

NOTES:
1) ALL DIMENSIONS ARE IN mm UNLESS CO-ORDINATES AND LEVELS ARE IN m UNLESS OTHERWISE STATED.
2) UNDER GROUND PIPE SHALL BE TREATED APPROPRIATELY TREATMENT AS PER IS:10501.
3) MINOR MODIFICATION MAY BE CARRIED AT SITE TO SUIT SITE CONDITION.
4) THE SOURCE OF WATER SUPPLY FOR THE DOMESTIC AND OTHER USE WILL BE FROM LOCAL MUNICIPALITY WATER SUPPLY.

Please submit separate drawing for DV house.
This drawing to be followed for Piping layout only

adani	Categories:
	☐ Cat-I Approved. Good for Manufacturing/Construction/Fabrication
	☒ Cat-II Approved with minor comments. No resubmission is required. To be incorporated in As-Built. Good for Manufacturing/Construction/ Fabrication subject to incorporation of comments
	☐ Cat-III Approved. Released for Manufacturing/fabrication/construction subjected to incorporation of comments. Modification as Noted. Resubmission is required.
Reviewer	☐ Cat-III Not Approved
Approver	☐ Cat-IV For Information & Records
Note: "Approval of this document does not absolve the Contractor/ Supplier/ Fabricator from fulfilling Contractual obligations in any way"	

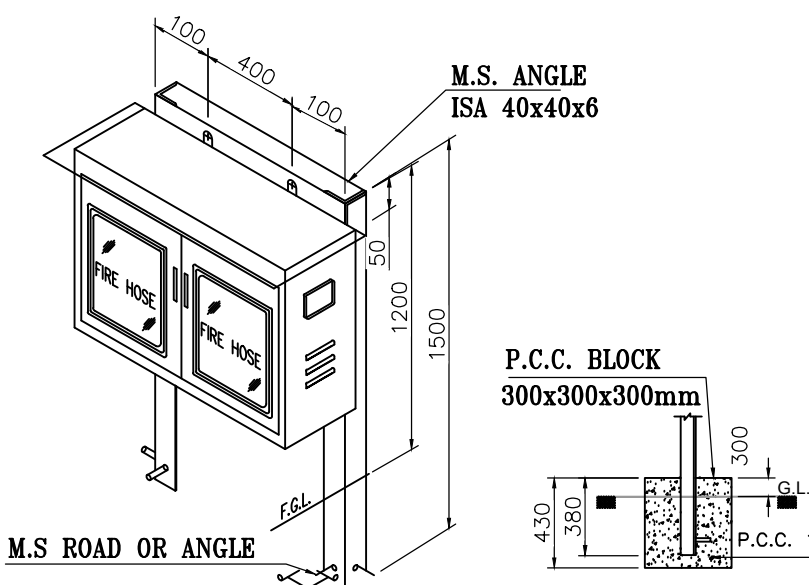
LEGEND:-

SYMBOL	DESCRIPTION
	HYDRANT PIPE A.G.
	HYDRANT PIPE (FUTURE)
	HYDRANT PIPE U.G.
	SINGLE HEADED HYDRANT VALVE (SH)
	GATE VALVE
	HUME PIPE
	HOSE BOX
	RISE/DROP
	PIPE SUPPORT

BILL OF MATERIAL

SR. No.	DESCRIPTION	SIZE (MM)	MOC	DESCRIPTION	QTY.
1	PIPE (A.G.)	250NB	M.S.	IS:3589 (5mm Thk.)	1008Mtrs.
2	PIPE (U.G.)	250NB	M.S.	IS:3589 (5mm Thk.)	282Mtrs.
3	PIPE (A.G.)	150NB	M.S.	IS:1239 Part -1 (Med.)	60Mtrs.
4	PIPE (U.G.)	150NB	M.S.	IS:1239 Part -1 (Med.)	66Mtrs.
5	PIPE (A.G.)	100NB	M.S.	IS:1239 Part -1 (Med.)	78Mtrs.
6	PIPE (U.G.)	100NB	M.S.	IS:1239 Part -1 (Med.)	18Mtrs.
7	PIPE (A.G.)	80NB	M.S.	IS:1239 Part -1 (Med.)	290Mtrs.
8	PIPE (U.G.)	80NB	M.S.	IS:1239 Part -1 (Med.)	18Mtrs.
9	SINGLE HEADED HYDRANT VALVE	63NB	G.M.	IS : 5290	23 NOS.
10	HOSE PIPE	63NBx15M	-	IS : 636 (TYPE-A)	46 NOS.
11	HOSE BOX (SUITABLE FOR 2x15M HOSE LENGTH)		C.I.	16 S.W.G. WITH 3 MM THICK GLASS	23 NOS.
12	BRANCH PIPE WITH NOZZLE	63NB	G.M.	IS : 903	23 NOS.
13	GATE VALVE	100NB	C.I.	BS : 5150	02 NOS.
14	HUME PIPE (FOR 250NB SYS PIPE)	450MM DIA	R.C.C.	IS:458 NP3 CLASS	62 Mtrs.
15	HUME PIPE (FOR 150NB TO 80NB SYS. PIPE)	300MM DIA	R.C.C.	IS:458 NP3 CLASS	52 Mtrs.

TYP. MOUNTING ARRANGEMENT FOR HOSE BOX



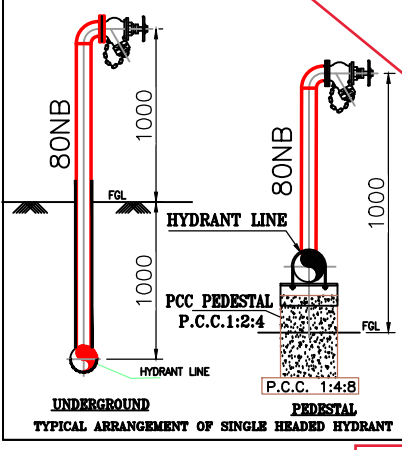
please consider UG pipe with overall length of 5 metre

Control Room area is subject to clearance of Plan layout

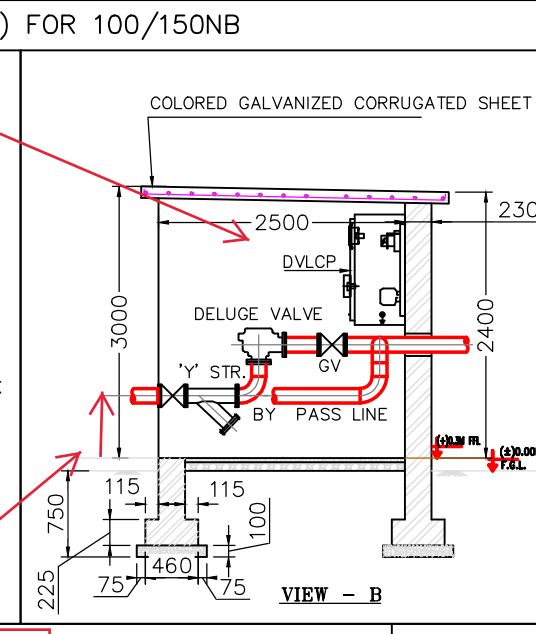
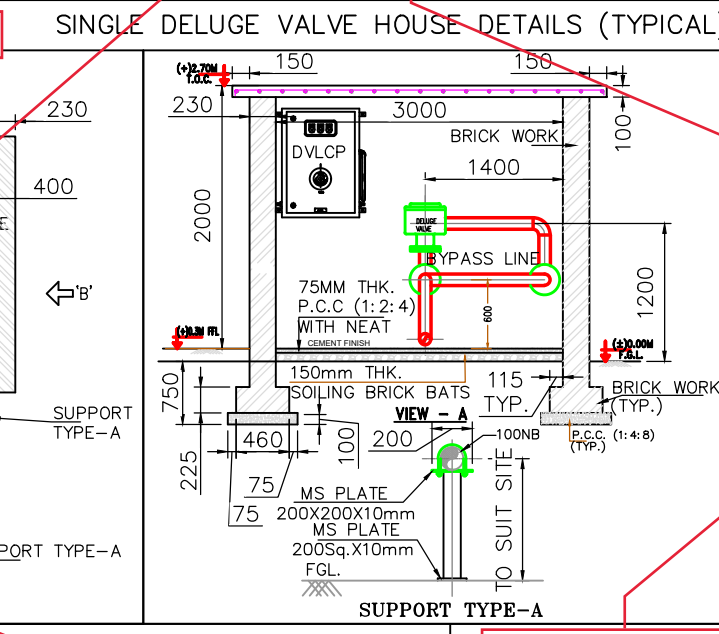
100 mm PVC pipe to be embedded in floor for cabling work. same to be extended to nearest cable trench

Plan & section not matching. All the accessories can be accommodated in the DV house

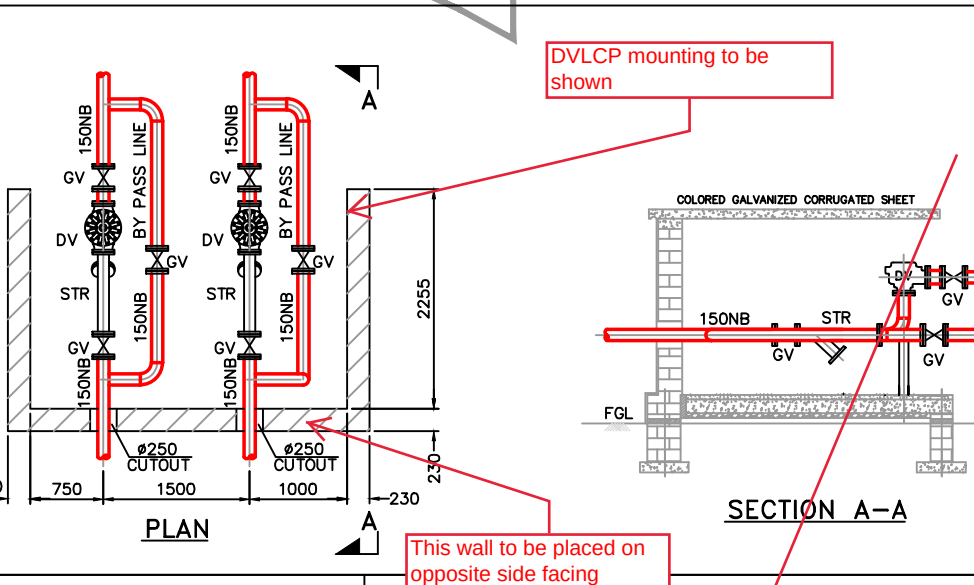
TYP. DETAIL OF SINGLE HEADED HYDRANT VALVE AT ABOVE GROUND HEAD



Trafo/reactor side



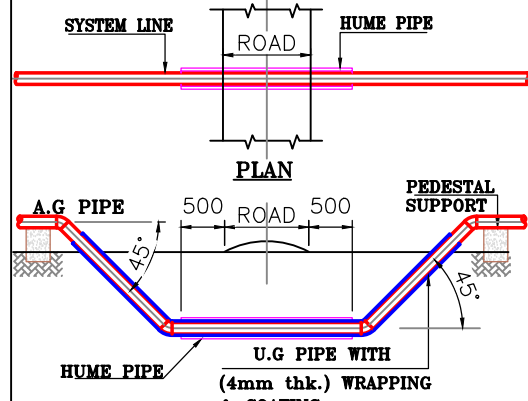
TYPICAL MOUNTING ARRANGEMENT OF DOUBLE DELUGE VALVE HOUSING



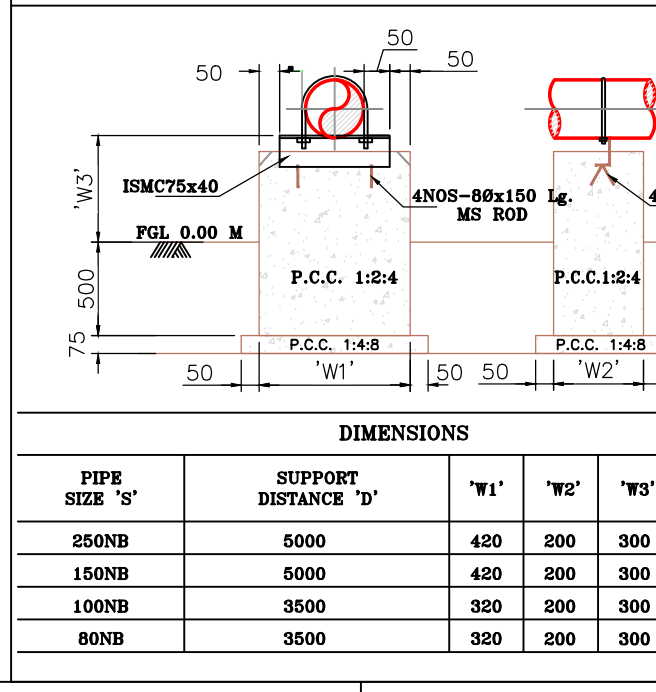
DVLCV mounting to be shown

This wall to be placed on opposite side facing transformer

TYP. DETAIL OF ROAD CROSSING



TYPICAL PEDESTAL SUPPORT DETAIL



3	15.07.2021	REVISED AS PER CLIENTS COMMENT		
2	15.06.2021	REVISED AS PER CLIENTS COMMENT		
1	04.09.2020	REVISED AS PER LATEST LAYOUT		
0	02.03.2020	FIRST SUBMISSION		
REV.	DATE	REMARKS	APPROVAL CAT.	ISSUED FOR CONSTRU.

CLIENT WRSS-21(A) Transco Limited (WTL)

EPC TECHNO ELECTRIC & ENGG. CO. LTD.
ENGINEERS & CONSTRUCTORS
KOLKATA, INDIA

PO ref PO NO. - 4500313982 DATED : 21.10.2019

S0 ref SO NO. - 5700277667 DATED : 23.10.2019

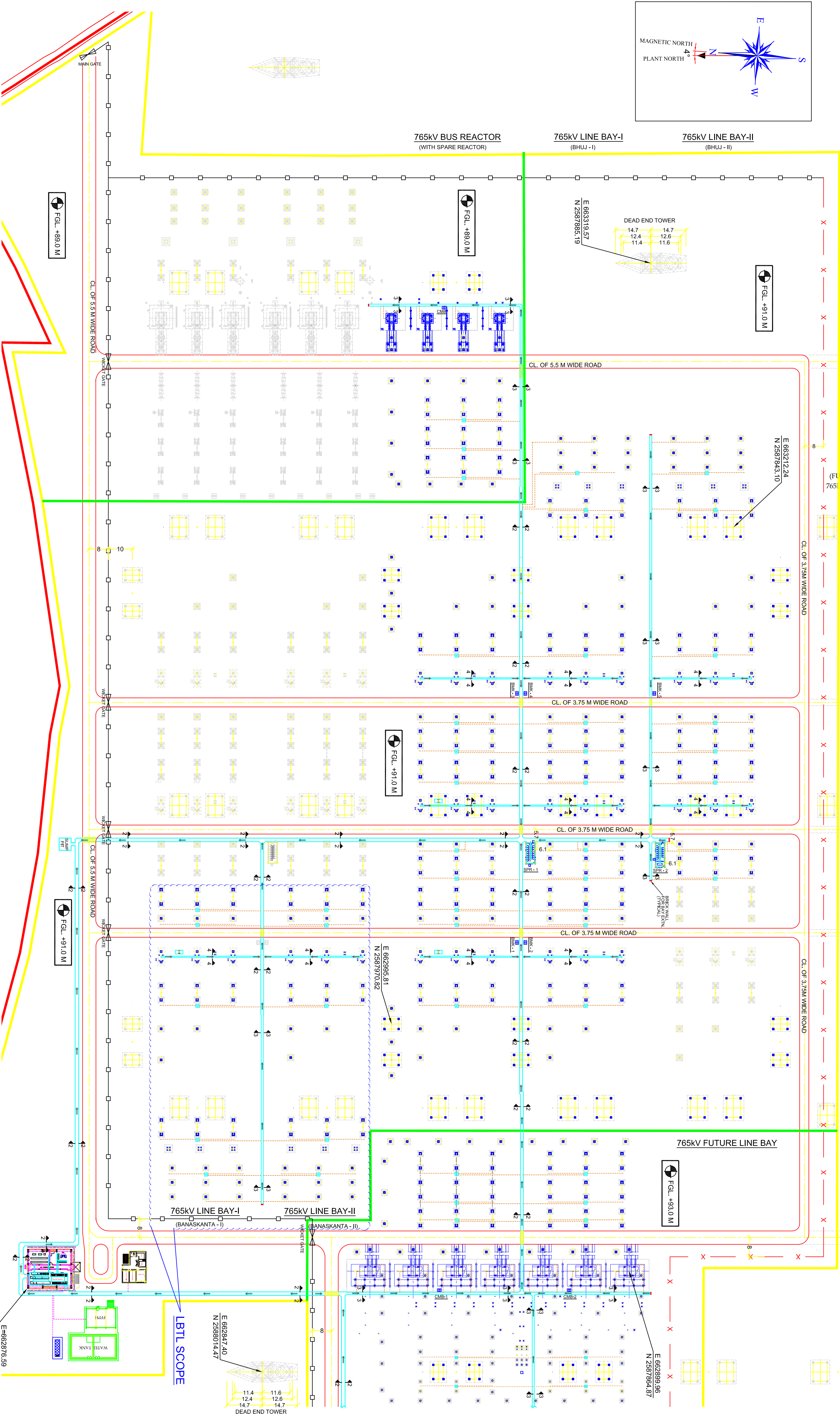
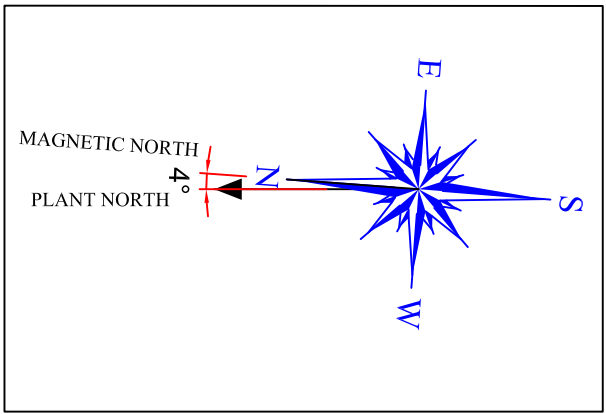
SUBSTATION 765/400KV LAKADIA SUBSTATION

TITLE	DRAWN BY	DS
PIPING LAYOUT OF HYDRANT & SPRAY SYSTEM FOR LAKADIA S/S.	DESIGNED BY.	AM
	CHECKED BY.	BS
	APPROVED BY.	BS
	SCALE	1:1300

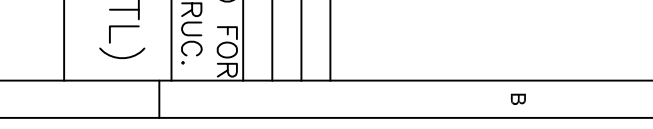
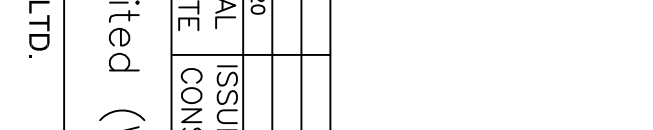
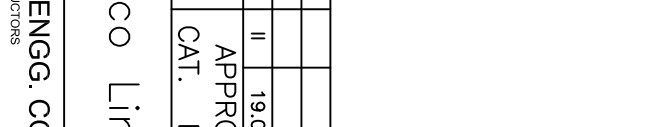
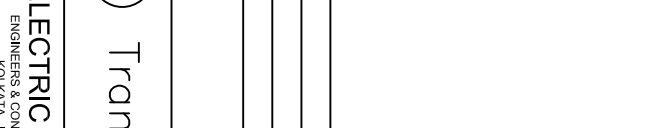
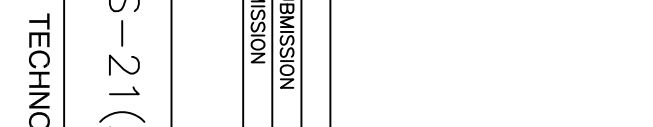
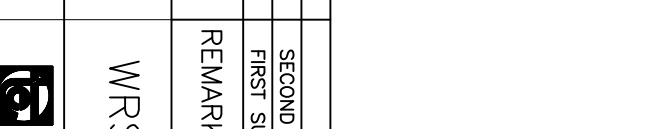
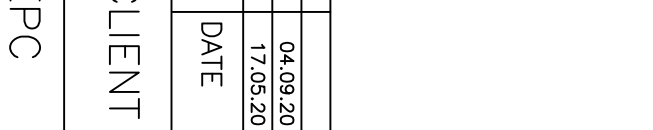
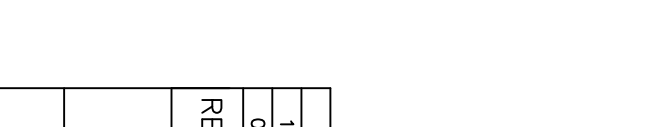
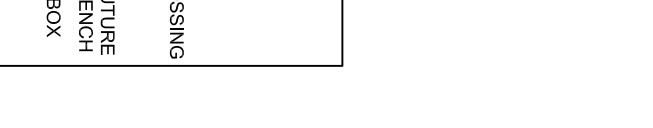
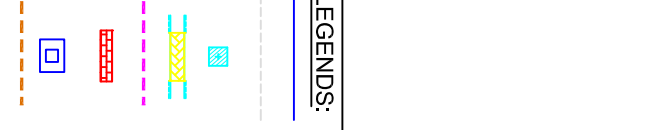
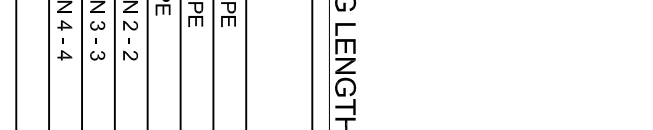
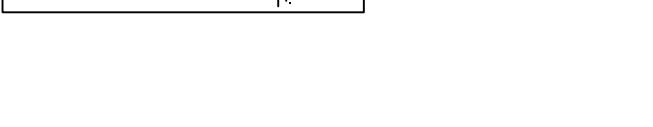
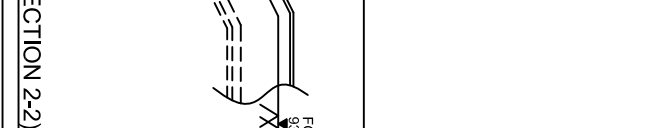
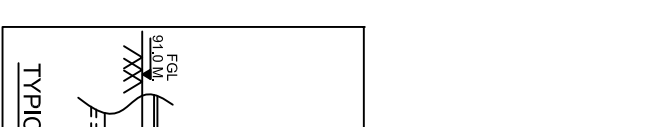
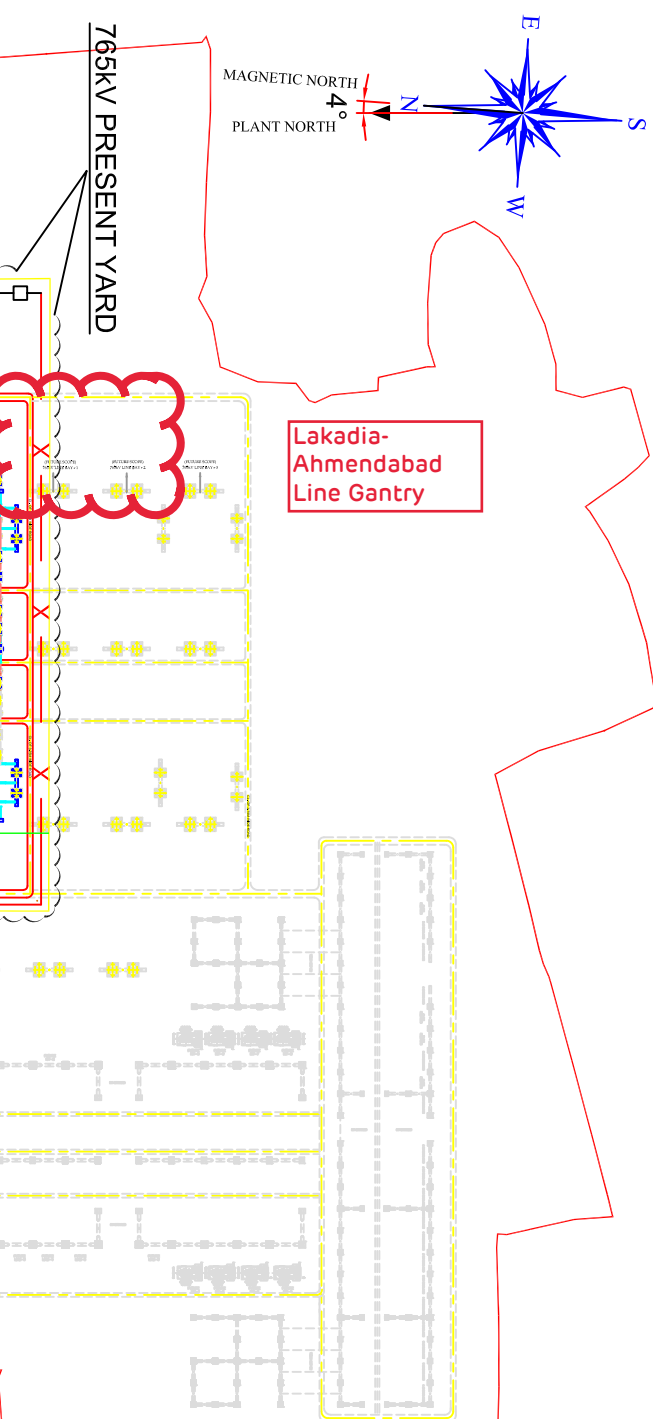
TECHNO DWG. NO. AD-TECH-LAK-FF-04

WTL DWG. NO.

SHEET NO. 01 REV. 03



765KV SWITCHYARD



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Print: 08-Jan-21

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	1	2	3	4	5	6	7	8																																													
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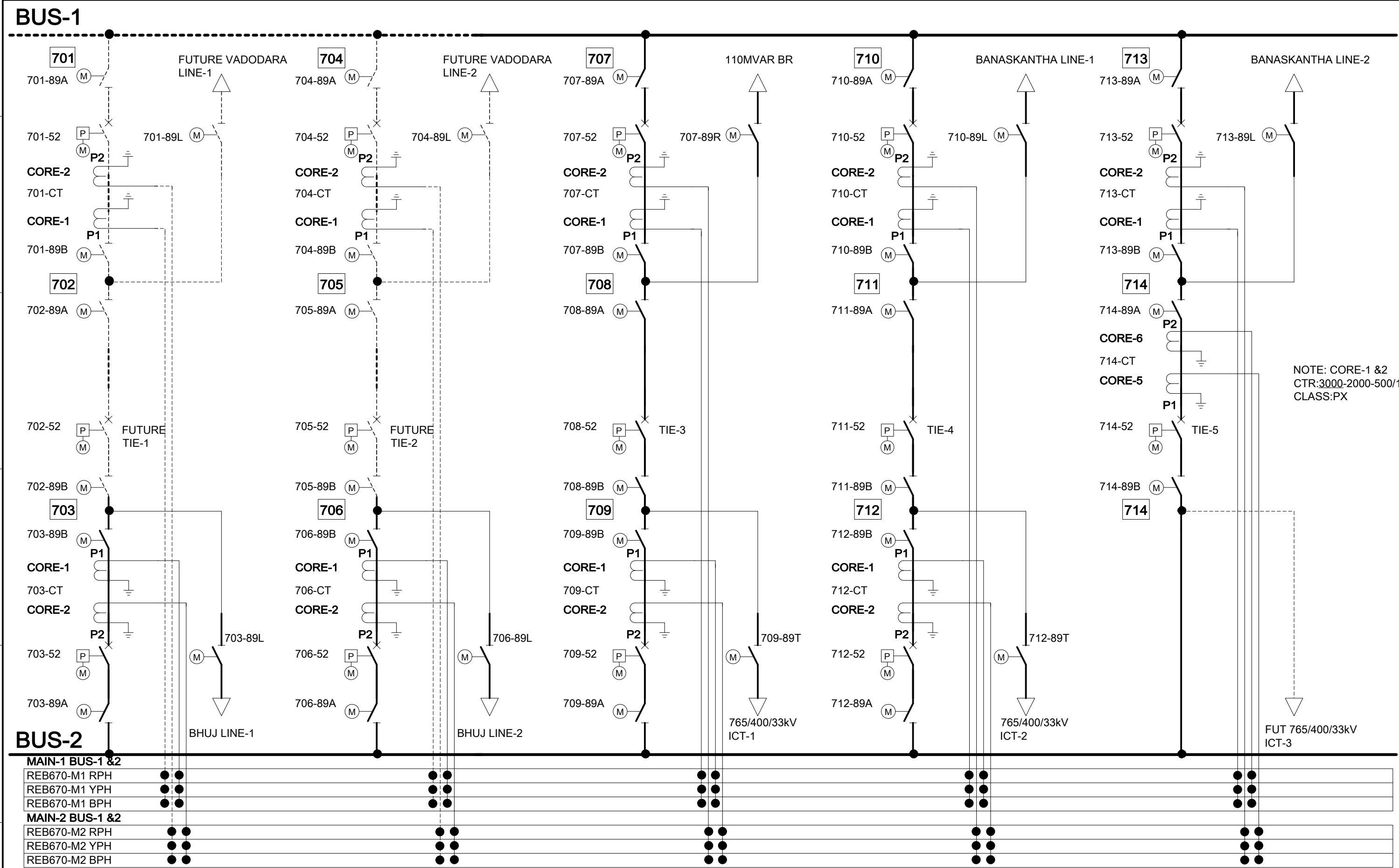
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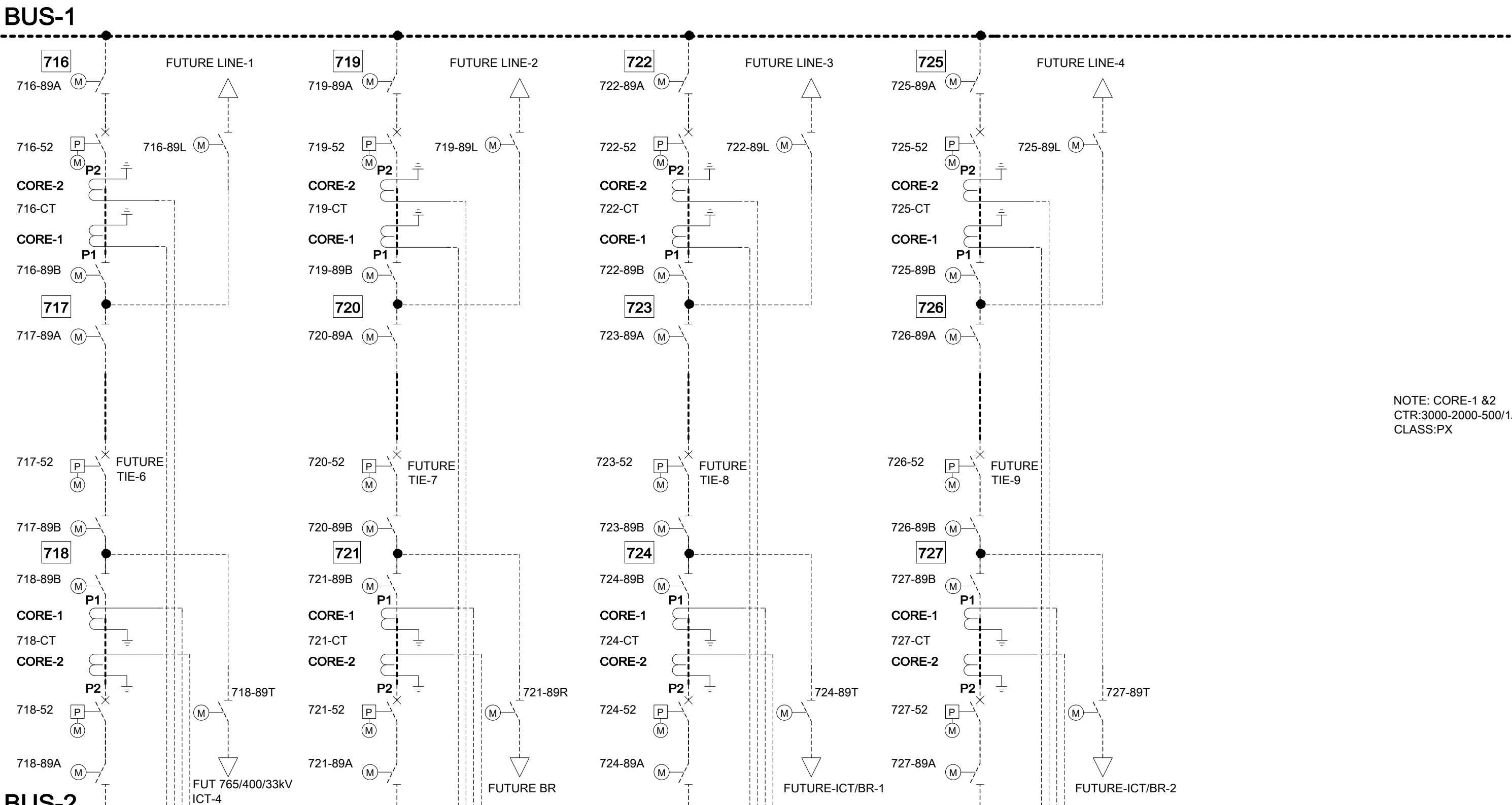
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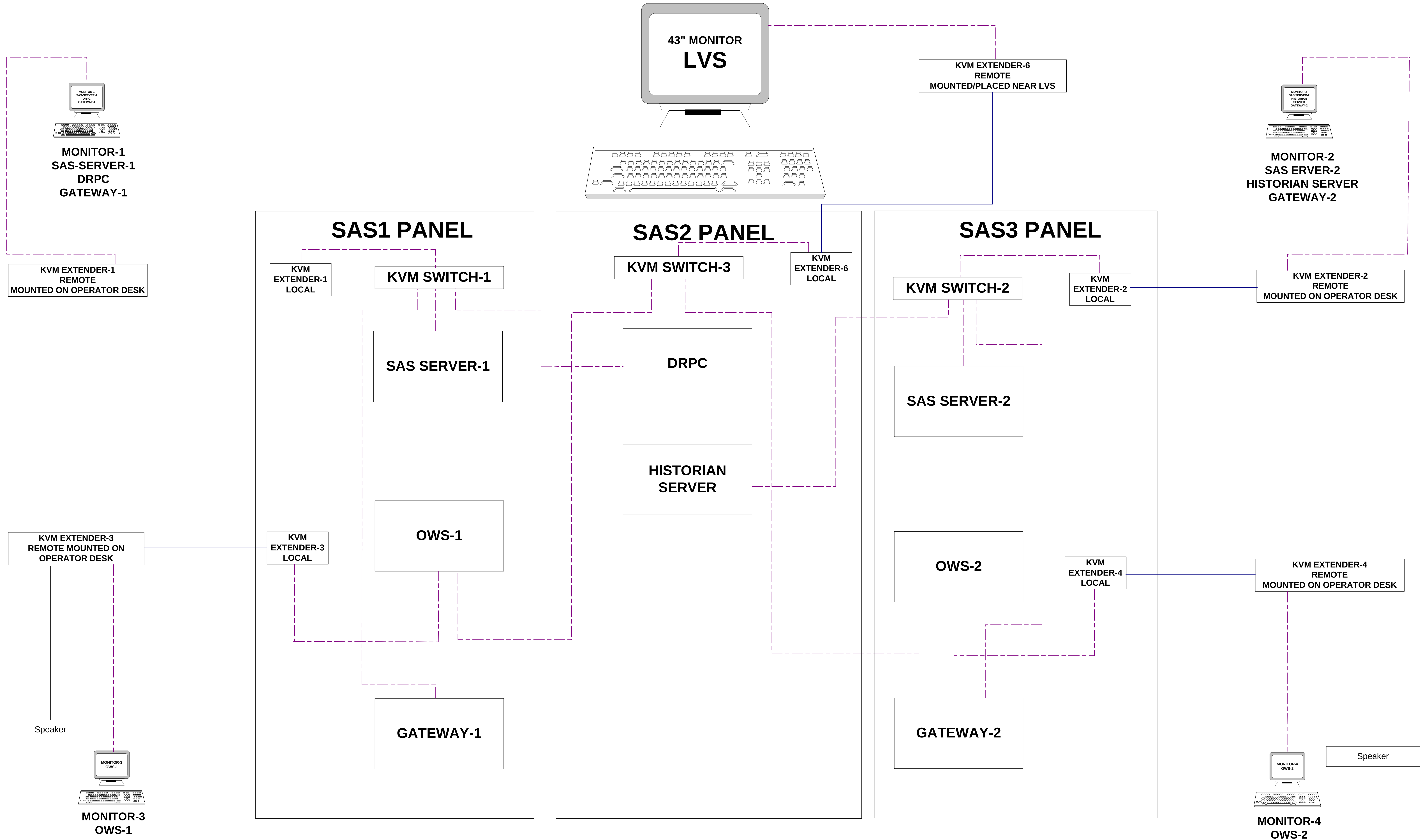
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1MYN691003-102(A3)REV01									

765/400kV LAKADIA SUBSTATION
- COMMUNICATION CONNECTIVITY DIAGRAM
CLIENT : WRSS 21-(A) TRANSCO LIMITED

KVM Switch and KVM Extender Connectivity
with CPU's and Monitors



LEGEND:-

--- VGA CABLE WITH USB PORT FOR KB & MOUSE CONNECTIVITY

--- CAT6 LAN CABLE WITH RJ45 CONNECTORS

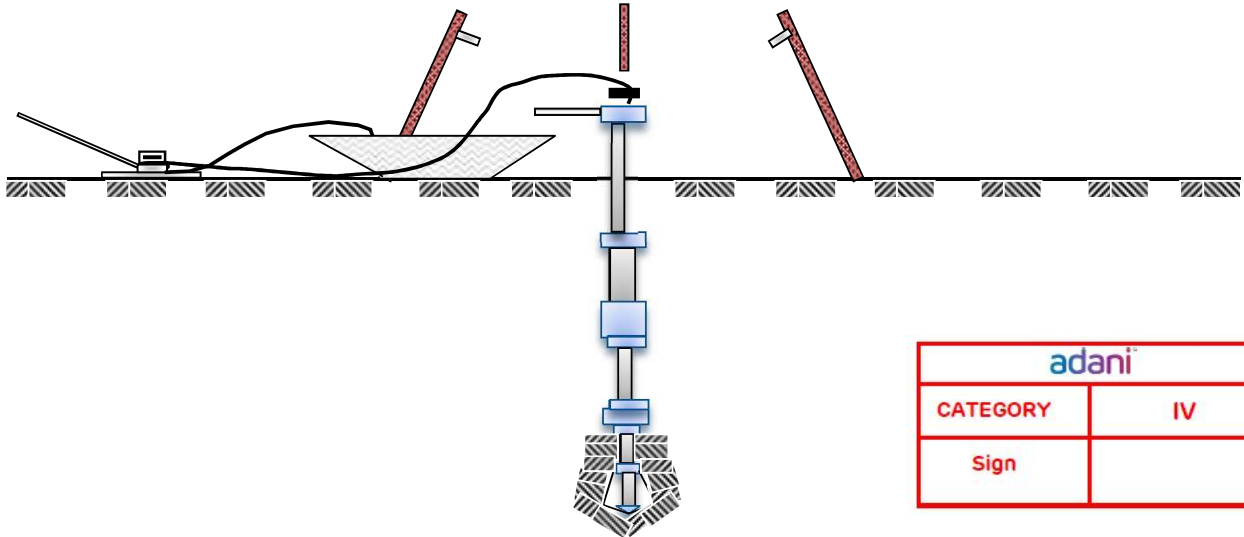
Based on Sales Order: 300029961		Title: 765/400kV LAKADIA SUBSTATION	
Prepared: EDS		WRSS 21-(A) TRANSMISSION LIMITED	
Approved: PSK		TECHNO ELECTRIC & ENGG. CO LTD	
Project: 765/400kV LAKADIA SUBSTATION WRSS 21-(A) TRANSMISSION LIMITED TECHNO ELECTRIC & ENGG. CO LTD		Doc. des: COMMUNICATION CONNECTIVITY DIAGRAM	Ref. des:
Resp. dept: PG-GA		Rev. ind: 00	Lang: English
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GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

1 of 194

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BRIEF DETAIL OF PROJECT SITE

CLIENT	: Techno Electric & Engineering Co. Ltd		
AGENCY	: _		
CONSULTANT	: --		
NAME OF WORK	: Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani		
REF.No.	: W.O. No 0756LA/19-20/25535, Dtd.10/10/2019		
PROJECT No.	: BRD/GIR/4538/284001/01-15	REPORT DT.	: 14/3/2020
JOB No.	: 4538/284001	SAMPLE NO.	: 01-15
REF. Code	: IS : 2720, IS : 1892 - 1997		
LOCATION	: Lakadia , Gujarat	BORE HOLE DEPTH	: 10 meter
BOREHOLE ID	: BH-1 to BH-15	BORE HOLE IN	: Existing Ground
BOREHOLE DIA	: 150mm	WATER TABLE	: Encountered
TYPE OF BORING	: Calax Rotary Drilling Machine		
FIELD WORK STARTING DATE	: 18/12/2019		
FIELD WORK COMP. DATE	: 28/2/2020		
NO. OF BORE HOLE	: Fifteen		

1.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity and Safe bearing pressure

- Fifteen boreholes executed up to the depth 10 meter below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity and safe bearing pressure of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

The actual field investigation work was started on 18/12/2019 and Completed on Dated 28/2/2020.

2.0 SUMMARY OF BOREHOLE :

Field work of executed boreholes is summarised as follows,

Sr.no.	At Site	Location ID	Filed work started on	Filed work completed on	Water table (below EGL)	Depth of investigation
1	Lakadia , Gujarat	BH-1	18/12/2019	18/12/2019	2.5m	10.0 m
2		BH-2	18/12/2019	19/12/2019	5.5m	10.0 m
3		BH-3	20/12/2019	20/12/2019	5.0m	10.0 m
4		BH-4	20/12/2019	20/12/2019	Not Encountered	10.0 m
5		BH-5	20/12/2019	20/12/2019	Not Encountered	10.0 m
6		BH-6	23/12/2019	23/12/2019	Not Encountered	10.0 m
7		BH-7	28/02/2020	28/02/2020	4.2m	10.0 m
8		BH-8	27/02/2020	27/02/2020	4.7m	10.0 m
9		BH-9	27/02/2020	27/02/2020	4.6m	10.0 m
10		BH-10	26/02/2020	26/02/2020	4.0m	10.0 m
11		BH-11	26/02/2020	26/02/2020	4.3m	10.0 m
12		BH-12	25/02/2020	26/02/2020	5.4m	10.0 m
13		BH-13	21/02/2020	22/02/2020	3.5m	10.0 m
14		BH-14	24/02/2020	24/02/2020	4.0m	7.5 m
15		BH-15	21/02/2020	21/02/2020	4.0m	10.0 m

Note: Depth of termination of borehole and nos. of boreholes are investigated as directed by Client/site incharge.

3.0 SUB SURFACE EXPLORATION

3.1 DRILLING:

Fifteen borehole of 150mm diameter are drill up to the 10 meter. Where caving of the borehole occurred, casing was used to keep the borehole stable. The work was in general accordance with IS: 1892 – 1997.

3.1.1 DISTURBED SAMPLES:

Disturbed representative samples were collected, logged, labelled and placed in polythene bags.

3.1.2 UNDISTURBED SAMPLES:

Undisturbed soil samples are collected in 100 mm diameter thin walled sampler (Shelby tube) from the borehole. The sampler used for the sampling had smooth surface and appropriate area ratio and cutting edge angle thereby minimizing disturbance of soil during sampling. Samples are logged and labelled properly and transfer to the laboratory for further testing.

3.1.3 WATER TABLE:

Water table was encountered during the sub soil exploration work carried out in the month of December- 2019 & February - 2020

Water level fluctuations due to seasonal variations, amount of rainfall, runoff and other factors were not evident at the time of filed work. Trapped or "Perched" water could occur within low permeable strata.

3.1.4 METHOD OF SAMPLING:

Sampler is coupled together with a sampler head to form a sampling assembly. The sampler head provide a non-flexible connection between the sampling tube and the drill rods. Vent holes are provided in the sampler head to allow escape of water from the top of sampler tube during penetration. The sampling tubes are made free from dust and rust. Coating of oil is applied on both sides to obtain the undisturbed samples in best possible manner.

The sampler is then lowered inside the bore hole on a string of rods and driven to a pre-determined level. On completion of driving the sampler is first rotated within the borehole to shear the soil sample at bottom and then pulled out. Upon removal of the sampling tubes, the length of sample in the tube is recorded. The disturbed material in the upper end of the tube, if any, is completely removed before sealing.

The soil at the lower end of the tube is trimmed to a distance of about 10 to 20 mm. After cleaning and inserting an impervious disc at each end, both ends are sealed. The empty space in the sampler, if any, is filled with the moist soil, and the ends covered with tight wrapper. The identification mark is then made on each sample.

3.2 STANDARD PENETRATION TEST:

The standard penetration tests are conducted in each bore as per IS: 2131: 1981 (Reaffirmed 2002).

The split spoon sampler resting on the bottom of bore hole is allowed to sink under its own weight, then the split spoon sampler is seated 15 cm with the blows of hammer falling through 750mm. The driving assembly consists of a driving head and a 63.5 kg weight.

It is ensured that the energy of the falling weight is not reduced by friction between the drive weight and the guides or between ropes. The rods to which the sampler is attached for driving are straight, tightly coupled and straight in alignment. Thereafter the split spoon sampler is further driven by 30cm. The number of blows required to drive each 15cm penetration is recorded. The first 15cm of drive considered as seating drive. The total blows required for the second and third 15cm penetration is termed as a penetration resistance - N value. The N- values for each bore hole are given in borelogs

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Triaxial Shear Test (UU) (IS: 2720 Part 11, 1992)
8. Direct Shear Test (IS: 2720, Part 13, 1992)
9. One Dimensional Consolidation Test (IS: 2720 Part 15, 1992)

4.A.1 Natural Moisture Content Test (IS: 2720, 1992 Part 2)

Test procedure conforms to IS: 2720 - Part - 2. A moisture cup is loosely filled with soil sample and weighed with lid. It is then kept in oven with lid removed and maintained at temperature of oven at 110oC for 24 hours. The lid of the container is then replaced and the dry weight found out. The percentage of water content is calculated using the formula.

$$W = ((W2 - W3) / (W3 - W1)) \times 100$$

Where,

W1 = weight of container with lid, in g.

W2 = weight of container with wet soil, in g.

W3 = weight of container with dry soil, in g.

W = moisture content (%)

4.A.2 Grain Size Analysis (IS: 2720, 1992 Part 4)

Testing procedure generally conforms to IS: 2720 Part 4. Both sieve and hydrometer analysis has been carried out.

Sieve Analysis: Sieve analysis is done by wet sieving method. Oven dried soil is washed through 75m IS sieve. Fraction retained was oven dried and particle size analysis carried out using sieve shaker by passing through the IS sieve.

Hydrometer Analysis : 50 g of soil 75μ passing IS sieve was mixed with 33 g passing sodium hexa-meta-phosphate and 7g sodium carbonate and soil suspension prepared. Suspension was made up to 1000 ml distilled water and then shaken thoroughly. Hydrometer is immersed to a depth slightly below its floating position and then allowed to float freely. Hydrometer readings are taken at 10, 20, 30 and 45 sec, subsequently at 1, 2, 4, 8,15 and 30 minutes and finally at 1, 2, 4, 8 and 24 hour interval. Diameter of the particle in suspension at any sampling time't' is calculated using "Stokes" formula and the percentage finer was calculated. In the semi log graph, silt and clay fractions are indicated along with coarser fractions.

4.A.3 Atterberg's Limits Test (IS: 2720, Part 5 1992)

Liquid limit and plastic limit test on cohesive and semi cohesive samples has been done as per procedure in IS 2720 (Part 5).

Liquid Limit: Liquid limit and plastic limit test on cohesive has been done as per procedure in IS 2720 (Part 5) using the more reliable "cone penetrometer", method where errors of grove cutting involved in Casagrande's device are minimized. In cone penetrometer test about 200 g of passing 425 μ sieve is taken mixed with requisite water, placed in cup and compacted lightly in 3 layers. The tip of penetrometer is adjusted such that it just touches soil surface. The needle is allowed to plunge slowly under its own weight for 5 seconds and penetration in mm is recorded. The water content is adjusted such that penetration is between 16-26mm. The following relationship is used to evaluate liquid limit.

Plastic Limit: About 20g of oven dried soil passing through 425 μ sieve is mixed with sufficient quantity of water to become plastic enough to be easily shaped into a ball. A portion of this ball is rolled on a glass plate with the palm into a thread of uniform diameter of 3mm. The corresponding water content represents the plastic limit of the soil.

Plastic Index: PI = Liquid limit – Plastic limit.

Shrinkage Limit (IS : 2720, Part 6, 1992): It is the maximum water content expressed as percentage of oven-dry weight at which any further reduction in water content will not cause a decrease in volume of the soil mass is calculated as follows:

$$SL = W - ((V - V_0) / W_0) \times 100$$

Where,

SL = Shrinkage limit in %.

W = Moisture content of wet soil pat in %.

V = Volume of wet soil pat in ml.

V₀ = Volume of dry soil pat in ml.

W₀ = Weight of oven-dried soil pat in gm.

4.A.4 Specific Gravity Test (IS: 2720, Part 3 1992)

The specific gravity of soil solids is determined by a 50 ml density bottle. The weight (W1) of the empty dry bottle is taken first. A sample of oven-dried soil about 10-20 g cooled in a desiccators, is put in the bottle, and weight (W2) of the bottle and the soil taken. The bottle is then filled with distilled water gradually removing the entrapped air either by applying Vacuum of 20mmhg & weighted as (W3) of the bottle, soil and water (full up to the top) is then taken. Finally the bottle is emptied completely and thoroughly washed and clean water is filled to the top and the weight (W4) is taken.

$$G = (W2 - W1) / [(W4 - W1) - (W3 - W2)]$$

4.A.5 Free Swell Value Test (IS: 2720, Part 40 1977)

Free Swell Index Test was conformed as per IS: 2720 – Part – 40 - 1977. In this test 10 gm of soil passing IS sieve 425 μ is taken. Two graduated cylinders of 100 ml capacity are taken. One cylinder is filled with Kerosene oil and the other with distilled water and soil. Remove entrapped air by shaking well and stirring using a glass rod. Allow the soil in both the jars to settle for a sufficient time (not less than 24 hours) for the soil sample to attain equilibrium state of volume without any further changes. Free swell index is calculated as follows:

$$\text{F.S.I (\%)} = [(V_d - V_k) / V_k] \times 100$$

Where,

V_d = The volume of soil sample read from the graduated cylinder containing distilled water.

V_k = The volume of soil sample read from the graduated cylinder containing Kerosene.

4.A.6 Swell Pressure Test (IS: 2720, Part 41, 1977)

The swell pressure tests are carried out at field dry density with zero percent moisture content and by constant and volume method. An oven dry soil specimen is compacted into the specimen ring with the specimen kept in between two porous stone saturated in boiling water providing a filter paper between the soil specimen and the porous stones. The loading block is then positioned centrally on the top of the porous stone. The assembly is then placed on the platen of loading unit. The load measuring proving ring is attached to the load frame and placed in contact with the consolidation cell without any eccentricity. A direct strain measuring dial gauge is fitted to the cell. The specimen is then inundated with distilled water and allowed to swell. The initial reading of the proving ring is noted. The swelling of the specimen with increasing volume is obtained in the strain measuring load gauge. The specimen is kept at constant volume by adjusting the strain dial gauge always at original reading. This adjustment is done at every 0.1mm of swell or earlier. The swell pressure is then calculated from the difference between the final and initial dial readings of the proving ring. Swell pressure (Kg/cm²) is calculated as follows: $SP = ((\text{Final Dial Gauge reading} - \text{Initial Dial Gauge reading}) / \text{Area of specimen}) \times \text{Calibration factor of the proving ring}$.

4.A.7 Triaxial Shear Test (UU) (IS: 2720 Part 11, 1992)

The extracted specimen is then placed in triaxial cell pedestal. The cell is assembled and placed on loading machine. A cell pressure through an operating fluid (oil) was applied. The plunger was made to have proper contact with specimen. A compressive force at a constant strain rate of 1.25 mm/min is applied, till the failure occurred within a period of 5-15 minutes or till the failure of 20% strain was removed, cell chamber cleaned and test continued on a new specimen. The test was repeated on three different specimens at three different cell pressures as per standard practice. Mohr-Coulomb envelopes were drawn for three stress values recorded and total stress parameters interpreted from the Mohr-Coulomb graph.

4.A.8 Direct Shear Test (IS: 2720, Part 13, 1992)

Direct shear test is carried out using shear box with the specimens (60mm x 60mm). Specimen with plain grid plate at the bottom of the specimen and plain grid plate at the top of the specimen is fitted into position in the shear box housing and assembly placed on the load frame. The serrations of the grid plates are kept at right angle to the direction of shear. The loading pad is kept on the top grid plate. The required normal stress is applied and the rate of longitudinal displacement shear stress application so adjusted that no drainage can occur in the sample during the test (1.25mm/min.). The upper part of the shear box is raised such that a gap of about 1mm is left between the two parts of the box. The test is conducted by applying horizontal shear load to failure or to 20 percent longitudinal displacement whichever occurs first. The test is repeated on identical specimens.

4.A.9 One Dimensional Consolidation Test (IS: 2720 Part 15, 1992)

Consolidation test was done to evaluate compressibility behavior of stiff / hard clayey silt. Procedure is described below. The empty consolidation ring W1 is weighed. Representative sample for testing is extruded and cut off, care being taken to ensure that the two plane faces of the resulting soil disc are parallel to each other. The soil sample thus obtained is trimmed flush with the top and bottom edges of the ring. A sample of soil similar to that in the ring taken from the trimmings is used for determining moisture content. The thickness of the specimen (H_0) is measured and it is weighed immediately (W2). The bottom porous stone is centered on the base of the consolidation cell. The ring and specimen is placed centrally on the bottom porous stone and then the loading cap is placed on top. The consolidometer is placed in position in the loading device and suitably adjusted. The dial gauge is then clamped into position for recording the relative movement between the base of the consolidation cell and the loading cap. A seating pressure of 0.05 kg/cm² is applied to the specimen. The consolidation cell is filled with distilled water. The specimen is then allowed to reach equilibrium for 24 hrs. The test is continued using a loading sequence, which would successively apply stress of 0.25, 0.5, 1.0, 2.0 , 4.0, 8.0 kg/cm² etc on the soil specimen. For each loading increment, after application of load, readings of the dial gauge are taken using a time sequence such as 0, 0.25, 4, 6.25, 9, 12.25, 16, 20.25, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225 min etc. up to 24 hr or 1. 1/4, 1/2, 1, 2, 4, 8, 15, 30, 60min, 2, 4, 8 and 24hr. These time sequences facilitate plotting of thickness or change of thickness of specimen against square root of time or against log time. The loading increment is left until readings become more or less constant. On completion of the final loading stage the specimen is unloaded by suitable pressure decrements. Dial gauge readings are taken as necessary during each stage of unloading. On completion of the decrement, the water is siphoned out of the cell and the consolidometer is rapidly dismantled after release of the final load. The specimen, preferably within the ring, is wiped free of water, weighed (W3) and thereafter placed in the oven for drying. Following drying, the specimen plus ring is reweighed (W4). E-log P curve is drawn and consolidation parameters deduced.

5(a) SAFE CAPACITY (for Open Foundation) FOR BH-01 TO BH-06

Looking to the proposed type of project, site conditions and sub soil stratification, RCC Open Foundation is recommended along with safe bearing capacity and safe bearing pressure at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) and soil bearing pressure (SBP) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c	=	<i>Cohesion</i>
q	=	<i>Overburden Pressure</i>
γ	=	<i>Density</i>
B	=	<i>Width of the Footing</i>
N_c, N_q, N_γ	=	<i>Bearing capacity Factor</i>
S_c, S_q, S_γ	=	<i>Shape Factor</i>
d_c, d_q, d_γ	=	<i>Depth Factor</i>

Following parameters are adopted out of executed bore hole considering worst soil parameter for the evaluation of bearing capacity for shallow foundation.

Properties	
Cohesion (kg/cm ²)	0.10
Angle of Internal Friction (Degree)	20
Dry Density (in gm/cc)	1.617
Specific Gravity	2.59
Factor of Safety	3.00
Void ratio, e (Computed)	0.6017
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for various sizes of individual footings having vertical static load intensity is evaluated as in TABLE- 1 , SAFE BEARING CAPACITY AND SAFE BEARING PRESSURE .

TABLE- 1 , SAFE BEARING CAPACITY AND SAFE BEARING PRESSURE					
Foundation Details			Safe Bearing Capacity (SBC) in t/m ²	Permissible Settlement of 40mm for RCC Open footing (SBP) in t/m ²	Permissible Settlement of 25mm for RCC Open footing (SBP) in t/m ²
Type	Depth below EGL (Mtr.)	Size in (Mtr.)			
RCC Open Foundation	1.50	1.0 X 1.0	11.84	+15	+15
		1.5 X 1.5	11.17	+14	+14
		2.0 x 2.0	10.99	+14	+14
		2.5 x 2.5	11.00	+14	+14
		3.0 x 3.0	11.12	+14	12.9
		3.5 x 3.5	11.28	+14	10.68
		4.0 x 4.0	11.48	+14	9.14
		4.5 x 4.5	11.71	12.72	7.95
		5.0 x 5.0	11.95	11.32	7.08
		5.5 x 5.5	12.20	10.29	6.43
		6.0 x 6.0	12.46	9.33	5.83
	2.00	1.0 X 1.0	14.04	+17	+17
		1.5 X 1.5	12.96	+17	+17
		2.0 x 2.0	12.58	+16	+16
		2.5 x 2.5	12.47	+16	+16
		3.0 x 3.0	12.50	+16	13.71
		3.5 x 3.5	12.60	+16	11.33
		4.0 x 4.0	12.76	15.48	9.68
		4.5 x 4.5	12.95	13.60	8.50
		5.0 x 5.0	13.16	11.96	7.48
		5.5 x 5.5	13.39	10.64	6.65
		6.0 x 6.0	13.63	9.54	5.96

Foundation Details			Safe Bearing Capacity (SBC) in t/m ²	Permissible Settlement of 40mm for RCC Open footing (SBP) in t/m ²	Permissible Settlement of 25mm for RCC Open footing (SBP) in t/m ²
Type	Depth below EGL (Mtr.)	Size in (Mtr.)			
RCC Open Foundation	2.50	1.0 X 1.0	16.38	+20	+20
		1.5 X 1.5	14.85	+20	+20
		2.0 x 2.0	14.23	+18	+18
		2.5 x 2.5	13.98	+18	18.03
		3.0 x 3.0	13.92	+18	14.43
		3.5 x 3.5	13.96	+18	12.21
		4.0 x 4.0	14.07	16.05	10.03
		4.5 x 4.5	14.22	15.00	9.37
		5.0 x 5.0	14.41	12.39	7.74
		5.5 x 5.5	14.61	11.00	6.88
		6.0 x 6.0	14.83	9.97	6.23
	3.00	1.0 X 1.0	18.85	+24	+24
		1.5 X 1.5	16.82	+24	+24
		2.0 x 2.0	15.95	+22	+22
		2.5 x 2.5	15.55	+22	19.07
		3.0 x 3.0	15.39	+20	15.02
		3.5 x 3.5	15.36	+19	12.53
		4.0 x 4.0	15.42	17.09	10.68
		4.5 x 4.5	15.53	14.62	9.14
		5.0 x 5.0	15.67	12.69	7.93
		5.5 x 5.5	15.85	11.53	7.21
		6.0 x 6.0	16.05	10.32	6.45

Note : 1) Minimum value of SBC & SBP shall be considered in design of foundation.

5(b) SAFE CAPACITY (for Open Foundation) (for BH-07 to BH-15)

Looking to the proposed type of project, site conditions and sub soil stratification, RCC Open Foundation is recommended along with safe bearing capacity and safe bearing pressure at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) and soil bearing pressure (SBP) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c	=	<i>Cohesion</i>
q	=	<i>Overburden Pressure</i>
γ	=	<i>Density</i>
B	=	<i>Width of the Footing</i>
N_c, N_q, N_γ	=	<i>Bearing capacity Factor</i>
S_c, S_q, S_γ	=	<i>Shape Factor</i>
d_c, d_q, d_γ	=	<i>Depth Factor</i>

Following parameters are adopted out of executed bore hole considering worst soil parameter for the evaluation of bearing capacity for shallow foundation.

Properties	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	30.00
Dry Density (in gm/cc)	1.543
Specific Gravity	2.64
Factor of Safety	3.0
Void ratio, e (Computed)	0.7110
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for various sizes of individual footings having vertical static load intensity is evaluated as in TABLE- 1 , SAFE BEARING CAPACITY AND SAFE BEARING PRESSURE .

TABLE- 1 , SAFE BEARING CAPACITY AND SAFE BEARING PRESSURE					
Foundation Details			Safe Bearing Capacity (SBC) in t/m ²	Permissible Settlement of 25mm for RCC Open footing (SBP) in t/m ²	Permissible Settlement of 40mm for RCC Open footing (SBP) in t/m ²
Type	Depth below EGL (Mtr.)	Size in (Mtr.)			
RCC Open Foundation	1.50	1.0 X 1.0	7.76	+15	+18
		1.5 X 1.5	7.97	+15	+18
		2.0 x 2.0	8.38	+15	+18
		2.5 x 2.5	8.89	+15	+18
		3.0 x 3.0	9.43	+15	+18
		3.5 x 3.5	10.00	+15	+18
		4.0 x 4.0	10.58	+15	+18
		4.5 x 4.5	11.18	+15	+18
		5.0 x 5.0	11.78	+15	+18
		5.5 x 5.5	12.38	+15	+18
		6.0 x 6.0	12.99	15.48	+18
	2.00	1.0 X 1.0	10.50	+18	+20
		1.5 X 1.5	10.37	+18	+20
		2.0 x 2.0	10.62	+18	+20
		2.5 x 2.5	11.03	+18	+20
		3.0 x 3.0	11.50	+18	+20
		3.5 x 3.5	12.03	+18	+20
		4.0 x 4.0	12.57	18.38	+20
		4.5 x 4.5	13.14	17.94	+20
		5.0 x 5.0	13.72	17.32	+20
		5.5 x 5.5	14.31	16.34	+20
		6.0 x 6.0	14.90	19.98	+20

Foundation Details			Safe Bearing Capacity (SBC) in t/m ²	Permissible Settlement of 25mm for RCC Open footing (SBP) in t/m ²	Permissible Settlement of 40mm for RCC Open footing (SBP) in t/m ²
Type	Depth below EGL (Mtr.)	Size in (Mtr.)			
RCC Open Foundation	2.50	1.0 X 1.0	13.52	+20	+25
		1.5 X 1.5	12.97	+20	+25
		2.0 x 2.0	13.01	+20	+25
		2.5 x 2.5	13.28	+20	+25
		3.0 x 3.0	13.67	+20	+25
		3.5 x 3.5	14.13	+20	+25
		4.0 x 4.0	14.64	19.05	+25
		4.5 x 4.5	15.17	19.78	+25
		5.0 x 5.0	15.72	17.93	+25
		5.5 x 5.5	16.28	16.90	+25
		6.0 x 6.0	16.86	20.89	+25
	3.00	1.0 X 1.0	16.82	+25	+28
		1.5 X 1.5	15.75	+25	+28
		2.0 x 2.0	15.53	+25	+28
		2.5 x 2.5	15.65	+25	+28
		3.0 x 3.0	15.94	23.78	+28
		3.5 x 3.5	16.32	20.83	+28
		4.0 x 4.0	16.77	20.29	+28
		4.5 x 4.5	17.26	19.29	+28
		5.0 x 5.0	17.77	18.37	+28
		5.5 x 5.5	18.31	17.72	+28
		6.0 x 6.0	18.86	21.63	+28

Note : 1) Minimum value of SBC & SBP shall be considered in design of foundation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out of Fifteen boreholes location at Lakadia , Gujarat
2. Based on the proposed type of project, bore log data, Laboratory test results safe bearing capacity is suggested for RCC Raft Foundation as shown in table-1
3. Settlement computed from m_v Value as per I.S.8009, Part I for 40mm & 25mm permissible settlement for RCC Open Foundation .
4. Effect of Water table was considered in analysis of SBC as it was encountered.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material.
6. Looking to all of the test results, SBC derived from borehole data are less than that of the trial pit data. Also plate load test was carried out at two locations to check UBC of 50t/sq.m (as suggested by client). Even at UBC of 50t/sq.m, observed settlement was within the permissible limit and no shear failure was observed at both the locations. Hence, the SBC values derived from borehole investigation are recommended to be considered in the design.
7. The above report is based on the soil strata encountered at site upto depth of Investigation i.e.10.0 mtr.
8. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory
Jignesh Trivedi
Technical Manager

BORE LOG										Job No	4538/284001		
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020		
Project	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani						Borehole	BH-1					
Client	Techno Electric & Engineering Co. Ltd						Depth of Borehole	10.0 m					
Location	Lakadia , Gujarat						Depth of casing	Not Applicable					
Dia of Borehole	150mm						Date of Starting	18/12/2019					
Depth of GWT	2.5m						Date of Completion	18/12/2019					
Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m					From	To	15	15	15	N	Graph	
1	0.5		Brownish Silty Sand of Non Plasticity	1/1	DS	0.0	0.50						
2	2.5		Brownish Clayey Sand of Low Plasticity	1/2	SPT	1.5	1.95	5	7	9	16	16	
3													
4				1/3	SPT	3.0	3.45	7	16	32	48	48	
5	3.0		Brownish White Silty Clay of Intermediate Plasticity	1/4	SPT	4.5	4.95	21 + 31 + 3cm / 50 Blows				>100	Refusal
6													
7				1/6	SPT	6.0	6.45	16 + 55 + 1cm / 50 Blows				>100	Refusal
8	3.0		Brownish Silty Clay of Intermediate Plasticity	1/7	SPT	7.5	7.95	>100				>100	Refusal
9													
10				1/8	SPT	9.0	9.45	35 + 60 + 5cm / 50 Blows				>100	Refusal
11	1.0		Brownish Silty Clay of Intermediate Plasticity	1/9	SPT	10.0	10.45	38 + 2cm / 50 Blows				>100	Refusal
12			Borehole is terminated at depth of 10.0 m										
13													
14													
15													
UDS : Undisturb Sample DS : Disturbed sample N : Penetration Resistance Value N' : Corrected Penetration Resistance Value CR : Core Recovery RQD : Rock Quality Designation PR : Rate of Penetration in Rock GWT : Ground Water Table SPT : Standard Penetration Test WS : Wash Sample													
Prepared By		Checked / Approved By		GEO TEST HOUSE									
AC		BC		B-10, Krishna Industrial Estate, Opp. B.I.D.C. Gorwa Estate, Vadodara-390016, Gujarat, INDIA. Tel :-0265-2290222, Fax :- 0265-2282014 Email :- lab@geogroup.in, soilgdr@geogroup.in									

BORE LOG										Job No	4538/284001		
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020		
Project : Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani													
Client : Techno Electric & Engineering Co. Ltd													
Location : Lakadia , Gujarat													
Dia of Borehole : 150mm													
Depth of GWT : 5.5m													
Borehole : BH-2													
Depth of Borehole : 10.0 m													
Depth of casing : Not Applicable													
Date of Starting : 18/12/2019													
Date of Completion : 19/12/2019													
Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m					From	To	15	15	15	N	Graph	
1	6.0		Brownish Silty Sand of Non Plasticity	2/1	DS	0.0	0.50						
2				2/2	SPT	1.5	1.95	6	12	20	32		
3				2/3	SPT	3.0	3.45	7	15	26	41		
4				2/4	SPT	4.5	4.95	9	18	26	44		
5				2/6	SPT	6.0	6.45	13	24	38	62		
6	1.5		Brownish Sandy Silt of Non Plasticity										Refusal
7				2/7	SPT	7.5	7.95	25 + 10 cm / 50 Blows					
8	2.5		Brownish Silty Sand of Non Plasticity										Refusal
9				2/8	SPT	9.0	9.45	26 + 86 + 2cm / 50 Blows					
10				2/9	SPT	10.0	10.45	20 + 38 + 2cm / 50 Blows					
11			Borehole is terminated at depth of 10.0 m										
12													
13													
14													
15													
UDS : Undisturb Sample DS : Disturbed sample N : Penetration Resistance Value N' : Corrected Penetration Resistance Value													
CR : Core Recovery RQD : Rock Quality Designation PR : Rate of Penetration in Rock													
GWT : Ground Water Table SPT : Standard Penetration Test WS : Wash Sample													
Prepared By		Checked / Approved By		GEO TEST HOUSE									
AC		BC		B-10, Krishna Industrial Estate, Opp. B.I.D.C. Gorwa Estate, Vadodara-390016, Gujarat, INDIA. Tel :-0265-2290222, Fax :- 0265-2282014 Email :- lab@geogroup.in, soilgdr@geogroup.in									

BORE LOG										Job No	4538/284001
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020
Project	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani						Borehole	:	BH-3	
Client	:	Techno Electric & Engineering Co. Ltd						Depth of Borehole	:	10.0 m	
Location	:	Lakadia , Gujarat						Depth of casing	:	Not Applicable	
Dia of Borehole	:	150mm						Date of Starting	:	20/12/2019	
Depth of GWT	:	5.0m						Date of Completion	:	20/12/2019	

Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)	SPT 'N' Value				SPT V/s Depth Graph	Remarks / Other tests	
m	m			No.		From	To	15	15	15	N		
1	9.0		Brownish Silty Sand of Non Plasticity	3/1	DS	0.0	0.50						
2				3/2	SPT	1.5	1.95	8	9	16	25		
3				3/3	SPT	3.0	3.45	11	16	18	34		
4				3/4	SPT	4.5	4.95	14	21	40	61		
5													
6				3/5	SPT	6.0	6.45	15	44	79	>100		Refusal
7				3/6	SPT	7.5	7.95	1 cm / 50 Blows					Refusal
8													
9				3/7	SPT	9.0	9.45	30 + 50 + 2 cm / 50 Blows				Refusal	
10	1.0		Brownish Sandy Silt of Non Plasticity	3/8	SPT	10.0	10.45	36 + 1 cm / 50 Blows				Refusal	
11			Borehole is terminated at depth of 10.0 m										
12													
13													
14													
15													

UDS : Undisturb Sample

DS : Disturbed sample

N : Penetration Resistance Value

N' : Corrected Penetration Resistance Value

CR : Core Recovery

RQD : Rock Quality Designation

PR : Rate of Penetration in Rock

GWT : Ground Water Table

SPT : Standard Penetration Test

WS : Wash Sample

Prepared By	Checked / Approved By	EO TEST HOUSE
AC	BC	B-10, Krishna Techno Electric & Engineering Co. Ltd 2282014 Email :- lab@geogroup.in, soilgdr@geogroup.in

BORE LOG		Job No	4538/284001
(As per IS : 1892-1979, 4453-1980 & 4464-1967)		Date	14/3/2020
Project	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani		Borehole : BH-4
Client	Techno Electric & Engineering Co. Ltd		Depth of Borehole : 10.0 m
Location	Lakadia , Gujarat		Depth of casing : Not Applicable
Dia of Borehole	150mm		Date of Starting : 20/12/2019
Depth of GWT	Not Encountered		Date of Completion : 20/12/2019

Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)	SPT 'N' Value				SPT V/s Depth	Remarks / Other tests	
m	m					From	To	15	15	15	N	Graph	
1			Brownish Silty Sand and Sandy Silty of Non Plasticity	4/1	DS	0.0	0.50						
2				4/2	SPT	1.5	1.95	4	10	18	28	28	
3				4/3	SPT	3.0	3.45	10	21	34	55	55	
4				4/4	SPT	4.5	4.95	9	27	51	78	78	
5				4/6	SPT	6.0	6.45	9	23	40	63	63	
6				4/7	SPT	7.5	7.95	12	34	58	92	92	
7				4/8	SPT	9.0	9.45	14 + 38 + 2cm / 50 Blows				>100	Refusal
8				4/9	SPT	10.0	10.45	22 + 62 + 2cm / Blows				>100	Refusal
9				Borehole is terminated at depth of 10.0 m									
10													
11													
12													
13													
14													
15													

UDS : Undisturb Sample
DS : Disturbed sample
N : Penetration Resistance Value
N' :Corrected Penetration Resistance Value

CR : Core Recovery
RQD : Rock Quality Designation
PR : Rate of Penetration in Rock

GWT : Ground Water Table
SPT : Standard Penetration Test
WS :Wash Sample

Prepared By	Checked / Approved By	GEO TEST HOUSE
AC	BC	B-10, Krishna Industrial Estate, Opp. B.I.D.C. Gorwa Estate, Vadodara:-390016,Gujarat, INDIA. Tel :-0265-2290222, Fax :- 0265-2282014 Email :- lab@geogroup.in, soilgdr@geogroup.in

BORE LOG										Job No	4538/284001		
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020		
Project	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani						Borehole	BH-5					
Client	Techno Electric & Engineering Co. Ltd						Depth of Borehole	10.0 m					
Location	Lakadia , Gujarat						Depth of casing	Not Applicable					
Dia of Borehole	150mm						Date of Starting	20/12/2019					
Depth of GWT	Not Encountered						Date of Completion	20/12/2019					
Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m					From	To	15	15	15	N	Graph	
1				5/1	DS	0.0	0.50						
2				5/2	SPT	1.5	1.95	5	8	10	18		
3				5/3	SPT	3.0	3.45	8	20	34	54		
4				5/4	SPT	4.5	4.95	12	33	55	88		
5	10.0		Brownish Silty Sand of Non Plasticity										
6				5/6	SPT	6.0	6.45	13 + 48 + 1cm / 50 Blows					Refusal
7				5/7	SPT	7.5	7.95	24 + 63 + 13cm / 50 Blows					Refusal
8				5/8	SPT	9.0	9.45	80 + 8 cm / 50 Blows					Refusal
9													
10				5/9	SPT	10.0	10.45	55 + 9 cm / Blows					Refusal
11			Borehole is terminated at depth of 10.0 m										
12													
13													
14													
15													
UDS : Undisturb Sample DS : Disturbed sample N : Penetration Resistance Value N' : Corrected Penetration Resistance Value CR : Core Recovery RQD : Rock Quality Designation PR : Rate of Penetration in Rock GWT : Ground Water Table SPT : Standard Penetration Test WS : Wash Sample													
Prepared By		Checked / Approved By		GEO TEST HOUSE									
AC		BC		B-10, Krishna Industrial Estate, Opp. B.I.D.C. Gorwa Estate, Vadodara:-390016,Gujarat, INDIA. Tel :-0265-2290222, Fax :- 0265-2282014 Email :- lab@geogroup.in, soilgdr@geogroup.in									

BORE LOG										Job No	4538/284001		
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020		
Project		Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhui in Gujarat under Adani						Borehole		BH-6			
Client		Techno Electric & Engineering Co. Ltd						Depth of Borehole		10.0 m			
Location		Lakadia , Gujarat						Depth of casing		Not Applicable			
Dia of Borehole		150mm						Date of Starting		23/12/2019			
Depth of GWT		Not Encountered						Date of Completion		23/12/2019			
Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth Graph	Remarks / Other tests
						From	To	15	15	15	N		
1				6/1	DS	0.0	0.50						
2				6/2	SPT	1.5	1.95	4	8	12	20	20	
3				6/3	SPT	3.0	3.45	15	20	27	47	47	
4				6/4	SPT	4.5	4.95	10	18	28	46	46	
5	10.0		Brownish Silty Sand of Non Plasticity										
6				6/6	SPT	6.0	6.45	17 + 50 + 1cm / 50 Blows				>100	Refusal
7				6/7	SPT	7.5	7.95	25 + 2cm / 50 Blows				>100	Refusal
8				6/8	SPT	9.0	9.45	>100				>100	Refusal
9													
10				6/9	SPT	10.0	10.45	>100				>100	Refusal
11			Borehole is terminated at depth of 10.0 m										
12													
13													
14													
15													
UDS : Undisturb Sample DS : Disturbed sample N : Penetration Resistance Value N' : Corrected Penetration Resistance Value CR : Core Recovery RQD : Rock Quality Designation PR : Rate of Penetration in Rock GWT : Ground Water Table SPT : Standard Penetration Test WS : Wash Sample													
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BORE LOG										Job No	4538/284001
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020
Project : Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhui in Gujarat under Adani											
Client : Techno Electric & Engineering Co. Ltd											
Location : Lakadia , Gujarat											
Dia of Borehole : 150mm											
Depth of GWT : 4.2m											
Borehole : BH-7											
Depth of Borehole : 10.0 m											
Depth of casing : Not Applicable											
Date of Starting : 28/02/2020											
Date of Completion : 28/02/2020											

Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)	SPT 'N' Value				SPT V/s Depth	Remarks / Other tests	
m	m					From	To	15	15	15	N	Graph	
1				7/1	DS	0.0	0.50						
2				7/2	SPT	1.5	1.95	6	7	8	15	15	
3				7/3	SPT	3.0	3.45	7	12	13	25	25	
4				7/4	SPT	4.5	4.95	5	7	33	40	40	
5	10.0		Brownish Silty Sand of Non Plasticity	7/6	SPT	6.0	6.45	14 + 31 + 8cm / 50 Blows				>100	Refusal
6				7/7	SPT	7.5	7.95	26 + 40 + 7cm / 50 Blows				>100	Refusal
7				7/8	SPT	9.0	9.45	33 + 6cm / 50 Blows				>100	Refusal
8				7/9	SPT	10.0	10.45	19	38	44	82	82	
9			Borehole is terminated at depth of 10.0 m										
10													
11													
12													
13													
14													
15													

UDS : Undisturb Sample
 DS : Disturbed sample
 N : Penetration Resistance Value
 N' : Corrected Penetration Resistance Value

CR : Core Recovery
 RQD : Rock Quality Designation
 PR : Rate of Penetration in Rock

GWT : Ground Water Table
 SPT : Standard Penetration Test
 WS : Wash Sample

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RP	BC	B-10, Krishna Industrial Estate, Opp. B.I.D.C. Gorwa Estate, Vadodara-390016, Gujarat, INDIA. Tel :-0265-2290222, Fax :- 0265-2282014 Email :- lab@geogroup.in, soilgdr@geogroup.in

BORE LOG										Job No	4538/284001		
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020		
Project : Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhui in Gujarat under Adani													
Client : Techno Electric & Engineering Co. Ltd													
Location : Lakadia , Gujarat													
Dia of Borehole : 150mm													
Depth of GWT : 4.7m													
Borehole : BH-8													
Depth of Borehole : 10.0 m													
Depth of casing : Not Applicable													
Date of Starting : 27/02/2020													
Date of Completion : 27/02/2020													
Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m					From	To	15	15	15	N	Graph	
1	9.0		Brownish Poorly Graded and Silty Sand of Non Plasticity	8/1	DS	0.0	0.50						
2				8/2	SPT	1.5	1.95	4	5	7	12		
3				8/3	SPT	3.0	3.45	6	9	14	23		
4				8/4	SPT	4.5	4.95	8	15	18	33		
5				8/6	SPT	6.0	6.45	10	28	35	63		
6				8/7	SPT	7.5	7.95	25	42	58	100		
7				8/8	SPT	9.0	9.45	48 + 5cm / 50 Blows					
8													
9													
10				1.0		Yellowish Silty Gravel of Non Plasticity	8/9	SPT	10.0	10.45	68 + 4cm / 50 Blows		
11			Borehole is terminated at depth of 10.0 m										
12													
13													
14													
15													
UDS : Undisturb Sample DS : Disturbed sample N : Penetration Resistance Value N' : Corrected Penetration Resistance Value CR : Core Recovery RQD : Rock Quality Designation PR : Rate of Penetration in Rock GWT : Ground Water Table SPT : Standard Penetration Test WS : Wash Sample													
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(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020
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Client : Techno Electric & Engineering Co. Ltd											
Location : Lakadia , Gujarat											
Dia of Borehole : 150mm											
Depth of GWT : 4.6m											
Borehole : BH-9											
Depth of Borehole : 10.0 m											
Depth of casing : Not Applicable											
Date of Starting : 27/02/2020											
Date of Completion : 27/02/2020											

Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)	SPT 'N' Value				SPT V/s Depth	Remarks / Other tests		
m	m					From	To	15	15	15	N	Graph		
1	4.5		Brownish Poorly Graded and Silty Sand of Non Plasticity	9/1	DS	0.0	0.50							
2				9/2	SPT	1.5	1.95	2	3	4	7			
3														
4				9/3	SPT	3.0	3.45	12	16	21	37			
5														
6	1.5		Yellowish Poorly Graded Gravel	9/4	SPT	4.5	4.95	15	25	28	53			
7														
8	3.0		Yellowish Silty Sand of Non Plasticity	9/6	SPT	6.0	6.45	9	16	26	42			
9														
10				9/7	SPT	7.5	7.95	21 + 39 + 7cm / 50 Blows						Refusal
11	1.0		Yellowish Poorly Graded Gravel and Silty Gravel of Non Plasticity	9/8	SPT	9.0	9.45	27 + 45 + 5cm / 50 Blows						Refusal
12														
13				9/9	SPT	10.0	10.45	30	32	42	74			
14				Borehole is terminated at depth of 10.0 m										
15														

UDS : Undisturb Sample
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 N : Penetration Resistance Value
 N' :Corrected Penetration Resistance Value

CR : Core Recovery
 RQD : Rock Quality Designation
 PR : Rate of Penetration in Rock

GWT : Ground Water Table
 SPT : Standard Penetration Test
 WS :Wash Sample

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RP	BC	B-10, Krishna Industrial Estate, Opp. B.I.D.C. Gorwa Estate, Vadodara-390016,Gujarat, INDIA. Tel :-0265-2290222, Fax :- 0265-2282014 Email :- lab@geogroup.in, soilgdr@geogroup.in

BORE LOG										Job No	4538/284001				
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020				
Project		Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhui in Gujarat under Adani						Borehole		BH-10					
Client		Techno Electric & Engineering Co. Ltd						Depth of Borehole		10.0 m					
Location		Lakadia , Gujarat						Depth of casing		Not Applicable					
Dia of Borehole		150mm						Date of Starting		26/02/2020					
Depth of GWT		4.0m						Date of Completion		26/02/2020					
Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From To		SPT 'N' Value 15 15 15 N				SPT V/s Depth Graph	Remarks / Other tests		
1	6.0		Yellowish Silty Sand of Non Plasticity	10/1	DS	0.0	0.50								
2				10/2	SPT	1.5	1.95	4	7	12	19				
3				10/3	SPT	3.0	3.45	15	19	25	44				
4				10/4	SPT	4.5	4.95	16	20	39	59				
5															
6				10/6	SPT	6.0	6.45	10	18	21	39				
7	1.5		Yellowish Silty Gravel and Poorly Graded Gravel of Non Plasticity												
8				10/7	SPT	7.5	7.95	18 + 62 + 5cm / 50 Blows						>100	Refusal
9	2.5		Yellowish Poorly Graded and Silty Sand of Non Plasticity	10/8	SPT	9.0	9.45	48 + 4cm / 50 Blows						>100	Refusal
10															
10				10/9	SPT	10.0	10.45	15	39	42	81				
11			Borehole is terminated at depth of 10.0 m												
12															
13															
14															
15															
UDS : Undisturb Sample DS : Disturbed sample N : Penetration Resistance Value N' :Corrected Penetration Resistance Value CR : Core Recovery RQD : Rock Quality Designation PR : Rate of Penetration in Rock GWT : Ground Water Table SPT : Standard Penetration Test WS :Wash Sample															
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BORE LOG										Job No	4538/284001
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020
Project : Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhui in Gujarat under Adani											
Client : Techno Electric & Engineering Co. Ltd											
Location : Lakadia , Gujarat											
Dia of Borehole : 150mm											
Depth of GWT : 5.4m											
Borehole : BH-12											
Depth of Borehole : 10.0 m											
Depth of casing : Not Applicable											
Date of Starting : 25/02/2020											
Date of Completion : 26/02/2020											

Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)	SPT 'N' Value				SPT V/s Depth	Remarks / Other tests	
m	m					From	To	15	15	15	N	Graph	
1	4.5		Yellowish Poorly Graded and Silty Sand of Non Plasticity	12/1	DS	0.0	0.50					44	
2				12/2	SPT	1.5	1.95	10	14	30	44		
3													
4				12/3	SPT	3.0	3.45	7	12	32	44		
5	1.5		Yellowish Silty Gravel of Non Plasticity	12/4	SPT	4.5	4.95	4	10	28	38	38	
6				12/6	SPT	6.0	6.45	17	26	36	62		
7	1.5		Yellowish Silty Sand of Non Plasticity	12/7	SPT	7.5	7.95	21 + 30 + 8cm / 50 Blows				> 100	Refusal
8													
9	1.5		Yellowish Silty Gravel and Poorly Graded Gravel of Non Plasticity	12/8	SPT	9.0	9.45	26	33	38	71	71	
10													
11	1.0		Yellowish Sandy Silt of Non Plasticity	12/9	SPT	10.0	10.45	20 + 39 + 7cm / 50 Blows				> 100	Refusal
12													
13			Borehole is terminated at depth of 10.0 m										
14													
15													

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 N : Penetration Resistance Value
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RP	BC	

B-10, Krishna Industrial Estate, Opp. B.I.D.C. Gorwa Estate, Vadodara-390016, Gujarat, INDIA.
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BORE LOG										Job No	4538/284001
(As per IS : 1892-1979, 4453-1980 & 4464-1967)										Date	14/3/2020
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Client : Techno Electric & Engineering Co. Ltd											
Location : Lakadia , Gujarat											
Dia of Borehole : 150mm											
Depth of GWT : 3.5m											
Borehole : BH-13											
Depth of Borehole : 10.0 m											
Depth of casing : Not Applicable											
Date of Starting : 21/02/2020											
Date of Completion : 22/02/2020											

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth Graph	Remarks / Other tests
						From	To	15	15	15	N		
1	4.5		Yellowish Poorly Graded and Silty Sand of Non Plasticity	13/1	DS	0.0	0.50						
2				13/2	SPT	1.5	1.95	6	11	15	26		
3				13/3	SPT	3.0	3.45	7	8	19	27		
4				13/4	SPT	4.5	4.95	4	16	23	39		
5				1.5	Yellowish Silty Gravel of Non Plasticity	13/6	SPT	6.0	6.45	8	12	28	40
6	13/7	SPT	7.5			7.95	10	19	32	51			
7	3.0		Yellowish Sandy Silt of Non Plasticity	13/8	SPT	9.0	9.45	17	20	34	54		
8													
9				1.0	Yellowish Silty Sand of Non Plasticity	13/9	SPT	10.0	10.45	8cm / 50 Blows			
10										Refusal			
11			Borehole is terminated at depth of 10.0 m										
12													
13													
14													
15													

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 N : Penetration Resistance Value
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Client : Techno Electric & Engineering Co. Ltd											
Location : Lakadia , Gujarat											
Dia of Borehole : 150mm											
Depth of GWT : 4.0m											
Borehole : BH-14											
Depth of Borehole : 7.5 m											
Depth of casing : Not Applicable											
Date of Starting : 24/02/2020											
Date of Completion : 24/02/2020											

Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)	SPT 'N' Value				SPT V/s Depth	Remarks / Other tests	
m	m					From	To	15	15	15	N	Graph	
1				14/1	DS	0.0	0.50						
2				14/2	SPT	1.5	1.95	6	8	9	17		
3				14/3	SPT	3.0	3.45	7	10	19	29		
4	7.5		Yellowish Poorly Graded and Silty Sand of Non Plasticity	14/4	SPT	4.5	4.95	10	16	29	45		
5				14/6	SPT	6.0	6.45	26 + 52 + 5cm / 50 Blows					Refusal
6				14/7	SPT	7.5	7.95	10cm / 50 Blows					Refusal
7													
8			Borehole is terminated at depth of 7.5 m										
9													
10													
11													
12													
13													
14													
15													

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Client	Techno Electric & Engineering Co. Ltd						Depth of Borehole	10.0 m			
Location	Lakadia , Gujarat						Depth of casing	Not Applicable			
Dia of Borehole	150mm						Date of Starting	21/02/2020			
Depth of GWT	4.0m						Date of Completion	21/02/2020			

Depth	Thickness	Log	Description	Sample No.	Type	Depth (m)	SPT 'N' Value				SPT V/s Depth	Remarks / Other tests	
m	m					From	To	15	15	15	N	Graph	
1	1.5		Brownish Poorly Graded and Silty Sand of Non Plasticity	15/1	DS	0.0	0.50						
2	1.5		Yellowish Silty Gravel and Poorly Graded Gravel of Non Plasticity	15/2	SPT	1.5	1.95	7	13	22	35		
3													
4				15/3	SPT	3.0	3.45	5	12	19	31		
5													
6				15/4	SPT	4.5	4.95	5	8	15	23		
7													
8				15/6	SPT	6.0	6.45	6	10	28	38		
9													
10				15/7	SPT	7.5	7.95	3	10	25	35		
11													
12				15/8	SPT	9.0	9.45	62 + 8cm / 50 Blows					Refusal
13													
14				15/9	SPT	10.0	10.45	20 + 31 + 8cm / 50 Blows					Refusal
15													

UDS : Undisturb Sample
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 N : Penetration Resistance Value
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CR : Core Recovery
 RQD : Rock Quality Designation
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RP	BC	

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GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-1

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R .D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%
				%	%	%	%	%	%	Kg/cm ²	Degree		%	Kg/cm ²			
1	1/1	SM	0.0	17.9	NP	NP	1	82	17	-	-	-	Nil	-	2.69	-	-
2	1/2	SC	1.5	31.9	22.2	9.7	1	63	36	0.10	20	-	25	-	2.59	1.617 [*]	18.3
3	1/3	CI	3.0	41.5	30.5	11.0	13	35	52	-	-	0.016	36	-	2.61	1.658 [*]	20.1
4	1/4	CI	4.5	37.5	27.2	10.3	2	45	53	-	-	-	38	-	2.65	-	-
5	1/6	SC-CI	6.0	39.8	28.9	10.9	18	37	45	0.25	16	-	-	-	2.64	1.721 [*]	16.2
6	1/7	SC-CI	7.5	39.7	28.9	10.8	10	44	46	-	-	-	-	-	2.63	-	-
7	1/8	CI	9.0	47.4	37.3	10.1	0	45	55	-	-	-	-	-	2.59	-	-
8	1/9	CI	10.0	44.9	34.7	10.2	0	41	59	-	-	-	-	-	2.61	-	-

Abbreviation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

JOB No.4538/284001

Checked By :-JS

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat																	BH-2		
Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.		
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%		
				%	%	%	%	%	%	Kg/cm ²	Degree		%	Kg/cm ²					
1	2/1	SM	0.0	27.4	NP	NP	0	68	32	—	—	—	Nil	—	2.64	—	—		
2	2/2	SM	1.5	22.4	NP	NP	0	71	29	0.00	28	—	Nil	—	2.67	1.642 [*]	20.2		
3	2/3	SM	3.0	20.3	NP	NP	2	75	23	—	—	—	Nil	—	2.70	—	—		
4	2/4	SM	4.5	27.8	NP	NP	7	62	31	0.00	30	—	Nil	—	2.69	1.682 [*]	13.2		
5	2/6	ML	6.0	34.8	NP	NP	4	41	55	—	—	—	—	—	2.70	—	—		
6	2/7	SM	7.5	22.1	NP	NP	6	70	24	—	—	—	—	—	2.68	—	—		
7	2/8	ML	9.0	30.3	NP	NP	18	29	53	—	—	—	—	—	2.70	—	—		
8	2/9	SM	10.0	25.5	NP	NP	5	66	29	—	—	—	—	—	2.66	—	—		
Abbreviation :																			
LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C				Field Moisutre Content (%)				F.S.				Free Swell Index (%)			
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS				Unconfined Comp. Strength (Kg/Sq.cm)				S.P.				Swelling Pressure (Kg/Sq.cm.)			
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv				Coeff. of Volume Change (Sq.cm/kg)				G		Gravel	S	Sand			
NP	Non Plastic	R.D*	Remould Density(gm/cc)									M		Silt	C	Clay			
Tested By :-BC																			
JOB No.4538/284001																			
Checked By :-JS																			

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat																	BH-3		
Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.		
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%		
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%				Kg/cm ²	
1	3/1	SM	0.0	22.1	NP	NP	1	74	25	—	—	—	Nil	—	2.68	—	—		
2	3/2	SM	1.5	28.1	NP	NP	1	69	30	—	—	—	Nil	—	2.67	—	—		
3	3/3	SM	3.0	28.1	NP	NP	1	67	32	0.00	28	—	Nil	—	2.68	1.624 [*]	18.5		
4	3/4	SM	4.5	19.1	NP	NP	10	69	21	—	—	—	Nil	—	2.70	—	—		
5	3/5	SM	6.0	25.9	NP	NP	21	50	29	0.00	33	—	—	—	2.69	1.684 [*]	16.2		
6	3/6	SM	7.5	26.6	NP	NP	26	43	31	—	—	—	—	—	2.66	—	—		
7	3/7	ML	9.0	31.3	NP	NP	15	25	60	—	—	—	—	—	2.65	—	—		
8	3/8	SM	10.0	26.5	NP	NP	32	38	30	—	—	—	—	—	2.65	—	—		
Abbreviation :																			
LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C				Field Moisutre Content (%)				F.S.				Free Swell Index (%)			
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS				Unconfined Comp. Strength (Kg/Sq.cm)				S.P.				Swelling Pressure (Kg/Sq.cm.)			
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv				Coeff. of Volume Change (Sq.cm/kg)				G		Gravel	S	Sand			
NP	Non Plastic	R.D*	Remould Density(gm/cc)									M		Silt	C	Clay			
Tested By :-BC																			
JOB No.4538/284001																			
Checked By :-JS																			

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-4

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R .D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%
				%	%	%	%	%	%	Kg/cm ²	Degree		%	Kg/cm ²			
1	4/1	SM	0.0	31.6	NP	NP	1	58	41	-	-	-	Nil	-	2.64	-	-
2	4/2	SM	1.5	25.0	NP	NP	1	70	29	-	-	-	Nil	-	2.65	-	-
3	4/3	SM	3.0	22.9	NP	NP	4	69	27	0.00	29	-	Nil	-	2.67	1.638 [*]	13.2
4	4/4	SM	4.5	22.0	NP	NP	5	70	25	-	-	-	Nil	-	2.69	-	-
5	4/6	SM	6.0	21.6	NP	NP	12	68	20	0.00	34	-	-	-	2.70	1.711 [*]	18.5
6	4/7	SM	7.5	24.5	NP	NP	1	74	25	-	-	-	-	-	2.69	-	-
7	4/8	SM	9.0	-	NP	NP	21	66	13	-	-	-	-	-	2.74	-	-
8	4/9	SM	10.0	27.1	NP	NP	37	24	39	-	-	-	-	-	2.64	-	-

Abbreviation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

JOB No.4538/284001

Checked By :-JS

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GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat																	BH-5																																				
Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.																																				
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%																																				
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%				Kg/cm ²																																			
1	5/1	SM	0.0	22.9	NP	NP	1	73	26	—	—	—	Nil	—	2.68	—	—																																				
2	5/2	SM	1.5	25.0	NP	NP	5	68	27	—	—	—	Nil	—	2.67	—	—																																				
3	5/3	SM	3.0	25.6	NP	NP	1	73	26	0	30	—	Nil	—	2.69	1.675 [*]	16.2																																				
4	5/4	SM	4.5	24.4	NP	NP	9	64	27	—	—	—	Nil	—	2.67	—	—																																				
5	5/6	SM	6.0	25.9	NP	NP	7	64	29	0	34	—	—	—	2.69	1.701 [*]	18.4																																				
6	5/7	SM	7.5	26.3	NP	NP	15	57	28	—	—	—	—	—	2.68	—	—																																				
7	5/8	SM	9.0	31.2	NP	NP	9	49	42	—	—	—	—	—	2.64	—	—																																				
8	5/9	SM	10.0	30.7	NP	NP	7	49	44	—	—	—	—	—	2.63	—	—																																				
Abbreviation :																																																					
LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C				Field Moisutre Content (%)				F.S.				Free Swell Index (%)																																					
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS				Unconfined Comp. Strength (Kg/Sq.cm)				S.P.				Swelling Pressure (Kg/Sq.cm.)																																					
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv				Coeff. of Volume Change (Sq.cm/kg)				G		Gravel		S		Sand																																			
NP	Non Plastic	R.D*	Remould Density(gm/cc)									M		Silt		C		Clay																																			
Tested By :-BC																		JOB No.4538/284001																		Checked By :-JS																	

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-6

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%
				%	%	%	%	%	%	Kg/cm ²	Degree		%	Kg/cm ²			
1	6/1	SM	0.0	34.9	NP	NP	0	60	40	-	-	-	Nil	-	2.67	-	-
2	6/2	SM	1.5	-	NP	NP	1	84	15	-	-	-	-	-	2.75	-	-
3	6/3	SM	3.0	-	NP	NP	2	84	14	0	29	-	-	-	2.74	1.652 [*]	17.5
4	6/4	SM	4.5	-	NP	NP	0	88	12	0	31	-	-	-	2.73	1.685 [*]	13.4
5	6/6	SM	6.0	-	NP	NP	2	87	11	-	-	-	-	-	2.73	-	-
6	6/7	SM	7.5	-	NP	NP	3	83	14	-	-	-	-	-	2.74	-	-
7	6/8	SM	9.0	-	NP	NP	2	85	13	-	-	-	-	-	2.75	-	-
8	6/9	SM	10.0	-	NP	NP	0	88	12	-	-	-	-	-	2.74	-	-

Abbreviation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

JOB No.4538/284001

Checked By :-JS

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat																	BH-7		
Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.		
				L.L.	P.L.	P.I.	G	S	M & C	C	ϕ		F.S.	S.P.					
				%	°	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%		Kg/cm ²	gm/cc	%	
1	7/1	SM	0.0	—	NP	NP	4	70	26	—	—	—	10	—	2.66	—	—		
2	7/2	SM	1.5	21.4	NP	NP	3	61	36	0	30	—	—	—	2.65	1.551 [*]	8.4		
3	7/3	SM	3.0	—	NP	NP	14	66	20	0	31	—	—	—	2.68	1.639 [*]	7.6		
4	7/4	SM	4.5	—	NP	NP	35	52	13	—	—	—	—	—	2.70	—	—		
5	7/6	SM	6.0	—	NP	NP	38	56	6	—	—	—	—	—	2.72	—	—		
6	7/7	SM	7.5	—	NP	NP	36	60	4	—	—	—	—	—	2.59	—	—		
7	7/8	SM	9.0	—	NP	NP	26	67	7	—	—	—	—	—	2.71	—	—		
Abbreviation :																			
LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C Field Moisutre Content (%)						F.S. Free Swell Index (%)									
PL	Plastic Limit (%)	ϕ	Angle of Internal Friction (Degree)	UCS Unconfined Comp. Strength (Kg/Sq.cm)						S.P. Swelling Pressure (Kg/Sq.cm.)									
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv Coeff. of Volume Change (Sq.cm/kg)						G Gravel S Sand									
NP	Non Plastic	R.D*	Remould Density(gm/cc)							M Silt C Clay									
Tested By :-BC																		Checked By :-JS	
IQR No.4538/284001																			

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat																	BH-8
Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%			
1	8/1	SM	0.0	—	NP	NP	0	88	12	—	—	—	Nil	—	2.64	—	—
2	8/2	SP	1.5	—	NP	NP	3	93	4	—	—	—	—	—	2.66	—	—
3	8/3	SM	3.0	—	NP	NP	4	64	32	0	31	—	—	—	2.68	1.624 [*]	8.8
4	8/4	SM	4.5	—	NP	NP	0	88	12	—	—	—	—	—	2.70	—	—
5	8/6	SM	6.0	—	NP	NP	1	75	24	—	—	—	—	—	2.65	—	—
6	8/7	SM-SP	7.5	—	NP	NP	0	91	9	—	—	—	—	—	2.71	—	—
7	8/8	GM	9.0	—	NP	NP	56	43	1	—	—	—	—	—	2.68	—	—
Abbreviation :																	
LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C Field Moisutre Content (%)						F.S. Free Swell Index (%)							
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS Unconfined Comp. Strength (Kg/Sq.cm)						S.P. Swelling Pressure (Kg/Sq.cm.)							
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv Coeff. of Volume Change (Sq.cm/kg)						G Gravel S Sand							
NP	Non Plastic	R.D*	Remould Density(gm/cc)							M Silt C Clay							
Tested By :-BC																	Checked By :-JS
IQR No 4538/284001																	

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat																	BH-9		
Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C		
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%		
				%	‰	‰	%	%	%	Kg/cm ²	Degree		cm ² /kg	%				Kg/cm ²	
1	9/1	SM	0.0	—	NP	NP	0	81	19	—	—	—	Nil	—	2.67	—	—		
2	9/2	SP	1.5	—	NP	NP	32	66	2	0	30	—	—	—	2.64	1.543 [*]	—		
3	9/3	SM	3.0	—	NP	NP	0	73	27	0	31	—	—	—	2.68	1.700 [*]	—		
4	9/4	GP	4.5	—	NP	NP	54	42	4	—	—	—	—	—	2.69	—	—		
5	9/6	SM	6.0	—	NP	NP	31	56	13	—	—	—	—	—	2.66	—	—		
6	9/7	SM	7.5	—	NP	NP	25	69	6	—	—	—	—	—	2.61	—	—		
7	9/8	GP-GM	9.0	—	NP	NP	47	43	10	—	—	—	—	—	2.68	—	—		
Abbrivation :																			
LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C Field Moisutre Content (%)						F.S. Free Swell Index (%)									
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS Unconfined Comp. Strength (Kg/Sq.cm)						S.P. Swelling Pressure (Kg/Sq.cm.)									
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv Coeff. of Volume Change (Sq.cm/kg)						G Gravel		S Sand							
NP	Non Plastic	R.D*	Remould Density(gm/cc)							M Silt		C Clay							
Tested By :-BC																		Checked By :-JS	
IOP No 4538/284001																			

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-10

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.			
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%		Kg/cm ²	gm/cc
1	10/1	SM	0.0	—	NP	NP	2	76	22	—	—	—	33	—	2.63	—	—
2	10/2	SM	1.5	—	NP	NP	10	76	14	—	—	—	—	—	2.65	—	—
3	10/3	SM	3.0	—	NP	NP	30	56	14	0	32	—	—	—	2.68	1.700 [*]	—
4	10/4	SM	4.5	—	NP	NP	39	48	13	—	—	—	—	—	2.70	—	—
5	10/6	GM-GP	6.0	—	NP	NP	50	43	7	—	—	—	—	—	2.67	—	—
6	10/7	SM-SP	7.5	—	NP	NP	30	63	7	—	—	—	—	—	2.69	—	—
7	10/8	SM	9.0	—	NP	NP	1	83	16	—	—	—	—	—	2.65	—	—

Abbrivation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

Checked By :-JS

JOB No.4538/284001

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-11

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.			
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%		Kg/cm ²	gm/cc
1	11/1	SM-SP	0.0	—	NP	NP	0	93	7	—	—	—	17	—	2.66	—	—
2	11/2	SM-SP	1.5	—	NP	NP	41	51	8	—	—	—	—	—	2.71	—	—
3	11/3	GM-GP	3.0	—	NP	NP	61	32	7	0	33	—	—	—	2.64	1.700 [*]	—
4	11/4	SM-SP	4.5	—	NP	NP	41	53	6	—	—	—	—	—	2.68	—	—
5	11/6	GM	6.0	—	NP	NP	42	40	18	—	—	—	—	—	2.70	—	—
6	11/7	SM	7.5	—	NP	NP	15	67	18	—	—	—	—	—	2.69	—	—
7	11/8	GM	9.0	—	NP	NP	56	22	22	—	—	—	—	—	2.65	—	—

Abbrivation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

Checked By :-JS

JOB No.4538/284001

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-12

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R .D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%
				%%	%%	%%	%	%	%	Kg/cm ²	Degree		%%	Kg/cm ²			
1	12/1	SM-SP	0.0	—	NP	NP	1	91	8	—	—	—	Nil	—	2.67	—	—
2	12/2	SM	1.5	—	NP	NP	14	73	13	0	30	—	—	—	2.69	1.672 [*]	9.2
3	12/3	SM	3.0	—	NP	NP	9	57	34	—	—	—	—	—	2.65	—	—
4	12/4	GM	4.5	—	NP	NP	58	30	12	—	—	—	—	—	2.66	—	—
5	12/6	SM	6.0	—	NP	NP	32	49	19	—	—	—	—	—	2.61	—	—
6	12/7	GM-GP	7.5	—	NP	NP	53	42	5	—	—	—	—	—	2.64	—	—
7	12/8	ML	9.0	—	NP	NP	8	36	56	—	—	—	—	—	2.70	—	—
8	12/9	ML	10.0	—	NP	NP	3	28	69	—	—	—	—	—	2.68	—	—

Abbreviation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

JOB No.4538/284001

Checked By :-JS

48 of 194

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-13

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.			
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%		Kg/cm ²	gm/cc
1	13/1	SM	0.0	—	NP	NP	2	91	7	—	—	—	Nil	—	2.65	—	—
2	13/2	SM	1.5	—	NP	NP	15	71	14	0	29	—	—	—	2.69	1.646 [*]	10.2
3	13/3	SM-SP	3.0	—	NP	NP	29	67	4	—	—	—	—	—	2.70	—	—
4	13/4	GM	4.5	—	NP	NP	40	34	26	—	—	—	—	—	2.68	—	—
5	13/6	ML	6.0	—	NP	NP	10	40	50	—	—	—	—	—	2.66	—	—
6	13/7	ML	7.5	—	NP	NP	8	30	62	—	—	—	—	—	2.72	—	—
7	13/8	SM	9.0	—	NP	NP	4	66	30	—	—	—	—	—	2.71	—	—

Abbrivation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

Checked By :-JS

JOB No.4538/284001

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat																	BH-14		
Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.		
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.		gm/cc	%		
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%				Kg/cm ²	
1	14/1	SM-SP	0.0	—	NP	NP	1	93	6	—	—	—	Nil	—	2.66	—	—		
2	14/2	SM	1.5	—	NP	NP	16	70	14	0	31	—	—	—	2.68	1.572 [*]	10.1		
3	14/3	SM	3.0	—	NP	NP	33	56	11	—	—	—	—	—	2.70	—	—		
4	14/4	SM	4.5	—	NP	NP	47	51	2	—	—	—	—	—	2.73	—	—		
5	14/6	SM	6.0	—	NP	NP	34	53	13	—	—	—	—	—	2.69	—	—		
Abbreviation :																			
LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C				Field Moisutre Content (%)				F.S.				Free Swell Index (%)			
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS				Unconfined Comp. Strength (Kg/Sq.cm)				S.P.				Swelling Pressure (Kg/Sq.cm.)			
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv				Coeff. of Volume Change (Sq.cm/kg)				G		Gravel		S		Sand	
NP	Non Plastic	R.D*	Remould Density(gm/cc)	M				Silt		C		Clay							
Tested By :-BC																		Checked By :-JS	

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION at Lakadia , Gujarat

BH-15

Sr. No.	Sample No.	I.S Classification	Depth in mt	Atterberg's Limit			Grain Size Analysis			Shear Parameter		Settlement parameter (mv)	Swelling Parameter		Sp. Gravity	F.D.D./R.D	F.M.C.
				L.L.	P.L.	P.I.	G	S	M & C	C	φ		F.S.	S.P.			
				%	%	%	%	%	%	Kg/cm ²	Degree		cm ² /kg	%		Kg/cm ²	gm/cc
1	15/1	SM-SP	0.0	—	NP	NP	4	90	6	—	—	—	Nil	—	2.70	—	—
2	15/2	GM-GP	1.5	—	NP	NP	54	35	11	0	32	—	—	—	2.69	1.700 [*]	—
3	15/3	SP	3.0	—	NP	NP	39	60	1	—	—	—	—	—	2.68	—	—
4	15/4	SM	4.5	—	NP	NP	32	48	20	—	—	—	—	—	2.71	—	—
5	15/6	SM	6.0	—	NP	NP	35	25	40	—	—	—	—	—	2.69	—	—
6	15/7	ML	7.5	—	NP	NP	10	39	51	—	—	—	—	—	2.70	—	—
7	15/8	ML	9.0	—	NP	NP	10	19	71	—	—	—	—	—	2.72	—	—

Abbrivation :

LL	Liquid Limit (%)	C	Cohession (Kg/Sq.cm)	F.M.C	Field Moisutre Content (%)	F.S.	Free Swell Index (%)		
PL	Plastic Limit (%)	φ	Angle of Internal Friction (Degree)	UCS	Unconfined Comp. Strength (Kg/Sq.cm)	S.P.	Swelling Pressure (Kg/Sq.cm.)		
PI	Plasticity Index (%)	F.D.D	Field Dry Density (gm/cc)	mv	Coeff. of Volume Change (Sq.cm/kg)	G	Gravel	S	Sand
NP	Non Plastic	R.D*	Remould Density(gm/cc)			M	Silt	C	Clay

Tested By :-BC

Checked By :-JS

JOB No.4538/284001

CHEMICAL ANALYSIS OF SOIL FOR BH-01 TO BH-06							
Location ID.	BH- No.	Depth in mt.	pH Value	Chloride in (%)	Sulphate as SO ₃ in (%)	Organic Matter in (%)	Nitrate in (%)
Lakadia , Gujarat	BH-1	0.5	9.32	0.0355	0.0223	0.1240	0.0008
		3.0	9.41	0.0263	0.0343	0.0859	0.0012
	BH-2	1.5	9.52	0.0343	0.0261	0.1088	0.0007
		3.0	9.37	0.0459	0.0192	0.0817	0.0011
	BH-3	1.5	9.22	0.0352	0.0373	0.0964	0.0010
		3.0	9.52	0.0459	0.0323	0.0664	0.0010
	BH-4	0.5	9.52	0.0311	0.0299	0.1078	0.0020
		3.0	9.67	0.0216	0.0180	0.0806	0.0013
	BH-5	1.5	9.89	0.0207	0.0171	0.1126	0.0018
		3.0	9.37	0.0554	0.0603	0.0931	0.0032
	BH-6	0.0	9.24	0.0440	0.0592	0.0756	0.0021
		1.5	9.55	0.0270	0.0205	0.1321	0.0024

Note : Here Sulphates and Chloride Content for all boreholes sample is found less than 0.2 %. so Use of Ordinary portland cement or portland slag cement or portland pozzolana cement with minimum cement content of 300 kg/m³ & maximum free water cement ratio of 0.55 is recommended.

Whenever there is Chloride in concrete, there is an increased risk of corrosion of embedded metal. The total amount of Acid Soluble Chloride contents in the reinforced concrete or Plain concrete containing embedded metal should not exceed 0.6 kg/m³ of concrete. For the protection against chloride presence, the cover to the steel is should be approximate to the exposure conditions as per table-16 of IS:456,2000. Concrete should be dense & well compacted.

Loose Sample Test Results			
Sample ID	Modified Proctor		Lab CBR
	Max. Dry Density (gm/cc)	Optimum Moisture Content (%)	CBR (Soaked) (%)
Sample 1	2.111	6.7	19.5
Sample 2	2.062	7.2	21.0

CHEMICAL ANALYSIS OF SOIL FOR BH-07 TO BH-15							
Location ID.	BH- No.	Depth in mt.	pH Value	Chloride in (%)	Sulphate as SO ₃ in (%)	Organic Matter in (%)	Nitrate in (%)
Lakadia , Gujarat	BH-7	0.0	9.05	0.0220	0.0119	0.1200	0.0027
		1.5	9.65	0.0196	0.0085	0.0790	0.0017
		3.0	9.38	0.0288	0.0134	0.0599	0.0010
		4.5	9.75	0.0270	0.0240	0.0656	0.0009
		6.0	9.63	0.0316	0.0254	0.0934	0.0010
		7.5	9.45	0.0286	0.0183	0.0772	0.0019
		9.0	9.54	0.0340	0.0270	0.1356	0.0016
	BH-8	0.0	9.63	0.0380	0.0347	0.1454	0.0011
		1.5	9.59	0.0218	0.0169	0.0768	0.0020
		3.0	9.44	0.0261	0.0280	0.0840	0.0010
		4.5	9.53	0.0196	0.0120	0.0533	0.0009
		6.0	9.52	0.0162	0.0145	0.0546	0.0024
		7.5	9.44	0.0243	0.0169	0.0719	0.0022
		9.0	9.36	0.0415	0.0475	0.0640	0.0016
	BH-9	0.0	9.56	0.0206	0.0144	0.1562	0.0008
		1.5	9.75	0.0191	0.0166	0.0922	0.0009
		3.0	9.84	0.0145	0.0117	0.0725	0.0010
		4.5	9.55	0.0217	0.0168	0.1400	0.0021
		6.0	9.72	0.0262	0.0249	0.1267	0.0013
		7.5	9.53	0.0415	0.0475	0.1292	0.0014
		9.0	8.55	0.0433	0.0385	0.0592	0.0020
	BH-10	0.0	8.95	0.0188	0.0164	0.0511	0.0025
		1.5	9.42	0.0242	0.0236	0.0651	0.0010
		3.0	9.36	0.0318	0.0307	0.0591	0.0018
		4.5	9.15	0.0238	0.0215	0.0915	0.0014
		6.0	9.43	0.0293	0.0272	0.0988	0.0016
		7.5	9.46	0.0215	0.0299	0.1159	0.0020
		9.0	9.54	0.0221	0.0137	0.1106	0.0030
	BH-11	0.0	9.18	0.0262	0.0149	0.0640	0.0014
		1.5	9.42	0.0287	0.0166	0.0786	0.0007
		3.0	8.99	0.0269	0.0272	0.0857	0.0005
		4.5	8.97	0.0219	0.0220	0.0896	0.0010
		6.0	9.02	0.0246	0.0188	0.0775	0.0012
		7.5	8.78	0.0464	0.0357	0.0599	0.0017
		9.0	8.96	0.0374	0.0276	0.0534	0.0008

Lakadia , Gujarat	BH-12	0.0	9.05	0.0143	0.0116	0.0900	0.0011
		1.5	9.64	0.0220	0.0170	0.0643	0.0019
		3.0	9.63	0.0218	0.0101	0.1365	0.0020
		4.5	9.21	0.0262	0.0166	0.1280	0.0017
		6.0	9.32	0.0278	0.0177	0.1195	0.0014
		7.5	9.25	0.0340	0.0254	0.1300	0.0013
		9.0	9.25	0.0398	0.0261	0.1384	0.0011
		10.0	9.42	0.0388	0.0253	0.1256	0.0026
	BH-13	0.0	9.35	0.0196	0.0204	0.1098	0.0021
		1.5	8.99	0.0217	0.0185	0.1063	0.0020
		3.0	9.75	0.0164	0.0114	0.0988	0.0011
		4.5	10.11	0.0266	0.0185	0.0585	0.0017
		6.0	9.58	0.0193	0.0134	0.0657	0.0021
		7.5	9.87	0.0317	0.0255	0.1368	0.0020
		9.0	9.99	0.0379	0.0297	0.1317	0.0011
	BH-14	0.0	10.50	0.0185	0.0129	0.1257	0.0005
		1.5	10.10	0.0162	0.0113	0.0650	0.0009
		3.0	9.95	0.0236	0.0246	0.0599	0.0014
		4.5	9.64	0.0168	0.0150	0.0927	0.0008
		6.0	9.53	0.0218	0.0118	0.0846	0.0021
	BH-15	0.0	9.87	0.0148	0.0137	0.0799	0.0022
		1.5	9.12	0.0171	0.0102	0.1389	0.0019
		3.0	9.65	0.0259	0.0164	0.1105	0.0020
		4.5	9.45	0.0286	0.0199	0.1165	0.0010
		6.0	9.28	0.0254	0.0229	0.0600	0.0015
		7.5	9.98	0.0511	0.0372	0.0668	0.0021
		9.0	9.38	0.0603	0.0520	0.0779	0.0026

Note : Here Sulphates and Chloride Content for all boreholes sample is found less than 0.2 %. so Use of Ordinary portland cement or portland slag cement or portland pozzolana cement with minimum cement content of 300 kg/m³ & maximum free water cement ratio of 0.55 is recommended.

Whenever there is Chloride in concrete, there is an increased risk of corrosion of embedded metal. The total amount of Acid Soluble Chloride contents in the reinforced concrete or Plain concrete containing embedded metal should not exceed 0.6 kg/m³ of concrete. For the protection against chloride presence, the cover to the steel should be approximate to the exposure conditions as per table-16 of IS:456,2000. Concrete should be dense & well compacted.

Loose Sample Test Results			
Sample ID	Modified Proctor		Lab CBR
	Max. Dry Density (gm/cc)	Optimum Moisture Content (%)	CBR (Soaked) (%)
Sample 3	2.029	8.4	23.2
Sample 4	1.952	9.3	21.6
Sample 5	1.932	9.2	19.4
Sample 6	2.086	8.5	16.1

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

For BH-01 to BH-6

Shape of footing = Square ▼

Depth of footing $D = 3.00$ m

Width of footing $B = 6.00$ m

Length of footing $L = 6.00$ m

Cohesion $C = 0.10$ kg/cm²

Angle of Int.Fric $\phi = 20$ degrees

Specific Gravity $G = 2.59$

Inclination Angle $\alpha = 0$ degrees

Correction Factor for Water Table = 0.5

Dry Density $\gamma_d = 1.617$ gm/cc

Sat. density $\gamma_{sat} = 1.993$ gm/cc

Submerged density = 0.993 gm/cc

Factor of Safety = 3.0

Void Ratio $e_o = \frac{G \times \gamma_w}{\gamma_d} = -1$

Plate - 3

Sample Calculation

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.143	1.300	1.000
dq, sq, iq	1.071	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.071	0.800	1.000

$\gamma_d = 1.617$ it is ≥ 0.55 & ≤ 0.75 hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\phi = 20$

$c = 0.100$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\phi' = \tan^{-1}(0.67 \tan \phi)$

$c' = 0.067$ if $e_o > 0.75$, it is local shear failure

$\phi' = 13.70$

$c' = 0.091$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	13.66	$Nc' =$	10.30	$Nc =$	14.83
$Nq'' =$	5.67	$Nq' =$	3.56	$Nq =$	6.40
$N\gamma'' =$	4.59	$N\gamma' =$	2.28	$N\gamma =$	5.39

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N \gamma S \gamma d \gamma i \gamma W'$$

for general shear failure

= 0.00 $q_{ns} = 0.00$ t/m²

$$q_{un} = c'Nc'Scdic + q(N'q-1) Sqdqiq + 0.5 B \gamma N' \gamma S \gamma d \gamma i \gamma W'$$

for local shear failure

= 0.00 $q_{ns} = 0.00$ t/m²

$$q_{un} = c''Nc'Scdic + q(N''q-1) Sqdqiq + 0.5 B \gamma N'' \gamma S \gamma d \gamma i \gamma W'$$

for intermediate shear failure

= 48.15 t/m² JOB No.4538/284001 $q_{ns} = 16.05$ t/m²

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

For BH-07 to BH-15

Shape of footing = Square ▼

Depth of footing $D = 3.00$ m

Width of footing $B = 6.00$ m

Length of footing $L = 6.00$ m

Cohesion $C = 0.00$ kg/cm²

Angle of Int.Fric $\phi = 30$ degrees

Specific Gravity $G = 2.64$

Inclination Angle $\alpha = 0$ degrees

Correction Factor for Water Table = 0.5

Dry Density $\gamma_d = 1.543$ gm/cc

Sat. density $\gamma_{sat} = 1.959$ gm/cc

Submerged density = 0.959 gm/cc

Factor of Safety = 3.0

Void Ratio $e_o = \frac{G \times Y_w}{\gamma_d} = -1$

Plate - 3

Sample Calculation

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.173	1.300	1.000
dq, sq, iq	1.087	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.087	0.800	1.000

= 0.7110 *it is ≥ 0.55 & ≤ 0.75 hence it is an intermediate shear failure*

(General Shear Failure $e_o < 0.55$) $\phi = 30$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\phi' = \tan^{-1}(0.67 \tan \phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\phi' = 21.15$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	18.91	$Nc' =$	16.18	$Nc =$	30.14
$Nq'' =$	9.53	$Nq' =$	7.38	$Nq =$	18.40
$N\gamma'' =$	9.63	$N\gamma' =$	6.54	$N\gamma =$	22.40

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S\gamma d\gamma i\gamma W'$$

for general shear failure

= 0.00 $q_{ns} = 0.00$ t/m²

$$q_{un} = c'N'cScdcic + q(N'q-1) Sqdqiq + 0.5 B \gamma N'\gamma S\gamma d\gamma i\gamma W'$$

for local shear failure

= 0.00 $q_{ns} = 0.00$ t/m²

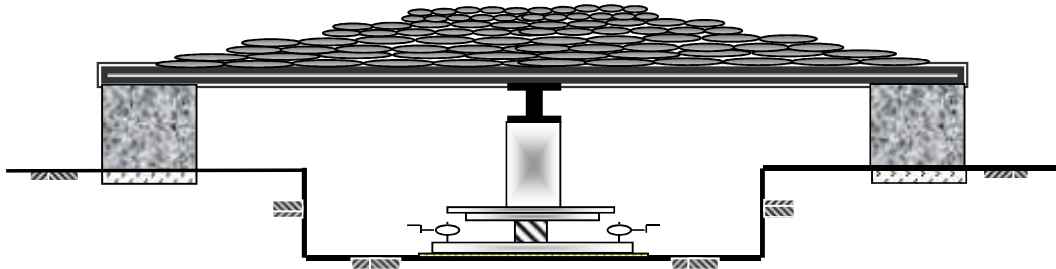
$$q_{un} = c''N''cScdcic + q(N''q-1) Sqdqiq + 0.5 B \gamma N''\gamma S\gamma d\gamma i\gamma W'$$

for intermediate shear failure

= 56.58 t/m² JOB No.4538/284001 $q_{ns} = 18.86$ t/m²

PLATE LOAD TEST REPORT

(IS : 1888-1997)



CLIENT

Techno Electric & Engineering Co. Ltd.

LOCATION

Lakadia Sub Station

NAME OF WORK

Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani Transmission Ltd.



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

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BRIEF DETAIL OF PLATE LOAD TEST

Name of Work	: Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr Adani Transmission Ltd.
Client	: Techno Electric & Engineering Co. Ltd.
Agency	: -
Ref. No	: Order No.0756LA/19-20/25535, Date:-10/10/2019
Job No.	4538/284001
Testing	: Geo Test House (A Division of Geo Designs & Research Pvt Ltd.)
Agency	B-10, Krishna Industrial Estate, Opp. B.I.D.C., Gorwa Estate, Vadodara - 390 016. Ph : 91-265-2290222. Telefax : 91-265-2282014. E-mail : geo_group@yahoo.com
Report No	: BRD/4538/284001
Ref.Code	: IS :1888-1997
Nos of PLT	: Two
Plate Size	: 0.3 X 0.3 mtr
Shape of Plate	: Squre
Pit Depth	: 1.5 mtr (For PLT-01) & 1.7mtr (For PLT-02)
Fine Sand Layer	: 5 mm thick.
Location I.D No	: PLT-01 & PLT-02
Location	: Lakadia Sub Station

Test Date	: 18/3/2020 to 21/3/2020
Test Load	: 4.5 MT
Load Increment	: Least of following ; i) 1 Kg / Sq.cm ii) 20 % of Ultimate Bearing Capacity
Hydraulic Jack	: 1 Nos.
RAM Dia of Jacks	: 15.0 cm
Total RAM Area	: 177 cm ²
Capacity	: 100 MT
Pressure Cell	: 1 Nos.
Resolution	: 1.0 Kg/cm ²
Capacity	: 0 - 100 Kg/cm ²
LVDT/ Dial Gauge	: 4 No.
Capacity	50 mm
L.C	: 0.01 mm

INTRODUCTION

Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr Adani Transmission Ltd. was referred to us by Techno Electric & Engineering Co. Ltd. Vide Order No.0756LA/19-20/25535, Date:-10/10/2019

With reference to above we were deputed our engineering team for the purpose of testing on PLT-01 & PLT-02 under the supervision of your representative at Project Site.

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of Allowable bearing Pressure.

- Two Plate load test was carried out at existing ground level to know the soil bearing capacity of soil
- Analyzing field data to evaluate Allowable Bearing Pressure of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia Sub Station

OBJECTIVE

The main objective of carrying out the Plate Load Test is to check the settlement for the ultimate bearing capacity of soil in place and its settlement. The Testing was carried out as per I.S. code 1888-1997.

METHODOLOGY

PLATE SIZE AND THICKNESS :

The plate of 0.3 X 0.3 mtrSquire with at least 2.5 cm thick was used for plate load test

The size of test pit was given by client at project site. Test plate was placed at the center of the test pit.

PLACING OF TEST PLATE :

The test plate shall be placed over a test layer of maximum thickness of 5 mm so that the centre of plate coincides with the centre of reaction girder / beam, with the help of a plumb and bob and horizontally leveled by a spirit level to avoid eccentric loading. The hydraulic jack was centrally placed over the plate with the loading column in between the jack and reaction beam so as to transfer load to the plate. A minimum seating pressure of 70-g/sq.cm was applied and removed before starting the load test.

METHOD OF LOADING:

The methodology adopted for Plate Load Test by Kentledge method is in such a way that the full test (Compression) load be supplied in the form of dead weight stacked above the foundation on framework. The kentledge reaction was applied through sand bags.

The test load was then applied through hydraulic jack and other Kentledge reaction assembly. The framework was capable of supporting the entire load at a single location where a hydraulic ram or jack could progressively transfer the load to the top of the pile. The center of gravity of the reaction load was generally be on the axis of the contact area of soil and the load applied by the jack was coaxial with contact area of plate and suitably positioned dial gauges record the settlement.

SETTLEMENT AND OBSERVATION :

Settlement was observed for each increment cycle, the readings had been taken at regular intervals at 1.0, 2.25, 4.0, 6.25, 9.0, 16, 25, and 60 min until the rate of settlement is less than 0.02 mm/min. The next increment of load was then applied and the observations repeated. The test was to be continued till a settlement of 25 mm under normal circumstances and 50 mm in case of special cases such as dense gravel, gravel and sand mixture is obtained, till failure occurs, or up to design ultimate safe bearing pressure, whichever was earlier.

OBSERVATION-TABLE- PLT

Type of Test : Static Plate Load Test

Client : Techno Electric & Engineering Co. Ltd.

Name of wor : Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr Adani Transmission Ltd.

Location : Lakadia Sub Station

Size of Pit : 6.0 X 2.0 m

Depth of Pit : 1.5 mtr

Size of Plate : 0.3 X 0.3 mtr

Date of Testing : 18/3/2020

Sr. No.	Date	Time in Min.	Pressure in Kg/cm ² (On Ram)	Pressure in T/m ² (on Plate)	Dial Gauge / LVDT Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	D		
LOADING										
1	Date 18/3/2020		1	1.19	4000	4000	4000	4000	4000.00	0.000
2		1:00	4.00	9.5	3892	3891	3910	3901	3898.50	1.015
		2.25			3892	3891	3909	3901	3898.25	1.018
		4.00			3892	3891	3909	3901	3898.25	1.018
		6.25			3892	3891	3909	3901	3898.25	1.018
		9.00			3892	3891	3909	3901	3898.25	1.018
		16.00			3892	3891	3909	3901	3898.25	1.018
		25.00			3892	3891	3909	3901	3898.25	1.018
		60.00			3892	3891	3909	3901	3898.25	1.018

Sr. No.	Date	Time in Min.	Pressure in Kg/cm ² (On Ram)	Pressure in T/m ² (on Plate)	Dial Gauge / LVDT Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	D		
LOADING										
3	Date 18/3/2020		8.0	19.0						
		1:00			3856	3869	3887	3874	3871.50	1.285
		2.25			3855	3869	3887	3874	3871.25	1.288
		4.00			3855	3869	3887	3874	3871.25	1.288
		6.25			3855	3869	3887	3874	3871.25	1.288
		9.00			3854	3868	3887	3873	3870.50	1.295
		16.00			3854	3868	3887	3873	3870.50	1.295
		25.00			3854	3868	3887	3873	3870.50	1.295
		60.00			3854	3868	3887	3873	3870.50	1.295
4			13.0	30.9						
		1:00			3806	3833	3854	3825	3829.50	1.705
		2.25			3806	3833	3854	3824	3829.25	1.708
		4.00			3805	3832	3854	3824	3828.75	1.713
		6.25			3805	3832	3853	3824	3828.50	1.715
		9.00			3805	3832	3853	3824	3828.50	1.715
		16.00			3805	3831	3852	3823	3827.75	1.723
		25.00			3805	3831	3852	3823	3827.75	1.723
		60.00			3805	3831	3852	3823	3827.75	1.723

Sr. No.	Date	Time in Min.	Pressure in Kg/Sq.cm (On Ram)	Pressure in T/Sq.m (on Plate)	Dial Gauge Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	C		
Loading										
5	Date 18/3/2020		17.0	40.4						
		1:00			3764	3808	3834	3780	3796.50	2.035
		2.25			3764	3808	3834	3780	3796.50	2.035
		4.00			3763	3808	3833	3779	3795.75	2.043
		6.25			3763	3807	3832	3779	3795.25	2.048
		9.00			3763	3807	3832	3779	3795.25	2.048
		16.00			3763	3807	3832	3779	3795.25	2.048
		25.00			3763	3807	3831	3779	3795.00	2.050
		60.00			3763	3807	3831	3779	3795.00	2.050
6			22.0	52.3						
		1:00			3701	3779	3774	3725	3744.75	2.553
		2.25			3701	3778	3774	3725	3744.50	2.555
		4.00			3701	3778	3774	3725	3744.50	2.555
		6.25			3700	3777	3774	3724	3743.75	2.563
		9.00			3700	3777	3774	3724	3743.75	2.563
		16.00			3699	3777	3773	3724	3743.25	2.568
		25.00			3699	3777	3773	3724	3743.25	2.568
		60.00			3699	3777	3773	3724	3743.25	2.568

Calculation :-

Pressure on ram : 4.0 Kg/cm² (Observed Pressure)

Load on Test Plate : Pressure on ram X C/S area of ram

$$: 4.0 \times 177$$

$$: 856.0 \text{ Kg}$$

$$: 0.86 \text{ MT}$$

Presssure on test Plate : Load on Test Plate/Bearing area of Plate

$$: 0.86 / (0.3 \times 0.3)$$

$$: 9.5 \text{ T / m}^2$$

:

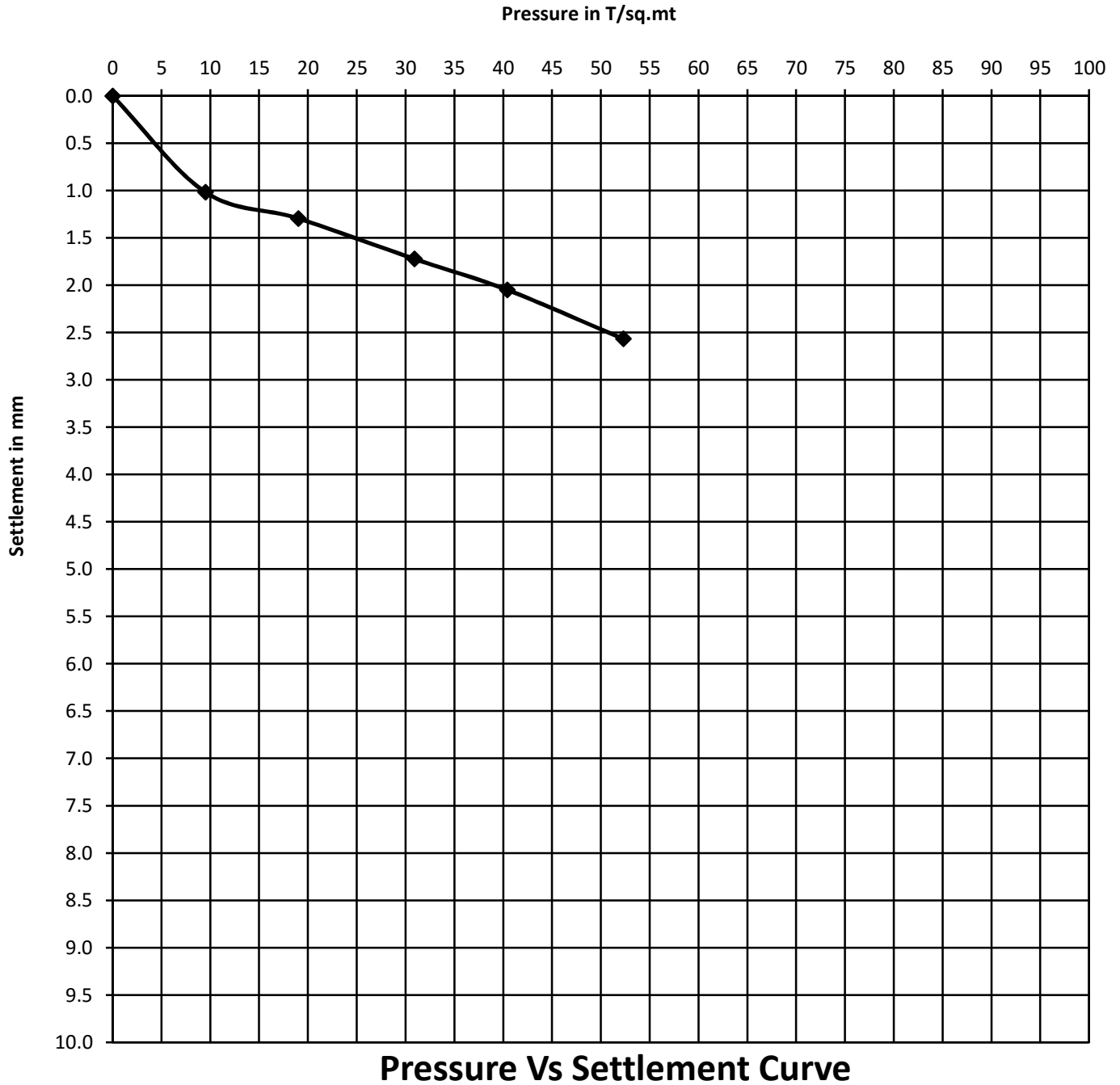
Presssure on test Plate : Load on Test Plate/Bearing area of Plate

$$: 4.7 / (0.3 \times 0.3)$$

$$: 52.31 \text{ T / m}^2$$

Tested By : JHP

GRAPH for PLT-01



OBSERVATION-TABLE- PLT

Type of Test : Static Plate Load Test

Client : Techno Electric & Engineering Co. Ltd.

Name of wor : Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr Adani Transmission Ltd.

Location : Lakadia Sub Station

Size of Pit : 6.0 X 2.0 m

Depth of Pit : 1.7 mtr

Size of Plate : 0.3 X 0.3 mtr

Date of Testing : 21/3/2020

Sr. No.	Date	Time in Min.	Pressure in Kg/cm ² (On Ram)	Pressure in T/m ² (on Plate)	Dial Gauge / LVDT Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	D		
LOADING										
1	Date 21/3/2020		0.5	1.19	4000	4000	4000	4000	4000.00	0.000
2		1:00	4.00	9.5	3911	3886	3862	3870	3882.25	1.178
		2.25			3910	3884	3861	3869	3881.00	1.190
		4.00			3910	3884	3861	3869	3881.00	1.190
		6.25			3910	3884	3861	3869	3881.00	1.190
		9.00			3909	3883	3860	3869	3880.25	1.198
		16.00			3909	3883	3860	3869	3880.25	1.198
		25.00			3909	3883	3859	3868	3879.75	1.203
		60.00			3909	3883	3859	3868	3879.75	1.203

Sr. No.	Date	Time in Min.	Pressure in Kg/cm ² (On Ram)	Pressure in T/m ² (on Plate)	Dial Gauge / LVDT Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	D		
LOADING										
3	Date 21/3/2020		8.0	19.0						
		1:00			3820	3725	3763	3750	3764.50	2.355
		2.25			3819	3724	3763	3750	3764.00	2.360
		4.00			3819	3724	3763	3750	3764.00	2.360
		6.25			3819	3724	3763	3749	3763.75	2.363
		9.00			3819	3724	3762	3749	3763.50	2.365
		16.00			3819	3724	3762	3748	3763.25	2.368
		25.00			3818	3723	3762	3748	3762.75	2.373
		60.00			3818	3723	3762	3748	3762.75	2.373
4			13.0	30.9						
		1:00			3743	3669	3712	3882	3751.50	2.485
		2.25			3742	3669	3711	3681	3700.75	2.993
		4.00			3742	3669	3711	3681	3700.75	2.993
		6.25			3741	3699	3710	3680	3707.50	2.925
		9.00			3741	3699	3710	3680	3707.50	2.925
		16.00			3740	3668	3710	3679	3699.25	3.008
		25.00			3740	3668	3710	3679	3699.25	3.008
		60.00			3740	3668	3710	3679	3699.25	3.008

Sr. No.	Date	Time in Min.	Pressure in Kg/Sq.cm (On Ram)	Pressure in T/Sq.m (on Plate)	Dial Gauge Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	C		
Loading										
5	Date 21/3/2020		17.0	40.4						
		1:00			3638	3580	3671	3610	3624.75	3.753
		2.25			3638	3580	3670	3610	3624.50	3.755
		4.00			3637	3580	3670	3610	3624.25	3.758
		6.25			3637	3579	3670	3609	3623.75	3.763
		9.00			3637	3579	3670	3609	3623.75	3.763
		16.00			3637	3579	3668	3609	3623.25	3.768
		25.00			3637	3579	3668	3609	3623.25	3.768
		60.00			3637	3578	3668	3607	3622.50	3.775
6			22.0	52.3						
		1:00			3521	3510	3518	3522	3517.75	4.823
		2.25			3520	3509	3518	3522	3517.25	4.828
		4.00			3520	3507	3517	3521	3516.25	4.838
		6.25			3520	3507	3517	3520	3516.00	4.840
		9.00			3519	3506	3516	3519	3515.00	4.850
		16.00			3519	3506	3516	3519	3515.00	4.850
		25.00			3518	3506	3515	3517	3514.00	4.860
		60.00			3518	3506	3515	3517	3514.00	4.860

Calculation :-

Pressure on ram : 4.0 Kg/cm² (Observed Pressure)

Load on Test Plate : Pressure on ram X C/S area of ram

$$: 4.0 \times 177$$

$$: 856.0 \text{ Kg}$$

$$: 0.86 \text{ MT}$$

Presssure on test Plate : Load on Test Plate/Bearing area of Plate

$$: 0.86 / (0.3 \times 0.3)$$

$$: 9.5 \text{ T / m}^2$$

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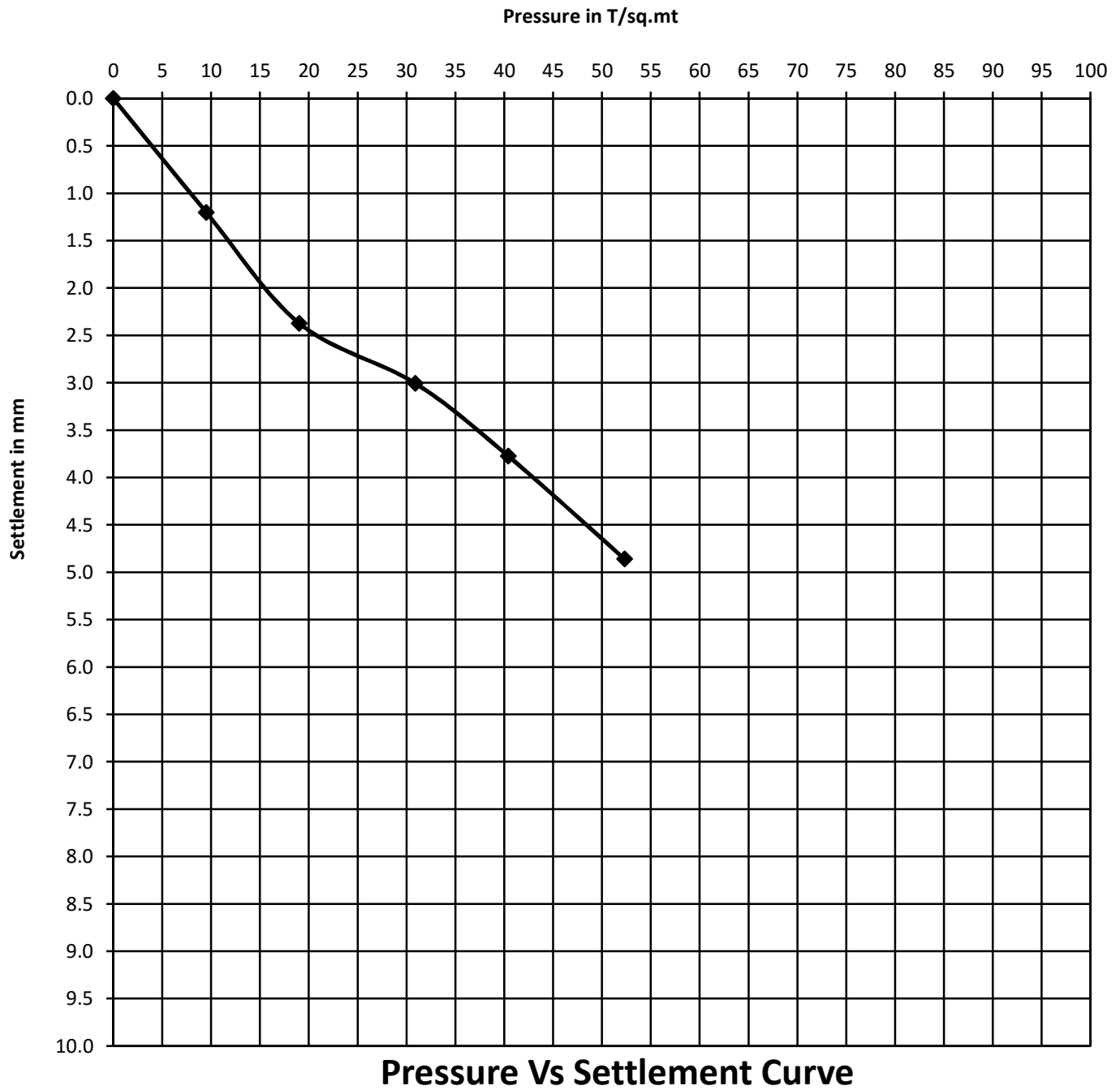
Presssure on test Plate : Load on Test Plate/Bearing area of Plate

$$: 4.7 / (0.3 \times 0.3)$$

$$: 52.31 \text{ T / m}^2$$

Tested By : JHP

GRAPH for PLT-02



ANALYSIS FOR PLATE LOAD TEST NO :- 01 & 02

i) For Safe Bearing Pressure Calculation.

SBC $(q_{SBC})_f$ = Safe bearing capacity of footing (From shear criteria)

B_f = Width of footing

B_p = Width of plate

(q_{UBC}) = Ultimate BC of plate (from load-settlement curve) = 50 t/m²

(q_{UBC}) = Ultimate bearing capacity of footing = $(q_{UBC}) \times [B_f/B_p]$

FOS = 3.0

(q_{SBC}) = $(q_{UBC}) / FOS$ **No shear failure is observed at 50t/m²**

SBP $(q_{SBP})_f$ = Safe bearing pressure of footing (from settlement criteria)

$(q_{SBP})_f$ = Safe bearing pressure of footing corresponding to $(S_a)_p$, from load settlement curve

Where,

$(S_a)_p$ = Allowable settlement of plate

= $(S_a)_f [B_p(B_f+0.3)/B_f(B_p+0.3)]^2$

$(S_a)_f$ = Allowable settlement of footing **25,50 & 100 mm** for isolated footing

B_f = Width of footing

B_p = Width of plate

0.30 m

Table -1 for Safe Bearing Pressure

Allowable settlement of footing in mm	Width of footing in m	Allowable settlement of plate in mm	Safe bearing pressure in t/m^2 (From Graph)	Recommended SBC in t/m^2
$(S_a)_f$	B_f	$(S_a)_p$	$(q_{SBP})_f$	
(1)	(2)	(3)	(4)	(5)
25	1.00	10.6	No shear failure is observed & settlement of Plate is within Permissible limit. Hence SBC of 20 T/m^2 ok. (For PLT-01 & PLT-02)	
25	2.00	8.3		
25	3.00	7.6		
25	4.00	7.2		
25	6.00	6.9		

Remarks :

1. Two test Was Conducted on Ultimate Bearing capacity of 50.0 T/m^2 (Provided by client/contractor/site incharge) is at this stage, allowable settlement for given size of footing is within Permissible limit, as only 2.568 mm Settlement are observed for PLT-01 & 4.860 mm Settlement are observed for PLT-02. No shear failure within the sub soil during the test load observed. Hence,assumed SBC of 20 T/m^2 (For PLT-01 & PLT-02) is satisfactory.

(Authorized Signatory)

Vishal Sakpal

Manager Technical

NOTE:

1.This certificate or report may not be published for commercial purpose except in full unless permission for the publication of an approved abstract has been obtained from the GEO TEST HOUSE,Vadodara.

2.This test certificate applies only to the test location.

CONCLUSION

1. Two Plate Load Tests were carried out at Lakadia Sub Station
2. Safe Bearing Capacity, Safe Bearing Pressure are determined as per as per I.S : 1888-1997 Clause No. 5.0
3. Ultimate bearing capacity is derived from the Pressure / Settlement curve, and Safe bearing capacity is determined by considering factor of safety of 3.0. Minimum value from SBC and SBP shall be considered in design of foundation as mentioned in Table-1.

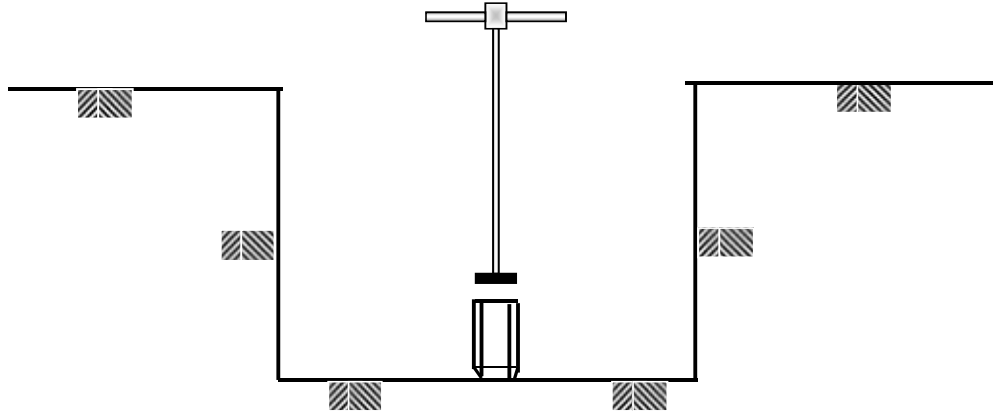
Limitations of Plate load tests are as follows :

- 1) Plate bearing test is of short duration test and hence consolidation settlement does not fully occur during this test. As such this test cannot be used to predict consolidation settlement. Hence from settlement considerations, its use is restricted to sandy soils and to partially saturated or rather slightly unsaturated clayey soils.
- 2) The test results reflect only the character of the soil located within a depth of less than twice the width of the bearing plate. Thus the results of the tests are likely to be misleading, if the character of the soil changes at shallow depth which is not uncommon.
- 3) For clayey soils the bearing capacity (from shear consideration) for a larger foundation is almost the same as that for the smaller test plate. But in dense sandy soils the bearing capacity increases with the size of the foundation. Thus test with smaller size plate tend to give conservative values in dense sandy soils.

There are inaccuracies introduced in extrapolating the results from small size plates to large size foundations. Hence, it is stressed here that plate bearing test alone is not to be used in predicting the allowable bearing pressure for foundation.

GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

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BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/01	REPORT DT. : 30/1/2020
JOB No.	:	4538/284001	SAMPLE NO. : 01
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-1	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	20/1/2020	
FIELD WORK COMP. DATE	:	20/1/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<u>SR. NO.</u>	<u>PERTICULARS</u>	<u>PAGES</u>
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7	Safe Bearing Capacity Calculation	10 of 10

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	28
Dry Density (in gm/cc)	1.623
Specific Gravity	2.65
Factor of Safety	3.0
Void ratio, e (Computed)	0.633
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-1	1.5	1.0 x 1.0	10.07
			1.5 x 1.5	10.37
			2.0 X 2.0	10.94
			2.5 X 2.5	11.62
			3.0 x 3.0	12.35
			3.5 x 3.5	13.10
			4.0 x 4.0	13.88
			4.5 x 4.5	14.67
			5.0 x 5.0	15.47
			5.5 x 5.5	16.28
			6.0 x 6.0	17.09
		2.0	1.0 x 1.0	13.58
			1.5 x 1.5	13.47
			2.0 X 2.0	13.83
			2.5 X 2.5	14.38
			3.0 x 3.0	15.03
			3.5 x 3.5	15.73
			4.0 x 4.0	16.46
			4.5 x 4.5	17.22
			5.0 x 5.0	17.99
			5.5 x 5.5	18.77
			6.0 x 6.0	19.56

RCC Open Foundation	TP-1	2.5	1.0 x 1.0	17.44
			1.5 x 1.5	16.80
			2.0 X 2.0	16.90
			2.5 X 2.5	17.29
			3.0 x 3.0	17.83
			3.5 x 3.5	18.45
			4.0 x 4.0	19.13
			4.5 x 4.5	19.84
			5.0 x 5.0	20.58
			5.5 x 5.5	21.33
		3.0	6.0 x 6.0	22.10
			1.0 x 1.0	21.66
			1.5 x 1.5	20.37
			2.0 X 2.0	20.14
			2.5 X 2.5	20.34
			3.0 x 3.0	20.75
			3.5 x 3.5	21.28
			4.0 x 4.0	21.88
			4.5 x 4.5	22.54
			5.0 x 5.0	23.23
			5.5 x 5.5	23.95
			6.0 x 6.0	24.63

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION OF PROJECT SITE																Plate - 1	
Sr. No.	Location ID	Depth in (mtr)	I.S Classification of Soil	Type	Atterberg's Limit			Grain Size Analysis			Free Swell	Shear Parameter		Sp. Gravity	FDD/ R.D	F.M.C/O. M.C	
					L.L.	P.L.	P.I.	G	S	M & C		C	φ		gm/cc	%	
					%	%	%	%	%	%	%	Kg/cm ²	Degree				
1	TP-1	1.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	15	70	15	—	--	--	2.63	1.595	6.3	
2		2.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	16	68	16	—	0	28	2.65	1.623	5.2	
3		3.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	11	49	40	—	--	--	2.68	1.665	9.6	
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	10	48	42	—	0	30	2.65	1.591	8.8	
Abbreviation :																	
LL	Liquid Limit (%)				C	Cohession (Kg/Sq.cm)											
PL	Plastic Limit (%)				φ	Angle of Internal Friction (Degree)											
PI	Plasticity Index (%)				R.D.	Remoulded Density (gm/cc)				G Gravel				S Sand			
NP	Non Plastic				F.M.C	Field Moisutre Content (%)				M Silt				C Clay			
Tested By :- DJ																	
Checked By :- JS																	

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square ▼

Plate - 3

Depth of footing $D =$

3.00 m

Sample Calculation

Width of footing $B =$

6.00 m

Length of footing $L =$

6.00 m

Cohesion $C =$

0.00 kg/cm²

Angle of Int.Fric $\phi =$

28 degrees

Specific Gravity $G =$

2.65

Inclination Angle $\alpha =$

0 degrees

Correction Factor for Water Table =

0.5

Dry Density $\gamma_d =$

1.623 gm/cc

Sat. density $\gamma_{sat} =$

2.011 gm/cc

Submerged density=

1.011 gm/cc

Factor of Safety =

3.0

Void Ratio $e_o =$

$\frac{G \times \gamma_w}{\gamma_d} = -1$

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.166	1.300	1.000
dq, sq, iq	1.083	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.083	0.800	1.000

$\frac{\gamma_d}{\gamma_{sat} - C} = 0.6328$

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\Phi = 28$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\Phi' = \tan^{-1}(0.67 \tan \Phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\Phi' = 19.61$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	21.47	$Nc' =$	14.53	$Nc =$	26.37
$Nq'' =$	11.54	$Nq' =$	6.21	$Nq =$	15.30
$N\gamma'' =$	12.45	$N\gamma' =$	5.18	$N\gamma =$	17.59

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S \gamma d \gamma i \gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'Nc'Scdic + q(N'q-1) Sqdqiq + 0.5 B \gamma N'\gamma S \gamma d \gamma i \gamma W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''Nc'Scdic + q(N''q-1) Sqdqiq + 0.5 B \gamma N''\gamma S \gamma d \gamma i \gamma W'$$

for intermediate shear failure

= 74.07

t/m²

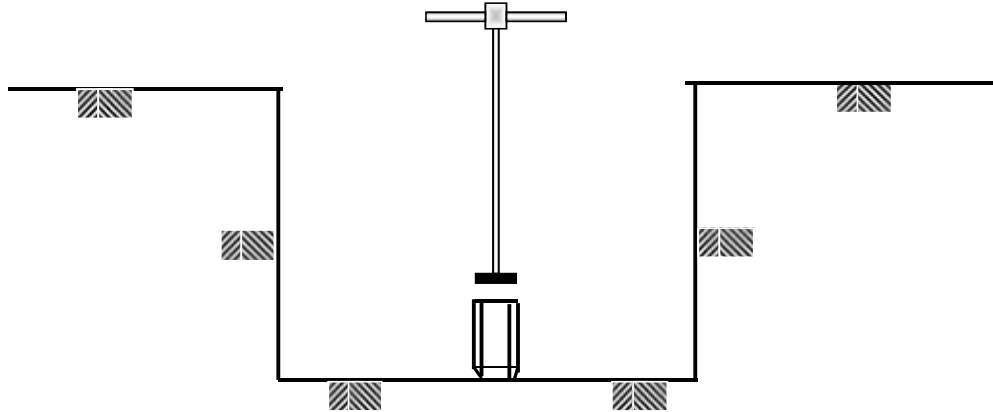
$q_{ns} =$

24.69

t/m²

GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

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BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/02	REPORT DT. : 30/1/2020
JOB No.	:	4538/284001	SAMPLE NO. : 02
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-2	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	20/1/2020	
FIELD WORK COMP. DATE	:	20/1/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<u>SR. NO.</u>	<u>PARTICULARS</u>	<u>PAGES</u>
1	Brief Details of Project	
2	Introduction	4 of 11
3	Sub Surface Exploration & Laboratory Test	5 of 11
4	Safe Bearing Capacity	6 of 11
5	Conclusion and Recommendation	9 of 11
6	Summury of Test Results	10 of 11
7	Safe Bearing Capacity Calculation	11 of 11

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	28
Dry Density (in gm/cc)	1.651
Specific Gravity	2.65
Factor of Safety	3.0
Void ratio, e (Computed)	0.605
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-2	1.5	1.0 x 1.0	11.49
			1.5 x 1.5	11.84
			2.0 X 2.0	12.50
			2.5 X 2.5	13.27
			3.0 x 3.0	14.11
			3.5 x 3.5	14.98
			4.0 x 4.0	15.87
			4.5 x 4.5	16.78
			5.0 x 5.0	17.70
			5.5 x 5.5	18.62
			6.0 x 6.0	19.55
		2.0	1.0 x 1.0	15.48
			1.5 x 1.5	15.37
			2.0 X 2.0	15.79
			2.5 X 2.5	16.42
			3.0 x 3.0	17.16
			3.5 x 3.5	17.97
			4.0 x 4.0	18.81
			4.5 x 4.5	19.68
			5.0 x 5.0	20.57
			5.5 x 5.5	21.47
			6.0 x 6.0	22.37

RCC Open Foundation	TP-2	2.5	1.0 x 1.0	19.89
			1.5 x 1.5	19.16
			2.0 X 2.0	19.28
			2.5 X 2.5	19.73
			3.0 x 3.0	20.35
			3.5 x 3.5	21.07
			4.0 x 4.0	21.85
			4.5 x 4.5	22.87
			5.0 x 5.0	23.51
			5.5 x 5.5	24.38
		3.0	6.0 x 6.0	25.26
			1.0 x 1.0	24.69
			1.5 x 1.5	23.23
			2.0 X 2.0	22.97
			2.5 X 2.5	23.21
			3.0 x 3.0	23.68
			3.5 x 3.5	24.29
			4.0 x 4.0	24.99
			4.5 x 4.5	25.75
			5.0 x 5.0	26.54
			5.5 x 5.5	27.37
			6.0 x 6.0	28.22

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION OF PROJECT SITE																Plate - 1
Sr. No.	Location ID	Depth in (mtr)	I.S Classification of Soil	Type	Atterberg's Limit			Grain Size Analysis			Free Swell	Shear Parameter		Sp. Gravity	FDD/ R.D	F.M.C/O. M.C
					L.L.	P.L.	P.I.	G	S	M & C		C	φ		gm/cc	%
					%	%	%	%	%	%	%	Kg/cm ²	Degree			
1	TP-2	1.0	SM (Silty Sand of Non Plasticity)	UDS	–	NP	NP	10	70	20	–	0	28	2.65	1.651	6.7
2		2.0	SM (Silty Sand of Non Plasticity)	UDS	–	NP	NP	8	73	19	–	--	--	2.64	1.662	2.8
3		3.0	SM (Silty Sand of Non Plasticity)	UDS	–	NP	NP	10	68	22	–	0	30	2.66	1.692	5.4
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	–	NP	NP	7	68	25	–	–	–	2.63	1.702	20.6
Abbreviation :																
LL Liquid Limit (%)					C Cohession (Kg/Sq.cm)											
PL Plastic Limit (%)					φ Angle of Internal Friction (Degree)											
PI Plasticity Index (%)					R.D. Remoulded Density (gm/cc)					G Gravel					S Sand	
NP Non Plastic					F.M.C Field Moisutre Content (%)					M Silt					C Clay	
Tested By :- DJ																
Checked By :- JS																

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square ▼

Plate - 3

Depth of footing $D =$

3.00 m

Sample Calculation

Width of footing $B =$

6.00 m

Length of footing $L =$

6.00 m

Cohesion $C =$

0.00 kg/cm²

Angle of Int.Fric $\phi =$

28 degrees

Specific Gravity $G =$

2.65

Inclination Angle $\alpha =$

0 degrees

Correction Factor for Water Table =

0.5

Dry Density $\gamma_d =$

1.651 gm/cc

Sat. density $\gamma_{sat} =$

2.028 gm/cc

Submerged density=

1.028 gm/cc

Factor of Safety =

3.0

Void Ratio $e_o =$

$\frac{G \times \gamma_w}{\gamma_d} - 1$

γ_d

=

0.6051

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\phi =$ 28

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\phi' = \tan^{-1}(0.67 \tan \phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\phi' =$ 19.61

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$N_c'' =$	23.11	$N_c' =$	14.53	$N_c =$	26.37
$N_q'' =$	12.80	$N_q' =$	6.21	$N_q =$	15.30
$N_{\gamma}'' =$	14.17	$N_{\gamma}' =$	5.18	$N_{\gamma} =$	17.59

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cN_cScdcic + q(N_q-1) Sqdqiq + 0.5 B \gamma N_{\gamma} S \gamma d \gamma i \gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'N_c'Scdic + q(N_q'-1) Sqdqiq + 0.5 B \gamma N_{\gamma}' S \gamma d \gamma i \gamma W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''N_c'Scdic + q(N_q''-1) Sqdqiq + 0.5 B \gamma N_{\gamma}'' S \gamma d \gamma i \gamma W'$$

for intermediate shear failure

= 84.65

t/m²

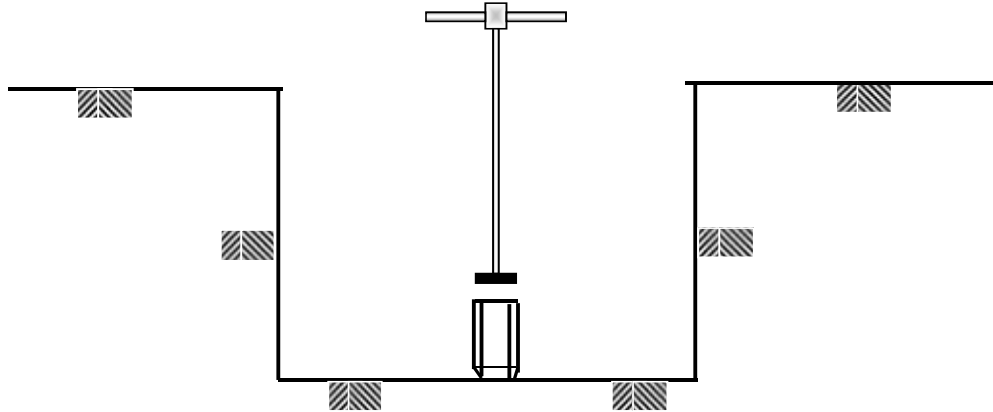
$q_{ns} =$

28.22

t/m²

GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

101 of 194

BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/02	REPORT DT. : 30/1/2020
JOB No.	:	4538/284001	SAMPLE NO. : 02
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-3	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	20/1/2020	
FIELD WORK COMP. DATE	:	20/1/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<u>SR. NO.</u>	<u>PARTICULARS</u>	<u>PAGES</u>
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6	Summury of Test Results	9 of 11
7	Safe Bearing Capacity Calculation	11 of 11

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	29
Dry Density (in gm/cc)	1.671
Specific Gravity	2.66
Factor of Safety	3.0
Void ratio, e (Computed)	0.592
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-3	1.5	1.0 x 1.0	13.69
			1.5 x 1.5	14.12
			2.0 X 2.0	14.91
			2.5 X 2.5	15.85
			3.0 x 3.0	16.86
			3.5 x 3.5	17.92
			4.0 x 4.0	19.00
			4.5 x 4.5	20.10
			5.0 x 5.0	21.21
			5.5 x 5.5	22.33
			6.0 x 6.0	23.45
		2.0	1.0 x 1.0	18.45
			1.5 x 1.5	18.31
			2.0 X 2.0	18.82
			2.5 X 2.5	19.59
			3.0 x 3.0	20.49
			3.5 x 3.5	21.46
			4.0 x 4.0	22.48
			4.5 x 4.5	23.53
			5.0 x 5.0	24.61
			5.5 x 5.5	25.69
			6.0 x 6.0	26.79

RCC Open Foundation	TP-3	2.5	1.0 x 1.0	23.69
			1.5 x 1.5	22.83
			2.0 X 2.0	22.97
			2.5 X 2.5	23.53
			3.0 x 3.0	24.28
			3.5 x 3.5	25.15
			4.0 x 4.0	26.09
			4.5 x 4.5	27.08
			5.0 x 5.0	28.10
			5.5 x 5.5	29.15
		3.0	6.0 x 6.0	30.22
			1.0 x 1.0	29.43
			1.5 x 1.5	27.67
			2.0 X 2.0	27.37
			2.5 X 2.5	27.66
			3.0 x 3.0	28.23
			3.5 x 3.5	28.97
			4.0 x 4.0	29.82
			4.5 x 4.5	30.73
			5.0 x 5.0	31.70
			5.5 x 5.5	32.70
			6.0 x 6.0	33.73

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION OF PROJECT SITE																Plate - 1		
Sr. No.	Location ID	Depth in (mtr)	I.S Classification of Soil	Type	Atterberg's Limit			Grain Size Analysis			Free Swell	Shear Parameter		Sp. Gravity	FDD/ R.D	F.M.C/O. M.C		
					L.L.	P.L.	P.I.	G	S	M & C		C	φ		gm/cc	%		
					%	%	%	%	%	%	%	Kg/cm ²	Degree					
1	TP-3	1.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	2	69	29	—	--	--	2.65	1.682	10.0		
2		2.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	3	68	29	—	0	29	2.66	1.671	10.7		
3		3.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	2	71	27	—	--	--	2.68	1.662	9.0		
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	1	73	26	—	0	30	2.67	1.692	6.3		
Abbreviation :																		
LL	Liquid Limit (%)				C	Cohession (Kg/Sq.cm)												
PL	Plastic Limit (%)				φ	Angle of Internal Friction (Degree)												
PI	Plasticity Index (%)				R.D.	Remoulded Density (gm/cc)							G	Gravel		S	Sand	
NP	Non Plastic				F.M.C	Field Moisutre Content (%)							M	Silt		C	Clay	
Tested By :- DJ																		
Checked By :- JS																		

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square ▼

Plate - 3

Depth of footing $D =$

1.50 m

Sample Calculation

Width of footing $B =$

6.00 m

Length of footing $L =$

6.00 m

Cohesion $C =$

0.00 kg/cm²

Angle of Int.Fric $\phi =$

29 degrees

Specific Gravity $G =$

2.66

Inclination Angle $\alpha =$

0 degrees

Correction Factor for Water Table =

0.5

Dry Density $\gamma_d =$

1.671 gm/cc

Sat. density $\gamma_{sat} =$

2.043 gm/cc

Submerged density=

1.043 gm/cc

Factor of Safety =

3.0

Void Ratio $e_o =$

$\frac{G \times \gamma_w}{\gamma_d} = -1$

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.085	1.300	1.000
dq, sq, iq	1.042	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.042	0.800	1.000

$=$

0.5919

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\phi = 29$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\phi' = \tan^{-1}(0.67 \tan \phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\phi' = 20.37$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	25.54	$Nc' =$	15.27	$Nc =$	28.26
$Nq'' =$	14.73	$Nq' =$	6.72	$Nq =$	16.85
$N\gamma'' =$	17.02	$N\gamma' =$	5.76	$N\gamma =$	20.00

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S\gamma d\gamma i\gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'Nc'Sc'dc'ic + q(N'q-1) S'q'dq'iq + 0.5 B \gamma' N'\gamma' S'\gamma'd\gamma'i\gamma' W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''N''c'Sc'dc''ic + q(N''q-1) S''q'dq''iq + 0.5 B \gamma'' N''\gamma'' S''\gamma'd\gamma''i\gamma'' W'$$

for intermediate shear failure

= 70.35

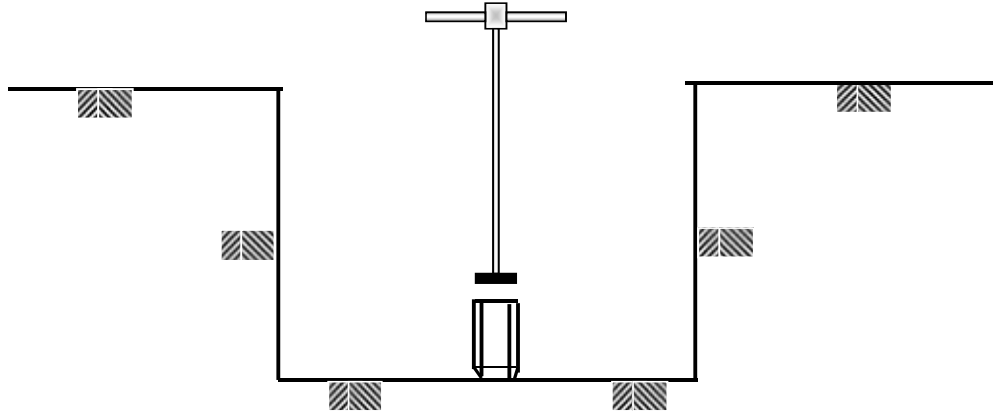
t/m²

$q_{ns} =$

23.45

t/m²

GEOTECHNICAL INVESTIGATION REPORT
(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

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BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/03	REPORT DT. : 30/1/2020
JOB No.	:	4538/284001	SAMPLE NO. : 03
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-4	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	20/1/2020	
FIELD WORK COMP. DATE	:	20/1/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<i>SR. NO.</i>	<i><u>PERTICULARS</u></i>	<i><u>PAGES</u></i>
1	Brief Details of Project	
2	Introduction	4 of 11
3	Sub Surface Exploration & Laboratory Test	5 of 11
4	Safe Bearing Capacity	6 of 11
5	Conclusion and Recommendation	9 of 11
6	Summury of Test Results	10 of 11
7	Safe Bearing Capacity Calculation	11 of 11

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	28
Dry Density (in gm/cc)	1.692
Specific Gravity	2.69
Factor of Safety	3.0
Void ratio, e (Computed)	0.590
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-4	1.5	1.0 x 1.0	12.55
			1.5 x 1.5	12.93
			2.0 X 2.0	13.64
			2.5 X 2.5	14.48
			3.0 x 3.0	15.39
			3.5 x 3.5	16.33
			4.0 x 4.0	17.30
			4.5 x 4.5	18.29
			5.0 x 5.0	19.28
			5.5 x 5.5	20.28
			6.0 x 6.0	21.29
		2.0	1.0 x 1.0	16.93
			1.5 x 1.5	16.79
			2.0 X 2.0	17.24
			2.5 X 2.5	17.93
			3.0 x 3.0	18.73
			3.5 x 3.5	19.60
			4.0 x 4.0	20.52
			4.5 x 4.5	21.46
			5.0 x 5.0	22.42
			5.5 x 5.5	23.39
			6.0 x 6.0	24.38

RCC Open Foundation	TP-4	2.5	1.0 x 1.0	21.75
			1.5 x 1.5	20.94
			2.0 X 2.0	21.06
			2.5 X 2.5	21.55
			3.0 x 3.0	22.22
			3.5 x 3.5	23.00
			4.0 x 4.0	23.84
			4.5 x 4.5	24.73
			5.0 x 5.0	25.65
			5.5 x 5.5	26.58
		3.0	6.0 x 6.0	27.54
			1.0 x 1.0	27.00
			1.5 x 1.5	25.39
			2.0 X 2.0	25.11
			2.5 X 2.5	25.35
			3.0 x 3.0	25.86
			3.5 x 3.5	26.52
			4.0 x 4.0	27.28
			4.5 x 4.5	28.10
			5.0 x 5.0	28.96
			5.5 x 5.5	29.86
			6.0 x 6.0	30.77

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION OF PROJECT SITE																Plate - 1	
Sr. No.	Location ID	Depth in (mtr)	I.S Classification of Soil	Type	Atterberg's Limit			Grain Size Analysis			Free Swell	Shear Parameter		Sp. Gravity	FDD/ R.D	F.M.C/O. M.C	
					L.L.	P.L.	P.I.	G	S	M & C		C	φ		gm/cc	%	
					%	%	%	%	%	%	%	Kg/cm ²	Degree				
1	TP-4	1.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	11	60	29	—	--	--	2.67	1.638	10.0	
2		2.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	10	61	29	—	0	28	2.69	1.692	10.7	
3		3.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	11	59	30	—	--	--	2.71	1.702	9.7	
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	—	NP	NP	11	61	28	—	0	32	2.72	1.712	11.9	
Abbreviation :																	
LL	Liquid Limit (%)				C	Cohession (Kg/Sq.cm)											
PL	Plastic Limit (%)				φ	Angle of Internal Friction (Degree)											
PI	Plasticity Index (%)				R.D.	Remoulded Density (gm/cc)				G Gravel				S Sand			
NP	Non Plastic				F.M.C	Field Moisutre Content (%)				M Silt				C Clay			
Tested By :- DJ																	
Checked By :- JS																	

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square

Plate - 3

Depth of footing D =

3.00

m

Sample Calculation

Width of footing B =

6.00

m

Length of footing L =

6.00

m

Cohesion C =

0.00

kg/cm²

Angle of Int.Fric ϕ =

28

degrees

Specific Gravity G =

2.69

Inclination Angle α =

0

degrees

Correction Factor for Water Table =

0.5

Dry Density Yd =

1.692

gm/cc

Sat. density Ysat =

2.063

gm/cc

Submerged density=

1.063

gm/cc

Factor of Safety =

3.0

Void Ratio eo =

$\frac{G \times Yw}{Yd}$

-1

Yd

=

0.5898

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\Phi = 28$

c= 0.000 if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\Phi' = \tan^{-1}(0.67 \tan \Phi)$

c'= 0.000 if $e_o > 0.75$, it is local shear failure

$\Phi' = 19.61$

c''= 0.000 if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
Nc'' =	24.01	Nc' =	14.53	Nc =	26.37
Nq'' =	13.49	Nq' =	6.21	Nq =	15.30
N γ '' =	15.12	N γ ' =	5.18	N γ =	17.59

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cN_c S_{cd} c_{ic} + q(N_q - 1) S_{qd} q_{iq} + 0.5 B \gamma N_{\gamma} S_{\gamma d} \gamma_i \gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'N'_c S'_{cd} c'_{ic} + q'(N'_q - 1) S'_{qd} q'_{iq} + 0.5 B \gamma' N'_{\gamma} S'_{\gamma d} \gamma'_i \gamma' W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''N''_c S''_{cd} c''_{ic} + q(N''_q - 1) S''_{qd} q''_{iq} + 0.5 B \gamma N''_{\gamma} S''_{\gamma d} \gamma_i \gamma W'$$

for intermediate shear failure

= 92.32

t/m²

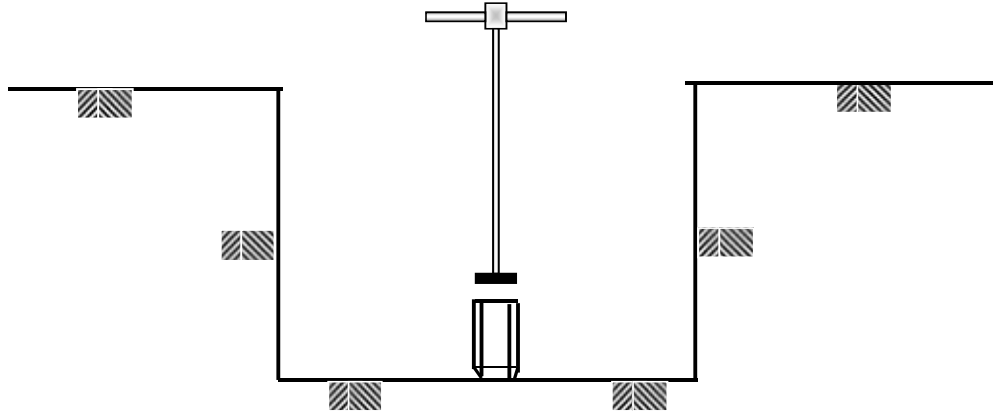
$q_{ns} =$

30.77

t/m²

GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

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BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/5	REPORT DT. : 24/3/2020
JOB No.	:	4538/284001	SAMPLE NO. : 5
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-5	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	13/3/2020	
FIELD WORK COMP. DATE	:	13/3/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<u>SR. NO.</u>	<u>PARTICULARS</u>	<u>PAGES</u>
1	Brief Details of Project	
2	Introduction	4 of 11
3	Sub Surface Exploration & Laboratory Test	5 of 11
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7	Safe Bearing Capacity Calculation	11 of 11

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	30
Dry Density (in gm/cc)	1.563
Specific Gravity	2.65
Factor of Safety	3.0
Void ratio, e (Computed)	0.695
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-5	1.5	1.0 x 1.0	8.70
			1.5 x 1.5	8.94
			2.0 X 2.0	9.42
			2.5 X 2.5	9.99
			3.0 x 3.0	10.61
			3.5 x 3.5	11.26
			4.0 x 4.0	11.92
			4.5 x 4.5	12.60
			5.0 x 5.0	13.28
			5.5 x 5.5	13.97
			6.0 x 6.0	14.66
		2.0	1.0 x 1.0	11.76
			1.5 x 1.5	11.63
			2.0 X 2.0	11.92
			2.5 X 2.5	12.38
			3.0 x 3.0	12.93
			3.5 x 3.5	13.52
			4.0 x 4.0	14.15
			4.5 x 4.5	14.79
			5.0 x 5.0	15.45
			5.5 x 5.5	16.12
			6.0 x 6.0	16.80

RCC Open Foundation	TP-5	2.5	1.0 x 1.0	15.13
			1.5 x 1.5	14.53
			2.0 X 2.0	14.58
			2.5 X 2.5	14.90
			3.0 x 3.0	15.35
			3.5 x 3.5	15.88
			4.0 x 4.0	16.45
			4.5 x 4.5	17.06
			5.0 x 5.0	17.69
			5.5 x 5.5	18.33
		3.0	6.0 x 6.0	18.98
			1.0 x 1.0	18.82
			1.5 x 1.5	17.64
			2.0 X 2.0	17.40
			2.5 X 2.5	17.55
			3.0 x 3.0	17.88
			3.5 x 3.5	18.33
			4.0 x 4.0	18.84
			4.5 x 4.5	19.40
			5.0 x 5.0	19.98
			5.5 x 5.5	20.59
			6.0 x 6.0	21.22

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION OF PROJECT SITE																Plate - 1	
Sr. No.	Location ID	Depth in (mtr)	I.S Classification of Soil	Type	Atterberg's Limit			Grain Size Analysis			Free Swell	Shear Parameter		Sp. Gravity	FDD/ R.D	F.M.C/O. M.C	
					L.L.	P.L.	P.I.	G	S	M & C		C	φ		gm/cc	%	
					%	%	%	%	%	%	%	Kg/cm ²	Degree				
1	TP-5	1.0	SM (Silty Sand of Non Plasticity)	UDS	22.3	NP	NP	0	72	28	—	0	30	2.65	1.563	8.5	
2		2.0	SM-SP (Silty Sand and Poorly Graded sand of Non Plasticity)	UDS	23.2	NP	NP	1	89	10	—	—	—	2.66	1.598	9.2	
3		3.0		UDS	22.2	NP	NP	13	78	9	—	0	32	2.65	1.621	9.8	
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	22.7	NP	NP	7	63	30	—	—	—	2.63	1.671	10.1	
Abbreviation :																	
LL	Liquid Limit (%)				C	Cohession (Kg/Sq.cm)											
PL	Plastic Limit (%)				φ	Angle of Internal Friction (Degree)											
PI	Plasticity Index (%)				R.D.	Remoulded Density (gm/cc)				G Gravel				S Sand			
NP	Non Plastic				F.M.C	Field Moisutre Content (%)				M Silt				C Clay			
Tested By :- DJ																	
Checked By :- JS																	

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Plate - 3

Sample Calculation

Shape of footing = Square ▼

Depth of footing $D = 3.00$ m

Width of footing $B = 6.00$ m

Length of footing $L = 6.00$ m

Cohesion $C = 0.00$ kg/cm²

Angle of Int.Fric $\phi = 30$ degrees

Specific Gravity $G = 2.65$

Inclination Angle $\alpha = 0$ degrees

Correction Factor for Water Table = 0.5

Dry Density $\gamma_d = 1.563$ gm/cc

Sat. density $\gamma_{sat} = 1.973$ gm/cc

Submerged density = 0.973 gm/cc

Factor of Safety = 3.0

Void Ratio $e_o = \frac{G \times \gamma_w}{\gamma_d} = -1$

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.173	1.300	1.000
dq, sq, iq	1.087	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.087	0.800	1.000

$$= \frac{0.6955}{1} = 0.6955$$

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\phi = 30$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\phi' = \tan^{-1}(0.67 \tan \phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$$\phi' = 21.15$$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	19.99	$Nc' =$	16.18	$Nc =$	30.14
$Nq'' =$	10.38	$Nq' =$	7.38	$Nq =$	18.40
$N\gamma'' =$	10.86	$N\gamma' =$	6.54	$N\gamma =$	22.40

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S\gamma d\gamma i\gamma W'$$

for general shear failure

$$= 0.00 \quad q_{ns} = 0.00 \text{ t/m}^2$$

$$q_{un} = c'Nc'Sc'dcic + q(N'q-1) Sqdqiq + 0.5 B \gamma N'\gamma S\gamma d\gamma i\gamma W'$$

for local shear failure

$$= 0.00 \quad q_{ns} = 0.00 \text{ t/m}^2$$

$$q_{un} = c''N''cSc'dcic + q(N''q-1) Sqdqiq + 0.5 B \gamma N''\gamma S\gamma d\gamma i\gamma W'$$

for intermediate shear failure

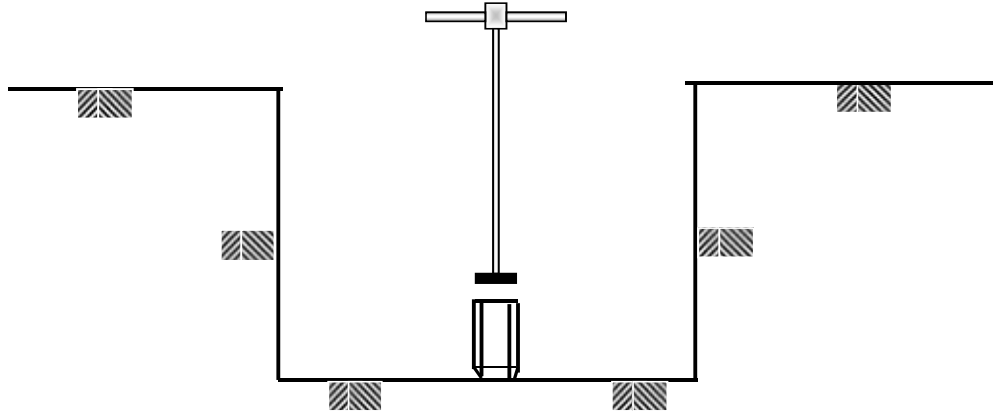
$$= 63.67 \text{ t/m}^2 \quad q_{ns} = 21.22 \text{ t/m}^2$$

Photographs :



GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

135 of 194

BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/6	REPORT DT. : 24/3/2020
JOB No.	:	4538/284001	SAMPLE NO. : 6
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-6	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	13/3/2020	
FIELD WORK COMP. DATE	:	13/3/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<u>SR. NO.</u>	<u>PARTICULARS</u>	<u>PAGES</u>
1	Brief Details of Project	
2	Introduction	4 of 11
3	Sub Surface Exploration & Laboratory Test	5 of 11
4	Safe Bearing Capacity	6 of 11
5	Conclusion and Recommendation	9 of 11
6	Summury of Test Results	10 of 11
7	Safe Bearing Capacity Calculation	11 of 11

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	31
Dry Density (in gm/cc)	1.552
Specific Gravity	2.66
Factor of Safety	3.0
Void ratio, e (Computed)	0.714
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-6	1.5	1.0 x 1.0	8.77
			1.5 x 1.5	9.00
			2.0 X 2.0	9.48
			2.5 X 2.5	10.05
			3.0 x 3.0	10.67
			3.5 x 3.5	11.32
			4.0 x 4.0	11.99
			4.5 x 4.5	12.67
			5.0 x 5.0	13.36
			5.5 x 5.5	14.05
			6.0 x 6.0	14.75
		2.0	1.0 x 1.0	11.86
			1.5 x 1.5	11.71
			2.0 X 2.0	12.00
			2.5 X 2.5	12.46
			3.0 x 3.0	13.01
			3.5 x 3.5	13.60
			4.0 x 4.0	14.23
			4.5 x 4.5	14.88
			5.0 x 5.0	15.54
			5.5 x 5.5	16.21
			6.0 x 6.0	16.89

RCC Open Foundation	TP-6	2.5	1.0 x 1.0	15.27
			1.5 x 1.5	14.64
			2.0 X 2.0	14.69
			2.5 X 2.5	15.00
			3.0 x 3.0	15.45
			3.5 x 3.5	15.98
			4.0 x 4.0	16.55
			4.5 x 4.5	17.16
			5.0 x 5.0	17.79
			5.5 x 5.5	18.43
		3.0	6.0 x 6.0	19.09
			1.0 x 1.0	19.00
			1.5 x 1.5	17.78
			2.0 X 2.0	17.53
			2.5 X 2.5	17.67
			3.0 x 3.0	18.00
			3.5 x 3.5	18.44
			4.0 x 4.0	18.95
			4.5 x 4.5	19.51
			5.0 x 5.0	20.10
			5.5 x 5.5	20.71
			6.0 x 6.0	21.35

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square ▼

Plate - 3

Depth of footing $D =$

3.00 m

Sample Calculation

Width of footing $B =$

6.00 m

Length of footing $L =$

6.00 m

Cohesion $C =$

0.00 kg/cm²

Angle of Int.Fric $\phi =$

31 degrees

Specific Gravity $G =$

2.66

Inclination Angle $\alpha =$

0 degrees

Correction Factor for Water Table =

0.5

Dry Density $\gamma_d =$

1.552 gm/cc

Sat. density $\gamma_{sat} =$

1.969 gm/cc

Submerged density =

0.969 gm/cc

Factor of Safety =

3.0

Void Ratio $e_o =$

$\frac{G \times \gamma_w}{\gamma_d} = -1$

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.177	1.300	1.000
dq, sq, iq	1.088	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.088	0.800	1.000

$=$

0.7139

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\Phi = 31$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\Phi' = \tan^{-1}(0.67 \tan \Phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\Phi' = 21.93$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	20.03	$Nc' =$	17.10	$Nc =$	33.34
$Nq'' =$	10.45	$Nq' =$	8.04	$Nq =$	21.38
$N\gamma'' =$	10.96	$N\gamma' =$	7.31	$N\gamma =$	27.53

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S\gamma d\gamma i\gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'Nc'Scdic + q(N'q-1) Sqdqiq + 0.5 B \gamma N'\gamma S\gamma d\gamma i\gamma W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''N''cScdcic + q(N''q-1) Sqdqiq + 0.5 B \gamma N''\gamma S\gamma d\gamma i\gamma W'$$

for intermediate shear failure

= 64.04

t/m²

$q_{ns} =$

21.35

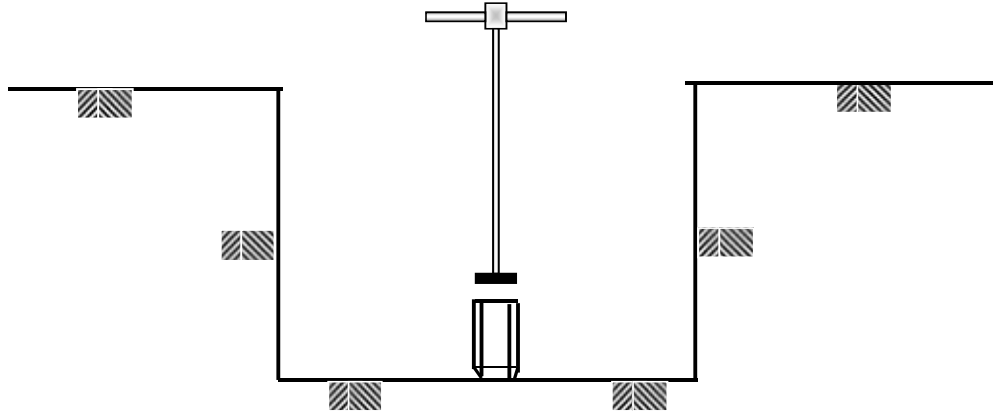
t/m²

Photographs :



GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

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BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/7	REPORT DT. : 26/3/2020
JOB No.	:	4538/284001	SAMPLE NO. : 7
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-7	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	13/3/2020	
FIELD WORK COMP. DATE	:	13/3/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<u>SR. NO.</u>	<u>PERTICULARS</u>	<u>PAGES</u>
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7	Safe Bearing Capacity Calculation	11 of 11

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	30
Dry Density (in gm/cc)	1.567
Specific Gravity	2.65
Factor of Safety	3.0
Void ratio, e (Computed)	0.691
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-7	1.5	1.0 x 1.0	8.95
			1.5 x 1.5	9.21
			2.0 X 2.0	9.70
			2.5 X 2.5	10.29
			3.0 x 3.0	10.93
			3.5 x 3.5	11.60
			4.0 x 4.0	12.29
			4.5 x 4.5	12.98
			5.0 x 5.0	13.69
			5.5 x 5.5	14.40
			6.0 x 6.0	15.12
		2.0	1.0 x 1.0	12.10
			1.5 x 1.5	11.97
			2.0 X 2.0	12.27
			2.5 X 2.5	12.75
			3.0 x 3.0	13.32
			3.5 x 3.5	13.93
			4.0 x 4.0	14.58
			4.5 x 4.5	15.24
			5.0 x 5.0	15.92
			5.5 x 5.5	16.61
			6.0 x 6.0	17.31

RCC Open Foundation	TP-7	2.5	1.0 x 1.0	15.57
			1.5 x 1.5	14.95
			2.0 X 2.0	15.01
			2.5 X 2.5	15.34
			3.0 x 3.0	15.81
			3.5 x 3.5	16.35
			4.0 x 4.0	16.95
			4.5 x 4.5	17.57
			5.0 x 5.0	18.22
			5.5 x 5.5	18.88
		3.0	6.0 x 6.0	19.56
			1.0 x 1.0	19.36
			1.5 x 1.5	18.15
			2.0 X 2.0	17.91
			2.5 X 2.5	18.06
			3.0 x 3.0	18.41
			3.5 x 3.5	18.87
			4.0 x 4.0	19.40
			4.5 x 4.5	19.97
			5.0 x 5.0	20.58
			5.5 x 5.5	21.21
			6.0 x 6.0	21.86

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION OF PROJECT SITE																Plate - 1	
Sr. No.	Location ID	Depth in (mtr)	I.S Classification of Soil	Type	Atterberg's Limit			Grain Size Analysis			Free Swell	Shear Parameter		Sp. Gravity	FDD/ R.D	F.M.C/O. M.C	
					L.L.	P.L.	P.I.	G	S	M & C		C	φ		gm/cc	%	
					%	%	%	%	%	%	%	Kg/cm ²	Degree				
1	TP-7	1.0	SM (Silty Sand of Non Plasticity)	UDS	21.1	NP	NP	0	72	28	—	—	—	2.66	1.537	9.2	
2		2.0	SM-SP (Silty Sand and Poorly Graded sand of Non Plasticity)	UDS	23.5	NP	NP	0	90	10	—	0	30	2.65	1.567	9.6	
3		3.0	SM (Silty Sand of Non Plasticity)	UDS	18.9	NP	NP	0	73	27	—	0	33	2.66	1.602	10.2	
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	21.3	NP	NP	2	76	22	—	—	—	2.63	1.652	10.7	
Abbreviation :																	
LL	Liquid Limit (%)				C	Cohession (Kg/Sq.cm)											
PL	Plastic Limit (%)				φ	Angle of Internal Friction (Degree)											
PI	Plasticity Index (%)				R.D.	Remoulded Density (gm/cc)				G Gravel				S Sand			
NP	Non Plastic				F.M.C	Field Moisutre Content (%)				M Silt				C Clay			
Tested By :- DJ																	
Checked By :- JS																	

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square ▼

Plate - 3

Depth of footing $D =$

1.50 m

Sample Calculation

Width of footing $B =$

1.00 m

Length of footing $L =$

1.00 m

Cohesion $C =$

0.00 kg/cm²

Angle of Int.Fric $\phi =$

30 degrees

Specific Gravity $G =$

2.65

Inclination Angle $\alpha =$

0 degrees

Correction Factor for Water Table =

0.5

Dry Density $\gamma_d =$

1.567 gm/cc

Sat. density $\gamma_{sat} =$

1.976 gm/cc

Submerged density =

0.976 gm/cc

Factor of Safety =

3.0

Void Ratio $e_o =$

$\frac{G \times \gamma_w}{\gamma_d} = -1$

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.519	1.300	1.000
dq, sq, iq	1.260	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.260	0.800	1.000

$=$

0.6911

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\Phi = 30$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\Phi' = \tan^{-1}(0.67 \tan \Phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\Phi' = 21.15$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	20.29	$Nc' =$	16.18	$Nc =$	30.14
$Nq'' =$	10.62	$Nq' =$	7.38	$Nq =$	18.40
$N\gamma'' =$	11.21	$N\gamma' =$	6.54	$N\gamma =$	22.40

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S\gamma d\gamma i\gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'Nc'Scdic + q(N'q-1) Sqdqiq + 0.5 B \gamma N'\gamma S\gamma d\gamma i\gamma W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''Nc'Scdic + q(N''q-1) Sqdqiq + 0.5 B \gamma N''\gamma S\gamma d\gamma i\gamma W'$$

for intermediate shear failure

= 26.86

t/m²

$q_{ns} =$

8.95

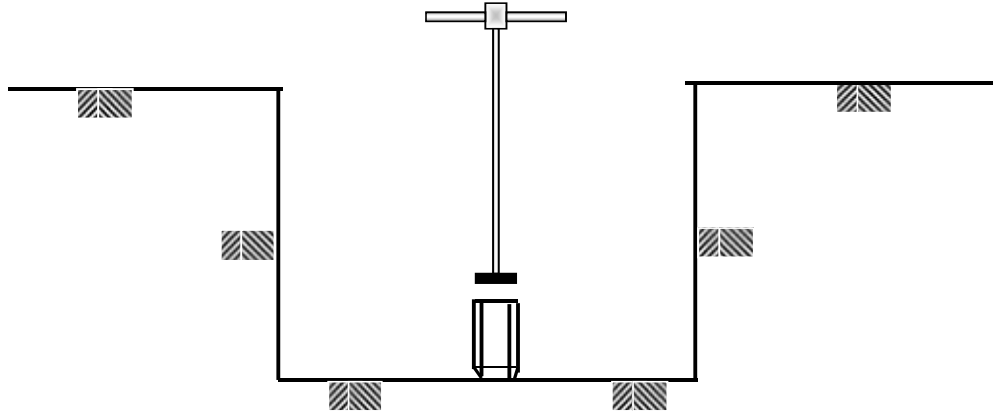
t/m²

Photographs :



GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

159 of 194

BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/8	REPORT DT. : 27/3/2020
JOB No.	:	4538/284001	SAMPLE NO. : 8
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-8	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	13/3/2020	
FIELD WORK COMP. DATE	:	13/3/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
<u>SR. NO.</u>	<u>PARTICULARS</u>	<u>PAGES</u>
1	Brief Details of Project	
2	Introduction	4 of 11
3	Sub Surface Exploration & Laboratory Test	5 of 11
4	Safe Bearing Capacity	6 of 11
5	Conclusion and Recommendation	9 of 11
6	Summury of Test Results	10 of 11
7	Safe Bearing Capacity Calculation	11 of 11

2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	31
Dry Density (in gm/cc)	1.56
Specific Gravity	2.65
Factor of Safety	3.0
Void ratio, e (Computed)	0.699
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-8	1.5	1.0 x 1.0	9.79
			1.5 x 1.5	10.07
			2.0 X 2.0	10.63
			2.5 X 2.5	11.29
			3.0 x 3.0	12.00
			3.5 x 3.5	12.74
			4.0 x 4.0	13.51
			4.5 x 4.5	14.28
			5.0 x 5.0	15.07
			5.5 x 5.5	15.86
		2.0	6.0 x 6.0	16.66
			1.0 x 1.0	13.23
			1.5 x 1.5	13.09
			2.0 X 2.0	13.43
			2.5 X 2.5	13.97
			3.0 x 3.0	14.60
			3.5 x 3.5	15.28
			4.0 x 4.0	16.00
			4.5 x 4.5	16.74
			5.0 x 5.0	17.50
			5.5 x 5.5	18.27
			6.0 x 6.0	19.04

RCC Open Foundation	TP-8	2.5	1.0 x 1.0	17.02
			1.5 x 1.5	16.34
			2.0 X 2.0	16.42
			2.5 X 2.5	16.79
			3.0 x 3.0	17.31
			3.5 x 3.5	17.92
			4.0 x 4.0	18.58
			4.5 x 4.5	19.28
			5.0 x 5.0	20.00
			5.5 x 5.5	20.74
		3.0	6.0 x 6.0	21.49
			1.0 x 1.0	21.17
			1.5 x 1.5	19.84
			2.0 X 2.0	19.58
			2.5 X 2.5	19.76
			3.0 x 3.0	20.15
			3.5 x 3.5	20.66
			4.0 x 4.0	21.25
			4.5 x 4.5	21.89
			5.0 x 5.0	22.57
			5.5 x 5.5	23.27
			6.0 x 6.0	24.00

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

GENERAL SUMMARY OF GEO-TECHNICAL INVESTIGATION OF PROJECT SITE																Plate - 1
Sr. No.	Location ID	Depth in (mtr)	I.S Classification of Soil	Type	Atterberg's Limit			Grain Size Analysis			Free Swell	Shear Parameter		Sp. Gravity	FDD/ R.D	F.M.C/O. M.C
					L.L.	P.L.	P.I.	G	S	M & C		C	φ		gm/cc	%
					%	%	%	%	%	%	%	Kg/cm ²	Degree			
1	TP-8	1.0	SM (Silty Sand of Non Plasticity)	UDS	24.2	NP	NP	2	72	26	—	—	—	2.65	1.551	8.2
2		2.0	SM (Silty Sand of Non Plasticity)	UDS	24.4	NP	NP	6	72	22	—	0	31	2.65	1.560	8.7
3		3.0	SM (Silty Sand of Non Plasticity)	UDS	20.0	NP	NP	1	82	17	—	—	—	2.66	1.611	9.6
4		4.0	SM-SP (Silty Sand and Poorly Graded sand of Non Plasticity)	UDS	25.0	NP	NP	5	83	12	—	0	34	2.64	1.674	10.1
Abbreviation :																
LL	Liquid Limit (%)				C	Cohession (Kg/Sq.cm)										
PL	Plastic Limit (%)				φ	Angle of Internal Friction (Degree)										
PI	Plasticity Index (%)				R.D.	Remoulded Density (gm/cc)							G	Gravel	S	Sand
NP	Non Plastic				F.M.C	Field Moisutre Content (%)							M	Silt	C	Clay
Tested By :- DJ																
Checked By :- JS																

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square ▼

Plate - 3

Depth of footing $D =$

3.00 m

Sample Calculation

Width of footing $B =$

6.00 m

Length of footing $L =$

6.00 m

Cohesion $C =$

0.00 kg/cm²

Angle of Int.Fric $\phi =$

31 degrees

Specific Gravity $G =$

2.65

Inclination Angle $\alpha =$

0 degrees

Correction Factor for Water Table =

0.5

Dry Density $\gamma_d =$

1.560 gm/cc

Sat. density $\gamma_{sat} =$

1.971 gm/cc

Submerged density=

0.971 gm/cc

Factor of Safety =

3.0

Void Ratio $e_o =$

$\frac{G \times \gamma_w}{\gamma_d} = -1$

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.177	1.300	1.000
dq, sq, iq	1.088	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.088	0.800	1.000

$= \frac{0.6987}{0.6987}$

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\phi = 31$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\phi' = \tan^{-1}(0.67 \tan \phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\phi' = 21.93$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	21.26	$Nc' =$	17.10	$Nc =$	33.34
$Nq'' =$	11.46	$Nq' =$	8.04	$Nq =$	21.38
$N\gamma'' =$	12.50	$N\gamma' =$	7.31	$N\gamma =$	27.53

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S \gamma d \gamma i \gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'Nc'Scdic + q(N'q-1) Sqdqiq + 0.5 B \gamma N'\gamma S \gamma d \gamma i \gamma W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''N''cScdcic + q(N''q-1) Sqdqiq + 0.5 B \gamma N''\gamma S \gamma d \gamma i \gamma W'$$

for intermediate shear failure

= 71.99

t/m²

$q_{ns} =$

24.00

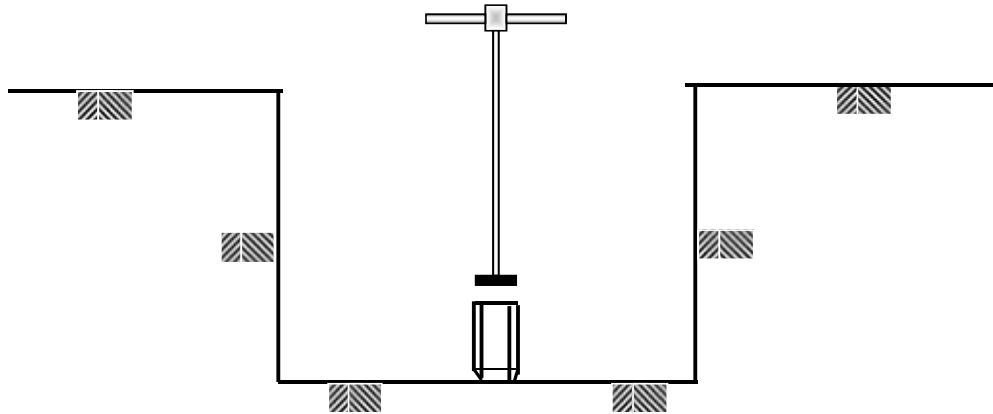
t/m²

Photographs :



GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

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BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/9	REPORT DT. : 27/3/2020
JOB No.	:	4538/284001	SAMPLE NO. : 9
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-9	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	13/3/2020	
FIELD WORK COMP. DATE	:	13/3/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
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2.0 INTRODUCTION

Sub surface investigation and laboratory tests for Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani was referred us by Techno Electric & Engineering Co. Ltd

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

4.0 LABORATORY TEST

A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
2. Grain Size Analysis (IS: 2720, 1992 Part 4)
3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

5.0 SAFE BEARING CAPACITY

Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	32
Dry Density (in gm/cc)	1.545
Specific Gravity	2.66
Factor of Safety	3.0
Void ratio, e (Computed)	0.722
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-9	1.5	1.0 x 1.0	9.22
			1.5 x 1.5	9.46
			2.0 X 2.0	9.96
			2.5 X 2.5	10.57
			3.0 x 3.0	11.22
			3.5 x 3.5	11.90
			4.0 x 4.0	12.61
			4.5 x 4.5	13.32
			5.0 x 5.0	14.05
			5.5 x 5.5	14.78
			6.0 x 6.0	15.51
		2.0	1.0 x 1.0	12.48
			1.5 x 1.5	12.32
			2.0 X 2.0	12.62
			2.5 X 2.5	13.10
			3.0 x 3.0	13.68
			3.5 x 3.5	14.30
			4.0 x 4.0	14.96
			4.5 x 4.5	15.64
			5.0 x 5.0	16.34
			5.5 x 5.5	17.05
			6.0 x 6.0	17.76

RCC Open Foundation	TP-9	2.5	1.0 x 1.0	16.09
			1.5 x 1.5	15.41
			2.0 X 2.0	15.45
			2.5 X 2.5	15.77
			3.0 x 3.0	16.24
			3.5 x 3.5	16.80
			4.0 x 4.0	17.40
			4.5 x 4.5	18.04
			5.0 x 5.0	18.70
			5.5 x 5.5	19.38
		3.0	6.0 x 6.0	20.07
			1.0 x 1.0	20.04
			1.5 x 1.5	18.73
			2.0 X 2.0	18.45
			2.5 X 2.5	18.59
			3.0 x 3.0	18.93
			3.5 x 3.5	19.39
			4.0 x 4.0	19.93
			4.5 x 4.5	20.51
			5.0 x 5.0	21.13
			5.5 x 5.5	21.78
			6.0 x 6.0	22.44

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Square ▼

Plate - 3

Depth of footing $D =$

3.00 m

Sample Calculation

Width of footing $B =$

6.00 m

Length of footing $L =$

6.00 m

Cohesion $C =$

0.00 kg/cm²

Angle of Int.Fric $\phi =$

32 degrees

Specific Gravity $G =$

2.66

Inclination Angle $\alpha =$

0 degrees

Correction Factor for Water Table =

0.5

Dry Density $\gamma_d =$

1.545 gm/cc

Sat. density $\gamma_{sat} =$

1.964 gm/cc

Submerged density=

0.964 gm/cc

Factor of Safety =

3.0

Void Ratio $e_o =$

$\frac{G \times \gamma_w}{\gamma_d} = -1$

d, s, i	depth factor	shape factor	inclination factor
dc, sc, ic	1.180	1.300	1.000
dq, sq, iq	1.090	1.200	1.000
$d\gamma, s\gamma, i\gamma$	1.090	0.800	1.000

$= \frac{0.7217}{0.7217}$

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\Phi = 32$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\Phi' = \tan^{-1}(0.67 \tan \Phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\Phi' = 22.72$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$Nc'' =$	20.65	$Nc' =$	18.03	$Nc =$	36.53
$Nq'' =$	10.93	$Nq' =$	8.72	$Nq =$	24.36
$N\gamma'' =$	11.58	$N\gamma' =$	8.10	$N\gamma =$	32.65

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cNcScdcic + q(Nq-1) Sqdqiq + 0.5 B \gamma N\gamma S\gamma d\gamma i\gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c'N'c'Scd'c'ic + q(N'q-1) Sqdq'iq + 0.5 B \gamma N'\gamma S'\gamma d'\gamma i'\gamma W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m²

$$q_{un} = c''N''c'Scd''c''ic + q(N''q-1) Sqdq''iq + 0.5 B \gamma N''\gamma S''\gamma d''\gamma i''\gamma W'$$

for intermediate shear failure

= 67.32

t/m²

$q_{ns} =$

22.44

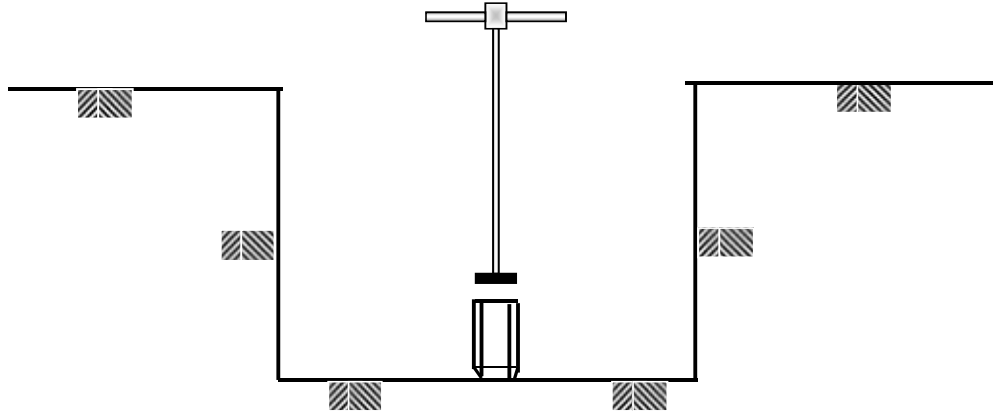
t/m²

Photographs :



GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



CLIENT

Techno Electric & Engineering Co. Ltd

LOCATION

Lakadia , Gujarat

NAME OF WORK

Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

JOB No.4538/284001

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BRIEF DETAIL OF PROJECT SITE

CLIENT	:	Techno Electric & Engineering Co. Ltd	
AGENCY	:	--	
CONSULTANT	:	--	
NAME OF WORK	:	Geotechnical Investigation Work for Work order for Contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani	
REF.No.	:	W.O. No 0756LA/19-20/25535, Dtd.10/10/2019	
PROJECT No.	:	BRD/GIR/4538/284001/10	REPORT DT. : 28/3/2020
JOB No.	:	4538/284001	SAMPLE NO. : 10
REF. Code	:	IS : 2720, IS : 1892 - 1997	DEPTH OF TRIAL PIT : 4.0m
LOCATION	:	Lakadia , Gujarat	TRAIL PIT IN : Existing Ground
TRIAL PIT ID	:	TP-10	
SIZE OF TRIAL PIT	:	2.0m x 2.0m	UDS DIA : 100mm
TYPE OF SAMPLE	:	Undisturbed Sample	
FIELD WORK STARTING DATE	:	13/3/2020	
FIELD WORK COMP. DATE	:	13/3/2020	
NO. OF TRIAL PIT	:	One	

<u>CONTENT</u>		
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2.0 INTRODUCTION

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The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of safe bearing capacity

- Undisturbed sampling from one trial pit From depth of 4.0m below Existing Ground in order to know the sub surface stratification, conducting necessary field tests and to collect disturb and undisturbed soil samples for laboratory testing.
- Testing soil / rock samples in the laboratory to determine its physical and engineering properties of the soil / rock samples, and
- Analyzing all field and laboratory data to evaluate safe bearing capacity of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia , Gujarat

3.0 SUB SURFACE EXPLORATION

3.1 TRIAL PIT:

One trial pit of size 2.0m x 2.0m and excavation up to depth of 4.0m . The work was in general accordance with IS: 1892 – 1997.

3.1.1 UNDISTURBED SAMPLES:

Undisturbed/Chunk samples were collected, logged, labelled and placed in polythene bags.

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A. Laboratory Test for Soil

1. Natural Moisture Content Test (IS: 2720, 1992 Part 2)
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3. Atterberg's Limits Test (IS: 2720, Part 5 1992)
4. Specific Gravity Test (IS: 2720, Part 3 1992)
5. Free Swell Value Test (IS: 2720, Part 40 1977)
6. Swell Pressure Test (IS: 2720, Part 41, 1977)
7. Field Dry Density & Moisture Content (I S 13030-1991)
8. Specific Gravity (I S 1122-1974)
9. Unconfined Compressive Strength of Rock (I S 9143-1979)

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Looking to the proposed type of project, site conditions and sub soil stratification, Open Foundation is recommended along with safe bearing capacity at different depths. Intensity of bearable load determined as soil bearing capacity (SBC) on soil.

SBC BASED ON SHEAR :- The ultimate net bearing capacity is evaluated after taking into consideration of shape factor and depth factor of the foundation in accordance with I.S. 6403-1981. The net bearing capacity worked out using the following equation.

$$Q = C N_c S_c d_c + q (N_q - 1) S_q d_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma$$

Where,

c = Cohesion

q = Overburden Pressure

γ = Density

B = Width of the 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

Following parameters are adopted for the evaluation of bearing capacity for shallow foundation.

Properties for	
Cohesion (kg/cm ²)	0.00
Angle of Internal Friction (Degree)	32
Dry Density (in gm/cc)	1.549
Specific Gravity	2.65
Factor of Safety	3.0
Void ratio, e (Computed)	0.711
Type of Shear Failure Considered	Intermediate Shear Failure

Thus, Intermediate Shear Failure was considered for safe bearing capacity computation. The net safe bearing capacity for following sizes of footings having vertical static load intensity is evaluated as in TABLE- 1, SAFE BEARING CAPACITY .

TABLE- 1, SAFE BEARING CAPACITY				
Foundation Details				
Type	Location ID	Depth (Mtr.) below E.G.L	Size in (Mtr.)	Safe Bearing Capacity (SBC) in t/m ²
RCC Open Foundation	TP-10	1.5	1.0 x 1.0	10.08
			1.5 x 1.5	10.36
			2.0 X 2.0	10.92
			2.5 X 2.5	11.60
			3.0 x 3.0	12.33
			3.5 x 3.5	13.10
			4.0 x 4.0	13.89
			4.5 x 4.5	14.68
			5.0 x 5.0	15.49
			5.5 x 5.5	16.31
			6.0 x 6.0	17.13
		2.0	1.0 x 1.0	13.62
			1.5 x 1.5	13.47
			2.0 X 2.0	13.81
			2.5 X 2.5	14.36
			3.0 x 3.0	15.00
			3.5 x 3.5	15.71
			4.0 x 4.0	16.45
			4.5 x 4.5	17.21
			5.0 x 5.0	17.99
			5.5 x 5.5	18.78
			6.0 x 6.0	19.58

RCC Open Foundation	TP-10	2.5	1.0 x 1.0	17.54
			1.5 x 1.5	16.83
			2.0 X 2.0	16.89
			2.5 X 2.5	17.27
			3.0 x 3.0	17.80
			3.5 x 3.5	18.42
			4.0 x 4.0	19.10
			4.5 x 4.5	19.82
			5.0 x 5.0	20.56
			5.5 x 5.5	21.32
		3.0	6.0 x 6.0	22.09
			1.0 x 1.0	21.84
			1.5 x 1.5	20.43
			2.0 X 2.0	20.15
			2.5 X 2.5	20.32
			3.0 x 3.0	20.72
			3.5 x 3.5	21.24
			4.0 x 4.0	21.85
			4.5 x 4.5	22.51
			5.0 x 5.0	23.20
			5.5 x 5.5	23.93
			6.0 x 6.0	24.67

Note: Settlement analysis is not considered in this report due to the limited field investigation.

6. CONCLUSION & RECOMMENDATION

1. The present report covers the Geotechnical investigation carried out for One trialpit at Lakadia , Gujarat.
2. Based on the proposed type of project, trialpit data, Laboratory test results, Open Foundation is suggested along with their Safe Bearing Capacities considering factor of safety of 3.0 as shown in Table - I.
3. Effect of water table was Considered in the analysis of SBC.
4. Safe Bearing Capacity is the maximum intensity of the loading that the foundation can safely carry without the risk of shear failure of the soil irrespective of any settlement that may occur.
5. At founding level, care to be taken that “Gentle Slope” should be maintained for the deposition of excavated material and necessary shoring arrangement may be done if required.
6. The above report is based on the soil strata encountered at site upto depth of Investigation i.e. 4.0m
7. The above recommendations are based on the collected field data, laboratory tests results conducted on soil samples recovered from the test locations. However if the actual subsoil condition during execution vary from what has been represented in this report, the client/agency may be referred to us for suggestions.

For **GEO TEST HOUSE, Vadodara.**

Authorized Signatory

Calculation of SBC of soil as per IS: 6403(Part I) - 1981

SAFE BEARING CAPACITY OF SOIL

Shape of footing =

Plate - 3

Depth of footing D = 3.00 m

Sample Calculation

Width of footing B = 6.00 m

Length of footing L = 6.00 m

Cohesion C = 0.00 kg/cm^2

Angle of Int.Fric ϕ = 32 degrees

Specific Gravity G = 2.65

Inclination Angle α = 0 degrees

Correction Factor for Water Table = 0.5

Dry Density γ_d = 1.549 gm/cc

Sat. density γ_{sat} = 1.964 gm/cc

Submerged density = 0.964 gm/cc

Factor of Safety = 3.0

Void Ratio e_o = $\frac{G \times \gamma_w}{\gamma_d}$ -1

γ_d

=

0.7108

it is ≥ 0.55 & ≤ 0.75

hence it is an intermediate shear failure

(General Shear Failure $e_o < 0.55$) $\phi = 32$

$c = 0.000$ if $e_o < 0.55$, it is general shear failure

(Local Shear Failure $e_o > 0.75$) $\phi' = \tan^{-1}(0.67 \tan \phi)$

$c' = 0.000$ if $e_o > 0.75$, it is local shear failure

$\phi' = 22.72$

$c'' = 0.000$ if $e_o \geq 0.55$ & ≤ 0.75 , it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
$N_c'' =$	21.66	$N_c' =$	18.03	$N_c =$	36.53
$N_q'' =$	11.78	$N_q' =$	8.72	$N_q =$	24.36
$N_{\gamma}'' =$	12.92	$N_{\gamma}' =$	8.10	$N_{\gamma} =$	32.65

Note:

Bearing capacity factors are considered in SBC analysis for Intermediate Shear Failure. These values are derived by interpolation of bearing capacity factor of local and general shear failure.

$$q_{un} = cN_cScdcic + q(N_q-1) Sqdqiq + 0.5 B \gamma N_{\gamma} S \gamma d \gamma i \gamma W'$$

for general shear failure

= 0.00

$q_{ns} =$

0.00

t/m^2

$$q_{un} = c'N_c'Scdic + q(N_q'-1) Sqdqiq + 0.5 B \gamma N_{\gamma}' S \gamma d \gamma i \gamma W'$$

for local shear failure

= 0.00

$q_{ns} =$

0.00

t/m^2

$$q_{un} = c''N_c''Scdcic + q(N_q''-1) Sqdqiq + 0.5 B \gamma N_{\gamma}'' S \gamma d \gamma i \gamma W'$$

for intermediate shear failure

= 74.01

t/m^2

$q_{ns} =$

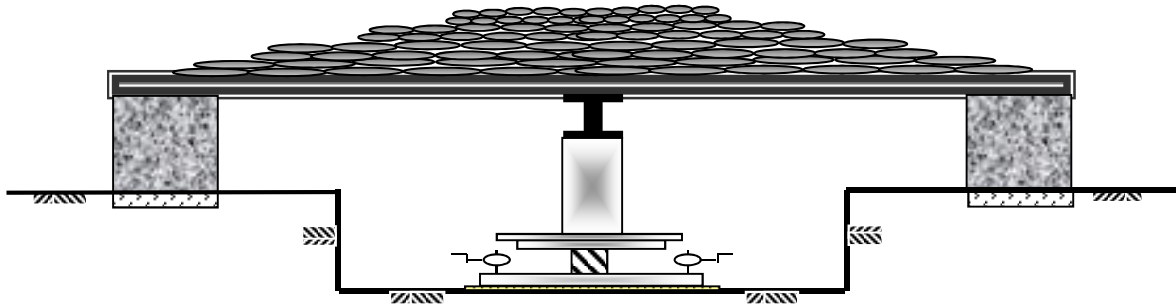
24.67

t/m^2

Photographs :



PLATE LOAD TEST REPORT (IS : 1888-1997)



CLIENT

Techno Electric & Engineering Co. Ltd.

LOCATION

Lakadia Sub Station

NAME OF WORK

Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat under Adani Transmission Ltd.



GEO TEST HOUSE

(A Division of Geo Designs & Research Pvt Ltd.)

B-10, Krishna Industrial Estate, Opp, B.I.D.C., Estate,

Gorwa Estate, Gorwa, Vadodara - 390023

Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

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BRIEF DETAIL OF PLATE LOAD TEST

Name of Work	: Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr Adani Transmission Ltd.
Client	: Techno Electric & Engineering Co. Ltd.
Agency	: -
Ref. No	: Order No.0756LA/19-20/25535, Date:-10/10/2019
Job No.	: 4538/284001
Testing Agency	: Geo Test House (A Division of Geo Designs & Research Pvt Ltd.) B-10, Krishna Industrial Estate, Opp. B.I.D.C., Gorwa Estate, Vadodara - 390 016. Ph : 91-265-2290222. Telefax : 91-265-2282014. E-mail : geo_group@yahoo.com
Report No	: BRD/4538/284001
Ref.Code	: IS :1888-1997
Nos of PLT	: One
Plate Size	: 0.3 X 0.3 mtr
Shape of Plate	: Squre
Pit Depth	: 1.5 mtr
Fine Sand Layer	: 5 mm thick.
Location I.D No	: PLT-03
Location	: Lakadia Sub Station

Test Date : 22/04/2020

Test Load : 4.5 MT

Load Increment : Least of following ;
i) 1 Kg / Sq.cm
ii) 20 % of Ultimate Bearing Capacity

Hydraulic Jack : 1 Nos.

RAM Dia of Jacks : 15.0 cm

Total RAM Area : 177 cm²

Capacity : 100 MT

Pressure Cell : 1 Nos.

Resolution : 1.0 Kg/cm²

Capacity : 0 - 100 Kg/cm²

LVDT/ Dial Gauge : 4 No.

Capacity 50 mm

L.C : 0.01 mm

INTRODUCTION

Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr Adani Transmission Ltd. was referred to us by Techno Electric & Engineering Co. Ltd. Vide Order No.0756LA/19-20/25535, Date:-10/10/2019

With reference to above we were deputed our engineering team for the purpose of testing on PLT-03 under the supervision of your representative at Project Site.

The objective of the exploration work was to determine the probable sub surface conditions such as stratification, denseness or hardness of the strata, position of ground water table etc. and to evaluate probable range of Allowable bearing Pressure.

- One Plate load test was carried out at existing ground level to know the soil bearing capacity of soil
- Analyzing field data to evaluate Allowable Bearing Preesure of the soil for given foundation sizes and necessary recommendations for foundation design and construction.

The site is located at Lakadia Sub Station

OBJECTIVE

The main objective of carrying out the Plate Load Test is to check the settlement for the ultimate bearing capacity of soil in place and its settlement. The Testing was carried out as per I.S. code 1888-1997.

METHODOLOGY

PLATE SIZE AND THICKNESS :

The plate of 0.3 X 0.3 mtrSquare with at least 2.5 cm thick was used for plate load test

The size of test pit was given by client at project site. Test plate was placed at the center of the test pit.

PLACING OF TEST PLATE :

The test plate shall be placed over a test layer of maximum thickness of 5 mm so that the centre of plate coincides with the centre of reaction girder / beam, with the help of a plumb and bob and horizontally leveled by a spirit level to avoid eccentric loading. The hydraulic jack was centrally placed over the plate with the loading column in between the jack and reaction beam so as to transfer load to the plate. A minimum seating pressure of 70-g/sq.cm was applied and removed before starting the load test.

METHOD OF LOADING:

The methodology adopted for Plate Load Test by Kentledge method is in such a way that the full test (Compression) load be supplied in the form of dead weight stacked above the foundation on framework. The kentledge reaction was applied through sand bags.

The test load was then applied through hydraulic jack and other Kentledge reaction assembly. The framework was capable of supporting the entire load at a single location where a hydraulic ram or jack could progressively transfer the load to the top of the pile. The center of gravity of the reaction load was generally be on the axis of the contact area of soil and the load applied by the jack was coaxial with contact area of plate and suitably positioned dial gauges record the settlement.

SETTLEMENT AND OBSERVATION :

Settlement was observed for each increment cycle, the readings had been taken at regular intervals at 1.0, 2.25, 4.0, 6.25, 9.0, 16, 25, and 60 min until the rate of settlement is less than 0.02 mm/min. The next increment of load was then applied and the observations repeated. The test was to be continued till a settlement of 25 mm under normal circumstances and 50 mm in case of special cases such as dense gravel, gravel and sand mixture is obtained, till failure occurs, or up to design ultimate safe bearing pressure, whichever was earlier.

OBSERVATION-TABLE- PLT

Type of Test : Static Plate Load Test

Client : Techno Electric & Engineering Co. Ltd.

Name of wor : Work order for contour survey work, topographical survey & geotechnical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr Adani Transmission Ltd.

Location : Lakadia Sub Station

Size of Pit : 6.0 X 2.0 m

Depth of Pit : 1.5 mtr

Size of Plate : 0.3 X 0.3 mtr

Date of Testing : 22/04/2020

Sr. No.	Date	Time in Min.	Pressure in Kg/cm ² (On Ram)	Pressure in T/m ² (on Plate)	Dial Gauge / LVDT Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	D		

LOADING

1	Date 22/04/2020		1	1.19	4000	4000	4000	4000	4000.00	0.000
2		1:00	4.00	9.5	3889	3880	3871	3870	3877.50	1.225
		2.25			3888	3880	3870	3870	3877.00	1.230
		4.00			3888	3880	3870	3869	3876.75	1.233
		6.25			3888	3880	3870	3869	3876.75	1.233
		9.00			3888	3880	3870	3869	3876.75	1.233
		16.00			3888	3880	3869	3869	3876.50	1.235
		25.00			3888	3879	3869	3868	3876.00	1.240
		60.00			3888	3879	3868	3868	3875.75	1.243

Sr. No.	Date	Time in Min.	Pressure in Kg/cm ² (On Ram)	Pressure in T/m ² (on Plate)	Dial Gauge / LVDT Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	D		
LOADING										
3	Date 22/04/2020		8.0	19.0						
		1:00			3809	3796	3778	3791	3793.50	2.065
		2.25			3809	3796	3777	3791	3793.25	2.068
		4.00			3809	3796	3777	3791	3793.25	2.068
		6.25			3809	3796	3777	3791	3793.25	2.068
		9.00			3809	3795	3776	3790	3792.50	2.075
		16.00			3809	3795	3776	3790	3792.50	2.075
		25.00			3809	3795	3776	3790	3792.50	2.075
		60.00			3809	3795	3776	3789	3792.25	2.078
4	Date 22/04/2020		13.0	30.9						
		1:00			3706	3677	3658	3685	3681.50	3.185
		2.25			3706	3676	3658	3685	3681.25	3.188
		4.00			3706	3676	3657	3684	3680.75	3.193
		6.25			3705	3676	3657	3684	3680.50	3.195
		9.00			3705	3676	3657	3684	3680.50	3.195
		16.00			3704	3675	3657	3683	3679.75	3.203
		25.00			3704	3675	3657	3683	3679.75	3.203
		60.00			3704	3675	3657	3683	3679.75	3.203

Sr. No.	Date	Time in Min.	Pressure in Kg/Sq.cm (On Ram)	Pressure in T/Sq.m (on Plate)	Dial Gauge Readings (L.C - 0.01 mm)				Average Reading	Settlement in mm
					A	B	C	C		
Loading										
5	Date 22/04/2020		17.0	40.4						
		1:00			3596	3542	3526	3570	3558.50	4.415
		2.25			3596	3542	3526	3570	3558.50	4.415
		4.00			3595	3541	3525	3570	3557.75	4.423
		6.25			3594	3541	3525	3569	3557.25	4.428
		9.00			3594	3541	3525	3569	3557.25	4.428
		16.00			3594	3541	3525	3569	3557.25	4.428
		25.00			3593	3541	3525	3569	3557.00	4.430
		60.00			3593	3541	3525	3569	3557.00	4.430
6	Date 22/04/2020		22.0	52.3						
		1:00			3491	3442	3418	3496	3461.75	5.383
		2.25			3491	3442	3418	3495	3461.50	5.385
		4.00			3491	3442	3418	3495	3461.50	5.385
		6.25			3491	3441	3417	3494	3460.75	5.393
		9.00			3491	3441	3417	3494	3460.75	5.393
		16.00			3490	3441	3416	3494	3460.25	5.398
		25.00			3490	3441	3416	3494	3460.25	5.398
		60.00			3490	3441	3416	3494	3460.25	5.398

Calculation :-

Pressure on ram : 4.0 Kg/cm² (Observed Pressure)

Load on Test Plate : Pressure on ram X C/S area of ram

$$: 4.0 \times 177$$

$$: 856.0 \text{ Kg}$$

$$: 0.86 \text{ MT}$$

Presssure on test Plate : Load on Test Plate/Bearing area of Plate

$$: 0.86 / (0.3 \times 0.3)$$

$$: 9.5 \text{ T / m}^2$$

:

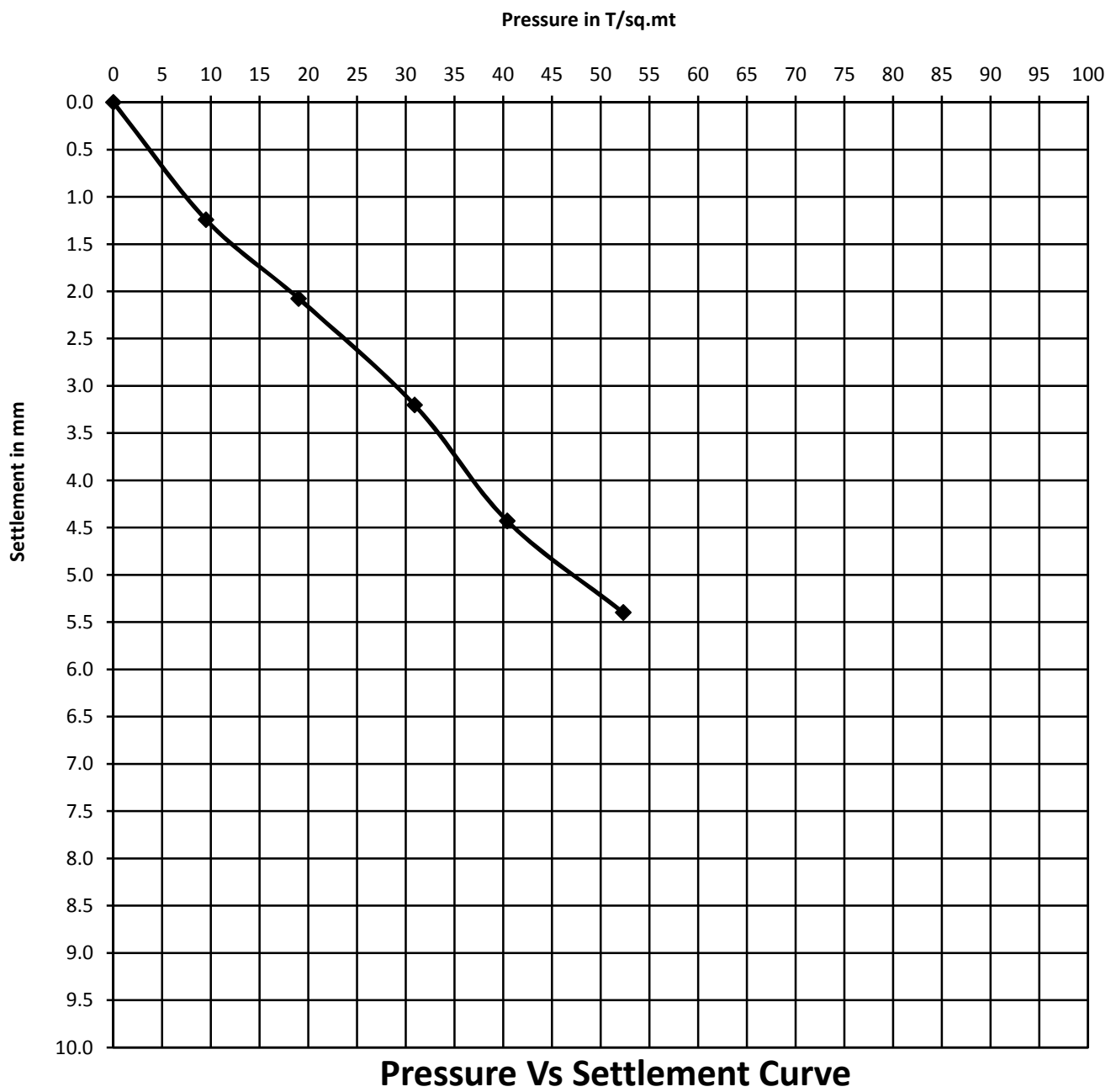
Presssure on test Plate : Load on Test Plate/Bearing area of Plate

$$: 4.7 / (0.3 \times 0.3)$$

$$: 52.31 \text{ T / m}^2$$

Tested By : JHP

GRAPH for PLT-01



ANALYSIS FOR PLATE LOAD TEST NO :- 03

i) For Safe Bearing Pressure Calculation.

SBC $(q_{SBC})_f$ = Safe bearing capacity of footing (From shear criteria)

B_f = Width of footing

B_p = Width of plate

(q_{UBC}) = Ultimate BC of plate (from load-settlement curve) = 50 t/m²

(q_{UBC}) = Ultimate bearing capacity of footing = $(q_{UBC}) \times [B_f/B_p]$

FOS =

3.0

(q_{SBC}) = $(q_{UBC}) / \text{FOS}$

No shear failure is observed at 50t/m²

SBP $(q_{SBP})_f$ = Safe bearing pressure of footing (from settlement criteria)

$(q_{SBP})_f$ = Safe bearing pressure of footing corresponding to $(S_a)_p$, from load settlement curve

Where,

$(S_a)_p$ = Allowable settlement of plate

= $(S_a)_f [B_p(B_f+0.3)/B_f(B_p+0.3)]^2$

$(S_a)_f$ = Allowable settlement of footing **25,50 & 100 mm** for isolated footing

B_f = Width of footing

B_p = Width of plate

0.30 m

Table -1 for Safe Bearing Pressure

Allowable settlement of footing in mm	Width of footing in m	Allowable settlement of plate in mm	Safe bearing pressure in t/m^2 (From Graph)	Recommended SBC in t/m^2
$(S_a)_f$	B_f	$(S_a)_p$	$(q_{SBP})_f$	
(1)	(2)	(3)	(4)	(5)
25	1.00	10.6	No shear failure is observed & settlement of Plate is within Permissible limit. Hence SBC of 20 T/m^2 ok.	
25	2.00	8.3		
25	3.00	7.6		
25	4.00	7.2		
25	6.00	6.9		

Remarks :

One test Was Conducted on Ultimate Bearing capacity of 50.0 T/m^2 (Provided by client/contractor/site incharge) is at this stage, allowable settlement for given size of footing is within Permissible limit, as only 5.398 mm Settlement are observed. No shear failure within the sub soil during the test load observed. Hence, assumed SBC of 20 T/m^2 is satisfactory.

(Authorized Signatory)

Vishal Sakpal

Manager Technical

NOTE:

1.This certificate or report may not be published for commercial purpose except in full unless permission for the publication of an approved abstract has been obtained from the GEO TEST HOUSE,Vadodara.

2.This test certificate applies only to the test location.

CONCLUSION

1. One Plate Load Tests were carried out at Lakadia Sub Station
2. Safe Bearing Capacity, Safe Bearing Pressure are determined as per as per I.S : 1888-1997 Clause No. 5.0
3. Ultimate bearing capacity is derived from the Pressure / Settlement curve, and Safe bearing capacity is determined by considering factor of safety of 3.0. Minimum value from SBC and SBP shall be considered in design of foundation as mentioned in Table-1.

Limitations of Plate load tests are as follows :

- 1) Plate bearing test is of short duration test and hence consolidation settlement does not fully occur during this test. As such this test cannot be used to predict consolidation settlement. Hence from settlement considerations, its use is restricted to sandy soils and to partially saturated or rather slightly unsaturated clayey soils.
- 2) The test results reflect only the character of the soil located within a depth of less than twice the width of the bearing plate. Thus the results of the tests are likely to be misleading, if the character of the soil changes at shallow depth which is not uncommon.
- 3) For clayey soils the bearing capacity (from shear consideration) for a larger foundation is almost the same as that for the smaller test plate. But in dense sandy soils the bearing capacity increases with the size of the foundation. Thus test with smaller size plate tend to give conservative values in dense sandy soils.

There are inaccuracies introduced in extrapolating the results from small size plates to large size foundations. Hence, it is stressed here that plate bearing test alone is not to be used in predicting the allowable bearing pressure for foundation.