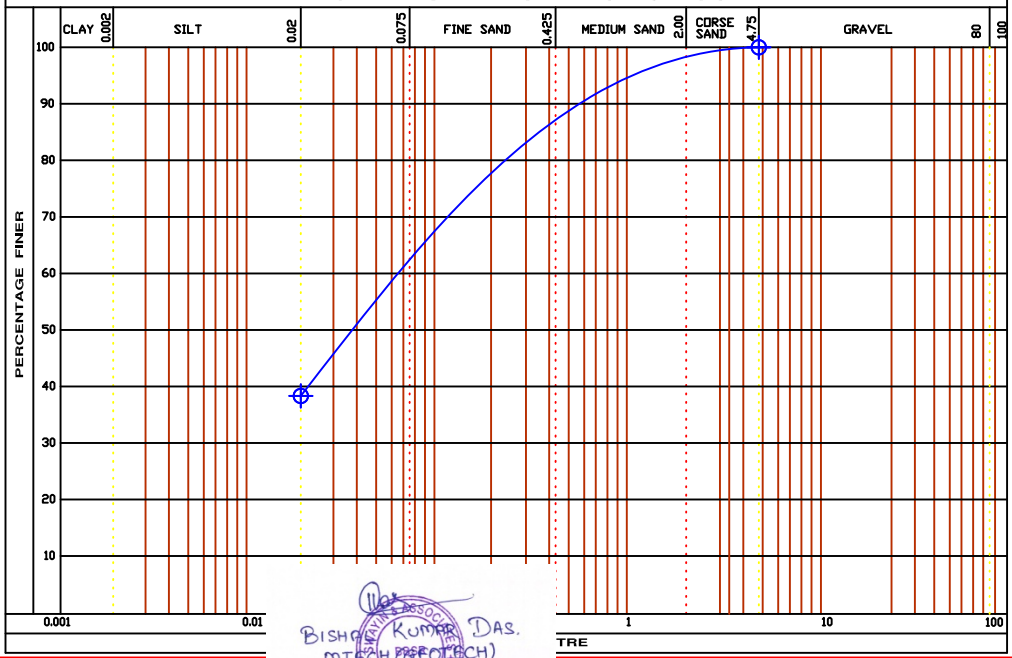
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

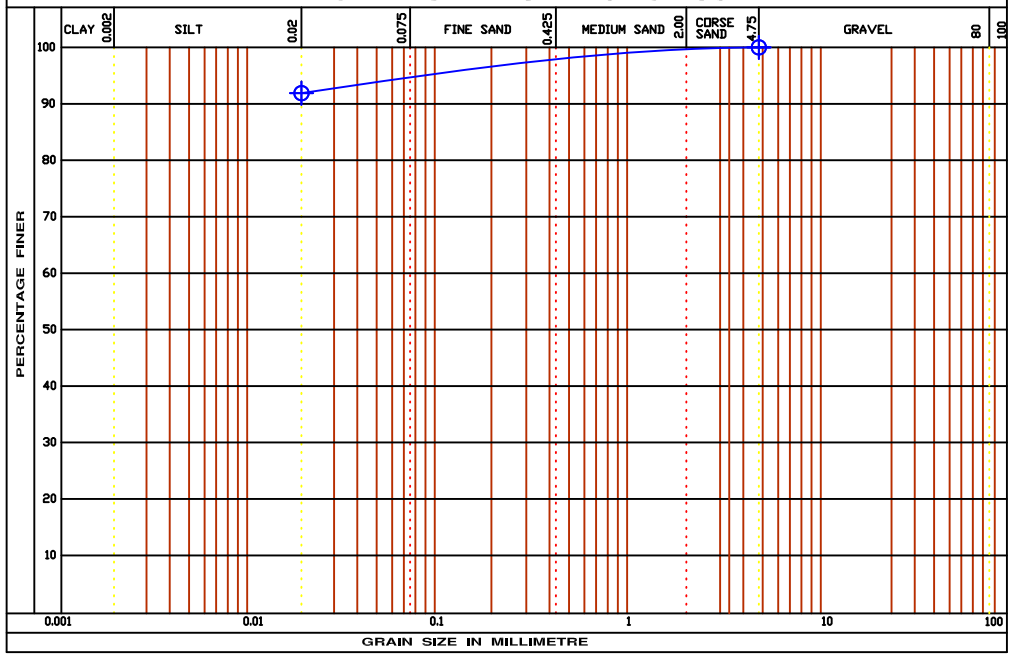
B.H NO:- 14

GRAIN SIZE DISTRIBUTION CURVE

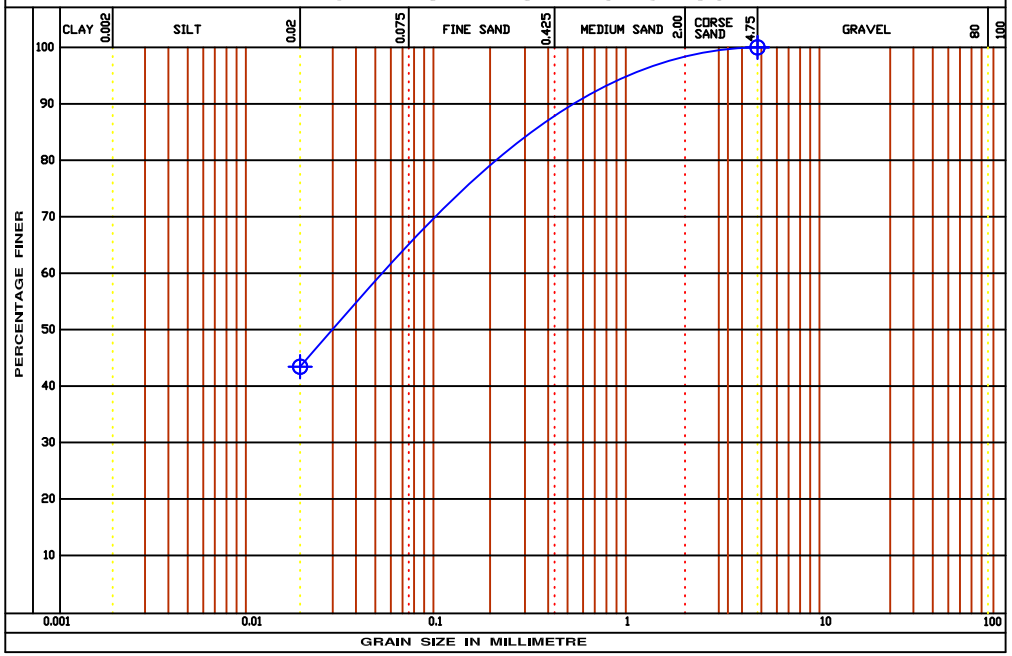


BISHO KUMAR DAS.
M TECH (GEOTECH)

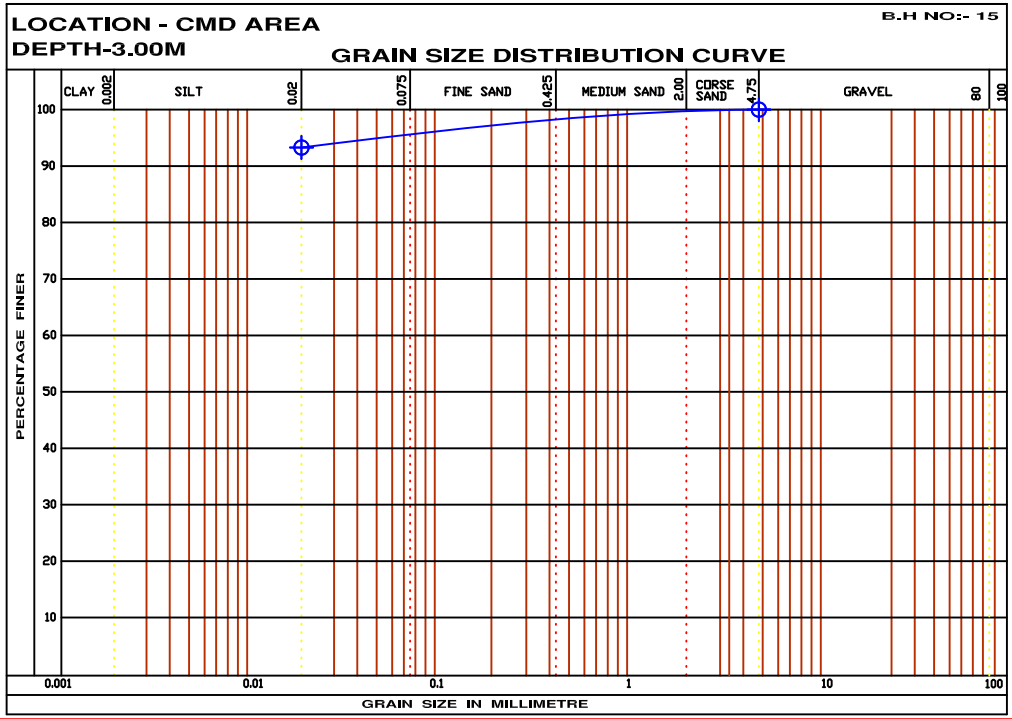
LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 14



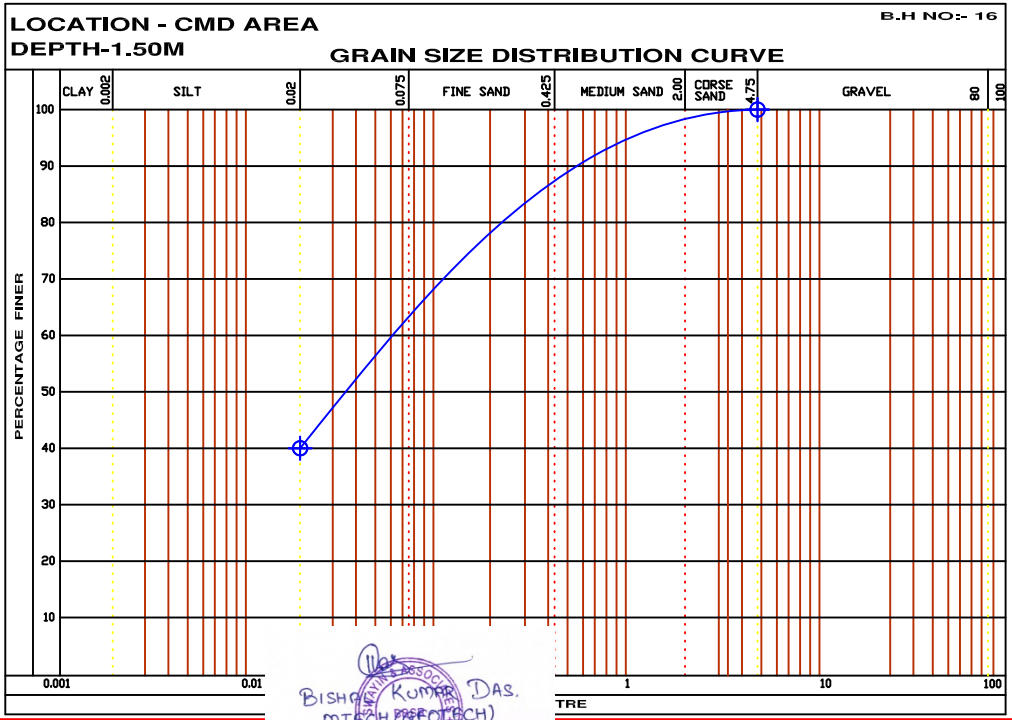
LOCATION - CMD AREA
DEPTH-2.00M
B.H NO:- 15



LOCATION - CMD AREA
DEPTH-3.00M
B.H NO:- 15



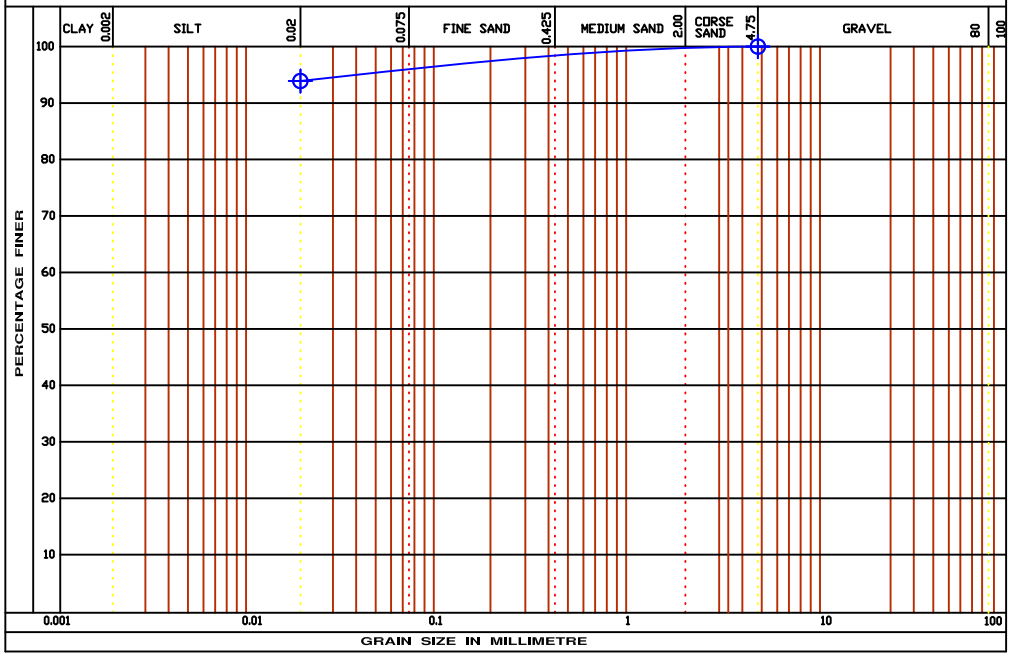
LOCATION - CMD AREA
DEPTH-1.50M
B.H NO:- 16



BISHO KUMAR DAS.
MTECH (GEOTECH)

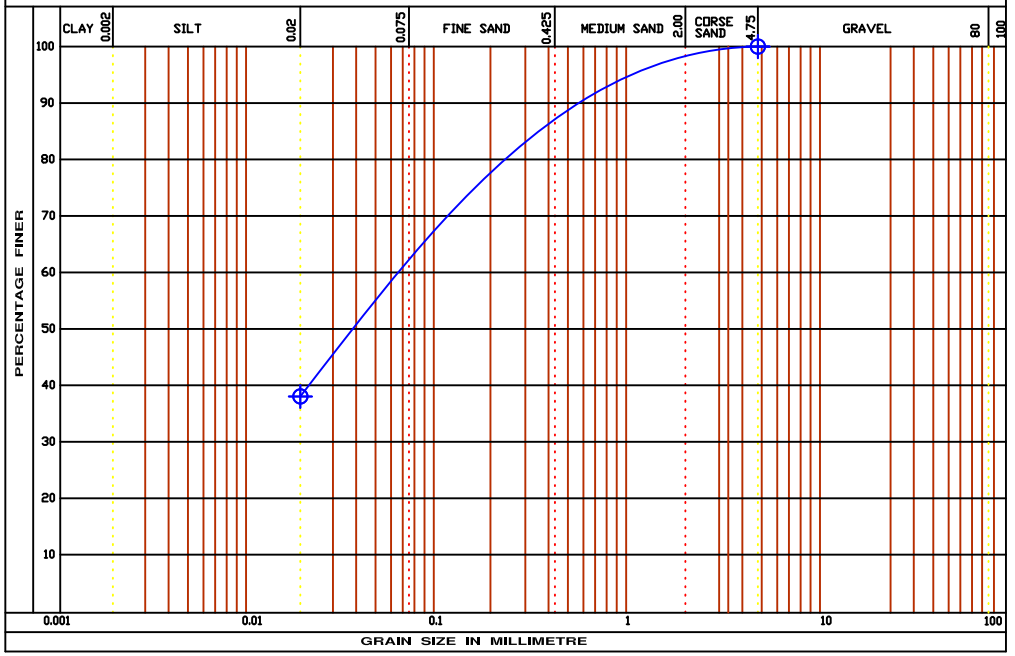
LOCATION - CMD AREA
DEPTH-6.00M
B.H NO:- 16

GRAIN SIZE DISTRIBUTION CURVE



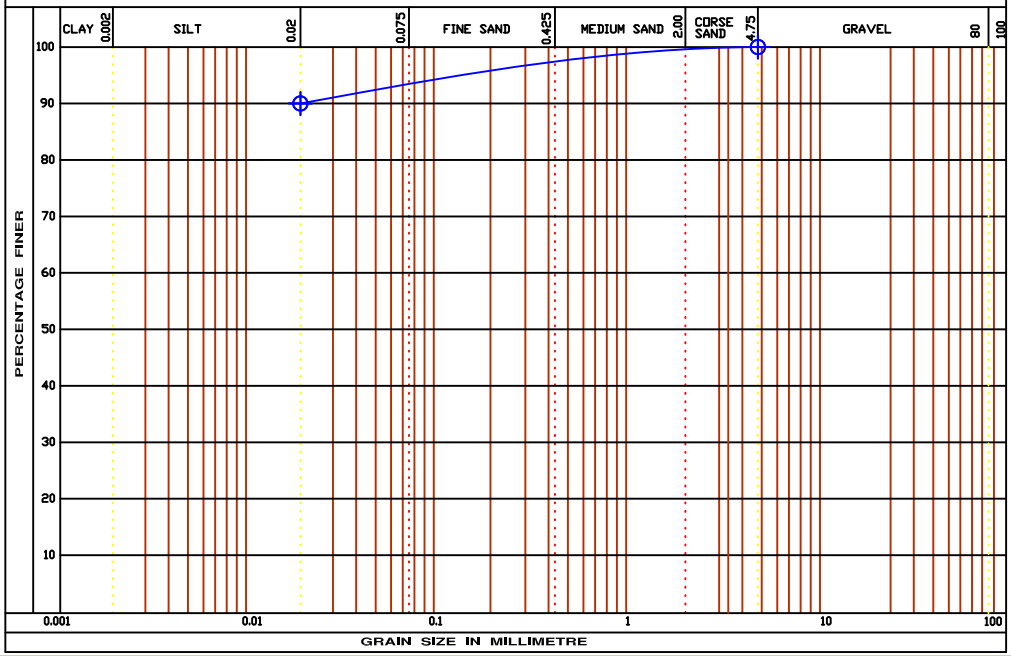
LOCATION - CMD AREA
DEPTH-2.00M
B.H NO:- 17

GRAIN SIZE DISTRIBUTION CURVE



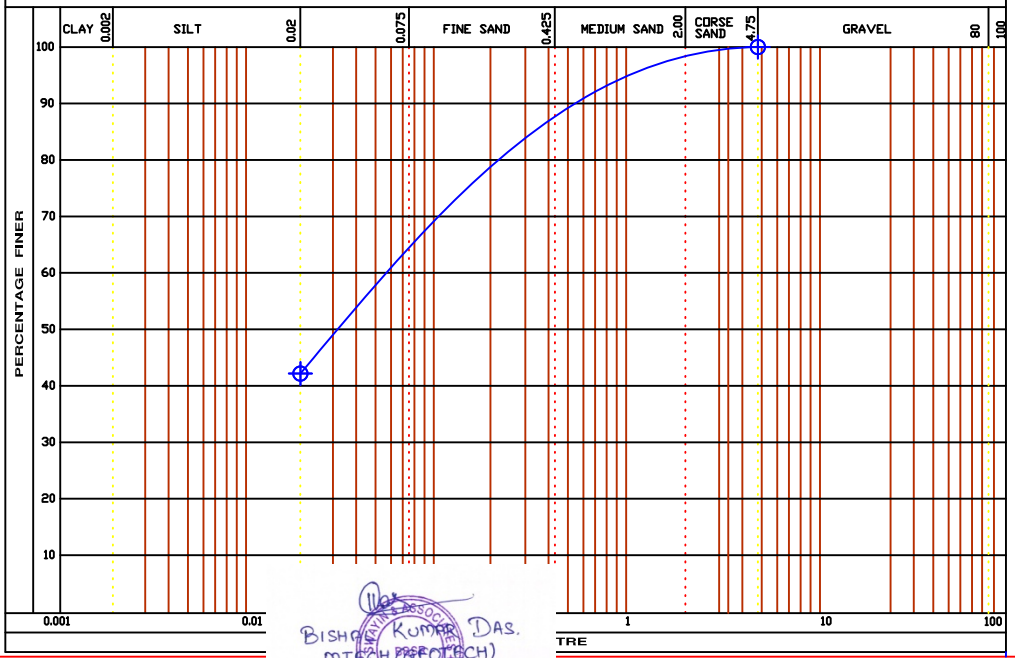
LOCATION - CMD AREA
DEPTH-6.00M
B.H NO:- 17

GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-3.00M
B.H NO:- 18

GRAIN SIZE DISTRIBUTION CURVE

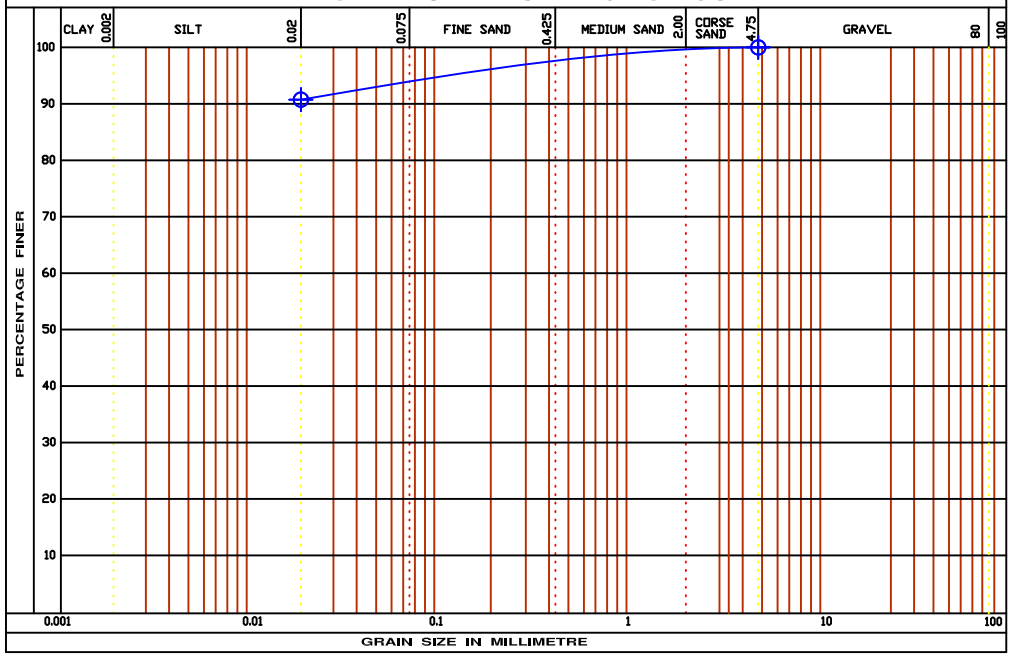


BISHNU KUMAR DAS.
MTECH (GEOTECH)

LOCATION - CMD AREA
DEPTH-7.50M

B.H NO:- 18

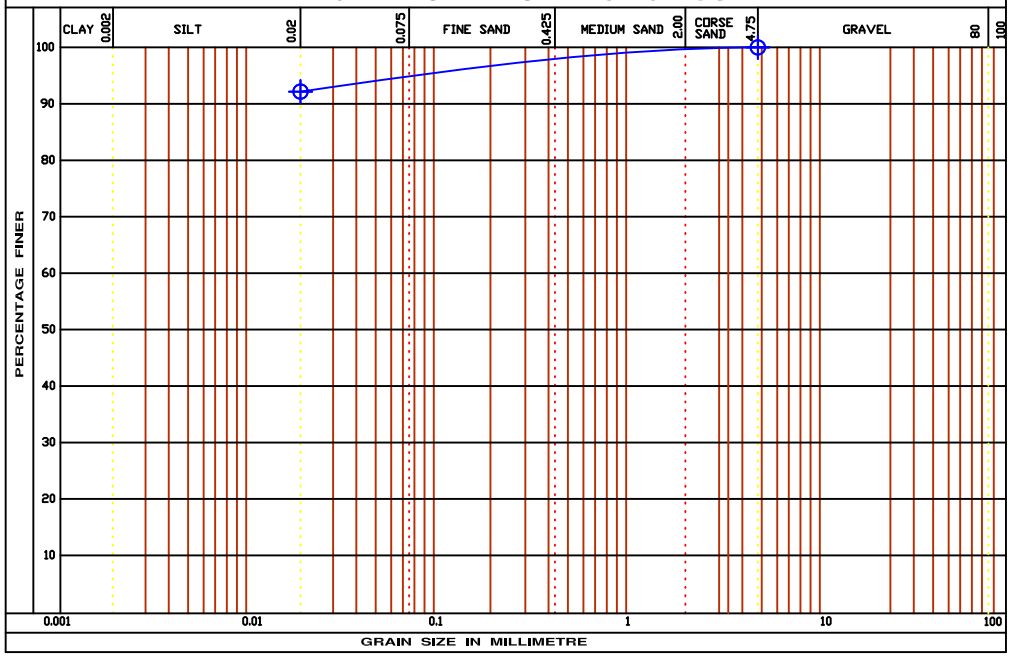
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 19

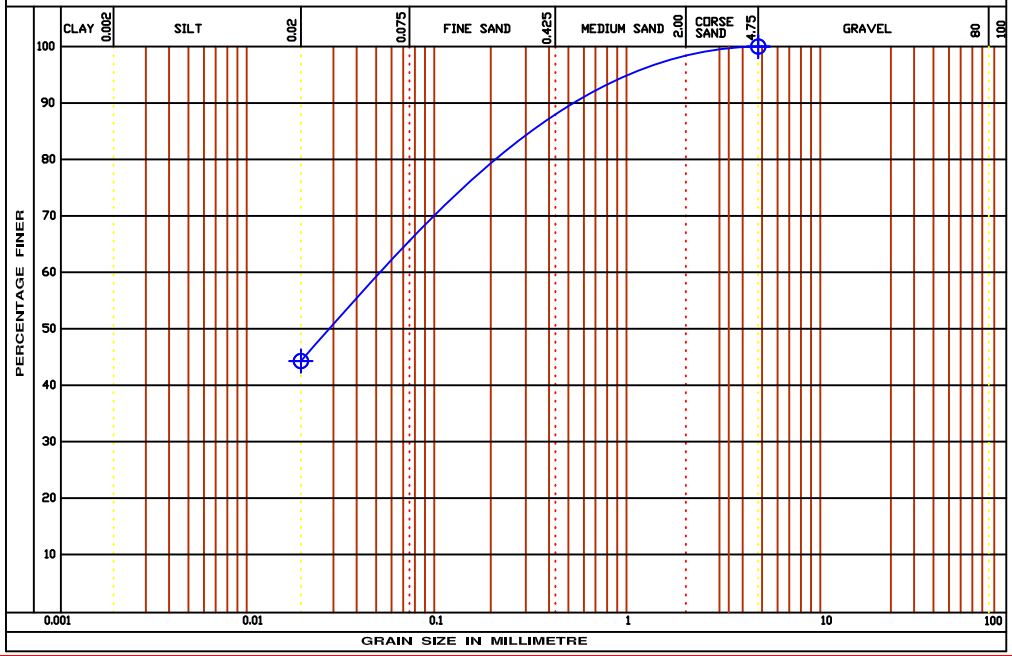
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-2.00M

B.H NO:- 20

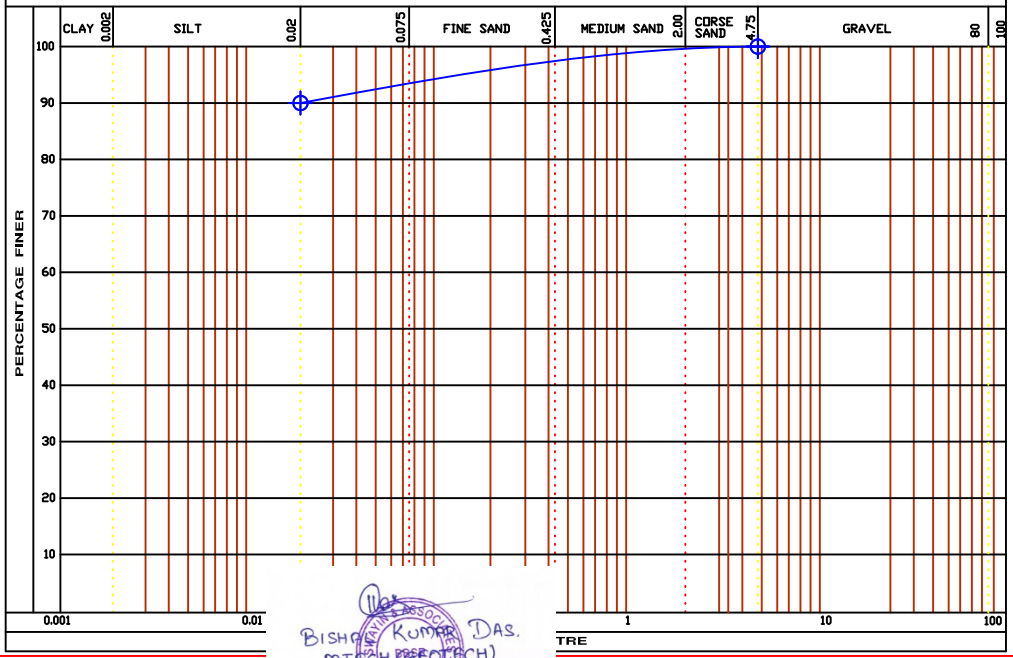
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-3.00M

B.H NO:- 20

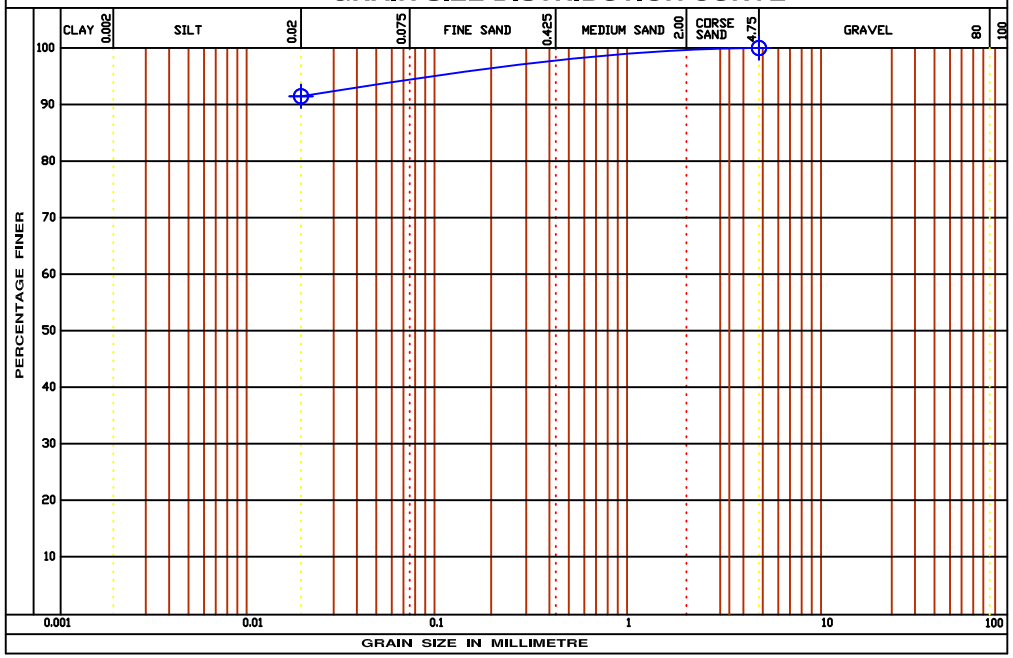
GRAIN SIZE DISTRIBUTION CURVE



BISHNU KUMAR DAS.
M.TECH (GEOTECH)
SWAYIN & ASSOCIATES
77, SATYANAGAR

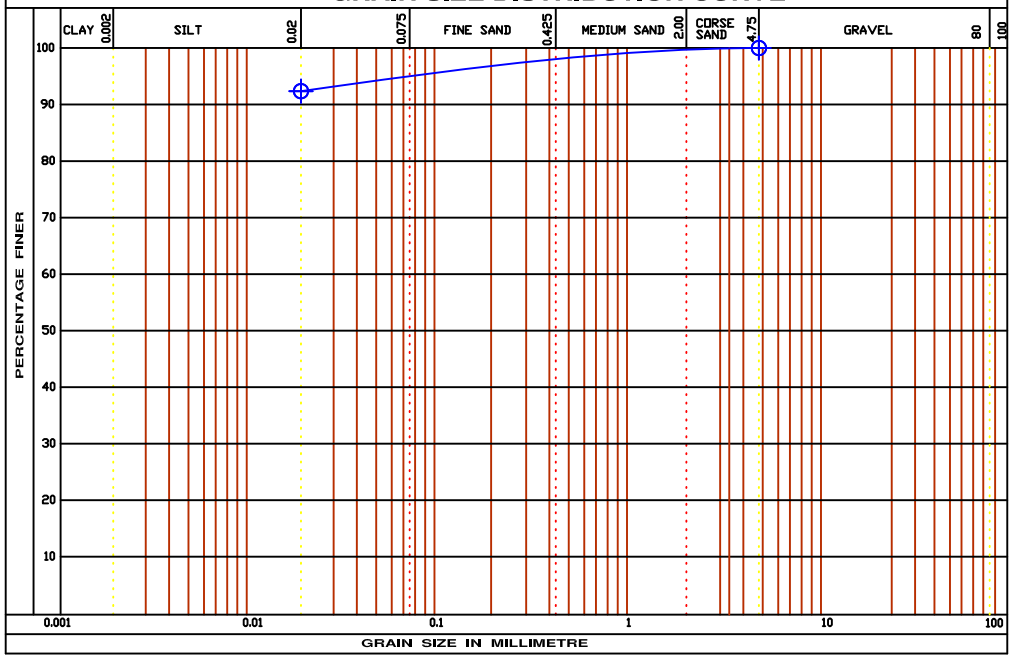
LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 21

GRAIN SIZE DISTRIBUTION CURVE



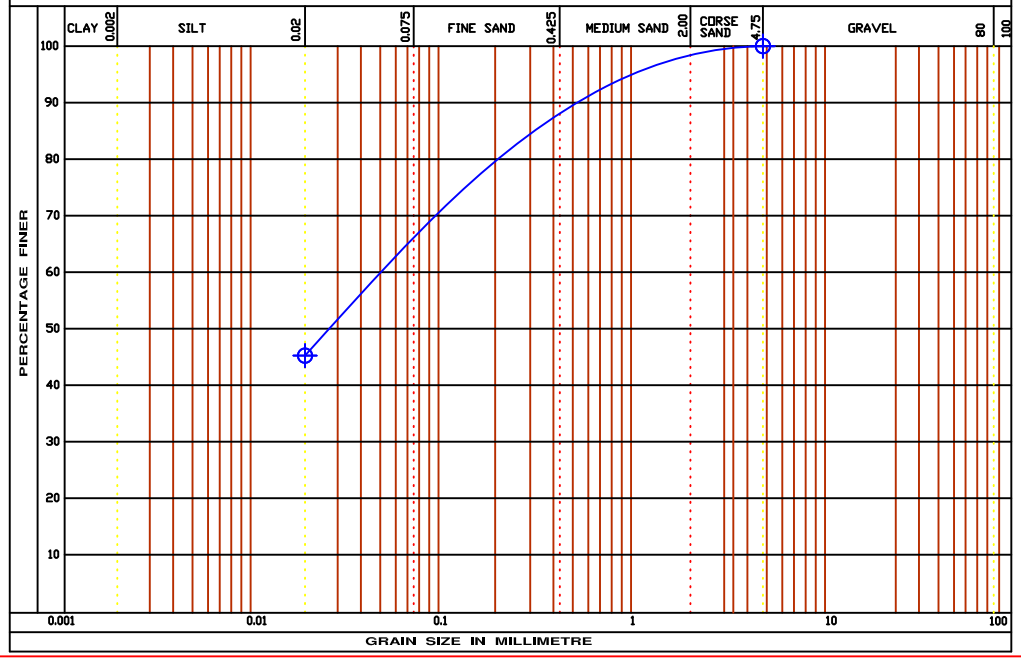
LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 22

GRAIN SIZE DISTRIBUTION CURVE



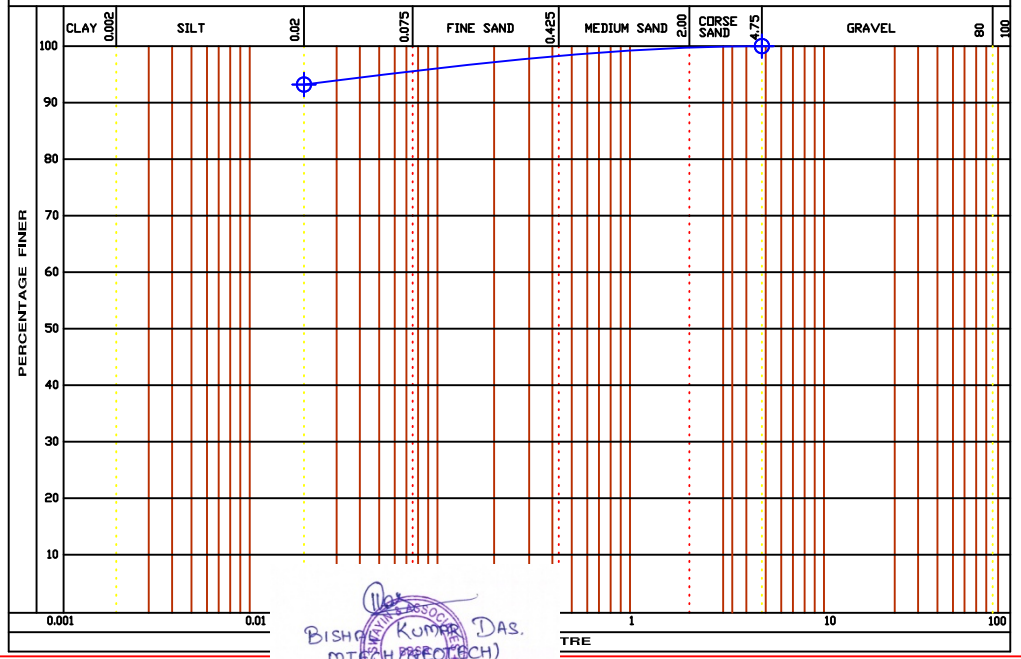
LOCATION - CMD AREA
DEPTH-1.50M
B.H NO:- 23

GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M
B.H NO:- 23

GRAIN SIZE DISTRIBUTION CURVE



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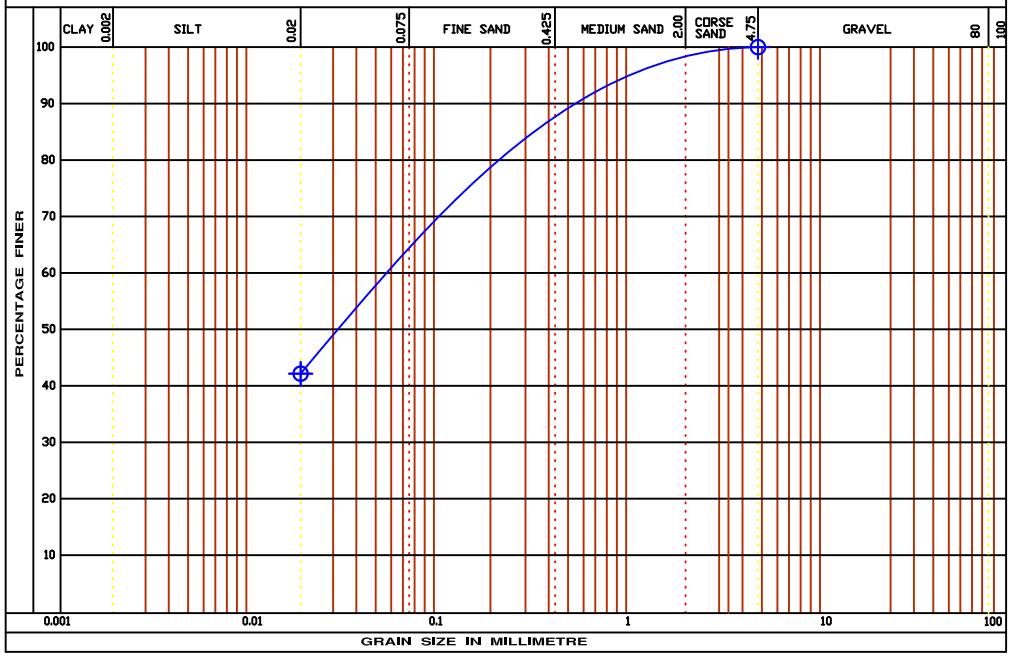
LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 24

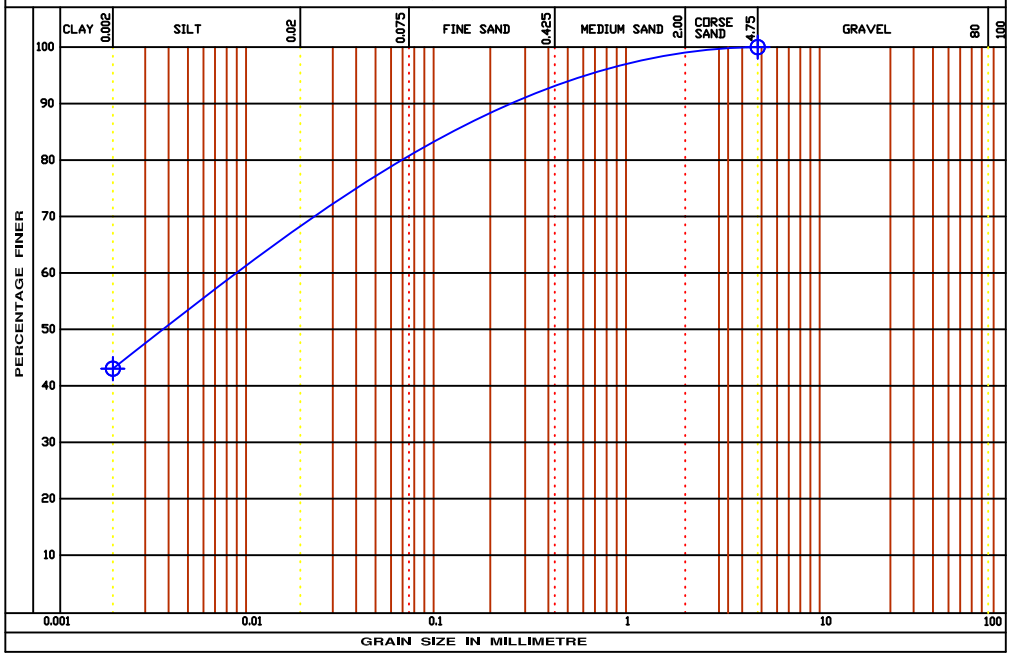
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-2.00M

B.H NO:- 25

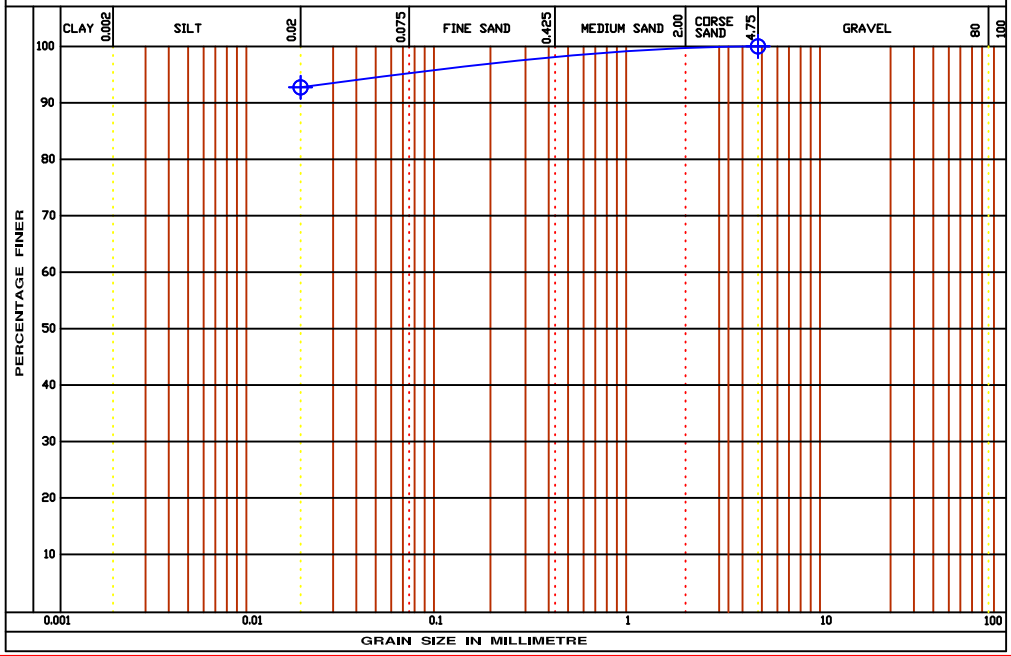
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-3.00M

B.H NO:- 25

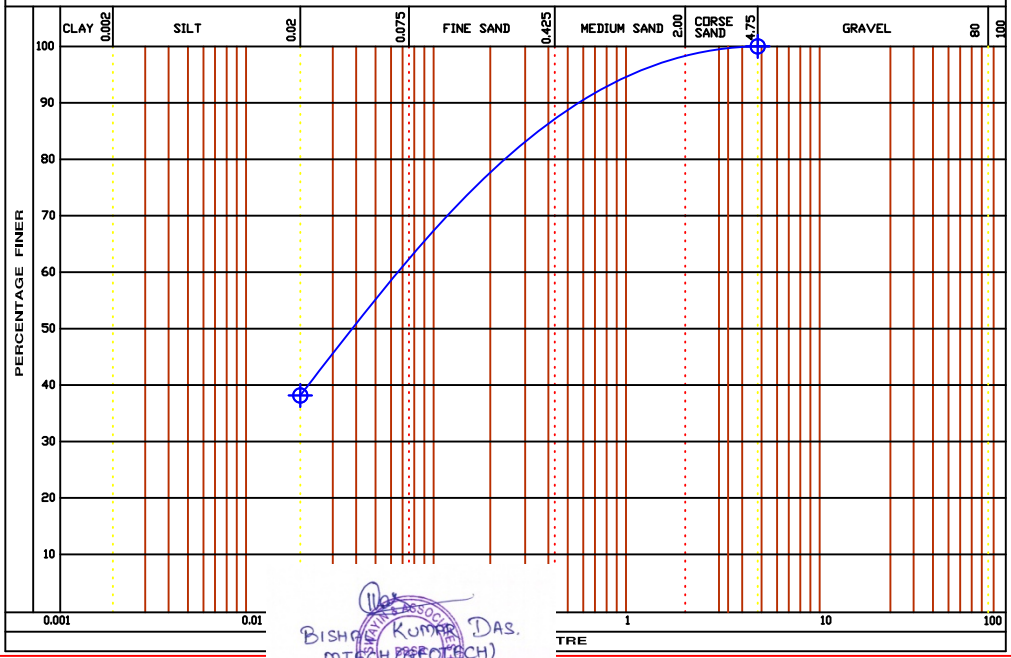
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 26

GRAIN SIZE DISTRIBUTION CURVE



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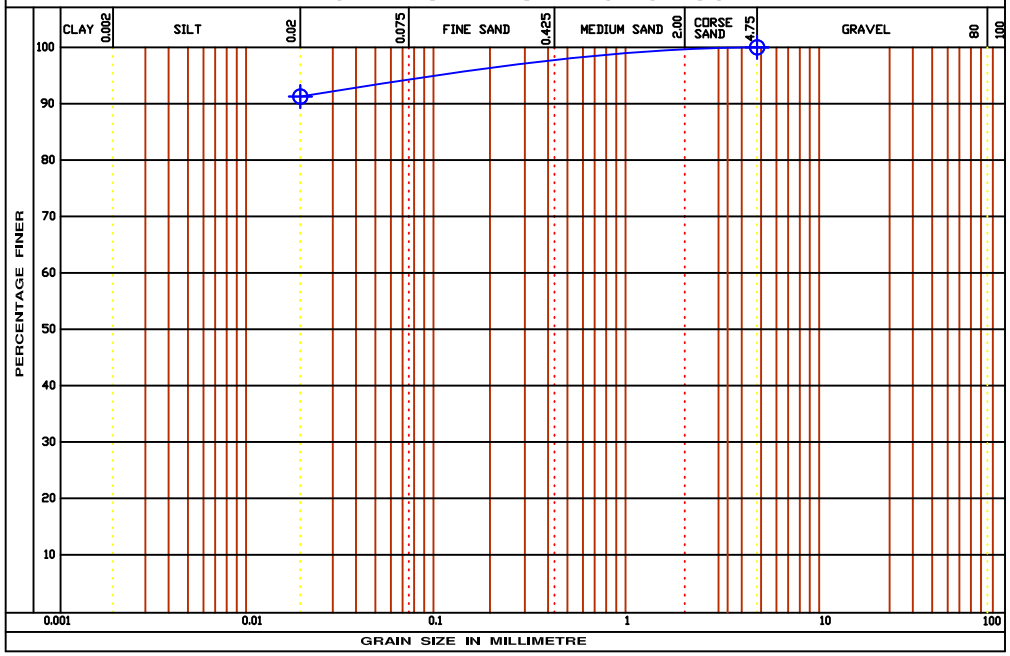
LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 26

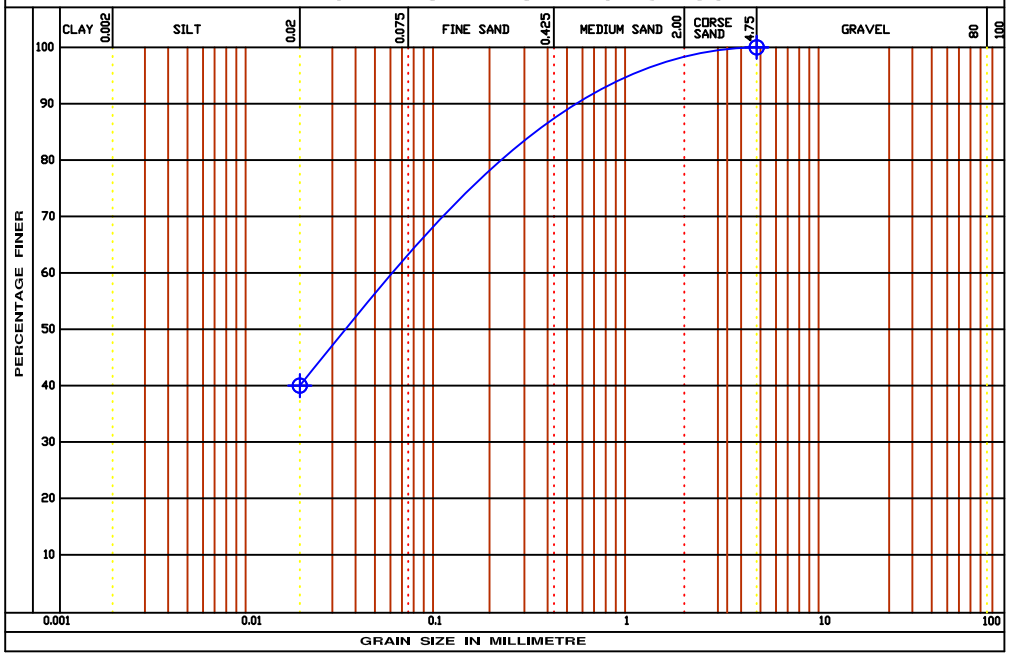
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 27

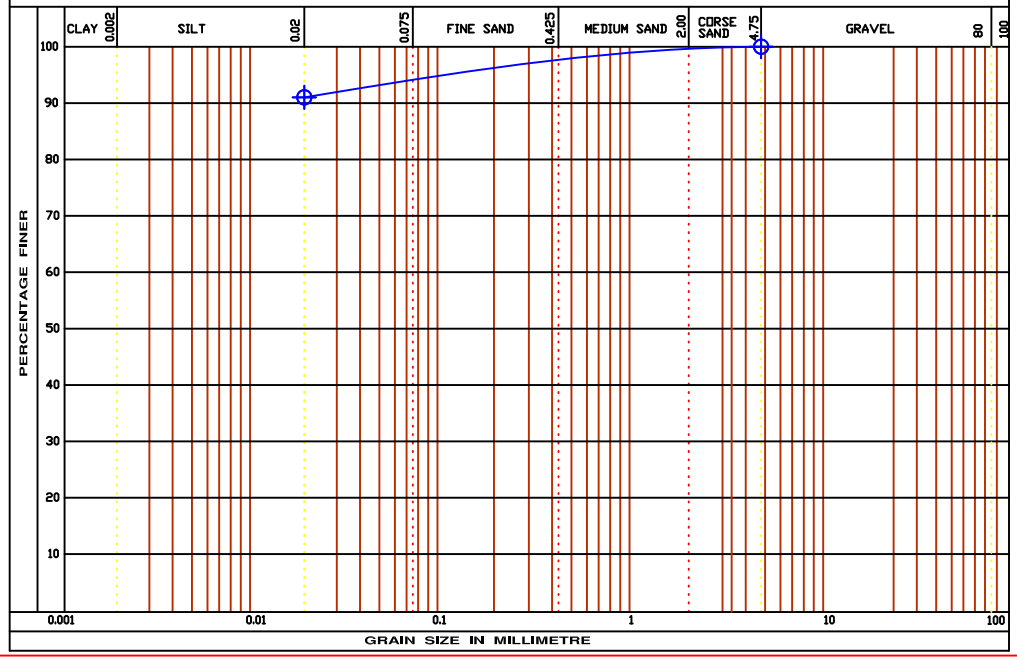
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 27

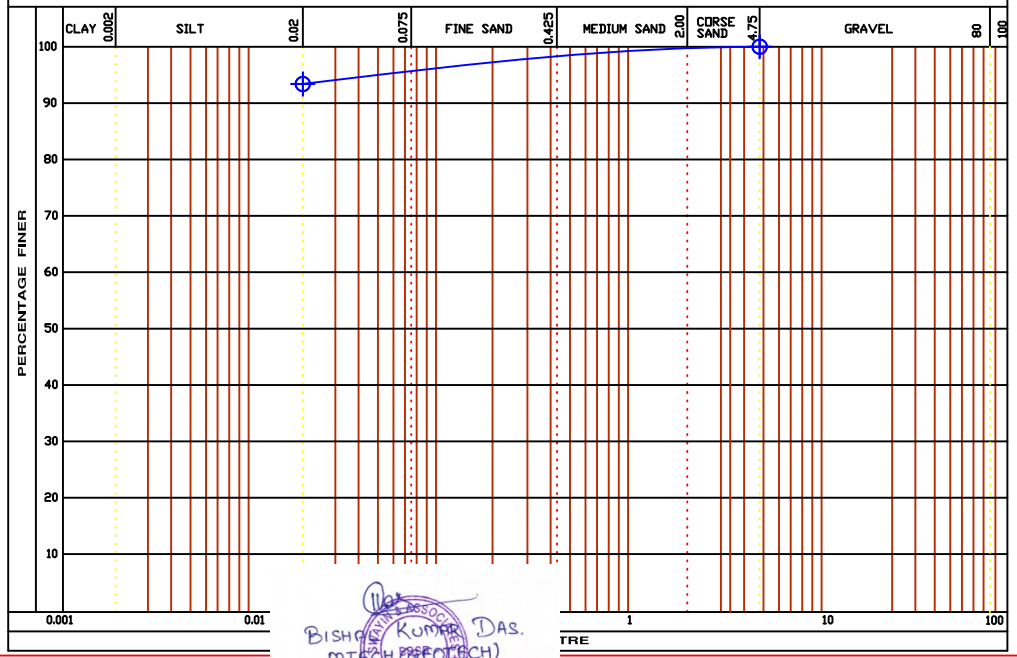
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 28

GRAIN SIZE DISTRIBUTION CURVE



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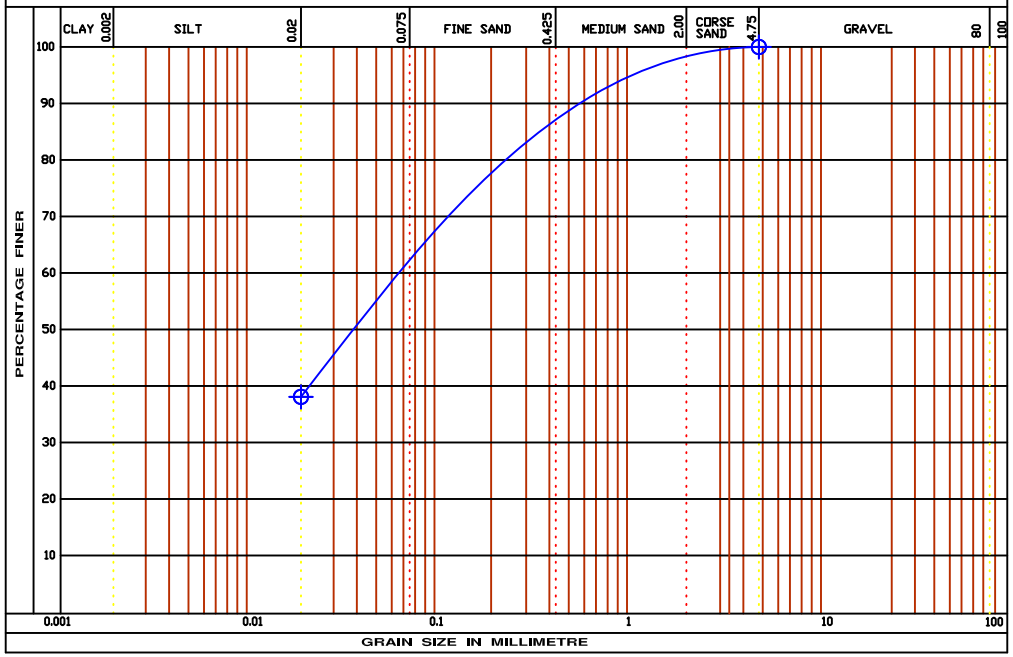
LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 29

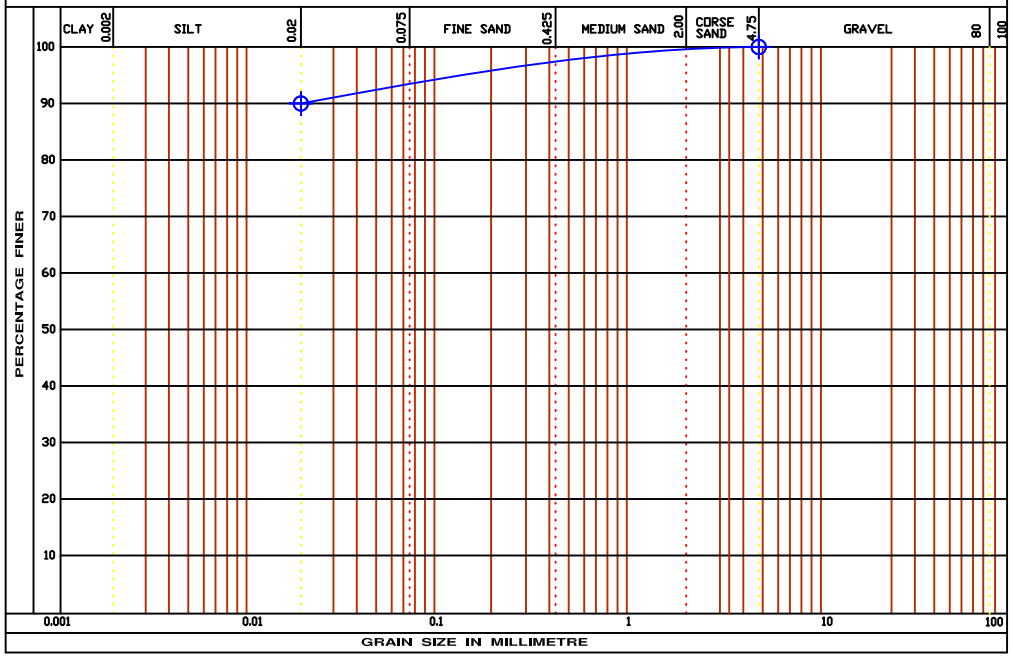
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 29

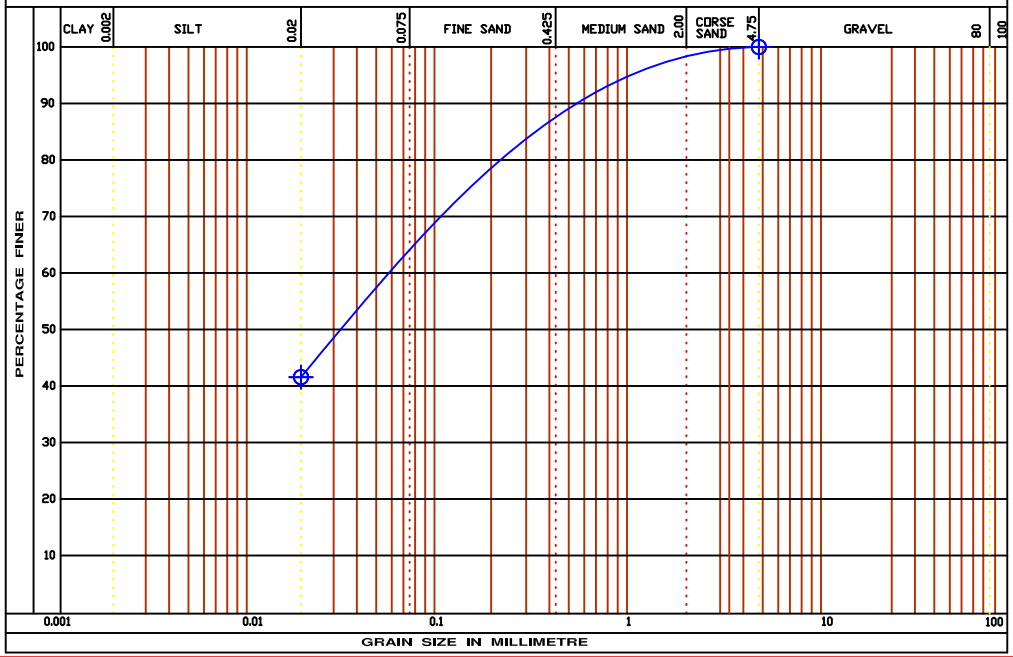
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-3.00M

B.H NO:- 30

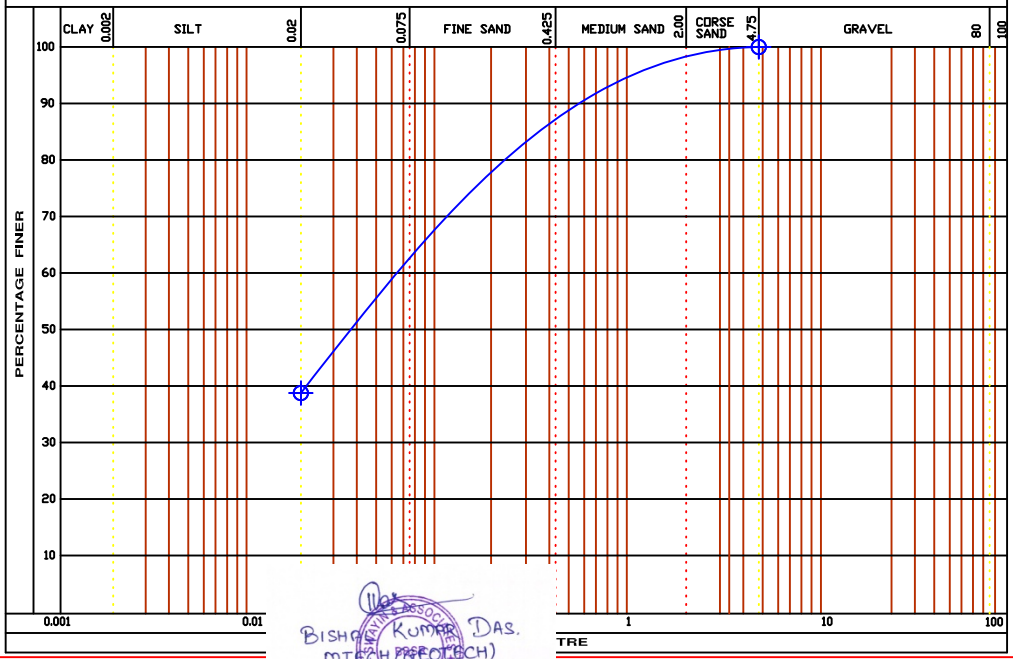
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 31

GRAIN SIZE DISTRIBUTION CURVE



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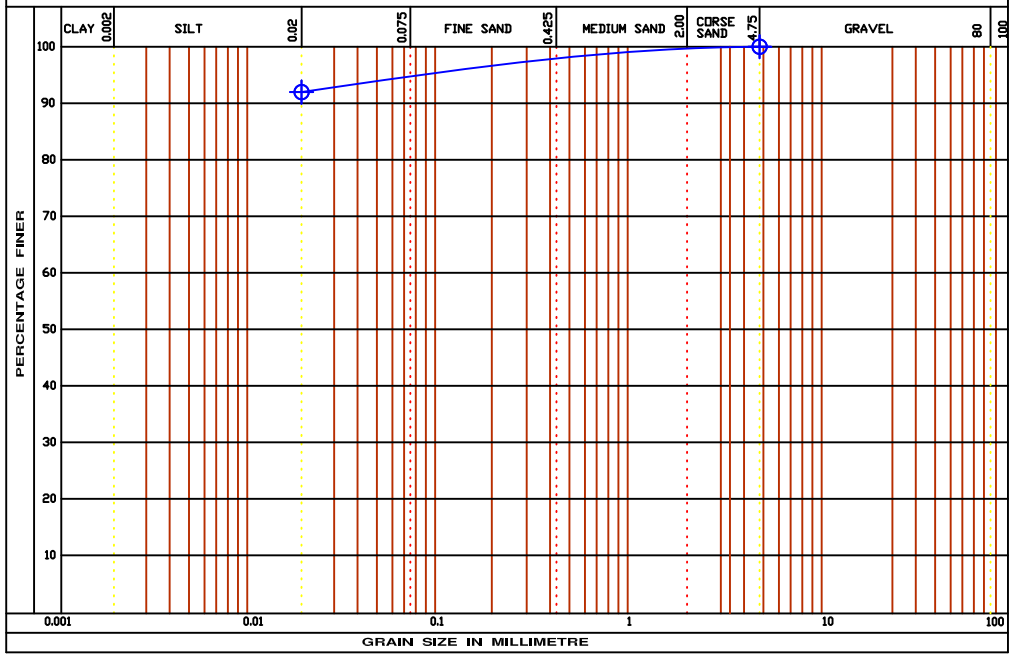
LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 31

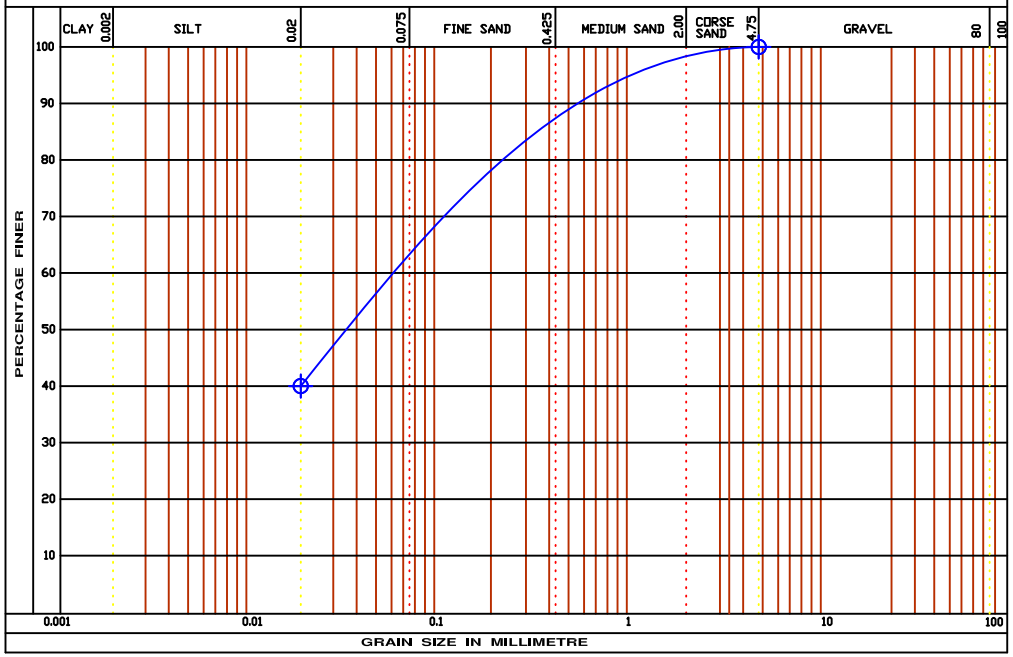
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-4.50M

B.H NO:- 32

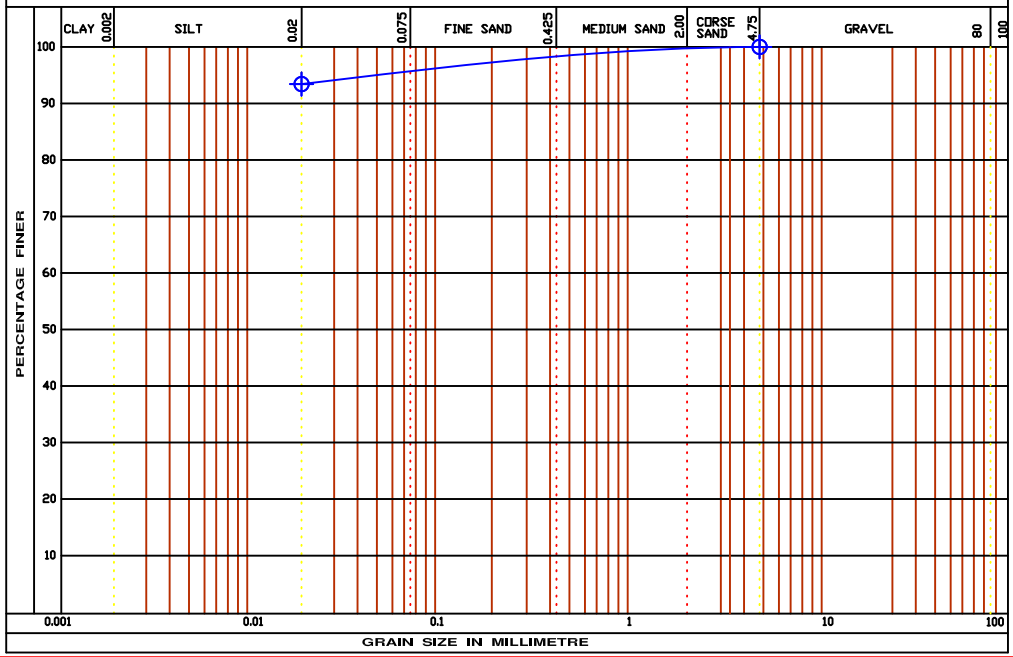
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-9.00M

B.H NO:- 32

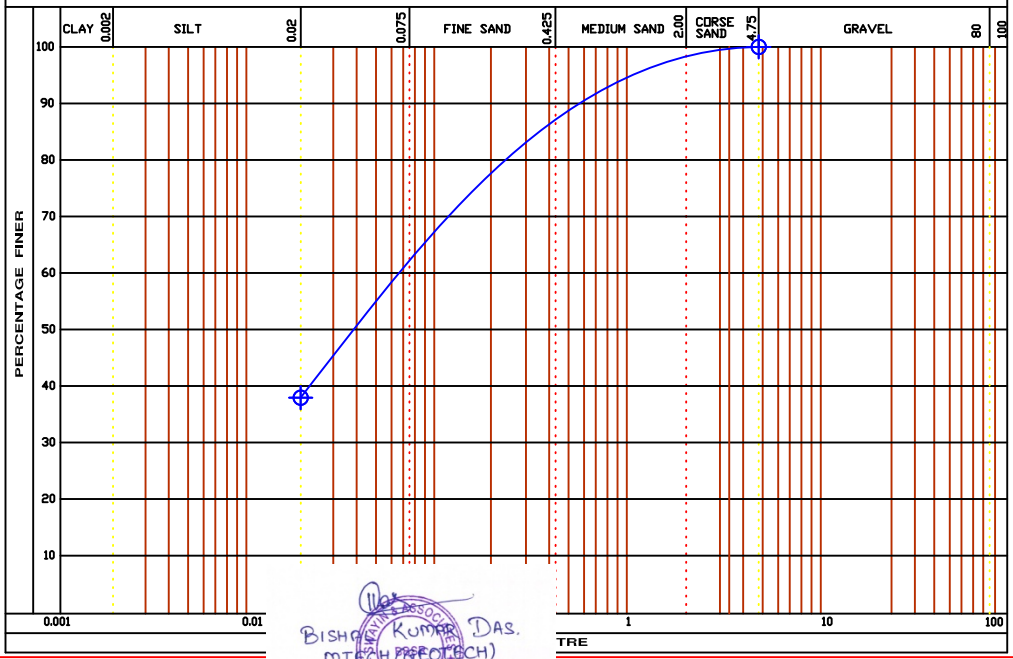
GRAIN SIZE DISTRIBUTION CURVE



LOCATION - CMD AREA
DEPTH-1.50M

B.H NO:- 33

GRAIN SIZE DISTRIBUTION CURVE



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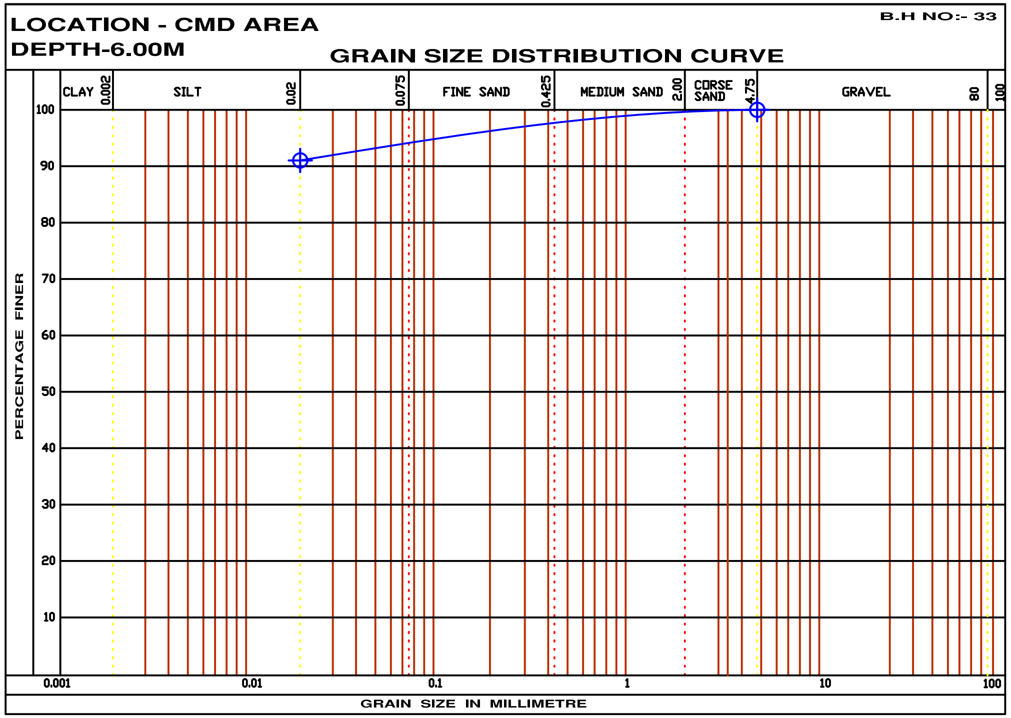
MTECH (GEOTECH)


LOCATION - CMD AREA
DEPTH-6.00M
B.H NO:- 33
GRAIN SIZE DISTRIBUTION CURVE
CLAY
0.002
SILT
0.02
0.075
FINE SAND
0.425
MEDIUM SAND
2.00
CORSE SAND
4.75
GRAVEL
80
100
PERCENTAGE FINER
100
90
80
70
60
50
40
30
20
10
0.001
0.01
0.1
1
10
100
GRAIN SIZE IN MILLIMETRE


BISHAL KUMAR DAS.
MTECH (GEOTECH)

SAFE BEARING CAPACITY

LOCATION:- CMD & CGU Area

BH No:-01 to 14 & 16 to 33

Shape of Footing:- SQUARE

Size of footing :- **3** **X** 3

Founding stratum:- CLAYEY SAND

THICKNESS OF 1st LAYER =	**3.15**	M
THICKNESS OF 2nd LAYER =	**3.36**	M
THICKNESS OF 3rd LAYER =	**4.13**	M
THICKNESS OF 4th LAYER =	**6.28**	M
THICKNESS OF 5th LAYER =	**4.63**	M
FOUNDATION DEPTH =	**3**	M
WIDTH OF FOOTING =	**3**	M

C	ϕ
1	25
5.5	5
0	32
0	35
0	35

SHEAR CRITERIA:

Based on Lab. Test results -
Considering sub - stratum as cohesive

D_f= 3 m
Cohesion (c) = 1 t/sqm
Angle of shearing Resistance (ϕ)= 25

Nc=	20.72	Nq=	10.66	Nγ=	10.88
Sc=	1.3	Sq=	1.2	Sγ=	0.8
dc=	1.199841	dq=	1.099920399	dγ=	1.09992
i_c=	1	iq=	1	iγ=	1
B=	**3**	m			
γ_{sub}=	**1.9**	t/m2			
F=	**2.5**				
W'=	**0.5**				

$$q_d = cN_cS_cd_ci_c + q(N_q-1)S_qd_qi_q + .5B\gamma' N_\gamma S_\gamma d_\gamma i_\gamma W'$$

qd = 118.638

$q_s=(1/F)q_d$ 47.46 t/m^2

where, F=Factor of safety

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Boussinesq equation	Two to One method

Using = Boussinesq equation

SETTLEMENT CRITERIA -

Settlement of 1st layer $S1=\lambda 1 \Delta_{p1} m_{v1} H1$

λ1=	**0.7**	
Δp1=	24.93845816	T/m²
m_{v1}=	**0.00095**	SQ.M/T
H1=	0.15	m
S1=	**2.487611202**	mm

Settlement of 2nd layer $S2=\lambda 2 \Delta_{p2} m_{v2} H2 I_{F2}$

λ2=	**0.7**	
Δp2=	3.170622517	T/m²
m_{v2}=	**0.0025**	SQ.M/T
H2=	3.36	m
S2=	**18.6432604**	mm

Settlement of 3rd layer $S3=\Delta_{p3} H3(1-\mu 3)/E$

E=	**3000**	T/m2
Δp3=	0.518641359	T/m²
μ3=	**0.11**	
H3=	2.49	m
S3=	**0.512365799**	mm

Settlement of 4th layer $S4=\Delta_{p4} H4(1-\mu 4)/E$

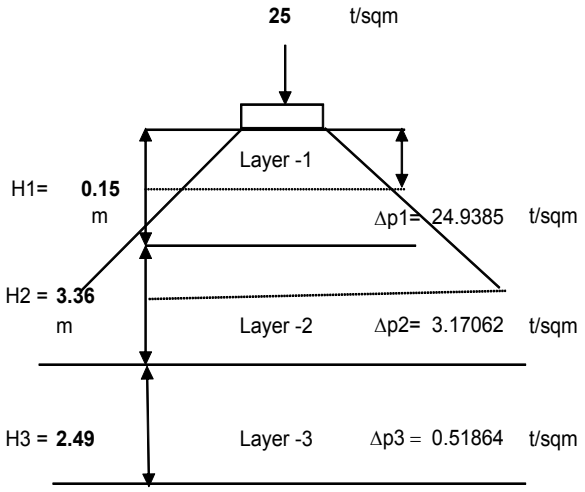
E=	**5000**	T/m2
Δp4=	0	T/m²
μ4=	**0.07**	
H4=	0	m
S4=	**0**	mm

Settlement of 5th layer $S5=\Delta_{p5} H5(1-\mu 5)/E$

E=	**8000**	T/m2
Δp5=	0	T/m²
μ5=	**0.11**	
H5=	0	m
S5=	**0**	mm

Total settlement S = S1+S2+S3+S4+S5 = 21.6432374 mm
Depth correction factor = **0.74**
Rigidity Factor = **1**
Final Settlement Sf = **16.01599568**

16.016 mm settlement is for **25** t/sqm
so, for **25** mm settlement ABP is = **39.02** t/sqm
40 mm settlement ABP is = **62.44** t/sqm
75 mm settlement ABP is = **117.07** t/sqm



3

BISHWAJIT KUMAR DAS. M.TECH (GEOTECH) SATYANAGAR

SAMPLE CALCULATION OF SAFE BEARING CAPACITY (IS-6403:1981) (FROM SHEAR PARAMETER)

BH No:-01 to 14 & 16 to 33

Zone-01

Shape of footing:-Square

Size of footing: 3 x 3m

Depth of footing: 3.00m

Founding Stratum: - Clayey sand

Average Thickness of 1st Layer:-3.15 m

Average Thickness of 2nd Layer:-3.36 m

Average Thickness of 3rd Layer:-4.13 m

Average Thickness of 4th Layer:-6.28 m

Average Thickness of 5th Layer:-4.63 m

C = Cohesion

Ø = Angle of shear Resistance

D_f = Depth of foundation

B = Width of footing

N_c, N_q, N_γ = Bearing Capacity Factor

S_c, S_q, S_γ = Shape Factor

d_c, d_q, d_γ = Depth Factor

I_c, I_q, I_γ = Inclination Factor

γ = Bulk density

W' = Correction factor for location of water table

SHEAR CRITERIA AS PER IS 6403:

BASED ON LAB TEST RESULTS :

Considering sub - stratum as cohesive

Depth of Foundation D_f	=	3.00 m	
Cohesion (c)	=	1.00 t/sqm	(from shear parameter)
Angle of Shearing Resistance (ø) =		25	(from shear parameter)

BEARING CAPACITY FACTOR

(As per IS 6403-1981 Class 5.1.2.2 page no 8)

So, Nc= 20.72 Nq= 10.66 Nγ= 10.88

SHAPE FACTOR

(As per IS 6403-1981 Table No-02 page no 8)

For Square Footing

Sc= 1.30 Sq= 1.2 Sγ= 0.80

DEPTH FACTOR

As per IS 6403-1981 page no 9)

dc = 1+0.2 x (depth of foundation/width of footing) x Tan ((PI()/180)*(45+(ø/2)))) = 1.20

dq = dγ

For 'ø' Value > 10

dq = dγ=1+0.1(Df/B) x (SQRT(Tan PI()/180+ ø x 3.14/2 x 180))

= 1.10

INCLINATION FACTOR

Ic= Iq= Iγ= 1

(γ_{bulk}) 1.90 t/sqm (As per lab test data)

Factor of Safety taken as = 2.5

W' = 0.50 Due to water table likely to rise have taken as 0.5

ULTIMATE NET BEARING CAPACITY (As Per IS 6403: clause 5.1.2

(GENERAL SHEAR FAILURE)

$q_d = cN_cS_cd_ci_c+q(N_q-1)S_qd_qi_q+0.5B\gamma'N_\gamma S_\gamma d_\gamma i_\gamma W'$

= 118.638 t/m^2.

qs=(1/F)qd

= 118.638/2.5

= 47.46 t/m^2

LOAD CARRYING CAPACITY OF PILE IN ROCK
AS PER IS 2911 (Part 1/Sec 2) : 2010

Location: CMD & Coal Gasification Unit Area
Borehole No: BH-01 to 14 & 16 to 33

Cut-off Level of Pile, L_c = 2.0 Mtr.
After Cut-off Length of Pile, L_p = 8.0 Mtr. Total Length of Pile from NGL = 10.00 Mtr.
Dia. of Pile, B = 0.45 Mtr.
Length of Socket, L = 2.82 Mtr. i.e from weathered rock
Safe load carrying of pile, in tones

$$Q_a = C_{u1} \cdot N_c \cdot (\pi.B^2/4.F_s) + \alpha.C_{u2} \cdot (\pi.B.L/F_s)$$ - As per B-8 of Annex-B of IS 2911 (Part 1/Sec 2)

C_{u1} = Shear strength of rock below the base of the pile
C_{u2} = Average shear strength of rock along socketed length of Pile
L = Length of Socket in 'm'
Q_a = Allowable capacity of Pile
N_c = 9
α = 0.9
} - As per B-8 of Annex-B of IS 2911 (Part 1/Sec 2)

C_{u1} = 12.00 MPa = 1176.80 KN/m2
C_{u2} = 15.69 MPa = 1538.66 KN/m2
} - Please refer Fig.3 of IS 2911 (Part 1/Sec 2)

F_s = Factor of Safety taken as 3 - As per B-8 of Annex-B of IS 2911 (Part 1/Sec 2)

Details of Layer I to IV as per IS 2911 (Part 1/Sec 2) :

Layer No.	Thickness of Stratum (m)	Cohesion (t/m^2)	Angle of friction (Ø°)	Density (γ)	Alpha (α)	K_i	P_{Di}	A_{si} (m^2)	Q_s
1 (NGL to 3.15m)	3.15	0.10	23	1.90	0	1	2.99	4.45	5.66 T
2 (3.15m to 6.51m)	3.36	5.20	2	1.79	0.7	0	8.99	4.75	0.00 T
3 (6.51m to 10.00m)	3.49	0.00	35	2.00	0	1	15.49	4.93	53.51 T
	0.00	0.00	0	0.00	0	0	18.98	0.00	0.00 T
	0.00	0.00	0	0.00	0	0	18.98	0.00	0.00 T
								Skin Friction Resistance, Q_s =	59.17 T

Note: * Since the Cut-Off length of Pile has been considered as 4.00m, the thickness of stratum has been considered accordingly.
* For Cohesiveless Soils, $Qs = K_i.P_{Di}.\tan\delta.A_{si}$ - As per Appendix-A of IS 2911 (Part 1/Sec 2)
* For Cohesive Soils, $Qs = \alpha.C.A_{si}$ - As per Appendix-B of IS 2911 (Part 1/Sec 2)

Allowable End Bearing Component = $C_{u1} \cdot N_c \cdot (\pi.B^2/4.F_s)$
= 561.48 KN

Allowable Shear Component = $\alpha.C_{u2} \cdot (\pi.B.L/F_s)$
= 1840.25 KN

Allowable Capacity of Pile, Q_a in Compr. = 301.74 T

Ultimate Uplift Load Carring capacity = (Shear Comp.+ Skin Friction + Weight of Pile) - As per clause no.6.3.2 of IS 2911 (Part 1/Sec 2)

Allowable Uplift Load Carring capacity = 100.76 T - (Unit wt. of pile as 15KN/m^3)

Allowable Load Carrying capacity in Lateral =
Modulus of Sub Grade Reaction = 10.00 MN/m^3 - From Table-3 of IS 2911 (Part 1/Sec 2)

Length of pile above GL L_1 = 0.00 m
Grade of concrete f_{ck} = 35.00 N/mm^2

Modulus of Elasticity of Concrete, E = 5000√fck
= 29580 N/mm^2
= 29580 MN/m^2
Moment of Inertia of Pile, I = $\pi D^4 / 64$
= 0.0020 m^4
Pile Stiffness, T = $(EI / \eta h)^{1/5}$ - From Clause C-2.3.2 of IS 2911 (Part 1/Sec 2)
= 1.562 m
L_1 / T = 0.00 m
L_f / T = 2.20 - From Fig 4 - IS 2911 (Part 1/Sec 2)
Length of Fixity L_f = 343.66 cm

Y = $Q(L_1+L_f)^3/12EI$ - (For Fixed Head) as per IS 2911 (Part 1/Sec 2)
Y = 0.50 cm = 0.005 m
L_1 = 0.00 cm = 0.00 m
L_f = 343.66 cm = 3.437 m
0.005 = $Q(0+6.110)^3/(12*29580*0.0201)$
Q = 0.08802 MN

Allowable Load Carrying capacity in Lateral = 8.80 T

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SITE PHOTO GRAPHS

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MTECH (GEOTECH)
SWAYIN & ASSOCIATES
T7, SATYANAGAR

Talcher Fertilizers	**PROJECT: DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER, ODISHA, INDIA.**	

CLIENT: TALCHER FERTILIZERS LIMITED. **CONTRACTOR: WUHUAN ENGINEERING CO., LTD.** **SUB - CONTRACTOR: SWAYIN & ASSOCIATES**	**JOB No: TLD/2020-03**

BISHAL KUMAR DAS.
MTECH (GEOTECH)

CLIENT : TALCHER FERTILIZERS LIMITED

CONTRACTOR : WUHUAN ENGINEERING CO., LTD.

GEOTECHNICAL INVESTIGATION REPORT OF PROPOSED ASU & CSU AREA UNIT IN TALCHER, ANUGUL

PROJECT : DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER

BISHNU KUMAR DAS.
M.TECH (GEOTECH)
SWAYIN & ASSOCIATES
77, SATYANAGAR

AUGUST-2020 (R-02)

Investigated & Prepared By:
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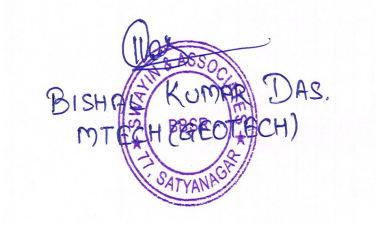
Email: kbs@swayinassociates.com / sns@swayinassociates.com
Website: www.swayinassociates.com

Name of Project	**DETAILED SOIL INVESTIGATION WORKS, SURVEY WORKS OF COAL GASIFICATION & AMMONIA UREA PLANT, TALCHER**
LOI No. & Date	**WUHUAN/SWAYIN/SOIL/TFL/2020 Dtd. 03/01/2020**
Job No.	**TLD/2020-03**
Client	**Talcher Fertilizers Limited**
Contractor	**Wuhuan Engineering Co., Ltd.**
Investigated & Prepared by	**Swayin & Associates** **77, Satya Nagar, Bhuabaneswar-751007**
Technical Consultant	**Shri. K.B Swayin** **(F.I.E)** **Shri. S.N Swayin** **(F.I.E)**
Technical Assistant	**Mr. Bishal Kumar Das** **M.Tech (Geo-Tech)**
Reports Prepared By	**Mr. Bibhu Ranjan Baliarsingh** **Diploma (Civil)**
Date of Commencement (Field Work)	**- 23.02.2020**
Date of Completion (Field Work)	**- 23.03.2020**
Date of Commencement (Laboratory)	**- 28.02.2020**
Date of Completion (Laboratory)	**- 30.03.2020**



Report Submitted by
Swayin & Associates

Report Submitted to
Wuhuan Engineering Co., Ltd.

PREFACE

We have the pleasure to collaborate ourselves with**Wuhuan Engineering Co., Ltd.**for rendering our services insoilinvestigation work of ProposedASU Area in M/s TFL, Talcher, Odisha.Our sincere thanks to the esteemed officials ofWuhuanEng (India), M/s TFL, M/s PDILincludingGM, DGM, SM, PMand Site-Engineer for their endeavour and collective interest in providing adequate support for execution of above work. We will be proud enough to associate ourselves for this kind of civil engineering activities with Wuhuan Engineering Co., Ltd. in future days.

SWAYIN & ASSOCIATES

TABLE OF CONTENT

INTRODUCTION

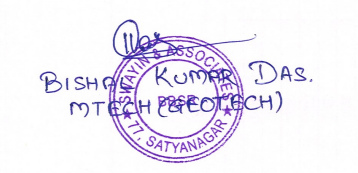
M/s Swayin & Associates has awarded to conduct the Soil Investigation Works, Survey works of coal gasification & ammonia urea plant, Talcher, Odisha, India for M/s Talcher Fertilizers Limited for the proposed construction structures, Industrial plant, Building, Boundary wall etc. located at Talcher in Odisha. This report provides the results of the geotechnical investigation conducted at ASU & CSU area Location of Talcher for TFL.

The geotechnical Investigation was completed and provides accurate detailed data of soil conditions of Proposed Area at Talcher under Talcher Fertilizers limited.

Through correspondence with the WUHUAN ENGINEERING CO.,LTD. The investigation was intended to assist in determining the most appropriate method for the development of construction structures, Industrial plant, Building, Boundary wall etc.

The work was completed in accordance with the proposal as per LOI No: WUHUAN/SWAYIN/SOIL/TFL/2020: DTD.03.01.2020.

This report has been prepared specifically and solely for the project described herein. It contains the Geotechnical Investigation and provides the observations and Recommendations for the proposed ASU & CSU area at Talcher, Odisha under M/s Talcher Fertilizers limited.



1. GENERAL INFORMATION ABOUT THE FIELD INVESTIGATION, INCLUDING EQUIPMENTS, METHODS, PERSONNEL, COMMENTS:

a) General Data:

Name of Owner: M/s Talcher Fertilizers Limited.

Name of Contractor: Wuhan Engineering Co., ltd.

Name of Sub-Contractor: M/s Swayin& Associates.

Name of Project: Detailed soil Investigation Works, Survey works of coal gasification & ammonia urea plant, Talcher, Odisha, India.

LOI No: WUHUAN/SWAYIN/SOIL/TFL/2020: DTD.03.01.2020

Description of Work: To execute/ providing services for soil investigation & allied works at TFL's Coal gasification, Ammonia & Urea unit for Solid ASU & CSU unit area in Talcher.

LIST OF EQUIPMENTS / PERSONNEL

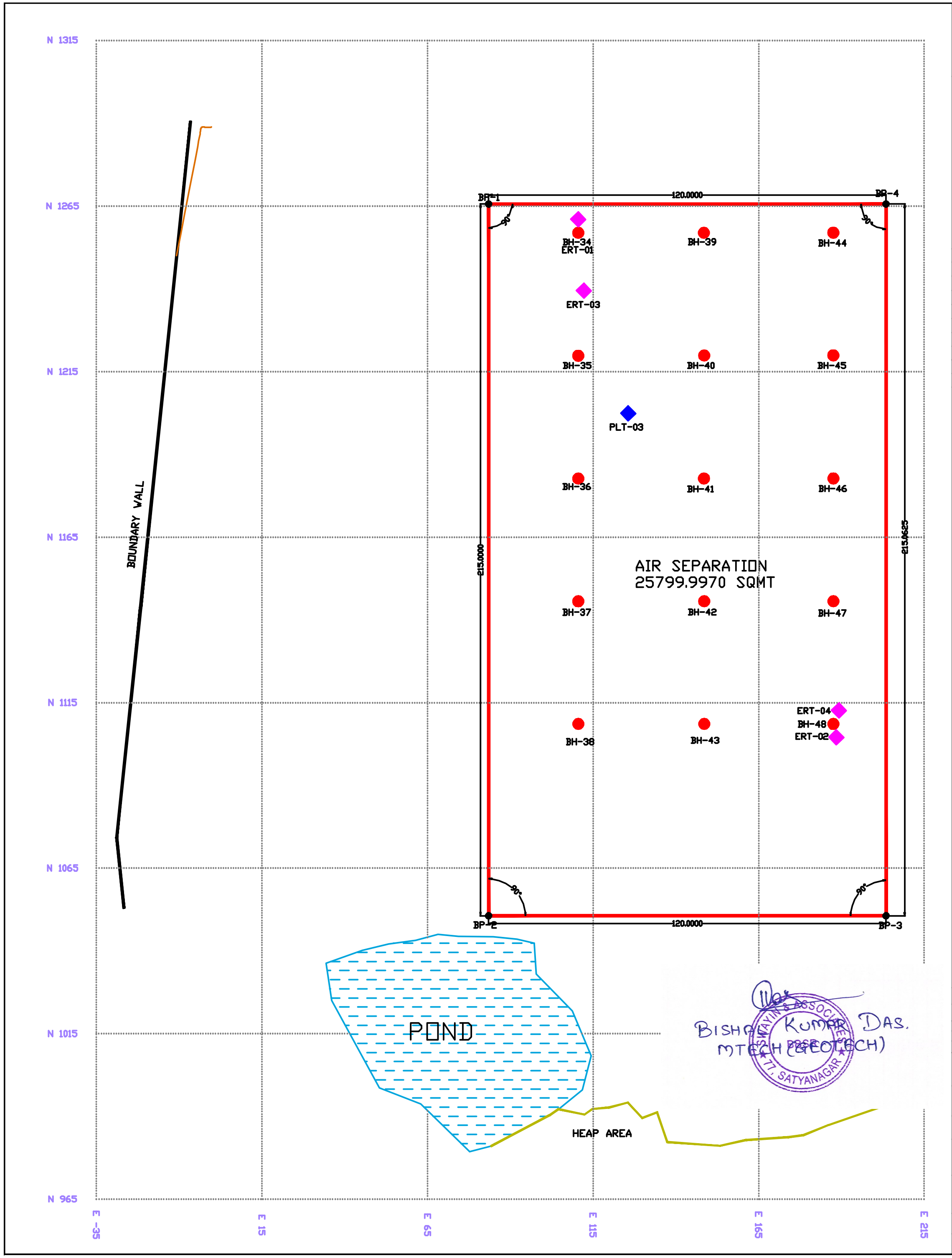
List of Equipments:

S No.	Name of the Equipments	Quantity
1.	8 HP Engine (Kirloskar)	03 no's
2.	8 HP Engine (Mahaveer)	01 no
3.	Tractor-Mounted Boring Rig	01 no
4.	Core Barrel (0.5, 1.0, 1.5mtr) NX-size Double tube	Each 05 no's
5.	Casing 4" dia.	15 no's
6.	Drilling Rod	200mtr
7.	Split Spoon Sampler	05 no's& extra 3 no's Available at site.
8.	UDS Tube	As per required
9.	UDS Lifter	05 no's
10.	Core Box	As per required
11.	SPT Hammer (63.5 kg)	05 no's
12.	Diamond Bit (NX Size)	As required
13.	TC Bit (NX Size)	As required
14.	Guide Rod	05 no's
15.	Water Pump	05 no's
16.	Hose pipe with football	05 no's
17.	Delivery pipe	05 set's
18.	Chhuri	08 no's
19.	Tool Kits	05 no's

List of Responsible Person for the Project:

S No.	Name of Personnel	Designation
1.	Shri.SambhunathSwayin	Managing Partner
2.	Mr.DharmaTeja Annam	Technical Manager
3.	Mr.Sukant Swain	Project Manager
4.	Mr.BibhuRanjanBaliarsingh	Asst. Technical Manager
5.	Mr.Deepak Kumar Sahoo	Civil Engineer
6.	Mr.SashankarDhali	Site Engineer
7.	Mr.BiswajitSahoo	Site Engineer
8.	Mr.BhabhenHalder	Site Engineer
9.	Mr.Sudev Pal	Surveyor
10.	Mr.Rajesh Das	Asst. Surveyor
11.	Duryodhan Pradhan	Site Supervisor
12.	Vijay Kumar	Site Supervisor
13.	Mr.Bijay Kumar Behera	Lab. Technician
14.	Mr.Sudhir Kumar Rout	Lab. Technician
15.	Ms.ManjulataNayak	Draftsman
16.	Mrs.Lija Rani Sethy	

BISHAL KUMAR DAS. MTECH (GEOTECH)



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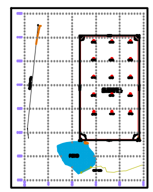
KEYPLAN:



NTS

LEGENDS:-

GRID LINE	
PROPOSED BOUNDARY	
BOUNDARY POINT	
BORE HOLE	
PLT	
ERT	
BOUNDARY WALL	
POND/WATER LOGGED AREA	
HEAP AREA	

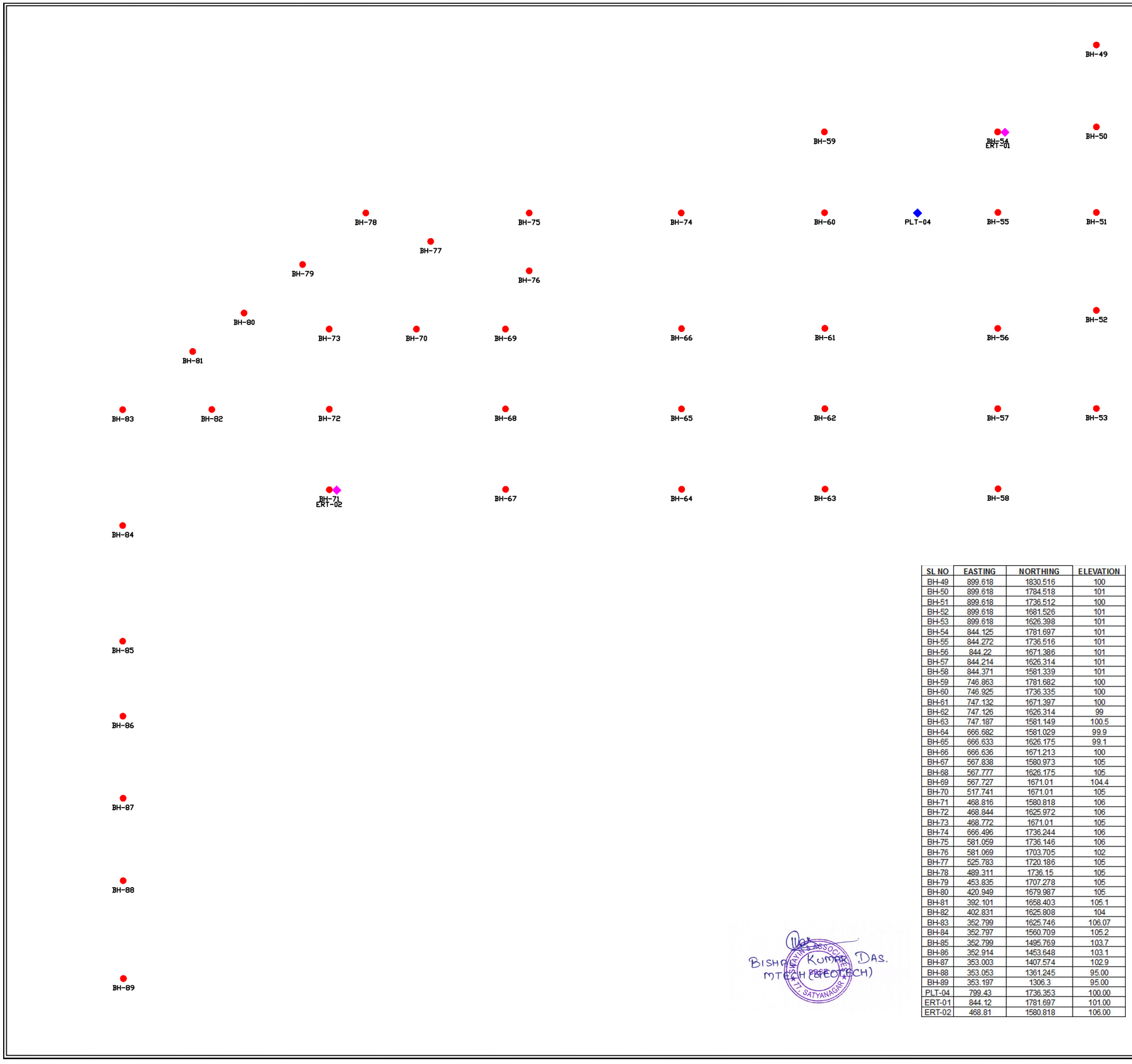
AIR SEPARATION : 25799.9970 Sqmt. 6.375 Acres

SL No.	BH No.	UTM Coordinates		RL (mtr.)
		Easting	Northing	
1	BH-34	110.5	1256.9	94.912
2	BH-35	110.5	1219.97	94. 540
3	BH-36	110.5	1182.65	94.9
4	BH-37	110.5	1145.57	95.12
5	BH-38	110.5	1108.52	94.45
6	BH-39	148.49	1256.9	95.001
7	BH-40	148.53	1219.83	95.08
8	BH-41	148.5	1182.68	95.1
9	BH-42	148.55	1145.6	94.98
10	BH-43	148.57	1108.52	94.988
11	BH-44	187.55	1256.97	94.89
12	BH-45	187.55	1219.97	95.111
13	BH-46	187.57	1182.7	94.341
14	BH-47	187.58	1145. 58	95.1
15	BH-48	187.56	1108.51	95.003
16	PLT-03	125.87	1202.44	94.682
17	ERT-01	110.54	1256.9	94.912
18	ERT-02	187.56	1108.51	95
19	ERT-03	112.02	1234.85	95.026
20	ERT-04	190.23	1112.352	94.896

NOTES:-

1. All the dimensions are in Meter unless other wise mentioned.
2. Spot Levels and Grids are Marked at distance of 50.0mX50.0m.

CLIENT	TALCHER FERTILIZERS LIMITED.
TITLE	LOCATION PLAN
LOCATION	ASU Area
PROJECT	SOIL INVESTIGATION AND TOPOGRAPHICAL SURVEY WORKS FOR CONSTRUCTION WORKS OF COAL GASIFICATION PLANT, TALCHER
SURVEYED & PREPARED BY	SWAYIN & ASSOCIATES
SCALE	DRAWING. NO.
	B/SA/TFL/LOCATION PLAN DWG.



SL NO	EASTING	NORTHING	ELEVATION
BH-49	899.618	1830.516	100
BH-50	899.618	1784.518	101
BH-51	899.618	1736.512	100
BH-52	899.618	1681.526	101
BH-53	899.618	1626.398	101
BH-54	844.125	1781.697	101
BH-55	844.272	1736.516	101
BH-56	844.22	1671.386	101
BH-57	844.214	1626.314	101
BH-58	844.371	1581.339	101
BH-59	746.863	1781.682	100
BH-60	746.925	1736.335	100
BH-61	747.132	1671.397	100
BH-62	747.126	1626.314	99
BH-63	747.187	1581.149	100.5
BH-64	666.682	1581.029	99.9
BH-65	666.633	1626.175	99.1
BH-66	666.636	1671.213	100
BH-67	567.838	1580.973	105
BH-68	567.777	1626.175	105
BH-69	567.727	1671.01	104.4
BH-70	517.741	1671.01	105
BH-71	468.816	1580.818	106
BH-72	468.844	1625.972	106
BH-73	468.772	1671.01	105
BH-74	666.496	1736.244	106
BH-75	581.059	1736.146	106
BH-76	581.069	1703.705	102
BH-77	525.783	1720.186	105
BH-78	489.311	1736.15	105
BH-79	453.835	1707.278	105
BH-80	420.949	1679.987	105
BH-81	392.101	1658.403	105.1
BH-82	402.831	1625.808	104
BH-83	352.799	1625.746	106.07
BH-84	352.797	1560.709	105.2
BH-85	352.799	1495.769	103.7
BH-86	352.914	1453.648	103.1
BH-87	353.003	1407.574	102.9
BH-88	353.053	1361.245	95.00
BH-89	353.197	1306.3	95.00
PLT-04	799.43	1736.353	100.00
ERT-01	844.12	1781.697	101.00
ERT-02	468.81	1580.818	106.00

BISHWAJIT KUMAR DAS.
M.TECH (GEOTECH)
SWAYIN & ASSOCIATES
77, SATYANAGAR, BHUBANESWAR

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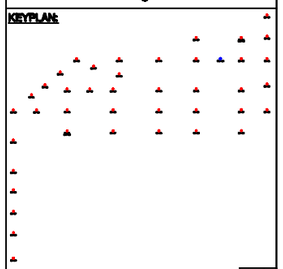
KEYPLAN:



NTS

LEGENDS:-

BORE HOLE	●
PLT	◆
ERT	

NOTES:-
1. All the dimensions are in Meter unless other wise mentioned.

12.04.2020	Abhay		FINAL SUBMISSION
DATE	INITIAL	SIGN	SUBJECT OF REVISION
	SURVEYED BY		
SUDHIR	TEJA		SMS
INITIAL SIGN	INITIAL	SIGN	INITIAL SIGN
DRAWN BY	CHECKED BY		APPROVED BY

CLIENT	TALCHER FERTILIZERS LIMITED.
TITLE	LOCATION PLAN
LOCATION	CSU Area
PROJECT	SOIL INVESTIGATION AND TOPOGRAPHICAL SURVEY WORKS FOR CONSTRUCTION WORKS OF COAL GASIFICATION PLANT, TALCHER
SURVEYED & PREPARED BY	SWAYIN & ASSOCIATES 77,SATYANAGAR, PH:[illegible]
SCALE	DRAWING. NO. / REV
1:1000	SWATFL/LOCATION PLAN DWG. / 0

LOCATION DETAILS

SL No.	Location	Type of BH	BH No.	DOS	DOC	Depth of BH (mtr.)	UTM Coordinates		RL (mtr.)	GWT (mtr.)
							Easting	Northing		
1.	ASU Area	B	BH-34	25.02.20	27.02.20	17.18	110.50	1256.90	94.912	0.00
2.		D	BH-35	28.02.20	29.02.20	12.85	110.50	1219.97	94. 540	1.02
3.		D	BH-36	28.02.20	29.02.20	12.69	110.50	1182.65	94.900	0.90
4.		B	BH-37	29.02.20	02.03.20	17.45	110.50	1145.57	95.120	1.00
5.		D	BH-38	02.03.20	03.03.20	12.95	110.50	1108.52	94.450	0.00
6.		D	BH-39	24.02.20	26.02.20	13.80	148.49	1256.90	95.001	1.45
7.		D	BH-40	23.02.20	26.02.20	13.50	148.53	1219.83	95.080	0.80
8.		B	BH-41	29.02.20	02.03.20	17.70	148.50	1182.68	95.100	1.00
9.		D	BH-42	26.02.20	27.02.20	13.25	148.55	1145.60	94.980	1.30
10.		D	BH-43	02.03.20	03.03.20	13.15	148.57	1108.52	94.988	0.00
11.		D	BH-44	25.02.20	26.02.20	14.40	187.55	1256.97	94.890	0.00
12.		B	BH-45	02.03.20	03.03.20	17.97	187.55	1219.97	95.111	1.10
13.		D	BH-46	02.03.20	03.03.20	13.40	187.57	1182.70	94.341	0.00
14.		D	BH-47	01.03.20	02.03.20	12.08	187.58	1145. 58	95.100	0.85
15.		B	BH-48	26.02.20	28.02.20	15.90	187.56	1108.51	95.003	0.00
16.		-	PLT-03	15.05.20	16.05.20	1.80	125.87	1202.44	94.682	1.00
17.		-	ERT-01	16.03.20	16.03.20	-	110.54	1256.900	94.912	-
18.		-	ERT-02	16.03.20	16.03.20	-	187.560	1108.510	95.000	-
19.		-	ERT-03	13.05.20	13.05.20	-	112.020	1234.85	95.026	-
20.		-	ERT-04	13.05.20	13.05.20	-	190.23	1112.352	94.896	-

BISHWA KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES LTD. SATYANAGAR

21	Coal Storage Unit	B	BH-49	19.03.20	20.03.20	22.80	899.618	1830.516	100.000	2.95
22		D	BH-50	19.03.20	20.03.20	17.50	899.618	1784.518	101.000	2.95
23		D	BH-51	20.03.20	21.03.20	20.49	899.618	1736.512	100.000	3.95
24		D	BH-52	21.03.20	23.03.20	18.54	899.618	1681.526	101.000	3.95
25		B	BH-53	11.03.20	12.03.20	21.10	899.618	1626.398	101.000	2.65
26		D	BH-54	21.03.20	23.03.20	18.31	844.125	1781.697	101.000	4.20
27		B	BH-55	21.03.20	23.03.20	24.08	844.272	1736.516	101.000	3.10
28		D	BH-56	05.03.20	06.03.20	23.00	844.220	1671.386	101.000	2.10
29		D	BH-57	07.03.20	08.03.20	21.10	844.214	1626.314	101.000	2.80
30		B	BH-58	06.03.20	08.03.20	20.05	844.371	1581.339	101.000	2.70
31		B	BH-59	20.03.20	21.03.20	24.27	746.863	1781.682	100.000	0.00
32		D	BH-60	06.03.20	08.03.20	19.40	746.925	1736.335	100.000	1.70
33		D	BH-61	05.03.20	06.03.20	18.00	747.132	1671.397	100.000	0.25
34		D	BH-62	11.03.20	12.03.20	16.50	747.126	1626.314	99.000	1.65
35		D	BH-63	05.03.20	06.03.20	18.00	747.187	1581.149	100.500	0.30
36		D	BH-64	05.03.20	07.03.20	18.00	666.682	1581.029	99.900	1.20
37		D	BH-65	04.03.20	05.03.20	18.65	666.633	1626.175	99.100	0.50
38		B	BH-66	07.03.20	08.03.20	19.25	666.636	1671.213	100.000	2.00
39		B	BH-67	12.03.20	14.03.20	21.00	567.838	1580.973	105.000	7.15
40		D	BH-68	12.03.20	14.03.20	17.35	567.777	1626.175	105.000	7.00
41		D	BH-69	13.03.20	14.03.20	17.09	567.727	1671.010	104.400	6.00
42		D	BH-70	14.03.20	15.03.20	18.45	517.741	1671.010	105.000	6.00
43		D	BH-71	16.03.20	17.03.20	23.09	468.816	1580.818	106.000	3.95
44		D	BH-72	14.03.20	15.03.20	17.95	468.844	1625.972	106.000	7.30
45		B	BH-73	15.03.20	16.03.20	23.09	468.772	1671.010	105.000	3.90
46		D	BH-74	06.03.20	07.03.20	18.98	666.496	1736.244	106.000	5.10
47		D	BH-75	13.03.20	14.03.20	17.95	581.059	1736.146	106.000	6.20
48		B	BH-76	11.03.20	12.03.20	21.45	581.069	1703.705	102.000	6.15
49		D	BH-77	13.03.20	14.03.20	18.09	525.7		000	6.50

BISHWA KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES 77, SATYANAGAR

50	Coal Storage Unit	D	BH-78	08.03.20	09.03.20	20.81	489.311	1736.150	105.000	3.60
51		D	BH-79	08.03.20	09.03.20	22.09	453.835	1707.278	105.000	4.25
52		D	BH-80	08.03.20	09.03.20	21.10	420.949	1679.987	105.000	5.84
53		D	BH-81	17.03.20	18.03.20	19.85	392.101	1658.403	105.100	4.16
54		D	BH-82	16.03.20	17.03.20	18.30	402.831	1625.808	104.000	4.20
55		D	BH-83	17.03.20	19.03.20	18.77	352.799	1625.746	106.070	3.45
56		D	BH-84	17.03.20	18.03.20	18.90	352.797	1560.709	105.200	3.89
57		B	BH-85	17.03.20	18.03.20	19.10	352.799	1495.769	103.700	2.60
58		D	BH-86	18.03.20	19.03.20	18.19	352.914	1453.648	103.100	3.50
59		D	BH-87	18.03.20	19.03.20	18.55	353.003	1407.574	102.900	2.80
60		D	BH-88	18.03.20	19.03.20	18.50	353.053	1361.245	95.000	1.50
61		B	BH-89	18.03.20	19.03.20	24.08	353.197	1306.300	95.000	1.70
62		-	PLT-04	14.05.20	14.05.20	1.80	799.43	1736.353	100.000	2.35
63		-	ERT-01	16.03.20	16.03.20	-	844.12	1781.697	101.000	-
64		-	ERT-02	16.03.20	16.03.20	-	468.81	1580.818	106.000	-

* RL – Reduced Level, which also refers Natural Ground Level (NGL) of particular position?

*GWT–Ground Water Table.

* DOS – Date of Start.

* DOC – Date of Completion.

Geological Information:

Talcher also named as City of Black Diamond or Coal City of Odisha is one of the fastest growing industrial and coal hubs in the state. Because of its huge coal reserves, the city has been ranked among the highest in terms of GDP in Odisha. It is also one of the 4 sub-divisions of Angul district in the Indian state of Odisha. Situated on the right bank of the river Brahmani, it is one of the fastest growing industrial and mining complexes of the country. The city is surrounded by the coalfields under MCL (Mahanadi Coalfields Limited) and has three Mega Power plants like NTPC, TTPS. Jindal power plant (FCIL), set up **Talcher** Unit over an area of 902 acre in the district of Angul, **Odisha** which is located about 126 km away from **Bhubaneswar** to produce urea using coal as feed stock. ... 1980 with Ammonia and Urea production capacity of 900 and 1500 Tons per day respectively.The “Talcher Fertilizers Limited” (TFL), a consortium of four state-run companies GAIL, CIL, RCF and FCIL was established in December 2014 to revive the Talcher unit. Joint Venture Company was incorporated on 27.10.2015 with contributing equity of GAIL, CIL and RCF being 29.67% each while FCIL retaining 10.99% equity. Projects & Development India Limited (PDIL) is the PMC for the project.

History:

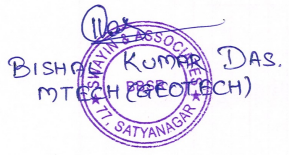
A legend states that Talcher was founded in the 12th century by one of four brothers belonging to the Kachwaha Rajput dynasty of Jaipur who were on a pilgrimage to Puri; during the same journey another brother became the ruler of Bonai State and two others were killed.At the time of the British Raj Talcher was one among the 26 feudatory states of Odisha.The state's accession to the Indian Union was signed by its last ruler Hrudaya Chandra Dev Birabar on 1 January 1948.

Population Density:

As of 2011 India census, Talcher had a population of 40,841 . Males constitute 55% of the population and females 45%. Talcher has an average literacy rate of 75%, higher than the national average of 59.5%: male literacy is 80%, and female literacy is 62%. In Talcher, 12% of the population is under 6 years of age.

Climate:

The Talcherlies on 92m above sea level Talcher's climate is classified as tropical. The summers are much rainier than the winters in Talcher. According to Köppen and Geiger, this climate is classified as Aw. The average annual temperature is 27.0 °C | 80.7 °F in Talcher. About 1307 mm | 51.5 inch of precipitation falls annually.



	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	20.9	23.4	27.9	31.8	33.5	31.4	28.4	28.2	28.5	26.9	23.3	20.3
Min. Temperature (°C)	14	16.4	20.6	24.9	27	26.6	25.4	25.3	25.2	22.8	17.6	13.6
Max. Temperature (°C)	27.8	30.5	35.2	38.8	40	36.3	31.4	31.2	31.8	31.1	29	27.1
Avg. Temperature (°F)	69.6	74.1	82.2	89.2	92.3	88.5	83.1	82.8	83.3	80.4	73.9	68.5
Min. Temperature (°F)	57.2	61.5	69.1	76.8	80.6	79.9	77.7	77.5	77.4	73.0	63.7	56.5
Max. Temperature (°F)	82.0	86.9	95.4	101.8	104.0	97.3	88.5	88.2	89.2	88.0	84.2	80.8
Precipitation / Rainfall (mm)	10	31	32	33	50	195	293	327	224	90	19	3

Potential geology Hazards

The Project site dose not posses any type of Potential geological hazards.

Site Surface Description:

- According to the Topography of site location (ASU & Coal Storage unit) the terrain was observed to be Sub-undulated to flat terrain.
- Due to the recent rain fall, the site location posses some patches of water logging with the depth of water 30cm around.

Description of above ground Obstructions:

- Since the above ground surface was leveled, there is no presence of above ground obstacles except some patches of water logging due to difference in ground levels.

b) Subsurface Conditions:

- As per the scope and contract conditions 56 no's of Boreholes were executed in this ASU & Coal Storage unit and corresponding RL (in mtr) were recorded and tabulated in location details and log sheets.
- Center to Center distance between proposed BH positions was around 20-25m and since the BH'S were executed at closely spaced, there is no difference in soil strata inside boreholes.

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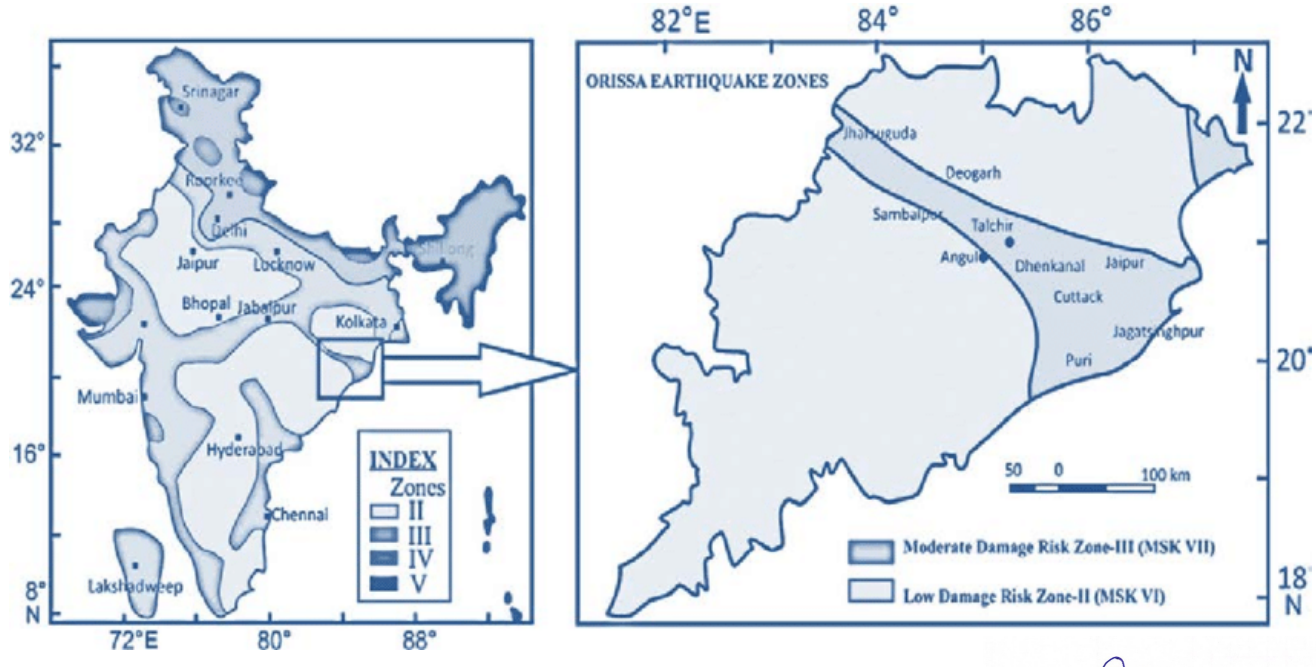
- The top surface layer consists of clayey sand which is dense to very dense in condition upto an average depth of 3.00m. Mostly the ground water table was encountered in the top surface layer.
- Underlain the top layer, there is a presence of compact clay with 'N' value greater than 100. The condition of soil strata is very hard upto an average depth of 6.50m followed by weathered Rock, Sandstone & Clay stone & DI rock.
- Difference in soil strata w.r. to ground levels and water table has been represented in a profile manner (please refer sub-soil profile)

Analysis & Discussion of Chemical Nature:

- Ground water quality is accessed on the basis of water samples collected from site. As per analysis of Ground water from the test results sulphate content is less than 400 mg/l and chloride content is less than 500 mg/l, hence the ground water may be used for construction purpose.
- The chemical analysis test result reveals that the sub-soil/ground water is not aggressive against chemical attack on sub-structures. Hence, no special precautions/remedial measures are required for underground reinforced concrete structure, steel or any other building material.

Seismic Hazard:

- As per seismic hazard map of India (refer figure below), the project site (Talcher, Odisha) lies in Moderate Damage Risk Zone-III.
- As per IS:1893 the type of soil encountered in project site is Type-I (Rock or Hard Soil Strata) as per Figure-2.



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SCOPE OF WORK

The Geo-Technical Investigation consists of advancement of 56 boreholes at proposed Solid Material storage and Transportation unit area. The boreholes were drilled upto required depths as per contract requirement and based on the level of the founding in which the foundations for the proposed structures & sub-structures, leading to their economical and safe design.

The Scope of work for the Field Investigation was as follows:

1. Advancement of 56 boreholes at the specified locations as per the tender terms & conditions.
2. Record the soil conditions encountered in the boreholes.
3. Conducting Standard Penetration test (SPT) &disturbed (DS) soil samples from boreholes.
4. Conducting other allied activities of Soil Investigation as per tender requirement.
5. Conducting laboratory test on collected soil samples as per Bill of Quantities proposed.
6. Analysis of Field and laboratory tests data and provide geotechnical characterization of the soils encountered.
7. Preparation & Submission of the Geotechnical Investigation report, with appropriate descriptions of the existing Soil encountered in the boreholes advanced for the investigation and provide recommendations with respect to the implications for construction of Buildings and Structures etc., in Solid Material storage and Transportation unit area.

EXPLORATION TECHNIQUE

i. Soil exploration was conducted with 150mm dia. boreholes. The bore were done with Rotary calyx technique as per IS 1892-1962. The top of the borehole is taken from the actual bed level at the time of boring. Standard Penetration tests were conducted at every required interval using Standard split spoon sampler driven by a 63.5 kg hammer with free fall height of 750 mm as per IS 2131-1963. The results are recorded and represented graphically in logs of boreholes. Disturbed sample was collected in plastic bags for visual inspection and classification of strata from all the layers as recorded in log sheets of boreholes.

ii. Collection representative undisturbed/disturbed soil samples from the exploratory boreholes for carrying out detailed laboratory analysis, which would help finalization of design soil parameters and foundation type.

iii. Carrying out standard penetration tests as per the provisions laid down in IS:2131-1981 in the holes and subsequently maintaining penetration chart depth-wise upto the test depth in each of the 1 nos. Exploratory bore holes at locations.

BORING METHOD

Boreholes were dug in ASU & CSU Areas are as per direction of Engineer-in-charge.
The boreholes of 150mm dia. in soil & rocky strata upto the desired depth are indicating in borelog data sheet.
The boring was done by using Rotary calyx core drilling 04 no's & Tractor mount 01 no.
The drilling was stopped on reaching the specified depth within the layer.

CORE DRILLING (as per IS 6926:1996)

Core drilling was done where the formation encountered is too hard to be sampled by any soil sampling methods. The switching over from soil sampling method to core drilling should be normally done in accordance with the guidelines given in IS-2131:1981 and IS-2132:1986. However, the final decision should be taken by the geologist and engineer-in-charge of the site.
Casing was seated on bedrock or in a firm formation to prevent travelling of the borehole and to prevent loss of drilling fluid. Surface of the rock or hard formation at the bottom of the casing, was leveled, when necessary, using the appropriate bits. The core drilling may be carried out by an NX-size double-

tube swivel-type core barrel approved by the engineer-in-charge. Core drilling was continued until core blockage occurs or until the net length of the core barrel has been drilled in.

The recovered core was placed in the core box with the upper (surface) end of the core. at the upper-left corner of the core box. The cores with proper markings is placed into core boxes at appropriate spacing's, with blocks. Soft or friable cores, or those which change materially upon drying, was wrapped in plastic film or seal in wax, or both as required by the engineer. Spacer blocks or slug properly marked are used to indicate any noticeable gap in recovered cores which might indicate a change or void in the formation. The fractured, bedded and/or jointed pieces of the core should be reassembled in the sequential order of their recovery before keeping the same in the core box.

Core drilling was stopped when soft materials are encountered that produce less than 50 percent recovery. If necessary, samples of soft materials were taken as per IS-2131:1981 and IS-2132:1986 in consultation with geologist or engineer-in-charge. Diamond core drilling was resumed when hard formation is again encountered.

Sub-surface structures, including the dip of strata, the occurrence of seams, fissures, cavities and broken areas are among the most important items to be detected and described. Special care was taken to obtain and record information about these features. The core samples was properly logged into the cores boxes as per IS 1892:1979.

FIELD TEST

1. Standard Penetration Tests (as per IS.2131)

These tests were conducted by using split spoon sampler, which consists of a driving shoe, a split-barrel of circular cross-section which is longitudinally split into two parts and a coupling. IS: 2131-1981 gives the standard for carrying out the test.

Procedure:

1. The borehole is advanced to the required depth and the bottom cleaned.
2. The split-spoon sampler, attached to standard drill rods of required length is lowered into the borehole and rested at the bottom
3. The split-spoon sampler is driven into the soil for a distance of 750mm by blows of a drop hammer (monkey) of 63.5 kg falling vertically and freely from a height of 750 mm. The number of blows required to penetrate every 150 mm is recorded while driving the sampler. The number of blows required for the last 300 mm of penetration is added together and recorded as the N value at that particular depth of the borehole. The number of blows required to effect the first 150mm of penetration, called the seating drive, is disregarded.
4. The split-spoon sampler is then withdrawn and is detached from the drill rods. The split-barrel is disconnected from the cutting shoe and the coupling. The soil sample collected inside the split barrel is carefully collected so as to preserve the natural moisture content and transported to the laboratory for tests. Sometimes, a thin liner is inserted within the split-barrel so that at the end of the SPT, the liner containing the soil sample is sealed with molten wax at both its ends before it is taken away to the laboratory.5. The SPT is carried out at every 0.75 m vertical intervals in a borehole. This can be increased to 1.50 m if the depth of borehole is large. Due to the presence of boulders or rocks, it may not be possible to drive the sampler to a distance of 450 mm. In such a case, the N value can be recorded for the first 300 mm penetration. The boring log shows refusal and the test is halted if
   a) 50 blows are required for any 150mm penetration b) 100 blows are required for 300m penetration
   c) 10 successive blows produce no advance.

2. Disturbed Samples

Representative disturbed sample obtained from boring at every 1.5m interval in depth or change in stratum shall be placed in suitable sampling covers labeled properly for onward transmission to the laboratory. This sample shall be sent to the laboratory immediately after the boring is completed. All SPT samples shall also be similarly preserved.

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3. Plate Load Test Procedure (AS PER IS 1888-1982)

Two no's of Electrical Resistivity test were conducted in the field at CMD Area to determine the resistance to flow of an electric current through the sub surface material at interval of ground surface.

4.0 Electrical Resistivity Test (IS: 3043, 1966)

One no of Electrical Resistivity test was conducted in the field at CMD Area by Electrical resistivity method to determine the resistance to flow of an electric current through the sub surface material at interval of ground surface.

LABORATORY TESTING TECHNIQUE (AS PER IS)

The soil samples collected from the boreholes were tested in the laboratory and the field tests conducted at the site. The following tests were conducted.

a. Moisture content (IS - 2720 Pt. II)

Natural Moisture contents were obtained by oven drying method and the results are tabulated in Annexure-A.

b. Bulk and dry density

The bulk and dry density with saturated and buoyant density of samples are tabulated.

c. Grain Size Distribution (IS - 2720 Pt. IV)

Both sieve size analysis and hydrometer analysis were conducted on different samples and the findings are tabulated. Grain size classification scale confirms Indian Bureau of Standards (IS:1498).

d. Specific Gravity (IS-2720 Pt.III-2)

Specific gravity values were obtained by pycnometer method/Density Bottle method and the results are tabulated.

e. Atterberg's Limits (IS - 2720 Pt. V)

The consistency limits are the water contents at which the soil mass passes from one state to another. The soil mass interaction has four states of consistency limits. The Atterberg's limits useful for engineering purposes are Liquid Limit &Plastic Limit, which are tabulated along with other index properties.

f. Direct Shear Tests - IS 2720 (Part XIII)

These tests were done on identical sandy samples by shear box apparatus which was an undrained test. Shearing force was applied by increasing the successive load until the failure takes place. The plane of shear failure was determined & the graph is attached.

g. Tri-axial Shear Test (IS - 2720 Pt.XI)

This test was done by triaxial apparatus on all undisturbed &remolded soil samples of cylindrical shape, subjected to direct stress acting in three mutually perpendicular direction viz. Major principal stress in vertical direction and minor principal stress failure is determined. This test gives more accurate & precise result of C & Φ due to uniform stress distribution of fluid from the empirical formula
($\sigma 1 = \sigma 3 \tan^2 \Phi + 2c \tan \Phi$).

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h. Void Ratio (IS-2386 Pt.III-1963)

The percentage of voids shall be calculated as follows:

Percentage of voids = (V_v/V_s)

where, V_v = Volume of Void Space ; V_s =Volume of Solids.

i. Unconfined Compression Tests (IS-2720 Pt.-X)

This was generally performed on selected cohesive soil depends on shear characteristic of the soil which can be determined from the unconfined compression test result. Effective stress parameters (C & Φ) were determined from the failure envelope.

j. Permeability Test (IS-2720 Pt.-17)

This test is to determine the permeability (hydraulic conductivity) of a sandy soil by the constant head test method.

Permeability (or hydraulic conductivity) refers to the ease with which water can flow through a soil. This property is necessary for the calculation of seepage through earth dams or under- sheet pile walls, the calculation of the seepage rate from waste storage facilities (landfills, ponds, etc.), and the calculation of the rate of settlement of clayey soil deposits.

k. Water content of Rock (IS-13030-1991)

Water contents of rock test were obtained in our laboratory by oven drying method and the results are tabulated.

l. Density of Rock (IS-13030-1991

The density test of rock was obtained in our laboratory and the results are tabulated.

m. Porosity of Rock (IS-13030-1991

The Porosity test of rock was obtained in our laboratory and the results are tabulated.

n. Permeability of Rock (IS-5229-1-1985

The Permeability test of rock was obtained in our laboratory and the results are tabulated.

o. UCS Test of Rock (IS-9143-1-1979

The Unconfined Compressive Strength test of rock was obtained in our laboratory and the results are tabulated.

p. Mohr's Scale of hardness Test of Rock (IS-13630-13-2006

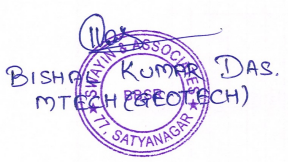
The Mohr's Scale of hardness test of rock was obtained in our laboratory and the results are tabulated.

q. Shear Strength Test of Rock (IS-1121-IV-1974

The Shear Strength test of rock was obtained in our laboratory and the results are tabulated.

r. Mineralogical & Petro logical Test of Rock (IS-2386-8-1963

The Mineralogical & Petro logical Test rock was obtained in our laboratory and the results are tabulated.



CHEMICAL ANALYSIS OF WATER

a. pH Tests- IS 3025 (Pt.-11)

The pH value of water was determined as per IS code 3025 Part-11 and results are tabulated.

b. Chloride Tests- IS 3025 (Pt.-32)

The chloride content was tested in our laboratory as per IS code 3025 Part-32 and results are tabulated.

c. Sulphate Tests- IS 3025 (Pt.-24)

The sulphate content was tested in our laboratory as per IS code 3025 Part-24 and results are tabulated.

d. Carbonate Tests- IS 3025 (Pt.-51)

The Carbonate content was tested in our laboratory as per IS code 3025 Part-51 and results are tabulated.

e. Magnesium Test-IS 3025 (Pt.-46)

The Magnesium content was tested in our laboratory as per IS code 3025 Part-46 and results are tabulated.

f. Ammonium Test-IS 3025 (Pt.-34)

The Ammonium content was tested in our laboratory as per IS code 3025 Part-34 and results are tabulated.

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DESIGN PARAMETERS

- Since the project site is having uniform Sub-Soil stratification, for ASU area boreholes grouped into two zones viz., Zone-01 (BH-34 to BH-42 & BH-45 to BH-48) & Zone-02 (BH-43 to BH-44) for CSU unit area bore holes has been grouped to four zones viz., Zone-01 (BH-49 to 58, 67, ,68, 70, 71, 74,75, & 77), Zone-02 (BH-63), Zone-03 (BH-78 to 79 & Zone-04 (BH-59 to 66, 69, 72, 73, 76, 80 to 89). Based on borelogs, Field &Laboratory Test results, the following Design Soil Profile has been used for the analysis of Open Foundation and Pile Foundations:

ASU AREA

Zone-01 (BH-34 to BH-42 & BH-45 to BH-48)

Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	Density Y_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Clayey Sand	NGL to 1.72	46	1.72	0.12	24	31	1.82
2	Compact Clay	1.72 to 3.56	73 to >100	1.84	0.53	6	42	1.77
3	Sandstone	3.56 to 5.57	>100	2.01	Completely to Highly Weathered – Sedimentary Rock			
H	Weathered Rock (Claystone	5.57 to 16.00	>100	10.43	Completely to Highly Weathered – Sedimentary Rock			

* Table 1.1

Zone-02 (BH-43 to BH-44)

Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	Density Y_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Clayey Sand	NGL to 2.57	42	2.57	0.12	24	32	1.90
2	Compact Clay	2.57 to 4.25	>100	1.68	0.53	5	41	1.77
3	Sandstone	4.25 to 6.00	>100	1.75	Completely Weathered – Sedimentary Rock			
4	Weathered Rock (Claystone	6.00 to 13.78	>100	7.78	Completely to Highly Weathered – Sedimentary Rock			

* Table 1.2

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CSU AREA

Zone-01 (BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77

Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	DensityY_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Moorum	NGL to 2.48	71	2.48	0.00	35	-	2.00
2	Clayey Sand	2.48 to 11.65	87	9.17	0.11	23	32	1.869
3	DI Rock	11.65 to 19.88	>100	8.22	Completely Weathered – Sedimentary Rock			

* Table 1.3

Zone-02 (BH-63)

Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	DensityY_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Field up Ash	NGL to 2.50	27	2.50	-	-	-	-
3	Clayey Sand	2.50 to 14.00	95 to >100	11.50	0.13	20	30	1.88
4	DI Rock	14.00 to 18.00	>100	4.00	Completely Weathered– Sedimentary Rock			

* Table 1.4

Zone-03 (BH-78 to 79)

Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	DensityY_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Clayey Sand	NGL to 1.00	-	1.00	-	-	-	-
2	Moorum	1.00 to 3.00	53 to 85	2.00	0	34	-	-
3	Clayey Sand	3.00 to 8.50	85 to >100	5.50	0.11	23	32	-
4	DI Rock	8.50 to 21.45	>100	12.95	Completely Weathered– Sedimentary Rock			

* Table 1.5

Zone-04 (BH-59 to BH-62, 64 to 66,69, 72, 73, 76, 80 to 89)

Layer No.	Stratum Description	Depth in (m)	Average 'N' Value	Thickness of Stratum (m)	Shear Parameters		Liquid Limit	DensityY_b (gm/cc)
					C (kg/cm^2)	Ø (°)		
1	Clayey Sand	NGL to 10.99	71 to >100	10.99	0.11	23	32	1.875
2	DI Rock	10.99 to 19.48	>100	8.49	Completely Weathered– Sedimentary Rock			

* Table 1.6

Note:
Rock classification is based on RQD % of rock.

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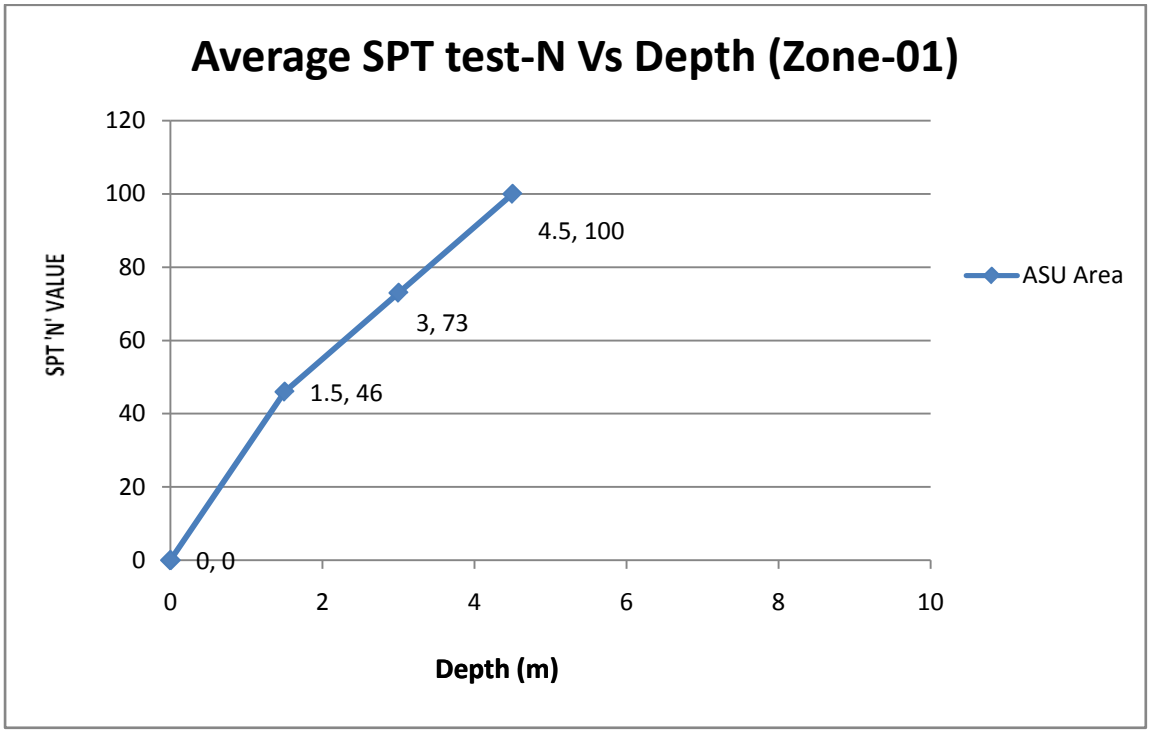

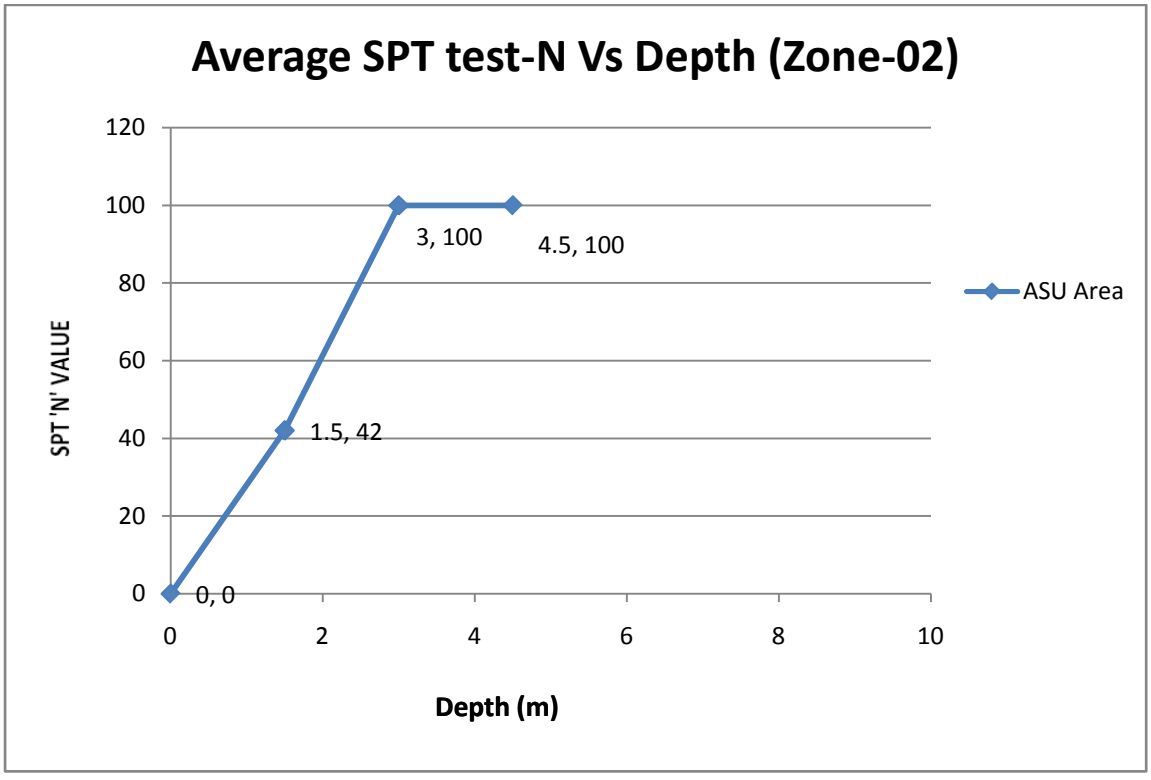

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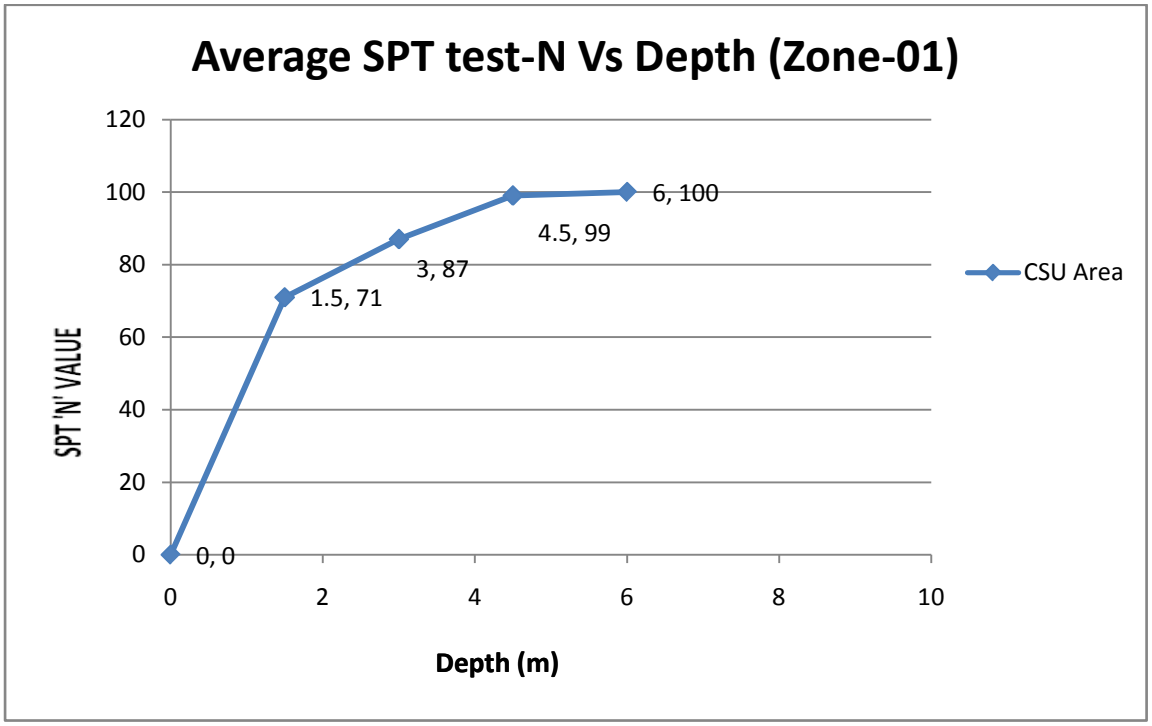
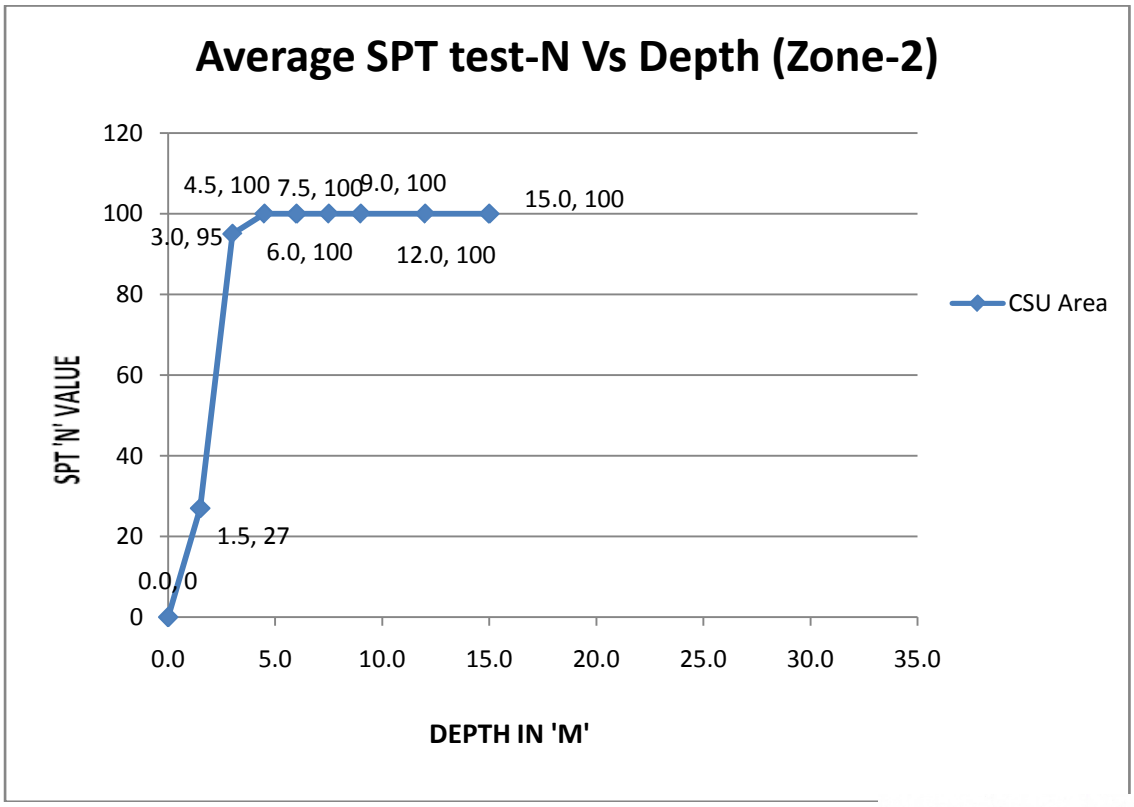
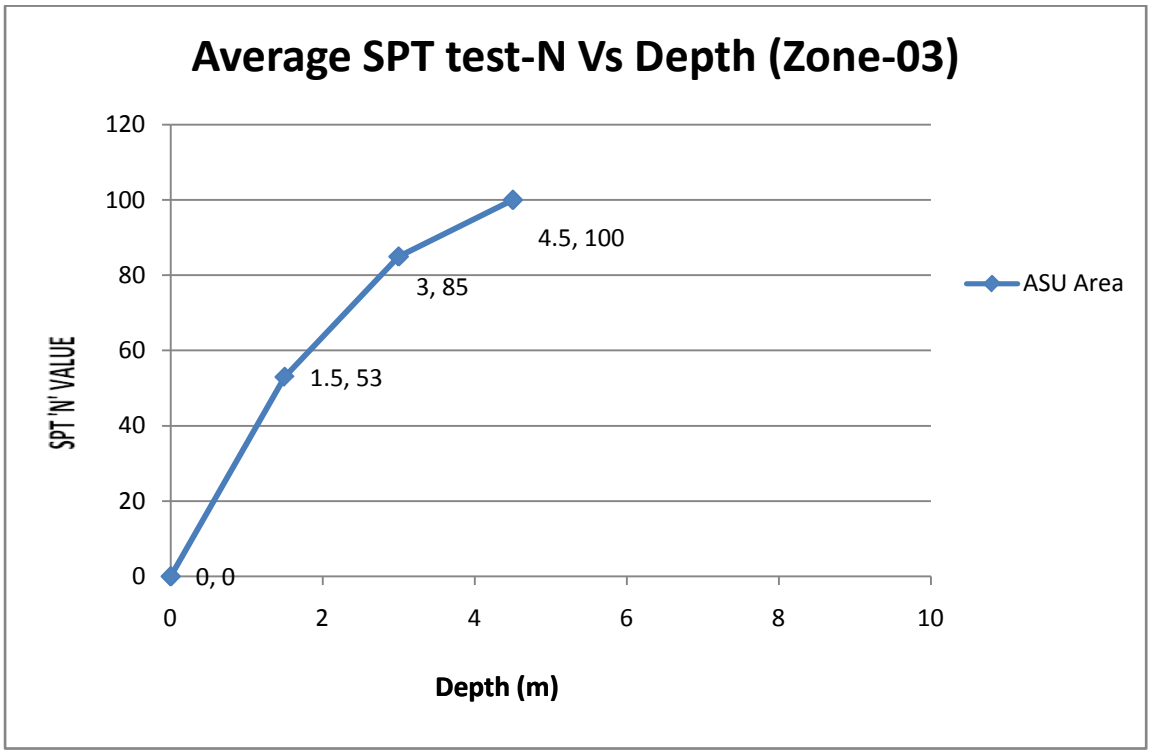
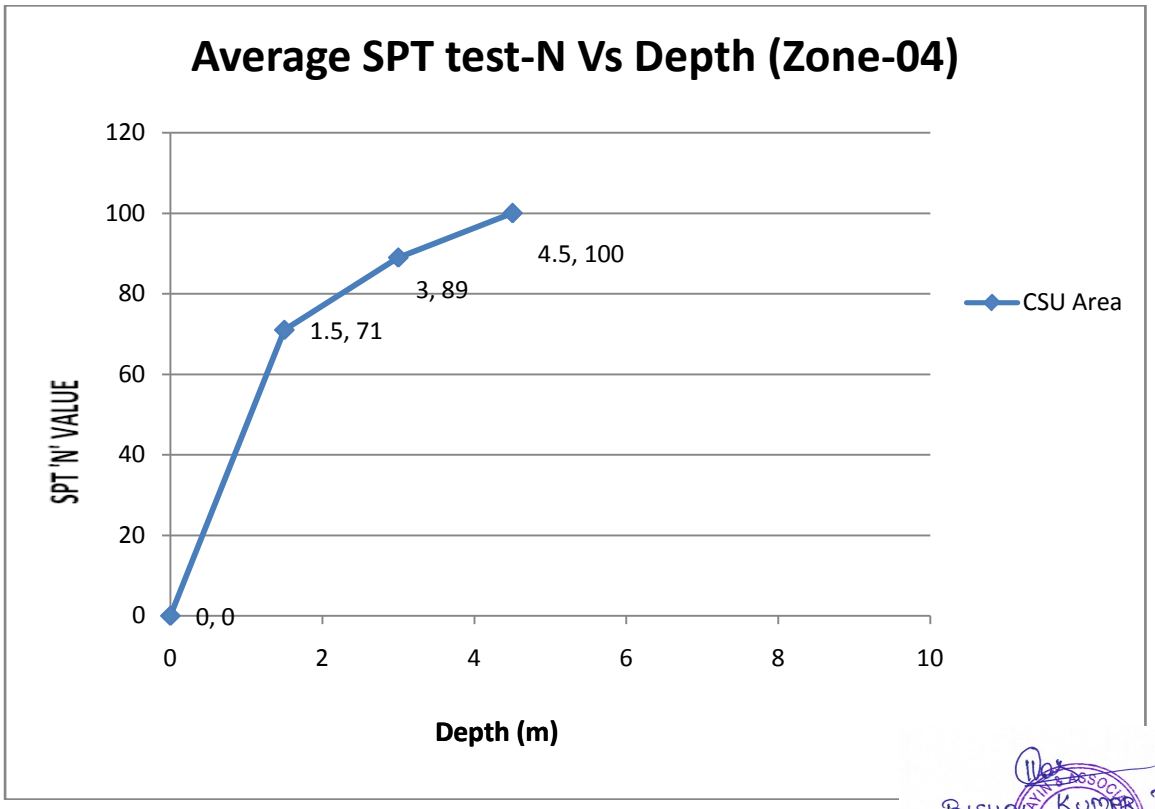

Average SPT test-N Vs Depth (Zone-01)
SPT 'N' VALUE
Depth (m)
CSU Area
0, 0
1.5, 71
3, 87
4.5, 99
6, 100
0
20
40
60
80
100
120
0
2
4
6
8
10


Average SPT test-N Vs Depth (Zone-2)
SPT 'N' VALUE
DEPTH IN 'M'
CSU Area
0.0, 0
1.5, 27
3.0, 95
4.5, 100
7.5, 100
9.0, 100
6.0, 100
12.0, 100
15.0, 100
0
20
40
60
80
100
120
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0





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ANALYSIS OF STRATUM

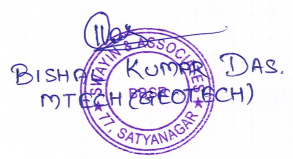
LOCATION: (ASU Area)

Zone-01 (BH-34 to BH-42 & BH-45 to BH-48)

Stratum	Average Depth Range (max 16.00m)	'N' Value	Type of soil	State
I	0.00-1.72	46	Clayey sand	Dense
II	1.72-3.56	73 to>100	Compact clay	Very Hard
III	3.56-5.57	>100	Sand stone	Sedimentary Rock
IV	5.57-16.00	>100	Weathered Rock	Sedimentary Rock

Zone-02 (BH-43 to BH-44)

Stratum	Average Depth Range (max 13.78m)	'N' Value	Type of soil	State
I	0.00-2.57	42	Clayey sand	Dense
II	2.57-4.25	>100	Compact clay	Very Hard
III	4.25-6.00	>100	Sand stone	Sedimentary Rock
IV	6.00-13.78	>100	Weathered Rock	Sedimentary Rock



ANALYSIS OF STRATUM

LOCATION: (Coal Storage Unit Area)

Zone-01 (BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77)

Stratum	Average Depth Range (max 19.88m)	'N' Value	Type of soil	State
I	0.00-2.48	71	Moorum	Very Dense
II	2.48-11.65	87	Clayey sand	Very Dense
III	11.65-19.88	>100	DI Rock	Sedimentary Rock

Zone-02 (BH-63)

Stratum	Average Depth Range (max 21.45m)	'N' Value	Type of soil	State
I	0.00-2.50	27	Filled up Ash	-
II	2.50-14.00	95 to >100	Clayey sand	Very Dense
III	14.00-18.00	>100	DI Rock	Sedimentary Rock

Zone-03 (BH-78 to 79)

Stratum	Average Depth Range (max 21.45m)	'N' Value	Type of soil	State
I	0.00-1.00	-	Clayey sand	-
II	1.00-3.00	53 to 85	Moorum	Very Dense
III	3.00-8.50	85 to >100	Clayey sand	Very Dense
IV	8.50-21.45	>100	DI Rock	Sedimentary Rock

Zone-04 (BH-59 to 62, 64 to 66, 69, 72, 73, 76, 80 to 89)

Stratum	Average Depth Range (max19.48m)	'N' Value	Type of soil	State
I	0.00-10.99	71 to >100	Clayey sand	Very Dense
II	10.99-19.48	>100	DI Rock	Sedimentary Rock

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COEFFICIENT FRICTION BETWEEN SOIL AND CONCRETE FOUNDATION:

Location-ASU Area

(BH-34 to 42 & 45 to 48)

Description	Coefficient of friction (μ)	
	Minimum	Maximum
Clayey sand	0.35	0.45
Compact clay	0.30	0.35
Sand stone/ Weathered Rock	0.65	0.70

(BH-43 to 44)

Description	Coefficient of friction (μ)	
	Minimum	Maximum
Clayey sand	0.35	0.45
Compact clay	0.30	0.35
Sand stone/ Weathered Rock	0.65	0.70

Location-Coal Storage Unit Area

(BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77)

Description	Coefficient of friction (μ)	
	Minimum	Maximum
Moorum	0.45	0.55
Clayey sand	0.35	0.45
DI Rock	0.65	0.70

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Location-Coal Storage Unit Area

(BH-63)

Description	Coefficient of friction (μ)	
	Minimum	Maximum
Clayey sand	0.35	0.45
DI Rock	0.65	0.70

Location-Coal Storage Unit Area

(BH-78 to 79)

Description	Coefficient of friction (μ)	
	Minimum	Maximum
Clayey sand	0.35	0.45
Moorum	0.45	0.55
Clayey sand	0.35	0.45
DI Rock	0.65	0.70

(BH-59 to-62, 64 to 66, 69, 72, 73, 76, 80 to 89)

Description	Coefficient of friction (μ)	
	Minimum	Maximum
Clayey sand	0.35	0.45
DI Rock	0.65	0.70

BISHAL KUMAR DAS.
M TECH (GEOTECH)

DYNAMIC PROPERTIES OF SOIL

POISSON'S RATIO- (μ)

Poisson's ratio is worked out from lateral strain (E_3) to axial strain (E_1) by Triaxial Compression Test apparatus on soil sample of cylindrical shape, subjected to direct acting in three mutually perpendicular direction viz, major principal stress in vertical direction and minor principal stress in lateral direction by fluid pressure and the plane shear failure is determined and test result is tabuled.

Poisson's ratio (μ) = E_3/ E_1

MODULUS OF ELASTICITY-(E)

Modulus of elasticity is obtained from the formula given below;

$$\delta L = PL_0/A_0E$$

$$E = PL_0/(A_0 \times \delta L)$$

SHEAR MODULUS-(G)

Shear Modulus is determined as per IS code 5249:1992 and result is tabulated.

$$G = E/2(1+\mu)$$

BULK MODULUS-(B)

(From Soil mechanics by T.William Lambe & Robert V.Whitman)

$$B = E/3(1-2E)$$

BH No:-36

Parameter	Observed Value
Poisson's Ratio(μ)	0.32
Modulus of Elasticity (E) in kg/cm^2	658
Shear Modulus (G) in kg/cm^2	245.63
Bulk Modulus (B) in kg/cm^2	597.04

SHEAR WAVE VELOCITY)

The Shear Wave Velocity at site is 1050 m/s.

BISHAKUMAR DAS. M.TECH (GEOTECH)

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.1 the following are the analysis of safe bearing capacity in open foundation:

ASU AREA

Zone-01 (BH-34 to 42 & 45 to 48)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
ASU Area (Zone-01)	1.50	Up to 3.0	30.75	32.13	51.41	96.39
		>3.0 to <6.0	33.00	28.80	46.08	86.40
	2.00	Up to 3.0	23.08	28.69	45.90	86.07
		>3.0 to <6.0	22.26	25.27	40.43	75.80
	3.00	Up to 3.0	25.02	38.52	61.63	115.55
		>3.0 to <6.0	23.70	30.89	49.42	92.66

* Table No. 1.7

ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

ASU AREA

Zone-01 (BH-34 to 42 & 45 to 48)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
ASU Area (Zone-01)	1.50	5 x 1	25.88	36.02	57.63	108.05
		10 x 2	25.58	30.97	49.55	92.91
		15 x 3	26.72	28.96	46.34	86.89
		20 x 4	28.22	28.03	44.84	84.08
		25 x 5	29.86	27.32	43.72	81.97
		30 x 6	31.58	33.42	53.47	100.26
	2.00	5 x 1	21.55	31.64	50.63	94.93
		10 x 2	18.75	27.12	43.39	81.36
		15 x 3	17.89	25.04	40.06	75.11
		20 x 4	17.51	24.00	38.41	72.01
		25 x 5	17.33	23.25	37.20	69.75
		30 x 6	17.24	28.29	45.27	84.88
	3.00	5 x 1	24.99	43.20	69.12	129.60
		10 x 2	20.74	37.65	60.25	112.96
		15 x 3	19.39	32.92	52.67	98.76
		20 x 4	18.78	29.80	47.69	89.41
		25 x 5	18.45	27.58	44.13	82.74
		30 x 6	18.27	32.35	51.76	97.04

* Table No. 1.8

BISHA KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES 17, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

ASU AREA

Zone-01 ((BH-34 to 42 & 45 to 48)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
ASU Area (Zone-01)	1.50	6 x 6	34.3	34.90	55.84
		10 x 10	39.89	31.43	50.29
		15 x 15	47.14	28.60	45.76
		20 x 20	54.48	26.45	42.32
		25 x 25	61.86	24.63	39.41
		30 x 30	69.26	23.06	36.90
		12 x 6	31.03	34.10	54.56
		20 x 10	35.15	31.01	49.61
		30 x 15	40.55	28.43	45.49
		40 x 20	46.04	26.33	42.13
		50 x 25	51.56	24.54	39.27
		60 x 30	57.1	22.99	36.79
	2.00	6 x 6	21.98	30.12	48.20
		10 x 10	21.83	26.48	42.37
		15 x 15	22.01	23.73	37.97
		20 x 20	22.31	21.65	34.64
		25 x 25	22.67	20.00	31.99
		30 x 30	23.05	18.59	29.75
		12 x 6	20.30	29.08	46.52
		20 x 10	20.10	26.00	41.60
		30 x 15	20.19	23.46	37.54
		40 x 20	20.4	21.52	34.43
		50 x 25	20.65	19.90	31.84
		60 x 30	20.93	18.52	29.63
	3.00	6 x 6	23.26	35.88	57.41
		10 x 10	22.85	27.27	43.63
		15 x 15	22.9	21.74	34.79
		20 x 20	23.15	18.19	29.11
		25 x 25	23.47	15.67	25.08
		30 x 30	23.82	13.78	22.05
		12 x 6	21.53	33.94	54.31
		20 x 10	21.09	26.51	42.41
		30 x 15	21.07	21.35	34.16
		40 x 20	21.22	17.95	28.72
		50 x 25	21.44	15.53	24.85
		60 x 30	21.69	13.70	21.92

* Table No. 1.9

BISHA KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES LL SATYANAGAR

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.2 the following are the analysis of safe bearing capacity in open foundation:

ASU AREA

Zone-02 (BH-43 to 44)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
ASU Area (Zone-02)	1.50	Up to 3.0	30.75	36.93	59.09	110.80
		>3.0 to <6.0	33.00	33.20	53.12	99.60
	2.00	Up to 3.0	35.72	35.88	57.42	107.65
		>3.0 to <6.0	37.61	31.68	50.69	95.04
	3.00	Up to 3.0	23.23	29.82	47.71	89.45
		>3.0 to <6.0	21.94	25.21	40.34	75.64
	4.00	Up to 3.0	24.94	52.34	83.74	157.01
		>3.0 to <6.0	23.17	38.72	61.95	116.16

* Table No. 1.10

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

ASU AREA

Zone-02 (BH-43 to 44)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
ASU Area (Zone-02)	1.50	5 x 1	25.88	44.62	71.38	133.85
		10 x 2	25.58	35.47	56.76	106.42
		15 x 3	26.72	33.29	53.27	99.88
		20 x 4	28.22	32.26	51.62	96.79
		25 x 5	29.86	31.50	50.39	94.49
		30 x 6	31.58	38.58	61.73	115.74
	2.00	5 x 1	31.43	41.37	66.19	124.11
		10 x 2	30.07	34.35	54.96	103.06
		15 x 3	30.86	31.32	50.10	93.95
		20 x 4	32.19	30.06	48.10	90.18
		25 x 5	33.72	29.15	46.64	87.45
		30 x 6	35.37	35.21	56.33	105.62
	3.00	5 x 1	23.40	31.43	50.29	94.30
		10 x 2	19.36	28.29	45.27	84.88
		15 x 3	18.07	25.48	40.77	76.45
		20 x 4	17.47	23.71	37.94	71.14
		25 x 5	17.14	22.51	36.02	67.54
		30 x 6	16.95	26.80	42.88	80.41
	4.00	5 x 1	26.58	76.74	122.79	230.23
		10 x 2	21.17	60.05	96.08	180.14
		15 x 3	19.42	46.62	74.59	139.86
		20 x 4	18.59	39.17	62.67	117.51
		25 x 5	18.12	33.24	53.18	99.72
		30 x 6	17.84	36.23	57.97	108.69

* Table No. 1.11

BISHWA KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES LT SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone-02 (BH-43 to 44)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
ASU Area (Zone-02)	1.50	6 x 6	34.30	40.29	64.46
		10 x 10	39.89	36.25	58.00
		15 x 15	47.14	33.07	52.91
		20 x 20	54.48	30.64	49.02
		25 x 25	61.86	28.59	45.74
		30 x 30	69.26	26.81	42.89
		12 x 6	31.03	39.37	62.98
		20 x 10	35.15	35.76	57.22
		30 x 15	40.55	32.87	52.59
		40 x 20	46.04	30.50	48.81
		50 x 25	51.56	28.48	45.57
		60 x 30	57.10	26.73	42.76
	2.00	6 x 6	38.83	37.48	59.97
		10 x 10	44.24	33.13	53.01
		15 x 15	51.4	29.70	47.52
		20 x 20	58.7	27.11	43.37
		25 x 25	66.06	25.04	40.07
		30 x 30	73.44	23.29	37.26
		12 x 6	35.53	36.18	57.89
		20 x 10	39.47	32.53	52.04
		30 x 15	44.79	29.36	46.98
		40 x 20	50.24	26.94	43.11
		50 x 25	55.74	24.92	39.88
		60 x 30	61.26	23.20	37.12
	3.00	6 x 6	21.65	29.73	47.57
		10 x 10	21.21	24.63	39.41
		15 x 15	21.19	21.13	33.81
		20 x 20	21.36	18.67	29.87
		25 x 25	21.59	16.77	26.84
		30 x 30	21.86	15.25	24.40
		12 x 6	20.03	28.12	45.00
		20 x 10	19.58	23.95	38.32
		30 x 15	19.50	20.75	33.19
		40 x 20	19.60	18.42	29.47
		50 x 25	19.75	16.62	26.59
		60 x 30	19.94	15.16	24.26

* Table No. 1.12

BISHNU KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES 77, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone-02 (BH-43 to 44)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
ASU Area (Zone-02)	4.00	6 x 6	22.76	41.51	66.42
		10 x 10	22.08	26.68	42.69
		15 x 15	21.95	18.43	29.49
		20 x 20	22.05	14.21	22.73
		25 x 25	22.25	11.57	18.51
		30 x 30	22.50	9.76	15.62
		12 x 6	21.10	38.84	62.15
		20 x 10	20.43	25.38	40.61
		30 x 15	20.24	17.98	28.76
		40 x 20	20.28	13.95	22.32
		50 x 25	20.41	11.40	18.24
		60 x 30	20.57	9.65	15.44

* Table No. 1.13

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.3, the following are the analysis of safe bearing capacity in open foundation:

CSU AREA:

Zone 01 (BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
Coal Storage Unit (Zone-1)	1.50	Up to 3.0	60.87	48.71	77.93	146.12
		>3.0 to <6.0	72.91	49.40	79.05	148.21
	2.00	Up to 3.0	75.62	59.96	95.93	179.87
		>3.0 to <6.0	87.05	64.74	103.58	194.21
	3.00	Up to 3.0	36.22	101.83	162.93	305.50
		>3.0 to <6.0	36.72	127.88	204.61	383.64
	4.00	Up to 3.0	45.07	101.83	162.93	305.50
		>3.0 to <6.0	44.62	122.65	196.24	367.95
	5.00	Up to 3.0	54.34	101.83	162.93	305.50
		>3.0 to <6.0	52.77	111.93	179.09	335.80

* Table No. 1.14

BISHA KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES 17, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

Zone 01 (BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
3Coal Storage Unit (Zone-1)	1.50	5 x 1	46.35	52.18	83.49	156.54
		10 x 2	51.94	43.53	69.65	130.60
		15 x 3	59.13	43.91	70.25	131.73
		20 x 4	66.74	45.39	72.62	136.16
		25 x 5	74.50	46.87	74.99	140.61
		30 x 6	82.34	58.35	93.36	175.05
	2.00	5 x 1	61.28	50.42	80.67	151.25
		10 x 2	64.98	48.70	77.91	146.09
		15 x 3	71.56	52.32	83.72	156.97
		20 x 4	78.84	56.58	90.53	169.75
		25 x 5	86.42	59.57	95.31	178.71
		30 x 6	94.14	73.77	118.03	221.31
	3.00	5 x 1	33.92	46.08	73.73	138.25
		10 x 2	30.00	66.14	105.83	198.43
		15 x 3	29.59	87.03	139.25	261.10
		20 x 4	30.06	108.77	174.03	326.31
		25 x 5	30.89	114.19	182.70	342.57
		30 x 6	31.89	140.71	225.13	422.12
	4.00	5 x 1	44.51	46.08	73.73	138.25
		10 x 2	37.84	70.59	112.95	211.78
		15 x 3	36.51	90.71	145.13	272.13
		20 x 4	36.53	109.07	174.52	327.22
		25 x 5	37.08	105.30	168.48	315.89
		30 x 6	37.90	128.24	205.18	384.71
	5.00	5 x 1	56.09	46.08	73.73	138.25
		10 x 2	46.17	71.65	114.65	214.96
		15 x 3	43.77	96.49	154.39	289.48
		20 x 4	43.24	98.82	158.11	296.46
		25 x 5	43.47	95.67	153.07	287.00
		30 x 6	44.07	116.21	185.94	348.64

* Table No. 1.15

BISHAL KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES PLOT-117 SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 01 (BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-1)	1.50	6 x 6	79.12	60.94	97.50
		10 x 10	104.35	59.04	94.47
		15 x 15	136.17	58.14	93.02
		20 x 20	168.10	57.84	92.55
		25 x 25	200.06	57.67	92.27
		30 x 30	232.04	57.55	92.08
		12 x 6	69.27	59.54	95.26
		20 x 10	88.10	58.25	93.20
		30 x 15	111.92	57.79	92.47
		40 x 20	135.84	57.59	92.14
		50 x 25	159.79	57.46	91.94
		60 x 30	183.77	57.38	91.81
	2.00	6 x 6	93.11	78.54	125.66
		10 x 10	118.04	74.96	119.93
		15 x 15	149.71	73.41	117.46
		20 x 20	181.56	72.66	116.26
		25 x 25	213.48	72.37	115.79
		30 x 30	245.43	72.17	115.48
		12 x 6	83.18	75.81	121.30
		20 x 10	101.71	73.60	117.75
		30 x 15	125.38	72.58	116.13
		40 x 20	149.22	72.23	115.57
		50 x 25	173.13	72.02	115.24
		60 x 30	197.08	71.89	115.02
	3.00	6 x 6	35.63	156.09	249.74
		10 x 10	39.07	144.21	230.74
		15 x 15	44.04	139.66	223.45
		20 x 20	49.23	137.49	219.98
		25 x 25	54.51	136.22	217.95
		30 x 30	59.83	135.38	216.61
		12 x 6	33.15	147.65	236.24
		20 x 10	35.55	140.20	224.31
		30 x 15	39.19	137.12	219.39
		40 x 20	43.04	135.63	217.02
		50 x 25	46.97	134.97	215.95
		60 x 30	50.94	134.58	215.33

* Table No. 1.16

BISHWA KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES 77, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 01 (BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-1)	4.00	6 x 6	42.82	146.95	235.12
		10 x 10	45.81	134.15	214.64
		15 x 15	50.55	126.94	203.10
		20 x 20	55.63	124.26	198.82
		25 x 25	60.84	122.71	196.34
		30 x 30	66.11	121.70	194.72
		12 x 6	40.28	137.49	219.99
		20 x 10	42.24	127.60	204.16
		30 x 15	45.66	123.82	198.11
		40 x 20	49.39	122.01	195.21
		50 x 25	53.26	120.95	193.51
		60 x 30	57.19	120.32	192.51
	5.00	6 x 6	50.21	135.64	217.02
		10 x 10	52.67	121.81	194.90
		15 x 15	57.14	114.20	182.72
		20 x 20	62.08	110.74	177.18
		25 x 25	67.21	108.99	174.38
		30 x 30	72.44	107.85	172.56
		12 x 6	47.61	124.42	199.08
		20 x 10	49.05	115.22	184.36
		30 x 15	52.21	110.23	176.37
		40 x 20	55.81	108.19	173.11
		50 x 25	59.60	107.01	171.21
		60 x 30	63.48	106.23	169.97

* Table No. 1.17

BISHWAJIT KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES 177, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.4, the following are the analysis of safe bearing capacity in open foundation:

CSU AREA:

Zone 02 (BH-63) (After Removing filled up ash from NGL to 2.50m depth)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
Coal Storage Unit (Zone-2)	1.50	Up to 3.0	21.26	54.91	87.85	164.72
		>3.0 to <6.0	22.33	50.73	81.17	152.19
	2.00	Up to 3.0	24.35	55.29	88.46	165.87
		>3.0 to <6.0	25.18	50.08	80.13	150.25
	3.00	Up to 3.0	30.79	53.95	86.32	161.84
		>3.0 to <6.0	31.02	47.00	75.20	141.01
	4.00	Up to 3.0	37.55	47.91	76.65	143.72
		>3.0 to <6.0	37.06	44.33	70.93	133.00
	5.00	Up to 3.0	44.63	41.92	67.06	125.75
		>3.0 to <6.0	43.29	39.81	63.69	119.42

* Table No. 1.18

BISHAL KUMAR DAS. MTECH (GEOTECH)

ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

Zone 02 (BH-63)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
Coal Storage Unit (Zone-2)	1.50	5 x 1	18.20	58.22	93.15	174.65
		10 x 2	17.60	51.52	82.44	154.57
		15 x 3	18.07	49.50	79.20	148.49
		20 x 4	18.82	48.63	77.81	145.90
		25 x 5	19.67	48.13	77.00	144.38
		30 x 6	20.58	58.25	93.20	174.75
	2.00	5 x 1	21.76	59.13	94.62	177.40
		10 x 2	20.42	51.30	82.08	153.90
		15 x 3	20.65	48.25	77.20	144.75
		20 x 4	21.27	47.11	75.37	141.32
		25 x 5	22.05	46.09	73.74	138.26
		30 x 6	22.90	55.73	89.17	167.20
	3.00	5 x 1	29.49	53.95	86.32	161.84
		10 x 2	26.37	49.80	79.68	149.39
		15 x 3	26	46.11	73.77	138.32
		20 x 4	26.32	44.07	70.51	132.21
		25 x 5	26.92	41.97	67.15	125.91
		30 x 6	27.66	50.68	81.08	152.03
	4.00	5 x 1	38.03	47.91	76.65	143.72
		10 x 2	32.72	47.20	75.52	141.59
		15 x 3	31.62	42.67	68.28	128.02
		20 x 4	31.58	40.55	64.87	121.64
		25 x 5	31.96	38.06	60.90	114.18
		30 x 6	32.55	45.63	73.00	136.88
	5.00	5 x 1	47.39	41.92	67.06	125.75
		10 x 2	39.48	41.92	67.06	125.75
		15 x 3	37.52	39.72	63.55	119.16
		20 x 4	37.04	35.95	57.52	107.85
		25 x 5	37.16	34.02	54.43	102.06
		30 x 6	37.58	41.07	65.71	123.20

* Table No. 1.19

BISHWAJIT KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES BBSR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 02 (BH-63)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-2)	1.50	6 x 6	23.01	60.83	97.33
		10 x 10	25.98	57.67	92.27
		15 x 15	29.89	56.65	90.64
		20 x 20	33.88	56.23	89.97
		25 x 25	37.89	55.92	89.48
		30 x 30	41.92	55.68	89.09
		12 x 6	20.95	59.44	95.10
		20 x 10	23.13	56.89	91.03
		30 x 15	26.04	56.32	90.10
		40 x 20	29.01	55.98	89.57
		50 x 25	32.01	55.73	89.16
		60 x 30	35.03	55.51	88.82
	2.00	6 x 6	25.79	59.34	94.94
		10 x 10	28.64	55.67	89.08
		15 x 15	32.49	54.40	87.03
		20 x 20	36.45	53.71	85.94
		25 x 25	40.44	53.37	85.39
		30 x 30	44.46	53.10	84.96
		12 x 6	23.72	57.28	91.64
		20 x 10	25.77	54.66	87.46
		30 x 15	28.62	53.78	86.05
		40 x 20	31.57	53.40	85.43
		50 x 25	34.55	53.12	84.99
		60 x 30	37.55	52.89	84.63
	3.00	6 x 6	31.49	56.22	89.95
		10 x 10	34.04	51.51	82.41
		15 x 15	37.74	49.77	79.63
		20 x 20	41.62	48.88	78.21
		25 x 25	45.57	48.32	77.32
		30 x 30	49.56	47.92	76.67
		12 x 6	29.36	53.18	85.08
		20 x 10	31.13	50.07	80.12
		30 x 15	33.84	48.86	78.18
		40 x 20	36.72	48.22	77.16
		50 x 25	39.66	47.88	76.61
		60 x 30	42.63	47.63	76.21

* Table No. 1.20

BISHAL KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES BBSR. PLOT NO. 177, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 02 (BH-63)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-2)	4.00	6 x 6	37.34	52.28	83.65
		10 x 10	39.53	47.65	76.23
		15 x 15	43.06	44.99	71.98
		20 x 20	46.85	43.94	70.31
		25 x 25	50.74	43.30	69.29
		30 x 30	54.69	42.85	68.57
		12 x 6	35.17	48.92	78.27
		20 x 10	36.59	45.32	72.51
		30 x 15	39.13	43.88	70.21
		40 x 20	41.91	43.15	69.03
		50 x 25	44.80	42.68	68.29
		60 x 30	47.74	42.37	67.79
	5.00	6 x 6	43.36	47.93	76.69
		10 x 10	45.13	42.97	68.76
		15 x 15	48.44	40.21	64.33
		20 x 20	52.12	38.91	62.25
		25 x 25	55.95	38.22	61.15
		30 x 30	59.86	37.74	60.39
		12 x 6	41.15	43.97	70.35
		20 x 10	42.15	40.65	65.04
		30 x 15	44.48	38.81	62.10
		40 x 20	47.16	38.02	60.83
		50 x 25	49.98	37.52	60.04
		60 x 30	52.88	37.18	59.48

* Table No. 1.21

BISHAL KUMAR DAS.
MTECH (GEOTECH)
SWAYIN & ASSOCIATES
17, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

* Based on the design parameters tabulated in Table 1.4, the following are the analysis of safe bearing capacity in open foundation:

CSU AREA:

Zone 03 (BH-78 to 79)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
Coal Storage Unit (Zone-3)	1.50	Up to 3.0	53.59	43.24	69.18	129.71
		>3.0 to <6.0	64.06	38.02	60.84	114.07
	2.00	Up to 3.0	66.64	45.89	73.43	137.68
		>3.0 to <6.0	76.57	38.47	61.55	115.41
	3.00	Up to 3.0	93.87	151.13	241.81	453.39
		>3.0 to <6.0	102.29	82.44	131.91	247.33
	4.00	Up to 3.0	43.02	104.67	167.47	314.01
		>3.0 to <6.0	42.51	61.30	98.09	183.91
	5.00	Up to 3.0	51.76	67.02	107.23	201.05
		>3.0 to <6.0	50.19	40.68	65.09	122.04

* Table No. 1.22

BISHWA KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES 17, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

Zone 03 (BH-78 to 79)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
Coal Storage Unit (Zone-3)	1.50	5 x 1	40.89	42.69	68.31	128.08
		10 x 2	45.72	38.98	62.37	116.95
		15 x 3	51.98	38.98	62.36	116.93
		20 x 4	58.60	38.07	60.91	114.21
		25 x 5	65.35	36.07	57.72	108.22
		30 x 6	72.18	42.95	68.72	128.85
	2.00	5 x 1	54.10	43.38	69.40	130.13
		10 x 2	57.27	40.24	64.38	120.72
		15 x 3	62.97	40.05	64.08	120.15
		20 x 4	69.31	37.90	60.64	113.70
		25 x 5	75.90	35.40	56.64	106.20
		30 x 6	82.62	41.64	66.63	124.92
	3.00	5 x 1	80.17	79.29	126.86	237.87
		10 x 2	78.64	115.10	184.15	345.29
		15 x 3	82.59	129.16	206.66	387.49
		20 x 4	87.92	93.76	150.02	281.29
		25 x 5	93.80	73.62	117.79	220.86
		30 x 6	99.96	75.93	121.49	227.79
	4.00	5 x 1	44.61	79.29	126.86	237.87
		10 x 2	37.92	122.84	196.55	368.53
		15 x 3	36.60	93.24	149.18	279.71
		20 x 4	36.62	67.77	108.43	203.31
		25 x 5	37.17	52.63	84.21	157.89
		30 x 6	37.99	53.60	85.75	160.79
	5.00	5 x 1	56.22	79.29	126.86	237.87
		10 x 2	46.28	98.86	158.17	296.57
		15 x 3	43.88	63.50	101.61	190.51
		20 x 4	43.35	44.71	71.54	134.13
		25 x 5	43.58	34.77	55.63	104.30
		30 x 6	44.18	35.28	56.45	105.84

* Table No. 1.23

BISHNU KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES PVT. LTD. 177, SATYANAGAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 03 (BH-78 to 79)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-3)	1.50	6 x 6	69.47	44.85	71.77
		10 x 10	91.43	55.20	88.32
		15 x 15	119.15	54.36	86.97
		20 x 20	146.95	54.08	86.53
		25 x 25	174.79	53.92	86.27
		30 x 30	202.64	53.81	86.09
		12 x 6	60.89	43.82	70.12
		20 x 10	77.28	54.46	87.13
		30 x 15	98.03	54.03	86.45
		40 x 20	118.86	53.84	86.15
		50 x 25	139.72	53.73	85.96
		60 x 30	160.60	53.65	85.84
	2.00	6 x 6	81.85	44.33	70.93
		10 x 10	103.55	56.33	90.13
		15 x 15	131.13	55.17	88.27
		20 x 20	158.87	54.61	87.37
		25 x 25	186.66	54.39	87.02
		30 x 30	214.49	54.24	86.78
		12 x 6	73.20	42.79	68.47
		20 x 10	89.33	55.31	88.49
		30 x 15	109.94	54.54	87.27
		40 x 20	130.70	54.28	86.85
		50 x 25	151.52	54.13	86.60
		60 x 30	172.38	54.02	86.44
	3.00	6 x 6	103.06	84.23	134.77
		10 x 10	123.19	288.30	461.28
		15 x 15	149.35	279.19	446.71
		20 x 20	175.83	274.85	439.77
		25 x 25	202.45	272.31	435.70
		30 x 30	229.13	270.65	433.03
		12 x 6	94.61	79.68	127.48
		20 x 10	109.38	280.27	448.43
		30 x 15	128.83	274.12	438.60
		40 x 20	148.61	271.15	433.84
		50 x 25	168.53	269.81	431.70
		60 x 30	188.51	269.04	430.46

* Table No. 1.24

BISHAL KUMAR DAS.
MTECH (GEOTECH)

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 03 (BH-78 to 79)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-3)	4.00	6 x 6	42.92	61.42	98.27
		10 x 10	45.93	161.53	258.45
		15 x 15	50.68	152.85	244.55
		20 x 20	55.78	149.63	239.41
		25 x 25	61.00	147.76	236.42
		30 x 30	66.30	146.54	234.47
		12 x 6	40.38	57.47	91.94
		20 x 10	42.35	153.65	245.84
		30 x 15	45.78	149.09	238.54
		40 x 20	49.53	146.91	235.06
		50 x 25	53.40	145.63	233.01
		60 x 30	57.35	144.88	231.81
	5.00	6 x 6	50.33	41.18	65.89
		10 x 10	52.80	86.95	139.12
		15 x 15	57.29	81.51	130.42
		20 x 20	62.25	79.04	126.47
		25 x 25	67.40	77.80	124.47
		30 x 30	72.64	76.98	123.18
		12 x 6	47.73	37.77	60.44
		20 x 10	49.18	82.25	131.60
		30 x 15	52.35	78.68	125.89
		40 x 20	55.96	77.23	123.57
		50 x 25	59.76	76.38	122.21
		60 x 30	63.65	75.83	121.33

* Table No. 1.25

BISHAL KUMAR DAS. M.TECH (GEOTECH) SWAYIN & ASSOCIATES LT. SATYANAGAR

ALLOWABLE BEARING CAPACITY OF SQUARE FOOTING FROM SHEAR PARAMETER

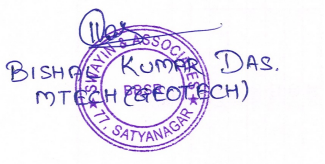
* Based on the design parameters tabulated in Table 1.5, the following are the analysis of safe bearing capacity in open foundation:

CSU AREA:

Zone-04 (BH-59 to 62, 64 to 66, 69, 72, 73, 76, 80 to 89)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
Coal Storage Unit (Zone-4)	1.50	Up to 3.0	26.94	35.42	56.68	106.27
		>3.0 to <6.0	28.91	32.20	51.51	96.59
	2.00	Up to 3.0	31.35	35.58	56.93	106.74
		>3.0 to <6.0	33.02	31.95	51.12	95.85
	3.00	Up to 3.0	40.53	34.51	55.22	103.54
		>3.0 to <6.0	41.44	30.27	48.44	90.82
	4.00	Up to 3.0	50.19	30.43	48.69	91.29
		>3.0 to <6.0	50.15	28.78	46.04	86.33
	5.00	Up to 3.0	60.33	25.95	41.52	77.85
		>3.0 to <6.0	59.15	25.97	41.56	77.92

* Table No. 1.26



ALLOWABLE BEARING CAPACITY OF STRIP FOOTING FROM SHEAR PARAMETER

Zone-04 (BH-59 to 62, 64 to 66, 69, 72, 73, 76, 80 to 89)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)			
			Shear Consideration	Allowable Settlement		
				25mm	40mm	75mm
Coal Storage Unit (Zone-4)	1.50	5 x 1	22.67	37.56	60.09	112.67
		10 x 2	22.42	33.24	53.18	99.72
		15 x 3	23.42	31.93	51.09	95.80
		20 x 4	24.73	31.37	50.20	94.12
		25 x 5	26.17	30.54	48.87	91.63
		30 x 6	27.68	37.92	60.68	113.77
	2.00	5 x 1	27.59	38.05	60.89	114.16
		10 x 2	26.41	33.01	52.82	99.03
		15 x 3	27.10	31.05	49.68	93.15
		20 x 4	28.26	30.31	48.50	90.94
		25 x 5	29.61	29.40	47.04	88.20
		30 x 6	31.05	36.42	58.27	109.26
	3.00	5 x 1	38.31	34.51	55.22	103.54
		10 x 2	34.84	31.86	50.97	95.57
		15 x 3	34.76	29.50	47.20	88.49
		20 x 4	35.54	27.73	44.37	83.20
		25 x 5	36.66	27.03	43.25	81.10
		30 x 6	37.95	33.32	53.32	99.97
	4.00	5 x 1	50.23	30.43	48.69	91.29
		10 x 2	43.86	29.98	47.97	89.94
		15 x 3	42.82	27.11	43.37	81.32
		20 x 4	43.12	25.58	40.93	76.74
		25 x 5	43.94	24.70	39.53	74.11
		30 x 6	45.04	30.11	48.17	90.32
	5.00	5 x 1	63.34	26.39	42.22	79.16
		10 x 2	53.48	26.39	42.22	79.16
		15 x 3	51.28	24.59	39.34	73.77
		20 x 4	50.99	22.92	36.67	68.75
		25 x 5	51.47	22.20	35.52	66.60
		30 x 6	52.33	26.99	43.18	80.97

* Table No. 1.27

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 04 (BH-59 to 62, 64 to 66, 69, 72, 73, 76, 80 to 89)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-4)	1.50	6 x 6	30.05	39.61	63.37
		10 x 10	34.95	38.29	61.26
		15 x 15	41.3	37.36	59.77
		20 x 20	47.73	36.83	58.93
		25 x 25	54.2	36.39	58.23
		30 x 30	60.68	36.00	57.59
		12 x 6	27.2	38.70	61.92
		20 x 10	30.81	37.77	60.43
		30 x 15	35.54	37.13	59.41
		40 x 20	40.35	36.67	58.67
		50 x 25	45.19	36.26	58.02
		60 x 30	50.05	35.89	57.42
	2.00	6 x 6	34.08	38.78	62.04
		10 x 10	38.82	36.91	59.05
		15 x 15	45.10	35.81	57.30
		20 x 20	51.50	35.12	56.19
		25 x 25	57.94	34.66	55.46
		30 x 30	64.40	34.25	54.81
		12 x 6	31.20	37.43	59.89
		20 x 10	34.66	36.24	57.98
		30 x 15	39.32	35.40	56.65
		40 x 20	44.09	34.91	55.86
		50 x 25	48.91	34.50	55.19
		60 x 30	53.75	34.12	54.59
	3.00	6 x 6	42.32	36.97	59.15
		10 x 10	46.68	34.03	54.45
		15 x 15	52.77	32.64	52.23
		20 x 20	59.07	31.83	50.93
		25 x 25	65.46	31.24	49.98
		30 x 30	71.88	30.76	49.21
		12 x 6	39.38	34.97	55.95
		20 x 10	42.47	33.08	52.93
		30 x 15	46.95	32.05	51.28
		40 x 20	51.63	31.40	50.24
		50 x 25	56.39	30.95	49.52
		60 x 30	61.19	30.58	48.92

* Table No. 1.28

BISHNU KUMAR DAS. MTECH (GEOTECH) SWAYIN & ASSOCIATES BHUBANESWAR

ALLOWABLE BEARING CAPACITY OF MAT FOOTING FROM SHEAR PARAMETER

Zone 04 (BH-59 to 62, 64 to 66, 69, 72, 73, 76, 80 to 89)

Location	Depth in 'm'	Width of Footing in 'm'	Net Safe Bearing Capacity (t/m^2)		
			Shear Consideration	Allowable Settlement	
				25mm	40mm
Coal Storage Unit (Zone-4)	4.00	6 x 6	50.79	34.50	55.20
		10 x 10	54.68	31.35	50.15
		15 x 15	60.53	29.37	46.99
		20 x 20	66.72	28.47	45.55
		25 x 25	73.03	27.84	44.55
		30 x 30	79.41	27.35	43.75
		12 x 6	47.79	32.28	51.65
		20 x 10	50.42	29.82	47.71
		30 x 15	54.67	28.65	45.83
		40 x 20	59.23	27.95	44.72
		50 x 25	63.92	27.44	43.90
		60 x 30	68.68	27.04	43.26
	5.00	6 x 6	59.51	31.50	50.40
		10 x 10	62.83	28.12	45.00
		15 x 15	68.39	26.10	41.76
		20 x 20	74.43	25.05	40.08
		25 x 25	80.66	24.41	39.05
		30 x 30	86.99	23.92	38.26
		12 x 6	56.45	28.90	46.23
		20 x 10	58.52	26.60	42.57
		30 x 15	62.48	25.19	40.31
		40 x 20	66.91	24.48	39.16
		50 x 25	71.52	23.97	38.34
		60 x 30	76.22	23.56	37.69

* Table No. 1.29

BISHAL KUMAR DAS.
MTECH (GEOTECH)

ALLOWABLE BEARING CAPACITY FROM PLATE LOAD TEST

Location:- ASU Area

Location	PLT No	Depth in (m)	Plate Size (m)	Footing size (m)	Allowable pressure from PLT graph(when st=25mm)	Allowable pressure from PLT graph(when st=40mm)
					For 25mm	For 40mm
ASU Area	01	1.80	0.50	1	36.80	89.19
				2	28.64	88.70
				3	26.12	88.42
				4	23.92	84.78
				5	22.12	80.64

* Table No. 1.30

- For ASU Area the Recommended value for the foundation at a depth

1.80 m depth footing size 3 x 3 is 26.12 T/m^2 for 25 mm settlement.

2.00 m depth footing size 3 x 3 is 29.02 T/m^2 for 25 mm settlement.

2.50 m depth footing size 3 x 3 is 36.28 T/m^2 for 25 mm settlement.

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

ALLOWABLE BEARING CAPACITY FROM PLATE LOAD TEST

Location:- CSU Area

Location	PLT No	Depth in (m)	Plate Size (m)	Footing size (m)	Allowable pressure from PLT graph(when st=25mm)	Allowable pressure from PLT graph(when st=40mm)
					For 25mm	For 40mm
CSU Area	01	1.80	0.50	1	37.00	89.68
				2	28.58	88.52
				3	24.96	84.49
				4	22.20	78.69
				5	20.92	76.26

* Table No. 1.31

- For CSU Area the Recommended value for the foundation at a depth

  1.80 m depth footing size 3 x 3 is 24.96 T/m^2 for 25 mm settlement.

  2.00 m depth footing size 3 x 3 is 27.73 T/m^2 for 25 mm settlement.

  2.50 m depth footing size 3 x 3 is 34.67 T/m^2 for 25 mm settlement.

BISHWAJIT KUMAR DAS. MTECH (GEOTECH)

ANALYSIS OF LOAD CAPACITIES IN PILE FOUNDATION

BORED CAST IN-SITU PILE:

- The recommended Pile Capacity of bored cast-in-situ RCC Piles for different length and diameters shall be as follows:
- Pile cut-off level is considered as 2.00m below Natural Ground Level (NGL).
- Since the soil strata in this location (ASU Area) has been possess Zone-01 the top soil as Clayey Sand (Dense in Nature) followed by Compact Clay and Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.26).
- Since the soil strata in this location (ASU Area) has been possess Zone-02 the top soil as Clayey Sand (Dense in Nature) followed by Compact Clay and Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.27).
- Since the soil strata in this location (CSU Area) has been possess Zone-01 the top soil as Moorum (Dense in Nature) followed by Clayey sand and Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.28).
- Since the soil strata in this location (CSU Area) has been possess Zone-02 the top soil as Filled up Ash (Medium in Nature) followed by Clayey sand & Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.29).
- Since the soil strata in this location (CSU Area) has been possess Zone-03 the top soil as Clayey sand (Dense in Nature) followed by Moorum, clayey sand & Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.30).
- Since the soil strata in this location (CSU Area) has been possess Zone-04 the top soil as Clayey sand (Dense in Nature) followed by Sedimentary Rock composition, the Safe load carrying capacity of pile foundation has been tabulated as below (Table No.1.31).

ASU AREA (Zone-01)

(BH-34 to 42 & 45 to 48)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	8.0	374.92	122.01	8.80
0.50		424.75	137.92	9.78
0.60		529.30	171.16	11.74
0.75		698.38	224.55	14.67
0.80		758.01	243.29	15.65

* Table No. 1.32

(Zone-02)

BH-43 to BH-44)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	8.0	376.56	122.55	8.80
0.50		426.57	138.52	9.78
0.60		531.48	171.88	11.74
0.75		701.11	225.46	14.67
0.80		760.92	244.26	15.65

* Table No. 1.33

CSU AREA (Zone-01)

(BH-49 to 58, 67, 68, 70, 71, 74, 75 & 77)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	8.00	171.41	66.77	7.45
0.50		193.97	76.55	8.27
0.60		241.16	97.51	9.93
0.75		317.20	132.49	12.41
0.80		343.95	145.10	13.24

* Table No. 1.34

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CSU AREA (Zone-02)

(BH-63)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	10.00	136.66	54.85	7.45
0.50		157.24	63.89	8.27
0.60		201.62	83.74	9.93
0.75		276.29	117.93	12.41
0.80		303.33	130.51	13.24

* Table No. 1.35

CSU AREA (Zone-03)

(BH-78-79)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	8.00	170.78	64.98	7.45
0.50		193.84	74.56	8.27
0.60		242.41	95.13	9.93
0.75		321.38	129.51	12.41
0.80		349.34	141.92	13.24

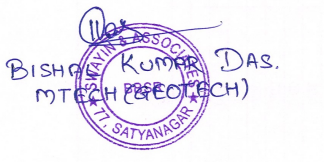
* Table No. 1.36

Zone-04

(BH-59 to 62, 64 to 66, 69, 72, 73, 76, 80 to 89)

Pile Diameter (m)	Length of Pile below Cut-Off Level (m)	Safe Load Carrying Capacity of Pile (MT)		
		Compression	Uplift / Tension	Lateral Capacity
0.45	8.00	173.73	67.54	8.13
0.50		196.54	77.40	9.04
0.60		244.24	98.54	10.84
0.75		321.06	133.78	13.56
0.80		348.06	146.47	14.46

* Table No. 1.37



DISCUSSION AND CONCLUSION

Based on the field and laboratory test results and the given recommendations the following are summarized:

- Since the project ASU site is having uniform Sub-Soil stratification, boreholes has been grouped in two zones viz., Zone-1 (BH-34 to 42 & 45 to 48) & Zone-2 (BH-43 to BH-44). Based on bore logs, Field & Laboratory Test results, the following Design Soil Profile has been used for the analysis of Open Foundation and Pile Foundations.
- Since the Coal storage unit site is having uniform Sub-Soil stratification, boreholes has been grouped to four zones viz., Zone-1 (BH-49 to BH-58,67, 68, 70, 71, 74, 75 & 77), Zone-2 (BH-63) Zone-03 (BH78 to 79) & Zone-4 (BH-59 to 62, 64 to 66, 69, 72, 73, 76, 80 to 89). Based on bore logs, Field & Laboratory Test results, the following Design Soil Profile has been used for the analysis of Open Foundation and Pile Foundations.

General Observation opinion:

- For ASU area in Zone-01 the top surface layer consists of clayey sand which is dense in condition up to an average depth of 1.72m.
- Undulation the top layer, there is a presence of compact clay with 'N' value is 73. The condition of soil strata is very hard up to an average depth of 3.56m followed by Sand stone, Weathered Rock & clay stone.
- For ASU area in Zone-02 the top surface layer consists of clayey sand which is dense in condition up to an average depth of 2.57m.
- Undulation the top layer, there is a presence of compact clay with 'N' value greater than 100. The condition of soil strata is very hard up to an average depth of 4.25m followed by Sand stone, Weathered Rock & clay stone.
- For CSU area in Zone-01 the top surface layer consists of Moorum which is very dense in condition up to an average depth of 2.48m.
- Undulation the top layer, there is a presence of clayey sand with 'N' value varies from 87 to greater than 100. The condition of soil strata is very dense up to an average depth of 11.65m followed by DI Rock.

- For CSU area in Zone-02 the top surface layer consists of filled up ash in condition up to an average depth of 2.50m.
- Undulation the top layer, there is a presence of Clayey sand with 'N' value varies from 95 to greater than up to an average depth of 14.00m. The condition of soil strata is very dense followed by DI Rock.
- For CSU area in Zone-03 the top surface layer consists of clayey sand in condition up to an average depth of 1.00m.
- Undulation the top layer, there is a presence of Moorum with 'N' value varies from 53 to 85 up to an average depth of 3.00m & clayey sand 'N' value varies from 85 to greater than100 up to an average depth of 8.50m. The condition of soil strata is very dense followed by DI Rock.
- For CSU area in Zone-04 the top surface layer consists of clayey sand which is dense to very dense in condition up to an average depth of 10.99m & followed by DI Rock.
- Difference in soil strata w.r.to ground levels and water table has been represented in a profile manner (please refer sub-soil profile).
- At project site in ASU area, it is observed that Sedimentary Rocks composition of Sandstone at deeper depths is present.
- At project site in CSU area, it is observed that Sedimentary Rocks composition of Weathered Rock at deeper depths is present.
- From the analysis of rock tests, it is noted that moderate weathering is formed at entire area with sandstone (fine grained).
- Details of rock test details have been given in Annexure-B of the report.

Recommendations for Foundation consideration:

ASU area:

- For lightly loaded structures in Zone-01(i.e., for structure loading upto 25 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.7
- For lightly loaded structures in Zone-02(i.e., for structure loading upto 23 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.10
- For heavy loaded structures i.e. Pile foundation please refer TABLE:- 1.32 & 1.33
- From the test results being performed (in-situ and laboratory), it is clear that there is no requirement of soil improvement in the site location. Moreover, the project site is not prone to liquefaction zone.

CSU area:

- For lightly loaded structures in Zone-01(i.e., for structure loading upto 36 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.14
- For lightly loaded structures in Zone-02(i.e., for structure loading upto 30 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.18

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- For lightly loaded structures in Zone-03(i.e., for structure loading upto 93 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.22
- For lightly loaded structures in Zone-04(i.e., for structure loading upto 40 t/m^2) Shallow/Open foundation of footing size 3.0 x 3.0 m upto 3.00m depth may be considered, please refer TABLE:-1.26
- For heavy loaded structures i.e. Pile foundation please refer TABLE:- 1.34 to 1.37.
- From the test results being performed (in-situ and laboratory), it is clear that there is no requirement of soil improvement in the site location. Moreover, the project site is not prone to liquefaction zone.

Suitability of the soils to be used as fill material:

- As per the laboratory test results the soil present at site location is clayey sand with slight plasticity. So it is recommended to use excavated soil as back filling material followed with layer to layer compaction upto maximum density.
- Since they will exhibit slight to no plasticity the soils can be compacted to fairly good compaction and provides good backfill and foundation support.
- For ASU Area in Zone-01 the natural ground water table is available at minimum depth of 0.60m to maximum 1.00m.
- For ASU Area in Zone-02 the submerged water level is 0.00m.
- For CSU Area in Zone-I the natural ground water table is available at minimum depth of 3.00m to maximum 4.00m.
- For CSU Area in Zone-II the natural ground water table is available at minimum depth of 0.00m to maximum 1.00m.
- For CSU Area in Zone-III the natural ground water table is available at minimum depth of 3.50m to maximum 4.50m.
- For CSU Area in Zone-IV the natural ground water table is available at minimum depth of 0.90m to maximum 1.50m.