

A REPORT ON  
GEO-TECHNICAL INVESTIGATION WORK FOR

**ANIRUDHADEVA JANMASTHAN AT DHALPUR,  
NARAYANPUR,  
LAKHIMPUR, ASSAM**

REPORT PREPARED BY

**NE ENGINEERS**  
GUWAHATI - 24

## **1. INTRODUCTION:**

**1.1** This report presented herein deals with the field and laboratory investigations carried out by us to access the nature of sub-strata and to evaluate the soil parameters required for design of foundations proposed to be constructed for proposed building.

**1.2** Client's help is gratefully acknowledged in providing bore hole locations, close supervision and checking during boring, sampling, various testing operations and cooperation and guidance during finalization of report.

**1.3** The work of Geotechnical Investigation was awarded to **NE ENGINEERS**, Guwahati

**1.4** This report is based upon the results of field, laboratory tests conducted on selected soil/rock samples collected from the 2 (Two) nos. of bore holes up to the depth of 9.0m respectively and interpretation of results were done as per IRC 78-2000 and pertinent IS code of practices.

## **2. SCOPE OF WORK:**

The scope of work provided to us for this project was limited to the following: -

**2.1** Mobilizing necessary plant, equipment and personnel to the project site, setting up the equipment, carrying out the field investigations on land and demobilization on completion of work.

**2.2** Making 150 mm nominal diameter bore holes at the site in all types of soil using suitable approved method of boring to be given at site by the Engineer-in-Charge. Refusal shall mean when SPT field 'N' value reaches 50 for 30 cm or less penetration of SPT sampler.

**2.2.1** Conducting standard penetration tests in the bore holes at 1.50 m interval in depth as per specifications / instructions of Engineer-in-Charge.

**2.2.2** Collecting undisturbed soil samples from bore holes at 3.0m interval or every change of strata, whichever is earlier as per specifications.

**2.2.3** Collecting disturbed soil samples from bore hole at regular interval and at every identifiable change of strata to supplement the boring records.

**2.2.4** Recording the depth of ground water table in all the bore hole if observed up to the depth of exploration during boring work as per specifications & withdrawing the casing pipe.

**2.3** Conducting the following laboratory tests on selected disturbed / undisturbed soil samples collected from bore hole / test locations: -

(a) Bulk density and Moisture content

(b) Sieve analysis

(c) Liquid limit & Plastic limits

(d) Specific gravity

(e) Shear test on undisturbed and remolded saturated disturbed soil samples

(f) Determination of void ratio.

(g) Determination of Shear Parameter

**2.4** Preparation and submission of report in three copies.

### **3.0 FIELD INVESTIGATIONS:**

**3.1** Necessary plant, equipment and personnel for conducting the requisite field work were mobilized to the site.

**3.2** Two numbers of boreholes were first marked on the ground surface as per the layout given to us by the Engineer-in-Charge.

**3.3** Bore hole was bored at this site using rotary drilling method as per IS:1892-1979.

**3.3.1** Standard penetration tests were conducted in the above bore hole at every 1.50 m interval & at change of strata per specifications / instructions of Engineer-in-Charge. The bore was cleaned up to the desired depths. Standard split spoon sampler attached to lower end of 'A' drill rods was driven in the bore holes by means of standard hammer of 63.5 Kg. falling freely from a height of 75 cm. The sampler was driven 45 cm as per specifications & the numbers of blows required for each 15 cm penetration were recorded. The numbers of blows for the first 15 cm penetration were not taken into account. This was considered as seating drive. The numbers of blows for next 30 cm penetration were designated as SPT 'N' value. Wherever the total penetration was less than 45 cm, the number of blows & the depth penetrated is incorporated in respective bore logs. Disturbed soil samples obtained from standard split spoon sampler for all the above standard penetration tests were collected in polythene bags of suitable size. These samples were properly sealed, labelled, recorded and carefully transported to the laboratory for testing.

**3.3.2** Undisturbed soil samples were collected from the bore hole at every 3.00 m interval in depth & at change of strata as per sampling specifications. These sampling tubes after retrieval from the bore hole were properly waxed and sealed at both ends. These were carefully labelled and transported to the laboratory for testing. Undisturbed soil samples wherever slipped during lifting, were duly marked in the field bore logs as well as in the soil profile.

**3.3.3** Disturbed soil samples were also collected from the bore hole at suitable depths/intervals to supplement the boring records. These samples were collected in polythene bags of suitable size. These samples were properly sealed, labelled, recorded & carefully transported to the laboratory for testing.

**3.3.4** The depth of ground water table was checked / measured in all boreholes.

#### 4.0 LABORATORY INVESTIGATIONS:

4.1 The following laboratory tests were conducted on selected soil

samples recovered from bore hole / test locations: -

- (a) Bulk density and Moisture content
- (b) Sieve analysis
- (c) Liquid limit & Plastic limits
- (d) Specific gravity
- (e) Shear test on remolded and saturated disturbed soil samples
- (f) Determination of void ratio.
- (g) Determination of Shear Parameter

All the above laboratory tests were carried out as per relevant Indian Standards. All the soil samples were identified and classified as per IS: 1498-1970.

#### 5.0 FINDING OF GEOTECHNICAL INVESTIGATION:

The study of bore logs/results of laboratory and other field tests are tabulated through different tables as annexure.

Analysis of liquefaction potential It is analyzed through Seed and Idriss (1982) approach Liquefaction is generally occurs in fine to medium sand within a depth of 10.0M from ground surface. With increasing overburden pressure, the chances of liquefaction usually decrease. (Cl 13.5.1, Theory and practice of Foundation design NN Som, S.C. Das, Prentice hall of India Pvt. Ltd Publisher). As the area is mostly boulder probability of liquefaction is almost nil.

#### 6.0 CALCULATION OF BEARING CAPACITY

##### (A) Calculation of Net Safe Bearing Capacity based on shear Criteria

IS: 6403-1981 recommends the following equation to calculate the net Safe Bearing Capacity 'Qs' based on Hansen's Bearing Capacity analysis:

$$Q_s = \frac{1}{F} \{ C N_c S_c d_c i_c + q (N_q - 1) S_q d_q i_q + 0.5 \gamma B N_\gamma S_\gamma d_\gamma i_\gamma R_w \} + \gamma D$$

Where, C = Cohesion of soil.

$\gamma$  = Saturated Density of

$R_w$  = Water table correction factor depending upon position of water table with respect to founding level

Q = Effective surcharge at footing level =  $\gamma D$  (D = depth of footing)

$N_c, N_q, N_\gamma$  = Bearing capacity factor

$S_c, S_q, S_\gamma$  = Shape factor

$d_c, d_q, d_\gamma$  = depth factor

$i_c, i_q, i_\gamma$  = inclination factors

$F$  = Factor of safety=3.0

$B$  = Width of footing

## SAFE LOAD CAPACITY FOR BORED CAST IN-SITU REINFORCED CONCRETE PILE

This section provides the Safe Load Carrying Capacity of few piles of predetermined diameter and length. For calculating the Safe Load Carrying Capacity, design philosophy as suggested by IS: 2911 (Part I) -1979 is followed. The Ultimate Load Capacity of each pile is determined using Static Pile Load Formulae considering shear criteria. The Ultimate Load Capacity is calculated as,

$$Q_u = Q_b + Q_s$$

Where,

$$Q_b = \text{Load carried by Point Bearing}$$

$$= A_b [ 1.2 c N_c + \gamma L_f (N_q - 1) + 0.4 \gamma B N_\gamma ]$$

Again,

$$Q_s = \text{Load carried by Skin Friction}$$

$$= A_s [ K \sigma_v \tan \delta + \alpha C_u ]$$

Where,

$$Q_u = A_b [ 1.2 c N_c + \gamma L_f (N_q - 1) + 0.4 \gamma B N_\gamma ] + A_s [ K \sigma_v \tan \delta + \alpha C_u ]$$

$\gamma$  = Unit weight of soil

$A_b$  = Sectional area of the pile at its base

$C$  = unit cohesion

$A_s$  = Surface Area of the pile in contact with the particular soil layer

$N_c, N_q, N_\gamma$  = bearing capacity factors

$L_f$  = embedded length of pile

$B$  = diameter of pile

$\delta$  = angle of friction between pile material and soil

$K$  = earth pressure coefficient

Safe Load Capacity,

$$Q_s = Q_u / \text{F.O.S.}$$

F.O.S. = Factor of Safety = 2.5

The Ultimate Pullout Resistance is calculated as,

$$Q_{ut} = A_s [ K \sigma_v \tan \delta + \alpha C_u ]$$

Again,  $Q_{st} = Q_{ut} / \text{F.o.S.}$

F.o.S. = Factor of Safety = 3.

#### **B) Calculation of safe bearing pressure based on tolerable settlement.**

The safe bearing pressure is to be found out from the elastic settlement consideration and is found from the following equation given I.S. 8009 (part-1) 1976

$$S_f = S_{ed} = \frac{H_t}{1 + e_0} C_c \log_{10} \frac{(p_0 + \Delta p)}{p_0}$$

$S_f$  = Final settlement in mm

$S_{ed}$  = Settlement computed from one dimensional test

$H_t$  = Thickness of soil layer in m

$e_0$  = Initial void ratio at mid height of layer

$C_c$  = Compression Index

$p_0$  = Initial effective pressure at mid height of layer

$\Delta p$  = pressure increment

For the computation of settlement of foundation founded at certain depth, a correction should be applied to the calculated  $S_f$  in the form of a depth factor to be read from Fig: 12 of I.S. 8009 (part-1) 1976.













Corrected settlement  $S_{fd} = S_f \times \text{depth factor}$  Depth factor is dependent on the following: -

- i.  $D$  = Depth of footing      ii.  $L$  = Length of footing      iii.  $B$  = Width of footing

## 7.0 OUTCOMES:

<b>BORELOG</b>																
<b>PREPARED BY:</b> <div style="border: 1px solid black; padding: 5px; min-height: 60px; margin-top: 5px;">           NE ENGINEERS GUWAHATI         </div>						<b>CLIENT:</b> <div style="border: 1px solid black; padding: 5px; min-height: 60px; margin-top: 5px;">           DEVELOPMENT OF ANIRUDDHADEVA JANMASTHAN, DHALPUR         </div>										
<b>BOREHOLE NO.:</b> 01						<b>BOREHOLE DIA.:</b> 100mm		<b>WATER LEVEL:</b> ---m								
						<b>CORE DIA.:</b> 100mm		<b>REDUCED LEVEL:</b> ---m								
<b>BORING METHOD:</b> WASH BORING						<b>NORTHING:</b>		<b>EASTING:</b>								
Description	Graphic Log	Depth (m)	Sample collection			Ground Water level (m)	SPT						Coring Details			
			D.S.	U.S.	C.S.		14	28	42	56	70	88	N-Value	Core Recovery (%)	R.Q.D. (%)	
Filled up soil	0.50	0.00	0.00													
Brownish, sand with trace of weatherd rock (CL)		1.50	1.50													
		2.00	2.00													
		3.00	3.00													
		4.50	4.50													
		5.00	5.00													
		6.00	6.00													
	7.50	7.50														
Hard rock (GP)	9.00	9.00	9.00													
<b>TO BE CONTINUED</b>		<b>REMARKS:</b>														
<b>LEGEND:</b> <div style="display: flex; justify-content: space-between; align-items: flex-start;"> <div style="width: 30%;"> <p><span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px; margin-right: 5px;"></span> - STANDARD PENETRATION TEST (P)</p> </div> <div style="width: 30%;"> <p>D.S. - DISTURBED SAMPLE</p> <p>U.S. - UNDISTURBED SAMPLE</p> </div> <div style="width: 30%;"> <p><span style="background-color: black; display: inline-block; width: 10px; height: 10px; margin-right: 5px;"></span> - CORE RUN (CR)</p> <p>R. - REFUSAL</p> </div> </div>																



BORELOG														
PREPARED BY:						CLIENT:								
NE ENGINEERS GUWAHATI						PROJECT: DEVELOPMENT OF ANIRUDDHADEVA JANMASTHAN, DHALPUR								
BOREHOLE NO.: 02			BOREHOLE DIA.: 100mm			WATER LEVEL: —m								
			CORE DIA.: 100mm			REDUCED LEVEL: — — — m								
			BORING METHOD: WASH BORING			NORTHING:			EASTING:					
Description	Graphic Log	Depth (m)	Sample collection			Ground Water level (m)	SPT					Coring Details		
			D.S.	U.S.	C.S.		14	28	42	56	70	88	N-Value	Core Recovery (%)
Filled up soil.		0.00	0.00									0		
Brownish, sand with trace of weatherd rock (CL) .		0.50												
		1.50	1.50									25		
		2.00												
		3.00	3.00									48		
		4.50	4.50									61		
		6.00	6.00									65		
		7.50	7.50									R		
Hard rock (GP)														
		9.00	9.00									R		
TO BE CONTINUED		REMARKS:												
<div>LEGEND:</div> <div><div> • STANDARD PENETRATION TEST (P)</div><div><div>D.S. - DISTURBED SAMPLE</div><div>U.S. - UNDISTURBED SAMPLE</div></div><div><div> • CORE RUN (CR)</div><div>R. - REFUSAL</div></div></div>														

Sub Head : Summary Result Sheet -Gotechnical Investigation : Bore Hole : BH1																					
Sample details				Stratification	Group of Soil	Particle size distribution					Physical Properties					Shear Parameter		Atterberg's Limit			
BH No	Depth of Sample	Type of Sample	N-Value			Organic %	Clay % (0.002mm & down)	Silt % (0.075mm & down)	Sand % (4.75mm & down)	Gravel % (10mm-4.25 & down)	Bulk Density gm/cc	Dry Density gm/cc	Specific Gravity	Void Ratio	NMC	Name of Test	Cohesion 'c' Kg/cm2	Angle of shearing resistant $\phi$	LL %	PL %	PI %
1	0.00		0	Filled up soil																	
	0.50																				
	1.50	DS	32	Brownish, sand with trace of weatherd rock	CL				78.65	21.35	1.99	1.77	2.70	0.528	12.65						
	2.00	DST														DST	0.386	27°	NA	NA	NA
	3.00	DS	35						74.99	25.01	2.00	1.76	2.71	0.543	13.87						
	4.50	DS	62						75.87	24.13	2.01	1.70	2.71	0.598	18.56						
	6.00	DS	68						73.75	26.25	2.02	1.77	2.71	0.528	13.87						
	7.50	DS	R						74.76	25.24	2.02	1.79	2.71	0.511	12.65						
	7.70																				
	9.00	DS	R	Hard rock	GP					100.00	2.03	1.82	2.71	0.492	11.76						

Sub Head : Summary Result Sheet -Geotechnical Investigation : Bore Hole : BH2																							
Sample details					Particle size distribution							Physical Properties					Shear Parameter			Atterberg's Limit			
BH No	Depth of Sample	Type of Sample	N-Value	Stratification	Group of Soil	Organic %	Clay % (0.002mm & down)	Silt % (0.075mm & down)	Sand % (4.75mm & down)	Gravel % (10mm-4.25 & down)	Bulk Density gm/cc	Dry Density gm/cc	Specific Gravity	Void Ratio	NMC	Name of Test	Cohesion 'c' Kg/cm2	Angle of shearing resistant $\phi$	LL %	PL %	PI %		
1	0.00		0	Filled up soil																			
	0.50																						
	1.50	DS	25	Brownish, sand with trace of weatherd rock	CL				68.97	31.03	2.00	1.79	2.70	0.507	11.65								
	2.00	DST																DST	0.389	27 <sup>0</sup>	NA	NA	NA
	3.00	DS	48							59.76	40.24	2.01	1.78	2.72	0.524	12.65							
	4.50	DS	61							55.76	44.24	2.01	1.80	2.72	0.512	11.76							
	6.00	DS	65							76.65	23.35	2.01	1.82	2.72	0.496	10.53							
	7.50	DS	R							73.65	26.35	2.01	1.80	2.72	0.511	11.65							
	9.00	DS	R	Hard rock	GP					100.00	2.03	1.81	2.72	0.499	11.87								

## 8.0 CONCLUSION AND RECOMMENDATION

Keeping into consideration the worst condition, safe load capacity of bored cast in situ RCC Pile (Single Pile) have been calculated and shown in the table below:

**Table 8.1:** ALLOWABLE BEARING PRESSURE OF SOIL (SHEAR CRITERIA) IN kN/m<sup>2</sup>  
(A) Reference Borehole No.-. 1

<b>D(m) Below EGSL</b>	<b>FOOTING SIZE OF 1.5m × 1.5m</b>	<b>FOOTING SIZE OF 2.00m × 2.00m</b>	<b>FOOTING SIZE OF 2.5m × 2.5m</b>	<b>FOOTING SIZE OF 2.0m × 2.5m</b>
1.50	231.2	221.2	215.9	199.4
2.00	258.0	243.7	235.7	220.3
2.50	285.7	266.9	256.1	241.9
3.00	314.5	290.5	277.1	263.9

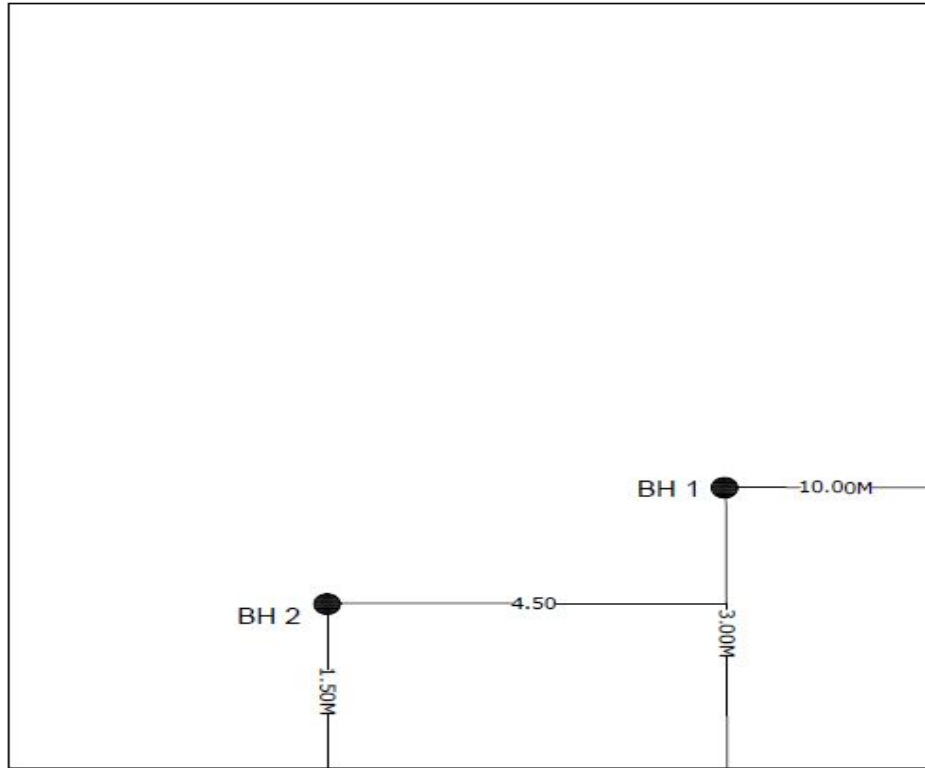
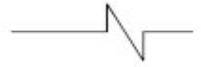
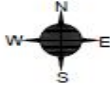
#### **RECOMMENDATION :**

On the basis of a careful examination of the field and laboratory test results as well as the analysis results as in Sec. 5 above, following recommendations are made-

- Shallow isolated footing may be used at a depth not less than 2.0m below G.L. and the bearing capacity of various footing sizes at 1.5m, 2.0m, 2.5m and 3.0m depth of foundation may be taken as per **Table-8.1**(Reference Bore Hole No.-1). A plate load test at the proposed depth of foundation may be carried out for better bearing capacity estimates.
- Heavily loaded structures may be allowed to rest on bored cast-in-situ RCC pile.



# SITE PLAN



SITE PLAN : NOT TO SCALE

THANK YOU