NOTES:
1) ALL DIMENSION ARE IN mm WHEREAS CO-ORDINATES AND LEVELS ARE IN m UNLESS OTHERWISE STATED.
2) UNDER GROUND PIPE SHALL BE TREATED ANTICORROSIVE TREATMENT AS PER IS:10221.
3) MINOR MODIFICATION MAY BE CARRIED AT SITE TO SUIT SITE CONDITION.
4) THE SOURCE OF WATER SUPPLY FOR THE DOMESTIC AND OTHERS 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

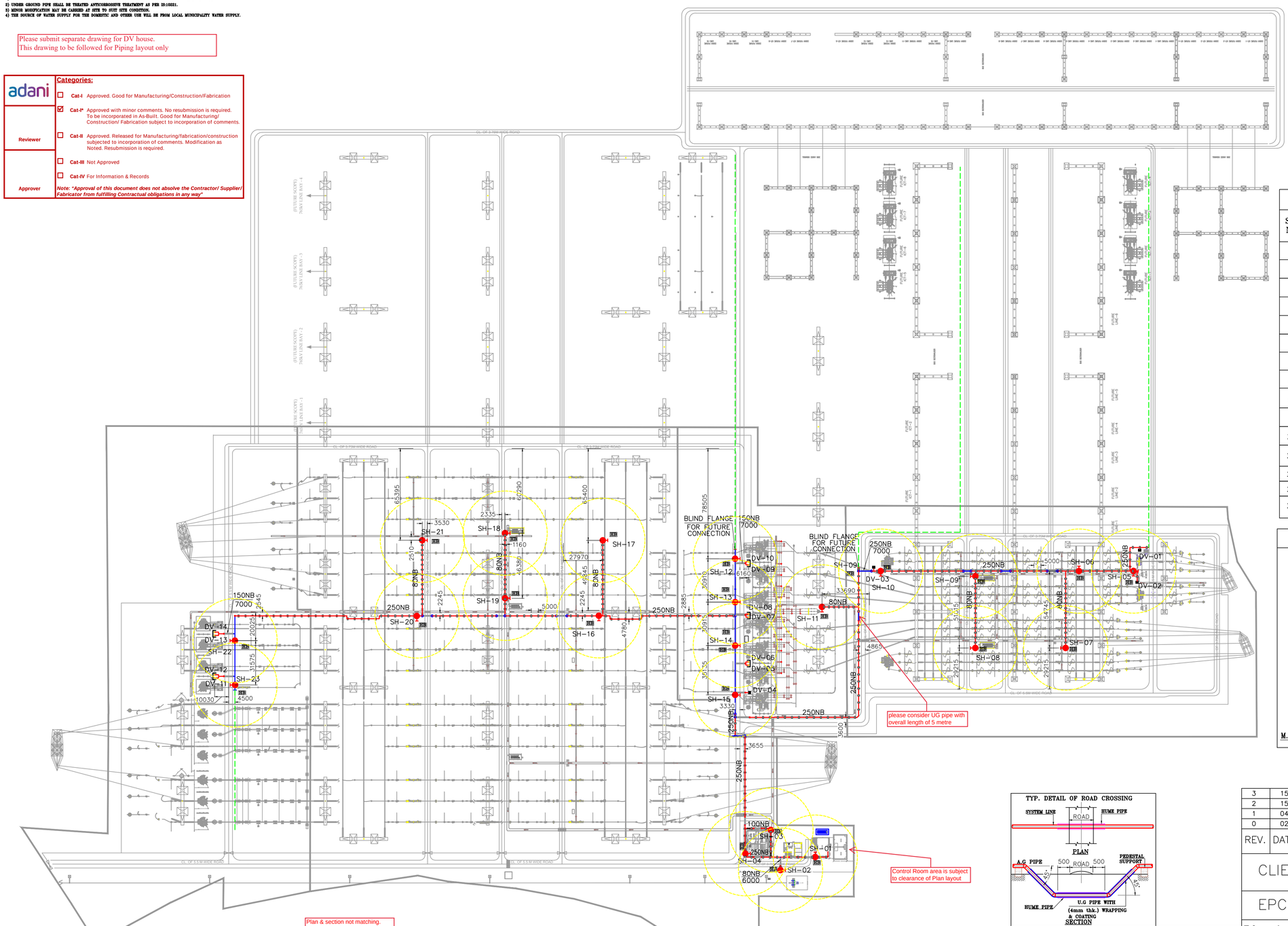
Reviewer

Approver

Categories:

- ☐ **Cat-I** Approved. Good for Manufacturing/Construction/Fabrication
- ☑ **Cat-I*** 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-II** Approved. Released for Manufacturing/fabrication/construction subjected to incorporation of comments. Modification as Noted. Resubmission is required.
- ☐ **Cat-III** Not Approved
- ☐ **Cat-IV** For Information & Records

Note: "Approval of this document does not absolve the Contractor/ Supplier/ Fabricator from fulfilling Contractual obligations in any way"



765KV SWITCHYARD

765kV LINE BAY-II (BHUJ - II)

765kV LINE BAY-I (BHUJ - I)

765kV BUS REACTOR (WITH SPARE REACTOR)

765kV FUTURE LINE BAY

765kV LINE BAY-II (BANASKANTA - JI)

765kV LINE BAY-I (BANASKANTA - I)

CL. OF 3.75M WIDE ROAD

CL. OF 5.5 M WIDE ROAD

CL. OF 3.75 M WIDE ROAD

FGL. +91.0 M

FGL. +89.0 M

FGL. +93.0 M

E 663212.24
N 2587843.10

E 663319.57
N 2587885.19

E 662899.96
N 2587864.87

E 662995.81
N 2587970.82

E 662847.40
N 2588014.47

E=662876.59
N=2588114.25

DEAD END TOWER 14.7 12.6 11.6

DEAD END TOWER 14.7 12.4 11.4

BRICK WALL FOR BAY EXTN. (TYPICAL)

BMK - 1

BMK - 2

BMK - 3

BMK - 4

BMK - 5

MAIN GATE

WICKET GATE

SUMP PIT

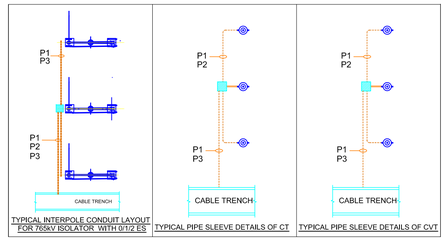
CABLE TRENCH

LBTL SCOPE

CL TOWER 15 | CL BAY REACTOR 8 | CL LA 5 | CL BPI 8 | CL ROAD 5.5mWIDE 11 | CL BPI 12 | CL BPI WO/ES 12 | CL BPI WO/ES 8 | CL BPI 18 | CL TOWER 102 | CL TOWER 20 | CL TOWER CL BPI+ 12 | CL TOWER 2 | CL TOWER 13 | CL BPI + 1ES 15 | CL BPI + 1ES 10 | CL CB 6 | CL ROAD 7.5mWIDE 9 | CL BPI + 1ES 13 | CL BPI + 1ES 15 | CL TOWER + CL CB 10 | CL ROAD 7.5mWIDE 6 | CL CT 9 | CL BPI + 1ES 13 | CL BPI + 1ES 9 | CL CT 6 | CL ROAD 7.5mWIDE 10 | CL CB 15 | CL BPI + 1ES 13 | CL TOWER CL BPI 12 | CL BPI CL TOWER 20 | CL TOWER 116 | CL TOWER 14 | CL BPI 8 | CL BPI WO/ES 12 | CL BPI + 1ES 12 | CL ROAD 7.5mWIDE 8 | CL BPI CL LA 5 | CL AT 8 | CL TOWER / DEAD END 42

102 | 116 | 126 | 110

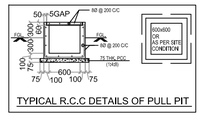
DETAILS OF PIPE TRENCH FOR EQUIPMENTS:



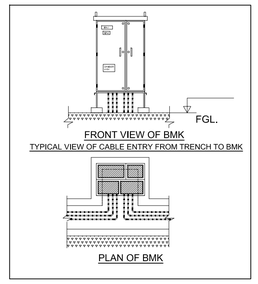
TYPICAL INTERPOLE CONDUIT LAYOUT FOR 765kV ISOLATOR WITH 0/1/2 ES | TYPICAL PIPE SLEEVE DETAILS OF CT | TYPICAL PIPE SLEEVE DETAILS OF CVT

TYPICAL PIPE SLEEVE DETAILS OF EQUIPMENTS:-

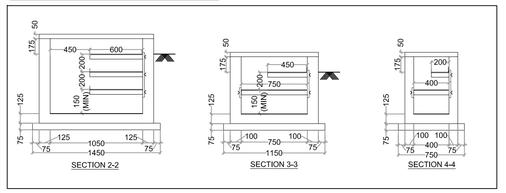
	DESCRIPTION
P1	1 X 50 MM Ø PVC PIPE FOR POWER CABLE
P2	1 X 110 MM Ø PVC PIPE FOR CONTROL CABLE
P3	1 X 200 MM Ø PVC PIPE FOR CONTROL CABLE



TYPICAL R.C.C DETAILS OF PULL PIT

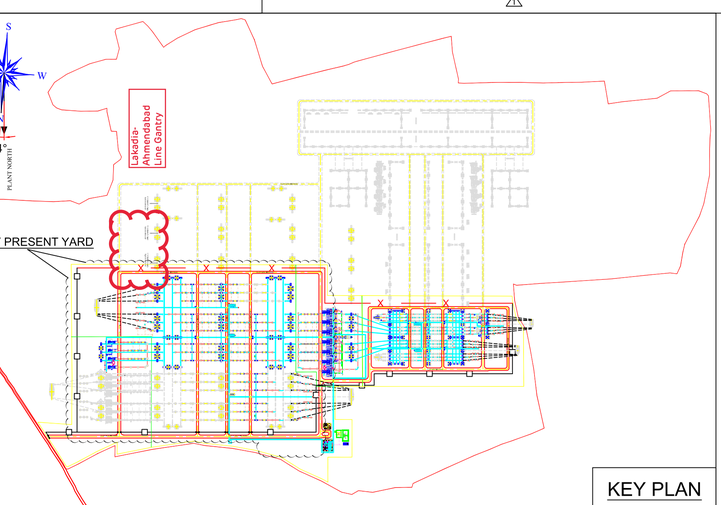


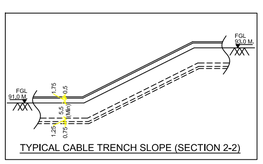
TYPICAL CABLE TRENCH SECTIONS :



GENERAL NOTES:-

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. FOR CABLE TRENCH SECTIONS PLEASE REFER " TYPICAL CABLE TRENCH SECTIONS".
3. THE EXACT LOCATION OF TRENCH AND PULL PIT MAY BE SHIFTED TO SUIT THE ACTUAL SITE CONDITIONS IN CONSULTATION WITH POWERGRID SITE INCHARGE
4. FOR EQUIPMENT CABLES PVC PIPES SHALL BE USED. PVC PIPE SHALL CONFIRM TO IS:4985 ,CLASS 4.
5. SEPARATE PVC PIPES SHALL BE LAID FOR POWER AND CONTROL CABLE.PVC PIPES SHALL BE BURIED AT A DEPTH OF 250MM FROM FGL.
6. SUITABLE OPENING SHALL BE PROVIDED IN CABLE TRENCH AT APPROPRIATE LOCATION FOR CABLE ENTRY AND EXIT.
7. A SLOPE OF 1:250 SHALL BE GIVEN IN THE DIRECTION PERPENDICULAR TO THE RUN AND 1:1000 ALONG THE RUN OF THE TRENCH FOR ALL SECTION. ALONG DIRECTION SLOPE OF TRENCH SLOPE AND LOCATION OF SUMP PIT TO BE SHOWN IN NEXT SUBMISSION.
8. LIGHTING CABLES TO RUN IN TRENCHES AS FAR AS POSSIBLE OTHERWISE BURIED CABLE IN THE GROUND IN SAND AND COVERED WITH BRICKS.
9. ROUTE OF BURIED CABLE TRENCH FOR ILLUMINATION SHALL BE AS PER RELEVANT ILLUMINATION LAYOUT.
10. PRECAST RCC REMOVAL COVERS WITH LIFTING ARRANGEMENT (AS PER CIVIL DRG.) SHALL BE PROVIDED OVER TRENCHES.
11. POWER CABLE WILL RUN THROUGH TOP TIER & CONTROL/INSTRUMENTATION CABLE WILL RUN THROUGH BOTTOM AND MIDDLE TIRE.
12. 60 PERCENT VOID SHALL BE MAINTAINED IN EACH PVC PIPE. PROPER SEALING AT BOTH ENDS TO BE DONE AS PER TECH. SPEC.
13. BEFORE EXCAVATION CHECK WITH ELECTRICAL LAYOUT DRAWING AND IF ANY DISCREPANCY NOTICED CLARIFY BEFORE STARTING ANY WORK AT SITE.
14. TRENCH SHALL BE AS CLOSE AS TO EQUIPMENT AS POSSIBLE BUT AWAY BY A MIN. OF 100 MM.
15. CABLE FROM BAY TRENCH TO EQUIPMENT SHALL BE LAID THROUGH PVC PIPE (EXCEPT CB) AS PER "DETAILS OF PIPE TRENCH FOR EQUIPMENTS".
16. FIBRE OPTIC CABLES SHALL RUN THROUGH HDPE (MIN. 25 MM DIA.) PIPES IN BOTTOM TIER OF TRENCH.
17. ROAD CROSSING DETAILS TO BE SUBMITTED SEPARATELY.





TYPICAL CABLE TRENCH SLOPE (SECTION 2-2)

TABLE OF RUNNING LENGTH:

S.NO.	DESCRIPTION	QUANTITY (WTL SCOPE)	QUANTITY (LBTL SCOPE)
1	200 MM Ø PVC PIPE	1700 MTR.	300 MTR.
2	110 MM Ø PVC PIPE	3500 MTR.	1000 MTR.
3	50 MM Ø PVC PIPE	3000 MTR.	700 MTR.
4	TRENCH SECTION 2 - 2	875 MTR.	80 MTR.
5	TRENCH SECTION 3 - 3	350 MTR.	80 MTR.
6	TRENCH SECTION 4 - 4	300 MTR.	85 MTR.
7	BURIED TRENCH	180 MTR.	

REFERENCE DRG:

1. 765KV ELECTRICAL LAYOUT - PLAN
   (DWG NO. : 0756LA_LKDA_SWYD_E_DRG_42_001A ,R-3)
2. 765KV FOUNDATION LAYOUT
   (DWG NO. : 0756LA_LKDA_SWYD_E_DRG_33_001A ,R-1)

LEGENDS:

- PRESENT
- NOT IN SCOPE OR FUTURE SCOPE
- PULL PIT
- TRENCH ROAD CROSSING
- BURIED TRENCH
- BRICK WALL FOR FUTURE EXTN. OF CABLE TRENCH
- BAY MARSHALLING BOX
- PVC PIPE

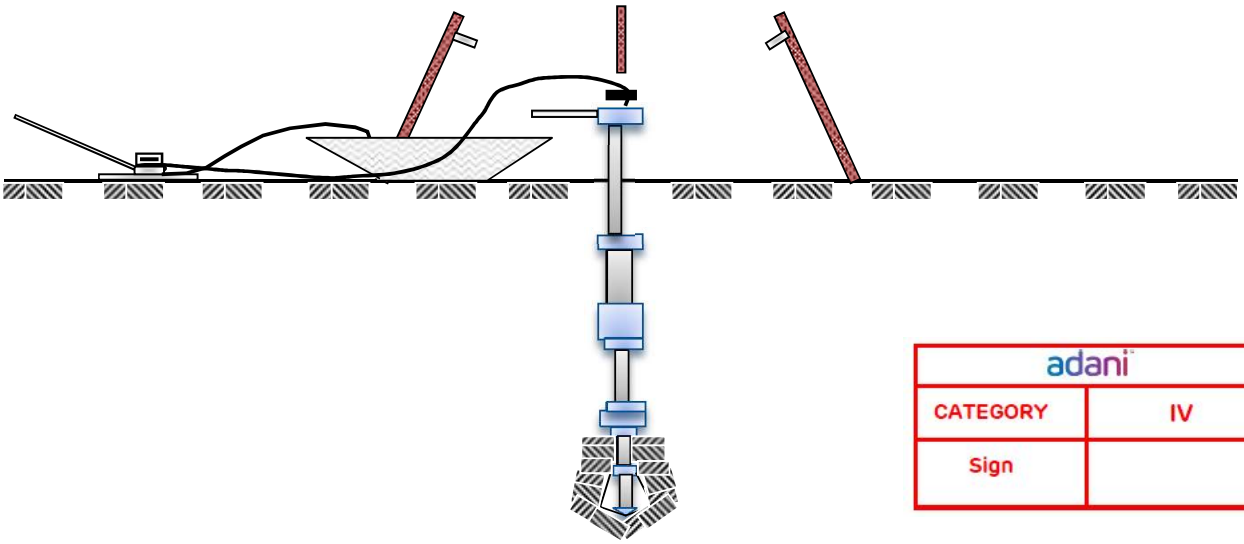
REV.	DATE	REMARKS	CAT.	APPROVAL DATE	ISSUED FOR CONSTRUC.
1	04.09.20	SECOND SUBMISSION			
0	17.05.20	FIRST SUBMISSION	II	19.06.20	

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
SO ref	SO NO. - 5700277667 DATED : 23.10.2019
SUBSTATION	765/400KV LAKADIA SUBSTATION

TITLE		
765KV TRENCH LAYOUT	DRAWN BY	DS
	DESIGNED BY.	AM
	CHECKED BY.	BS
	APPROVED BY.	BS
	SCALE	NTS
TECHNO DWG. NO.	0756LA_LKDA_SWYD_E_DRG_33_002A	
	SHEET NO.	01_OF_01

GEOTECHNICAL INVESTIGATION REPORT

(IS : 1892 - 1997)



adani	
CATEGORY	IV
Sign	

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

CONTENT

SR. NO.	PERTICULARS	PAGES
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BRIEF DETAIL OF PROJECT SITE

CIIENT	: 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 boreoles 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)) x 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 425µ sieve is taken mixed with requisite water, placed in cup and compacted lightly in 3layers. 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 425µ 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.

V_0 = Volume of dry soil pat in ml.

W_0 = 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 Veccume 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:

$F.S.I (\%) = [(Vd – Vk) / Vk] \times 100$

Where,

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

Vk = 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 s 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 frm the difference between the final and initial dial readings of the proving ring. Swell pressure (Kg/cm2) is calculated as follows: SP = ((Final Dial Gauge reading - Initial Dial Gauge reading) / Area of specimen) x 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 rill 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 (Ho) 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	=	*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 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/m2
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/m2
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	=	*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 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/m2	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/m2	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 capcaity 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

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No 4538/284001
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 m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
	0.5		Brownish Silty Sand of Non Plasticity	1/1	DS	0.0	0.50						
1													
2	2.5		Brownish Clayey Sand of Low Plasticity	1/2	SPT	1.5	1.95	5	7	9	16	16	
3				1/3	SPT	3.0	3.45	7	16	32	48	48	
4													
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				1/6	SPT	6.0	6.45	16 + 55 + 1cm / 50 Blows				>100	Refusal
7													
8	3.0		Brownish Silty Clay of Intermediate Plasticity	1/7	SPT	7.5	7.95	>100				>100	Refusal
9				1/8	SPT	9.0	9.45	35 + 60 + 5cm / 50 Blows				>100	Refusal
10	1.0		Brownish Silty Clay of Intermediate Plasticity	1/9	SPT	10.0	10.45	38 + 2cm / 50 Blows				>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

Prepared By	Checked / Approved By	GEO TEST HOUSE
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BORE LOG

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001		
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-2**
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	:	5.5m	Date of Completion	:	19/12/2019

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
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	32	
3				2/3	SPT	3.0	3.45	7	15	26	41	41	
4				2/4	SPT	4.5	4.95	9	18	26	44	44	
5													
6				2/6	SPT	6.0	6.45	13	24	38	62	62	
7	1.5		Brownish Sandy Silt of Non Plasticity	2/7	SPT	7.5	7.95	25 + 10 cm / 50 Blows				>100	Refusal
8	2.5		Brownish Silty Sand of Non Plasticity	2/8	SPT	9.0	9.45	26 + 86 + 2cm / 50 Blows				>100	Refusal
9													
10				2/9	SPT	10.0	10.45	20 + 38 + 2cm / 50 Blows				>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

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001
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	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m			No.		From	To	15	15	15	N	Graph	
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	25	
3				3/3	SPT	3.0	3.45	11	16	18	34	34	
4				3/4	SPT	4.5	4.95	14	21	40	61	61	
5													
6				3/5	SPT	6.0	6.45	15	44	79	>100	>100	Refusal
7				3/6	SPT	7.5	7.95	1 cm / 50 Blows				>100	Refusal
8				3/7	SPT	9.0	9.45	30 + 50 + 2 cm / 50 Blows				>100	Refusal
9													
10	1.0		Brownish Sandy Silt of Non Plasticity	3/8	SPT	10.0	10.45	36 + 1 cm / 50 Blows				>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

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001		
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	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m			No.		From	To	15	15	15	N	Graph	
1	10.0		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													
6				4/6	SPT	6.0	6.45	9	23	40	63	63	
7				4/7	SPT	7.5	7.95	12	34	58	92	92	
8				4/8	SPT	9.0	9.45	14 + 38 + 2cm / 50 Blows				>100	Refusal
9													
10				4/9	SPT	10.0	10.45	22 + 62 + 2cm / Blows				>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

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001		
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	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m			No.		From	To	15	15	15	N	Graph	
1	10.0		Brownish Silty Sand of Non Plasticity	5/1	DS	0.0	0.50						
2				5/2	SPT	1.5	1.95	5	8	10	18	18	
3				5/3	SPT	3.0	3.45	8	20	34	54	54	
4				5/4	SPT	4.5	4.95	12	33	55	88	88	
5				5/6	SPT	6.0	6.45	13 + 48 + 1cm / 50 Blows				>100	Refusal
6				5/7	SPT	7.5	7.95	24 + 63 + 13cm / 50 Blows				>100	Refusal
7				5/8	SPT	9.0	9.45	80 + 8 cm / 50 Blows				>100	Refusal
8				5/9	SPT	10.0	10.45	55 + 9 cm / Blows				>100	Refusal
9													
10			Borehole is terminated at depth of 10.0 m										
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

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001		
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 Guiarat 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	Thickness	Log	Description	Sample	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m			No.		From	To	15	15	15	N	Graph	
1	10.0		Brownish Silty Sand of Non Plasticity	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													
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

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001		
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 Guiarat under Adani	Borehole	:	**BH-7**
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	:	28/02/2020
Depth of GWT	:	4.2m	Date of Completion	:	28/02/2020

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
1	10.0		Brownish Silty Sand of Non Plasticity	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													
6				7/6	SPT	6.0	6.45	14 + 31 + 8cm / 50 Blows				>100	Refusal
7				7/7	SPT	7.5	7.95	26 + 40 + 7cm / 50 Blows				>100	Refusal
8				7/8	SPT	9.0	9.45	33 + 6cm / 50 Blows				>100	Refusal
9													
10				7/9	SPT	10.0	10.45	19	38	44	82	82	
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
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BORE LOG

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001		
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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 Guiarat under Adani	Borehole	:	**BH-8**
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	:	27/02/2020
Depth of GWT	:	4.7m	Date of Completion	:	27/02/2020

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
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	12	
3				8/3	SPT	3.0	3.45	6	9	14	23	23	
4				8/4	SPT	4.5	4.95	8	15	18	33	33	
5													
6				8/6	SPT	6.0	6.45	10	28	35	63	63	
7				8/7	SPT	7.5	7.95	25	42	58	100	100	
8				8/8	SPT	9.0	9.45	48 + 5cm / 50 Blows				>100	Refusal
9													
10	1.0		Yellowish Silty Gravel of Non Plasticity	8/9	SPT	10.0	10.45	68 + 4cm / 50 Blows				>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

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Job No 4538/284001
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 Guiarat under Adani	Borehole	:	**BH-9**
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	:	27/02/2020
Depth of GWT	:	4.6m	Date of Completion	:	27/02/2020

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
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	7	
3				9/3	SPT	3.0	3.45	12	16	21	37	37	
4				9/4	SPT	4.5	4.95	15	25	28	53	53	
5	1.5		Yellowish Poorly Graded Gravel										
6				9/6	SPT	6.0	6.45	9	16	26	42	42	
7	3.0		Yellowish Silty Sand of Non Plasticity	9/7	SPT	7.5	7.95	21 + 39 + 7cm / 50 Blows				>100	Refusal
8													
9				9/8	SPT	9.0	9.45	27 + 45 + 5cm / 50 Blows				>100	Refusal
10	1.0		Yellowish Poorly Graded Gravel and Silty Gravel of Non Plasticity	9/9	SPT	10.0	10.45	30	32	42	74	74	
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
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BORE LOG

(As per IS : 1892-1979, 4453-1980 & 4464-1967)

Job No	4538/284001		
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 Guiarat 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	Depth (m) 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	19	
3				10/3	SPT	3.0	3.45	15	19	25	44	44	
4				10/4	SPT	4.5	4.95	16	20	39	59	59	
5													
6				10/6	SPT	6.0	6.45	10	18	21	39	39	
7	1.5		Yellowish Silty Gravel and Poorly Graded Gravel of Non Plasticity	10/7	SPT	7.5	7.95	18 + 62 + 5cm / 50 Blows				>100	Refusal
8	2.5		Yellowish Poorly Graded and Silty Sand of Non Plasticity	10/8	SPT	9.0	9.45	48 + 4cm / 50 Blows				>100	Refusal
9													
10				10/9	SPT	10.0	10.45	15	39	42	81	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

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Job No	4538/284001		
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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 Guiarat under Adani	Borehole	:	**BH-11**
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	:	4.3m	Date of Completion	:	26/02/2020

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
1	3.0		Yellowish Poorly Graded and Silty Sand of Non Plasticity	11/1	DS	0.0	0.50						
2				11/2	SPT	1.5	1.95	10	14	30	44	44	
3				11/3	SPT	3.0	3.45	7	12	32	44	44	
4	1.5		Yellowish Silty Gravel and Poorly Graded Gravel of Non Plasticity	11/4	SPT	4.5	4.95	4	10	28	38	38	
5	1.5		Yellowish Silty Sand of Non Plasticity										
6				11/6	SPT	6.0	6.45	17	26	36	62	62	
7	1.5		Yellowish Silty Gravel of Non Plasticity	11/7	SPT	7.5	7.95	21 + 30 + 8cm / 50 Blows				>100	Refusal
8	1.5		Yellowish Silty Sand of Non Plasticity	11/8	SPT	9.0	9.45	26	33	38	71	71	
9													
10	1.0		Yellowish Silty Gravel of Non Plasticity	11/9	SPT	10.0	10.45	20 + 39 + 7cm / 50 Blows				>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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Job No 4538/284001
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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	:	25/02/2020
Depth of GWT	:	5.4m	Date of Completion	:	26/02/2020

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
1				12/1	DS	0.0	0.50						
2	4.5		Yellowish Poorly Graded and Silty Sand of Non Plasticity	12/2	SPT	1.5	1.95	10	14	30	44	44	
3				12/3	SPT	3.0	3.45	7	12	32	44	44	
4				12/4	SPT	4.5	4.95	4	10	28	38	38	
5	1.5		Yellowish Silty Gravel of Non Plasticity										
6				12/6	SPT	6.0	6.45	17	26	36	62	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	1.5		Yellowish Silty Gravel and Poorly Graded Gravel of Non Plasticity	12/8	SPT	9.0	9.45	26	33	38	71	71	
9													
10	1.0		Yellowish Sandy Silt of Non Plasticity	12/9	SPT	10.0	10.45	20 + 39 + 7cm / 50 Blows				>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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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	:	3.5m	Date of Completion	:	22/02/2020

Depth	Thickness	Log	Description	Sample	Type	Depth (m)		SPT 'N' Value				SPT V/s Depth	Remarks / Other tests
m	m			No.		From	To	15	15	15	N	Graph	
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	26	
3				13/3	SPT	3.0	3.45	7	8	19	27	27	
4				13/4	SPT	4.5	4.95	4	16	23	39	39	
5	1.5		Yellowish Silty Gravel of Non Plasticity										
6				13/6	SPT	6.0	6.45	8	12	28	40	40	
7	3.0		Yellowish Sandy Silt of Non Plasticity	13/7	SPT	7.5	7.95	10	19	32	51	51	
8				13/8	SPT	9.0	9.45	17	20	34	54	54	
9													
10	1.0		Yellowish Silty Sand of Non Plasticity	13/9	SPT	10.0	10.45	8cm / 50 Blows				>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
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Job No	4538/284001		
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Client	:	Techno Electric & Engineering Co. Ltd	Depth of Borehole	:	7.5 m
Location	:	Lakadia , Gujarat	Depth of casing	:	Not Applicable
Dia of Borehole	:	150mm	Date of Starting	:	24/02/2020
Depth of GWT	:	4.0m	Date of Completion	:	24/02/2020

Depth m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
1	7.5		Yellowish Poorly Graded and Silty Sand of Non Plasticity	14/1	DS	0.0	0.50						
2				14/2	SPT	1.5	1.95	6	8	9	17	17	
3				14/3	SPT	3.0	3.45	7	10	19	29	29	
4				14/4	SPT	4.5	4.95	10	16	29	45	45	
5				14/6	SPT	6.0	6.45	26 + 52 + 5cm / 50 Blows				>100	Refusal
6				14/7	SPT	7.5	7.95	10cm / 50 Blows				>100	Refusal
7			Borehole is terminated at depth of 7.5 m										
8													
9													
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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Job No	4538/284001		
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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 Guiarat under Adani	Borehole	:	**BH-15**
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 m	Thickness m	Log	Description	Sample No.	Type	Depth (m) From	Depth (m) To	SPT 'N' Value 15	15	15	N	SPT V/s Depth Graph	Remarks / Other tests
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	35	
3				15/3	SPT	3.0	3.45	5	12	19	31	31	
4	4.5		Brownish Poorly Graded and Silty Sand of Non Plasticity										
5				15/4	SPT	4.5	4.95	5	8	15	23	23	
6				15/6	SPT	6.0	6.45	6	10	28	38	38	
7				15/7	SPT	7.5	7.95	3	10	25	35	35	
8	2.5		Yellowish Sandy Silt of Non Plasticity	15/8	SPT	9.0	9.45	62 + 8cm / 50 Blows				>100	Refusal
9													
10				15/9	SPT	10.0	10.45	20 + 31 + 8cm / 50 Blows				>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

Prepared By	Checked / Approved By	GEO TEST HOUSE
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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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

JOB No.4538/284001

Checked By :-JS

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

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	_	_

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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

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

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

JOB No.4538/284001

Checked By :-JS

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

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.			
				%	%	%	%	%	%	Kg/cm^2	Degree	cm^2/kg	%	Kg/cm^2		gm/cc	%
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	_	_

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

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

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 lessthan 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/m^3 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 lessthan 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/m^3 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 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		**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 =	***0.10***	*kg/cm²*	
Angle of Int.Fric ϕ =	***20***	*degrees*	
Specific Gravity G =	***2.59***		
Inclination Angle α =	***0***	*degrees*	
Correction Factor for Water Table =	***0.5***		
Dry Density Yd =	***1.617***	gm/cc	
Sat.density Ysat =	**1.993**	gm/cc	
Submerged density=	**0.993**	gm/cc	
Factor of Safety =	***3.0***		
Void Ratio eo =	***G x Yw / Yd***	***-1***	
=	*0.6017*	***it is >= 0.55 & <= 0.75***	***hence it is an intermediate shear failure***

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*
dγ,sγ,iγ	*1.071*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 20

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

Φ' = 13.70

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

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

c''= ***0.091*** if e_o => 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
Nγ'' =	4.59	*Nγ' =*	2.28	*Nγ =*	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 γ N γ S γ d γ i γ 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 γ N' γ S γ d γ i γ 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 γ N'' γ S γ d γ i γ W'*

for intermediate shear failure

= ***48.15*** ***t/m²*** 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

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 ϕ =	***30***	*degrees*	
Specific Gravity G =	***2.64***		
Inclination Angle α =	***0***	*degrees*	
Correction Factor for Water Table =	***0.5***		
Dry Density Yd =	***1.543***	gm/cc	
Sat.density Ysat =	**1.959**	gm/cc	
Submerged density=	**0.959**	gm/cc	
Factor of Safety =	***3.0***		
Void Ratio eo =	***G x Yw / Yd***	***-1***	
=	*0.7110*	***it is >= 0.55 & <= 0.75***	***hence it is an intermediate shear failure***

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*
dγ,sγ,iγ	*1.087*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 30

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

Φ' = 21.15

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

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

c''= ***0.000*** if e_o => 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
Nγ'' =	9.63	*Nγ' =*	6.54	*Nγ =*	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 γ N γ S γ d γ i γ 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 γ N' γ S γ d γ i γ W'*

for local shear failure

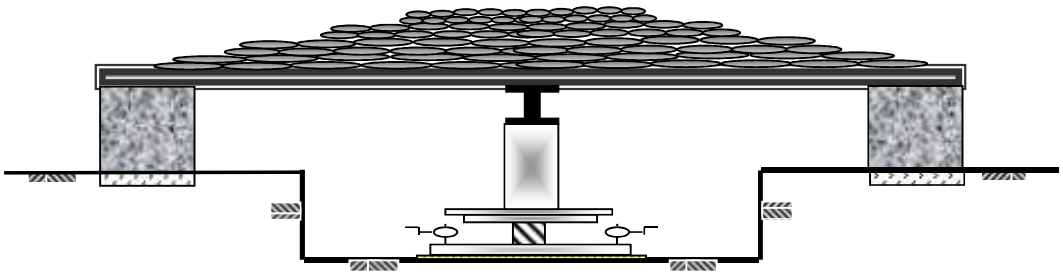
= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

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

for intermediate shear failure

= ***56.58*** ***t/m²*** 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 & geotechical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr 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

CONTENT

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1	Brief Details of Project	
2	Introduction	5 of 20
3	Objective	6 of 20
4	Methodology of Plate Load Test - Kentledge Method	7 of 20
5	Observation Table & Analysis of PLT	8 of 20

BRIEF DETAIL OF PLATE LOAD TEST

Name of Work	:	Work order for contour survey work, topographical survey & geotechical 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	:	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
Hyadraulic 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 & geotechical 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 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 mtrSqure 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 contanct 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 & geotechical 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			1	1.19	4000	4000	4000	4000	4000.00	0.000
2	Date 18/3/2020	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/cm^2 (Observed Pressure)

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

: 4.0 X 177

: 856.0 Kg

: 0.86 MT

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

: 0.86 / (0.3 X 0.3)

: 9.5 T / m^2

:

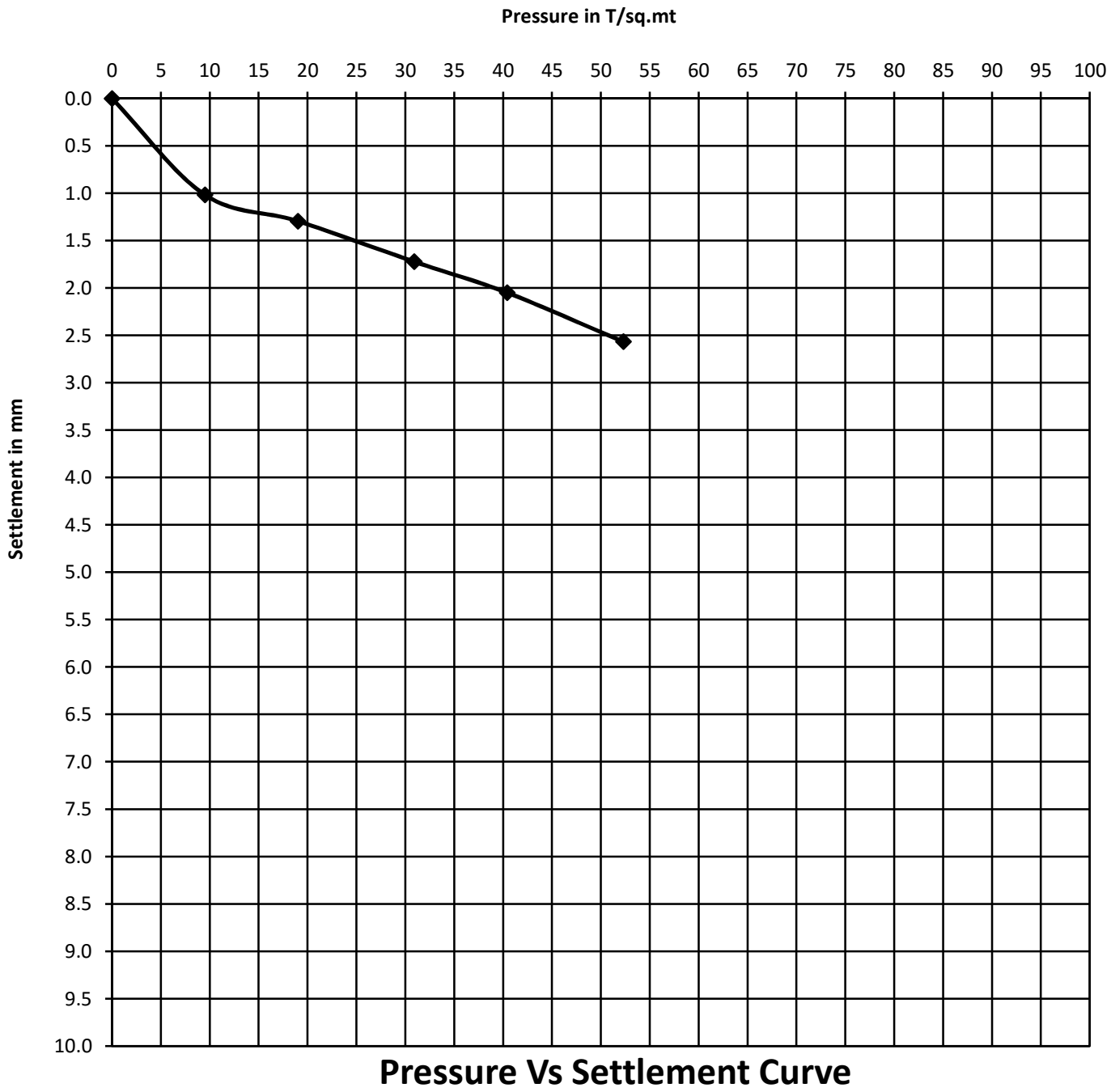
Presssure on test Plate : Load on Test Plate/Bearing area of Plate

: 4.7 / (0.3 X 0.3)

: 52.31 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 & geotechical 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/cm² (On Ram)*	*Pressure in T/m² (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/cm^2 (Observed Pressure)

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

: 4.0 X 177

: 856.0 Kg

: 0.86 MT

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

: 0.86 / (0.3 X 0.3)

: 9.5 T / m^2

:

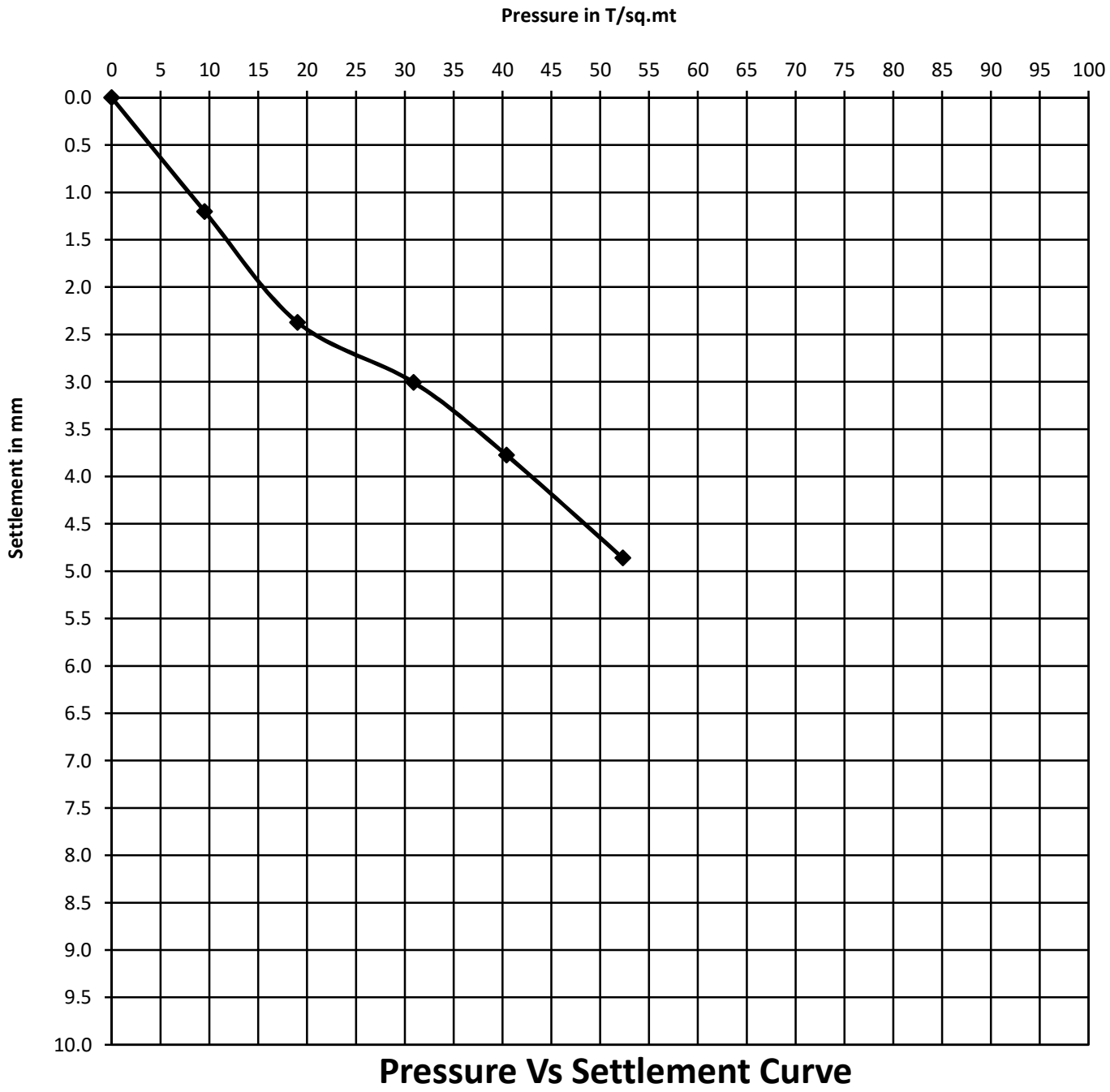
Presssure on test Plate : Load on Test Plate/Bearing area of Plate

: 4.7 / (0.3 X 0.3)

: 52.31 T / m^2

Tested By : JHP

GRAPH for PLT-02



Pressure Vs Settlement Curve

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/m^2

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

FOS = 3.0

(q_{SBC}) = (q_{UBC}) / FOS **No shear failure is observed at 50t/m^2**

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 :

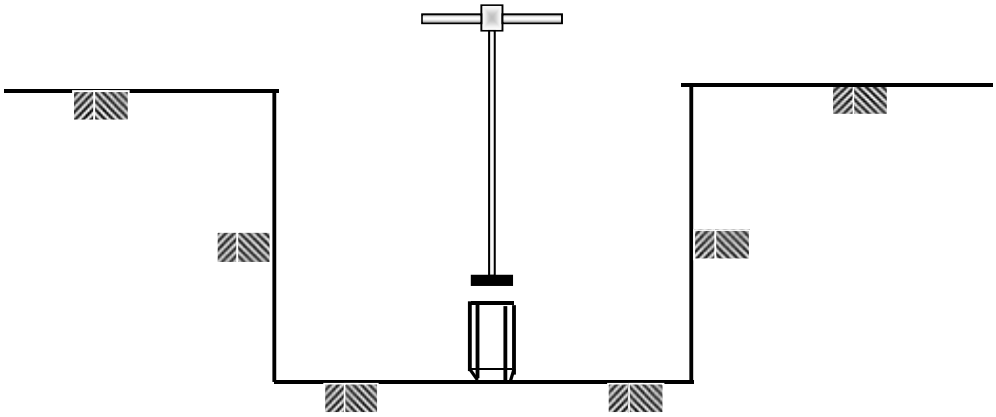
1) Plate bearing test is of short duration test and hence consolidation settlement does not fully occur during this test. As such this test cannot be used to predict consolidation settlement. Hence from settlement considerations, its use is restricted to sandy soils and to partially saturated or rather 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

BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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		

CONTENT

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4	Safe Bearing Capacity	6 of 10
5	Conclusion and Recommendation	8 of 10
6	Summury of Test Results	9 of 10
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 reffered 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
			6.0 x 6.0	22.10
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
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

Abbrivation :

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 ϕ =	***28***	*degrees*
Specific Gravity G =	***2.65***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.623***	gm/cc
Sat.density Ysat =	**2.011**	gm/cc
Submerged density=	**1.011**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	***G x Yw / Yd***	***-1***
=	*0.6328*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.083*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 28 — ***c= 0.000*** if e_o < 0.55, it is general shear failure

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)*** — ***c'= 0.000*** if e_o > 0.75, it is local shear failure

Φ' = 19.61 — ***c"= 0.000*** if e_o => 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
Nγ" =	12.45	Nγ' =	5.18	Nγ =	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 γ N γ S γ d γ i γ 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 γ N' γ S γ d γ i γ W'

for local shear failure

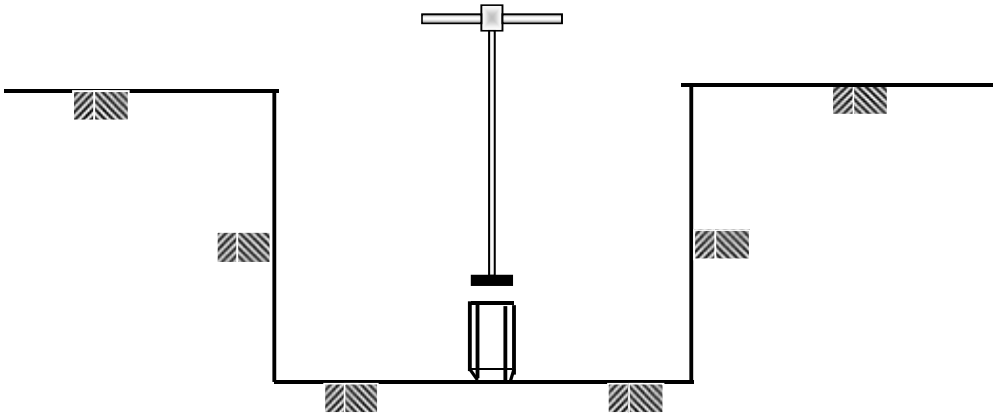
= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

q_{un} = c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γ N" γ S γ d γ i γ 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

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BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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		

CONTENT

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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 reffered 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.

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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)

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
			6.0 x 6.0	25.26
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
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

Abbrivation :

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 ϕ =	***28***	*degrees*
Specific Gravity G =	***2.65***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.651***	gm/cc
Sat.density Ysat =	**2.028**	gm/cc
Submerged density=	**1.028**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	***G x Yw / Yd***	***-1***
=	*0.6051*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.083*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 28 — ***c= 0.000*** if e_o < 0.55, it is general shear failure

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)*** — ***c'= 0.000*** if e_o > 0.75, it is local shear failure

Φ' = 19.61 — ***c"= 0.000*** if e_o > 0.55 & <= 0.75, it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
Nc" =	23.11	Nc' =	14.53	Nc =	26.37
Nq" =	12.80	Nq' =	6.21	Nq =	15.30
Nγ" =	14.17	Nγ' =	5.18	Nγ =	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 γ N γ S γ d γ i γ 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 γ N' γ S γ d γ i γ W'

for local shear failure

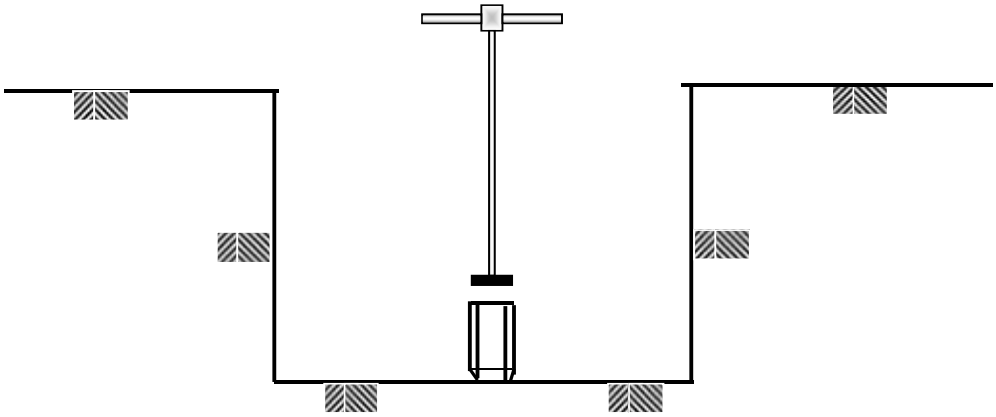
= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

q_{un} = c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γ N" γ S γ d γ i γ 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.)

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BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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			

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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 reffered 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
			6.0 x 6.0	30.22
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
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

Abbrivation :

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 =	***1.50***	*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 ϕ =	***29***	*degrees*
Specific Gravity G =	***2.66***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.671***	gm/cc
Sat.density Ysat =	**2.043**	gm/cc
Submerged density=	**1.043**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	***G x Yw / Yd***	***-1***
=	*0.5919*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.042*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 29 ***c= 0.000*** if e_o < 0.55, it is general shear failure

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)*** ***c'= 0.000*** if e_o > 0.75, it is local shear failure

Φ' = 20.37 ***c"= 0.000*** if e_o => 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
Nγ" =	17.02	*Nγ' =*	5.76	*Nγ =*	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 γN γS γd γi γ 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 γN' γS γd γi γ W'*

for local shear failure

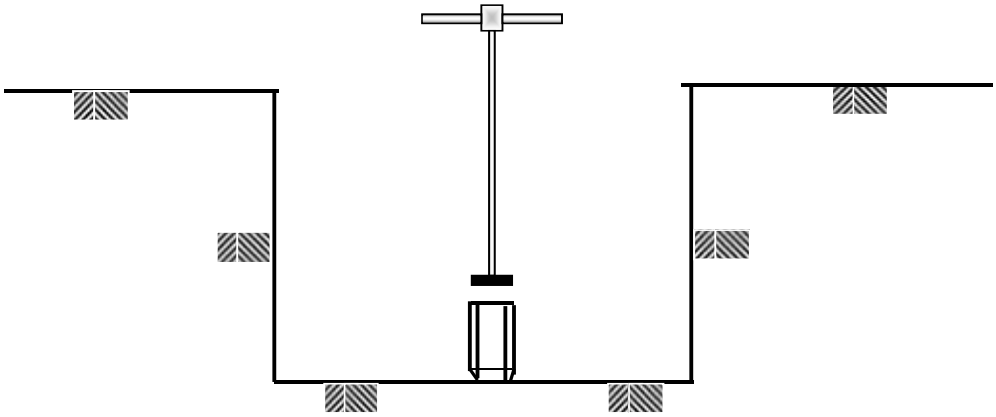
= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

q_{un} = *c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN" γS γd γi γ 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

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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			

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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
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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)

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
			6.0 x 6.0	27.54
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
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

Abbrivation :

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 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 =	***G x Yw / Yd***	***-1***
=	*0.5898*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.083*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 28

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)***

Φ' = 19.61

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

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

c"*= *0.000 if e_o => 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
Nγ" =	15.12	*Nγ' =*	5.18	*Nγ =*	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 γN γS γd γi γ 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 γN' γS γd γi γ W'*

for local shear failure

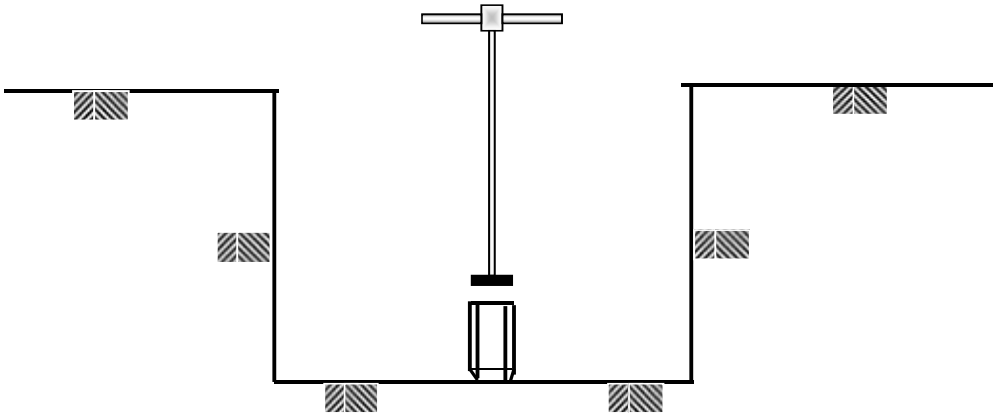
= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

q_{un} = *c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN" γS γd γi γ 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

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BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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			

CONTENT

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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 reffered 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
			6.0 x 6.0	18.98
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
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

Abbrivation :

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 ϕ =	***30***	*degrees*
Specific Gravity G =	***2.65***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.563***	gm/cc
Sat.density Ysat =	**1.973**	gm/cc
Submerged density=	**0.973**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	***G x Yw / Yd***	***-1***
=	*0.6955*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.087*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 30

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)***

Φ' = 21.15

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

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

c"*= *0.000 if e_o => 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
Nγ" =	10.86	*Nγ' =*	6.54	*Nγ =*	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 γNγSγdγiγ 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 γN'γSγdγiγ W'*

for local shear failure

= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

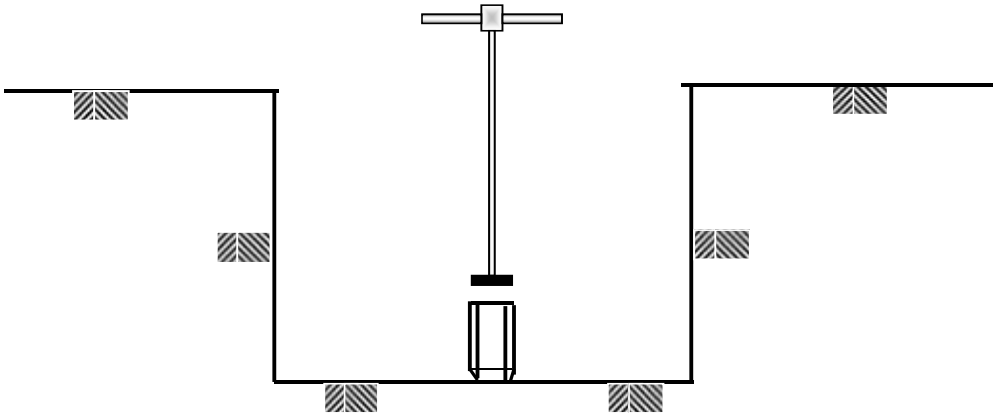
q_{un} = *c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN"γSγdγiγ W'*

for intermediate shear failure

= ***63.67*** ***t/m²*** q_{ns} = ***21.22*** ***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

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Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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			

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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 reffered 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
			6.0 x 6.0	19.09
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
1	TP-6	1.0	SM (Silty Sand of Non Plasticity)	UDS	20.2	NP	NP	0	73	27	_	_	_	2.63	1.534	7.4
2		2.0	SM (Silty Sand of Non Plasticity)	UDS	21.8	NP	NP	0	69	31	_	0	31	2.66	1.552	7.9
3		3.0	SM (Silty Sand of Non Plasticity)	UDS	20.6	NP	NP	4	82	14	_	_	_	2.65	1.591	8.5
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	21.2	NP	NP	3	74	23	_	0	32	2.66	1.651	8.9

Abbrivation :

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 ϕ =	***31***	*degrees*
Specific Gravity G =	***2.66***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.552***	gm/cc
Sat.density Ysat =	**1.969**	gm/cc
Submerged density=	**0.969**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	***G x Yw / Yd***	***-1***
=	*0.7139*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.088*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 31 — ***c= 0.000*** if e_o < 0.55, it is general shear failure

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)*** — ***c'= 0.000*** if e_o > 0.75, it is local shear failure

Φ' = 21.93 — ***c"= 0.000*** if e_o > 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
Nγ" =	10.96	Nγ' =	7.31	Nγ =	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 γN γS γd γi γ 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 γN' γS γd γi γ W'*

for local shear failure

= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

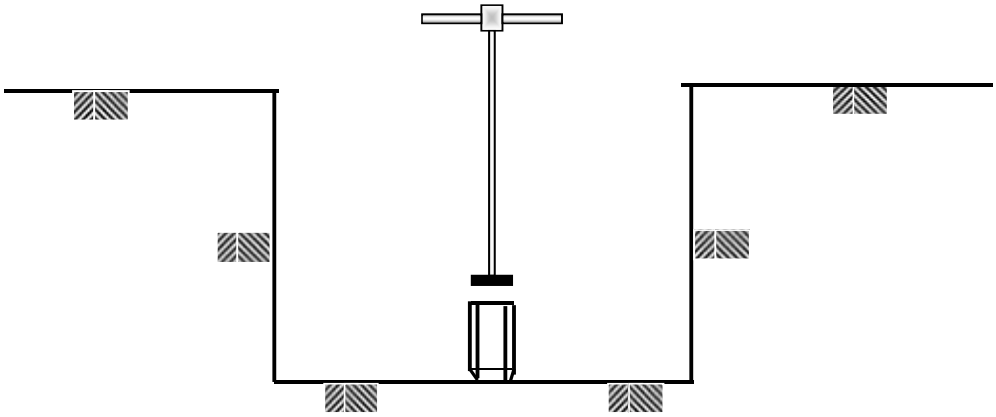
q_{un} = *c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN" γS γd γi γ W'*

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

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BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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			

CONTENT

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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 reffered 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
			6.0 x 6.0	19.56
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
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

Abbrivation :

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 =	***1.50***	*m*
Width of footing B =	***1.00***	*m*
Length of footing L =	***1.00***	*m*
Cohesion C =	***0.00***	*kg/cm²*
Angle of Int.Fric ϕ =	***30***	*degrees*
Specific Gravity G =	***2.65***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.567***	gm/cc
Sat.density Ysat =	**1.976**	gm/cc
Submerged density=	**0.976**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	***G x Yw / Yd***	***-1***
=	*0.6911*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.260*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 30 — ***c= 0.000*** if e_o < 0.55, it is general shear failure

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)*** — ***c'= 0.000*** if e_o > 0.75, it is local shear failure

Φ' = 21.15 — ***c"= 0.000*** if e_o => 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
Nγ" =	11.21	*Nγ' =*	6.54	*Nγ =*	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 γN γS γd γi γ 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 γN' γS γd γi γ W'*

for local shear failure

= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

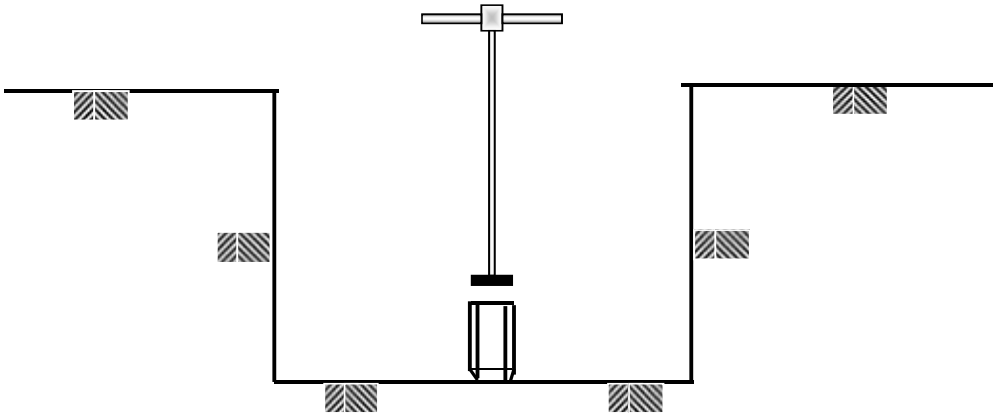
q_{un} = *c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN" γS γd γi γ W'*

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

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Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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			

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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 reffered 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
			6.0 x 6.0	16.66
		2.0	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
			6.0 x 6.0	21.49
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
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

Abbrivation :

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 ϕ =	***31***	*degrees*
Specific Gravity G =	***2.65***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.560***	gm/cc
Sat.density Ysat =	**1.971**	gm/cc
Submerged density=	**0.971**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	***G x Yw / Yd***	***-1***
=	*0.6987*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.088*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 31

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)***

Φ' = 21.93

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

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

c"*= *0.000 if e_o => 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
Nγ" =	12.50	*Nγ' =*	7.31	*Nγ =*	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 γN γS γd γi γ 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 γN' γS γd γi γ W'*

for local shear failure

= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

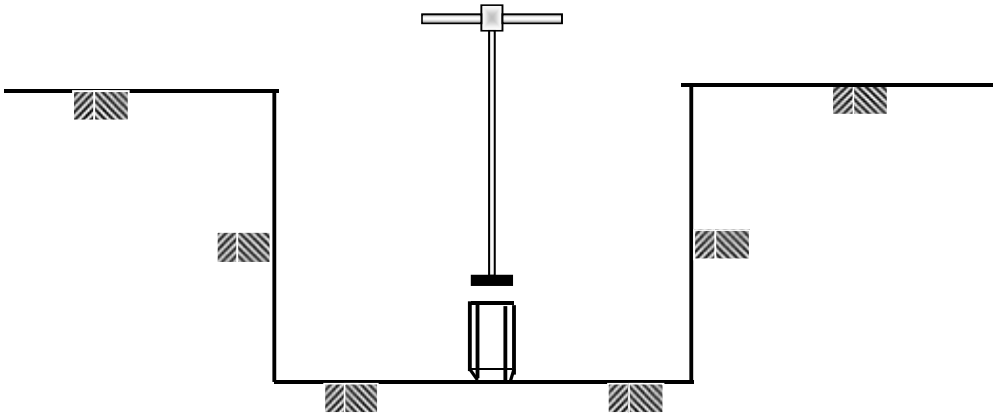
q_{un} = *c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN" γS γd γi γ W'*

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

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BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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			

CONTENT

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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 reffered 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
			6.0 x 6.0	20.07
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
1	TP-9	1.0	SM (Silty Sand of Non Plasticity)	UDS	17.2	NP	NP	16	63	21	_	0	32	2.66	1.545	9.9
2		2.0	SM-SP (Silty Sand and Poorly Graded sand of Non Plasticity)	UDS	22.8	NP	NP	5	83	12	_	_	_	2.65	1.552	10.2
3		3.0		UDS	23.1	NP	NP	8	80	12	_	0	33	2.65	1.647	10.4
4		4.0	SM (Silty Sand of Non Plasticity)	UDS	21.6	NP	NP	14	70	16	_	_	_	2.66	1.689	11.1

Abbrivation :

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 ϕ =	***32***	*degrees*
Specific Gravity G =	***2.66***	
Inclination Angle α =	***0***	*degrees*
Correction Factor for Water Table =	***0.5***	
Dry Density Yd =	***1.545***	gm/cc
Sat.density Ysat =	**1.964**	gm/cc
Submerged density=	**0.964**	gm/cc
Factor of Safety =	***3.0***	
Void Ratio eo =	$\frac{G \times Yw}{Yd}$	***-1***
=	*0.7217*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.090*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 32 — ***c= 0.000*** if e_o < 0.55, it is general shear failure

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)*** — ***c'= 0.000*** if e_o > 0.75, it is local shear failure

Φ' = 22.72 — ***c"= 0.000*** if e_o => 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
Nγ" =	11.58	*Nγ' =*	8.10	*Nγ =*	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 γN γS γd γi γ 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 γN' γS γd γi γ W'*

for local shear failure

= ***0.00*** q_{ns} = ***0.00*** ***t/m²***

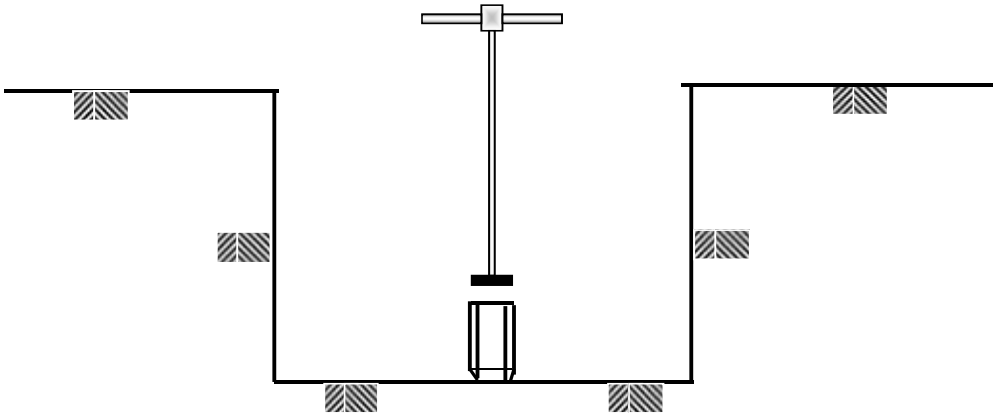
q_{un} = *c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN" γS γd γi γ W'*

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

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Ph.No. 0265 - 2283081, 2290222

E-Mail - lab@geogroup.in

BRIEF DETAIL OF PROJECT SITE

CIIENT	:	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			

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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 reffered 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)	1.549
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
			6.0 x 6.0	22.09
		3.0	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: Settelment 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			
					%	%	%	%	%	%	%	Kg/cm^2	Degree		gm/cc	%
1	TP-10	1.0	SM (Silty Sand of Non Plasticity)	UDS	23.5	NP	NP	18	52	30	_	_	_	2.63	1.541	8.5
2		2.0	SM (Silty Sand of Non Plasticity)	UDS	21.9	NP	NP	5	80	15	_	0	32	2.65	1.549	9.1
3		3.0	SM-SP (Silty Sand and Poorly Graded sand of Non Plasticity)	UDS	16.1	NP	NP	9	79	12	_	_	_	2.65	1.609	9.6
4		4.0		UDS	23.2	NP	NP	19	74	7	_	0	34	2.66	1.671	10.3

Abbrivation :

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 =

Plate - 3

Sample Calculation

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/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 Yd =	**1.549**	gm/cc
Sat.density Ysat =	**1.964**	gm/cc
Submerged density=	**0.964**	gm/cc
Factor of Safety =	**3.0**	
Void Ratio eo =	**G x Yw / Yd**	**-1**
=	*0.7108*	***it is >= 0.55 & <= 0.75***

hence it is an intermediate shear failure

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*
dγ,sγ,iγ	*1.090*	*0.800*	*1.000*

(General Shear Failure e_o < 0.55) Φ= 32 — ***c= 0.000*** if e_o < 0.55, it is general shear failure

(Local Shear Failure e_o > 0.75) Φ' = ***Tan^{-1} (0.67 tan Φ)*** — ***c'= 0.000*** if e_o > 0.75, it is local shear failure

Φ' = 22.72 — ***c"= 0.000*** if e_o => 0.55 & <= 0.75, it is an intermediate shear failure

for Intermediate Shear Failure		for Local Shear Failure		for General Shear Failure	
Nc" =	21.66	Nc' =	18.03	Nc =	36.53
Nq" =	11.78	Nq' =	8.72	Nq =	24.36
Nγ" =	12.92	Nγ' =	8.10	Nγ =	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 γNγSγdγiγ W'

for general shear failure

= ***0.00*** q_{ns} = ***0.00*** ***t/m^2***

q_{un} = c'N'cScdcic + q(N'q-1) Sqdqiq + 0.5 B γN'γSγdγiγ W'

for local shear failure

= ***0.00*** q_{ns} = ***0.00*** ***t/m^2***

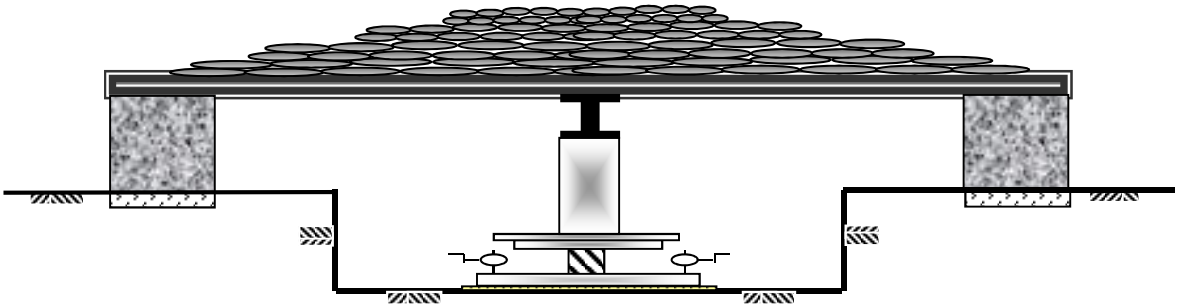
q_{un} = c"N"cScdcic + q(N"q-1) Sqdqiq + 0.5 B γN"γSγdγiγ W'

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 & geotechical investigation work at 765/400KV sub station at Lakadia & 2nos. 765KV line Bay extension at Bhuj in Gujarat undr 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

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BRIEF DETAIL OF PLATE LOAD TEST

Name of Work	:	Work order for contour survey work, topographical survey & geotechical 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
Hyadraulic 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 & geotechical 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 mtrSqure 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 contanct 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 & geotechical 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			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			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/cm^2 (Observed Pressure)

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

: 4.0 X 177

: 856.0 Kg

: 0.86 MT

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

: 0.86 / (0.3 X 0.3)

: 9.5 T / m^2

:

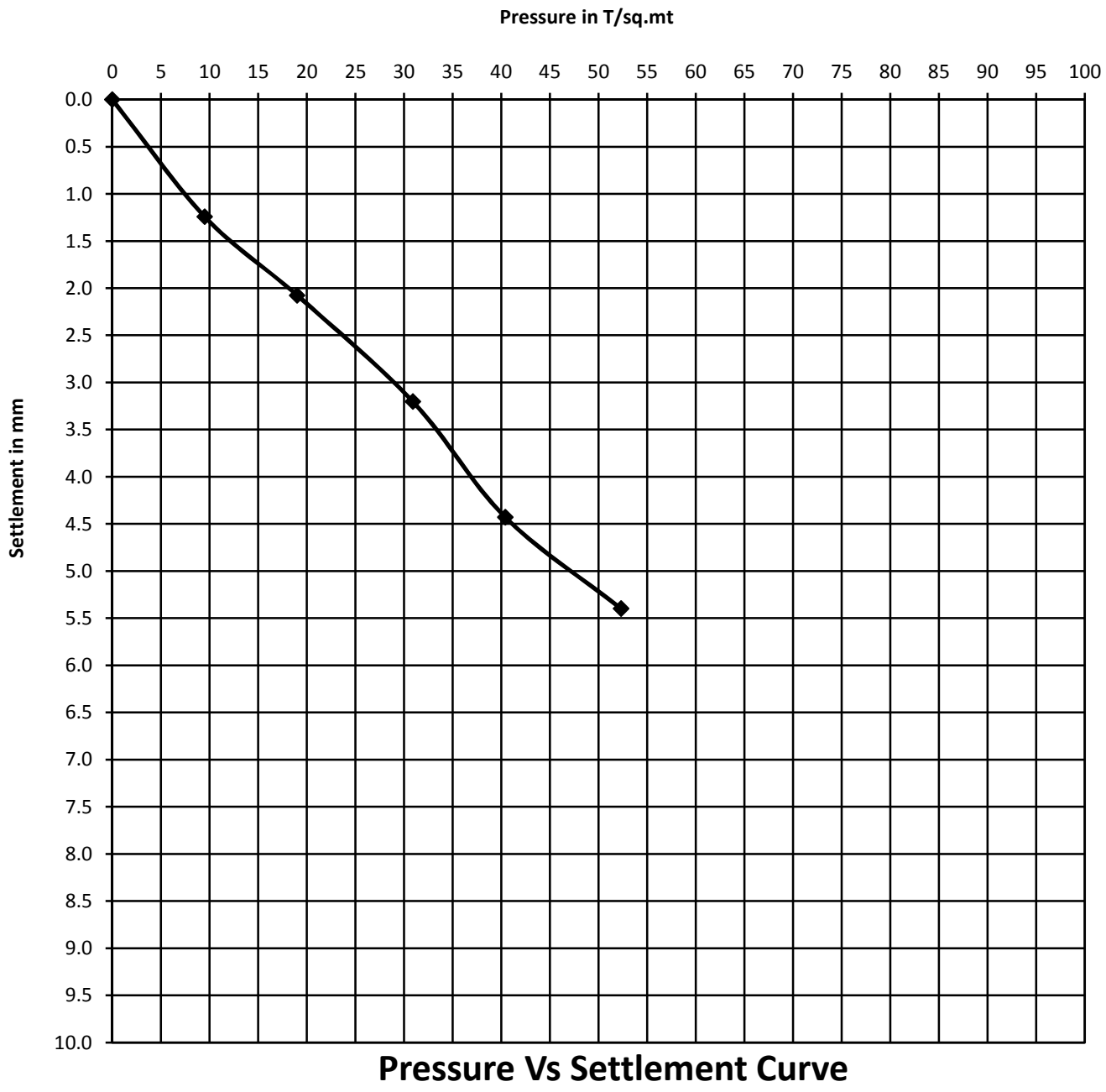
Presssure on test Plate : Load on Test Plate/Bearing area of Plate

: 4.7 / (0.3 X 0.3)

: 52.31 T / m^2

Tested By : JHP

GRAPH for PLT-01



Pressure Vs Settlement Curve

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/m^2

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

FOS = 3.0

(q_{SBC}) = (q_{UBC}) / FOS

No shear failure is observed at 50t/m^2

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.