GEOTECHNICAL INVESTIGATION REPORT

PROPOSED HADRON BEAM STRUCTURE AT ACTREC, TATA MEMORIAL CENTRE, KHARGHAR, NAVI MUMBAI

SUBMITTED TO:
HLL LIFECARE LIMITED

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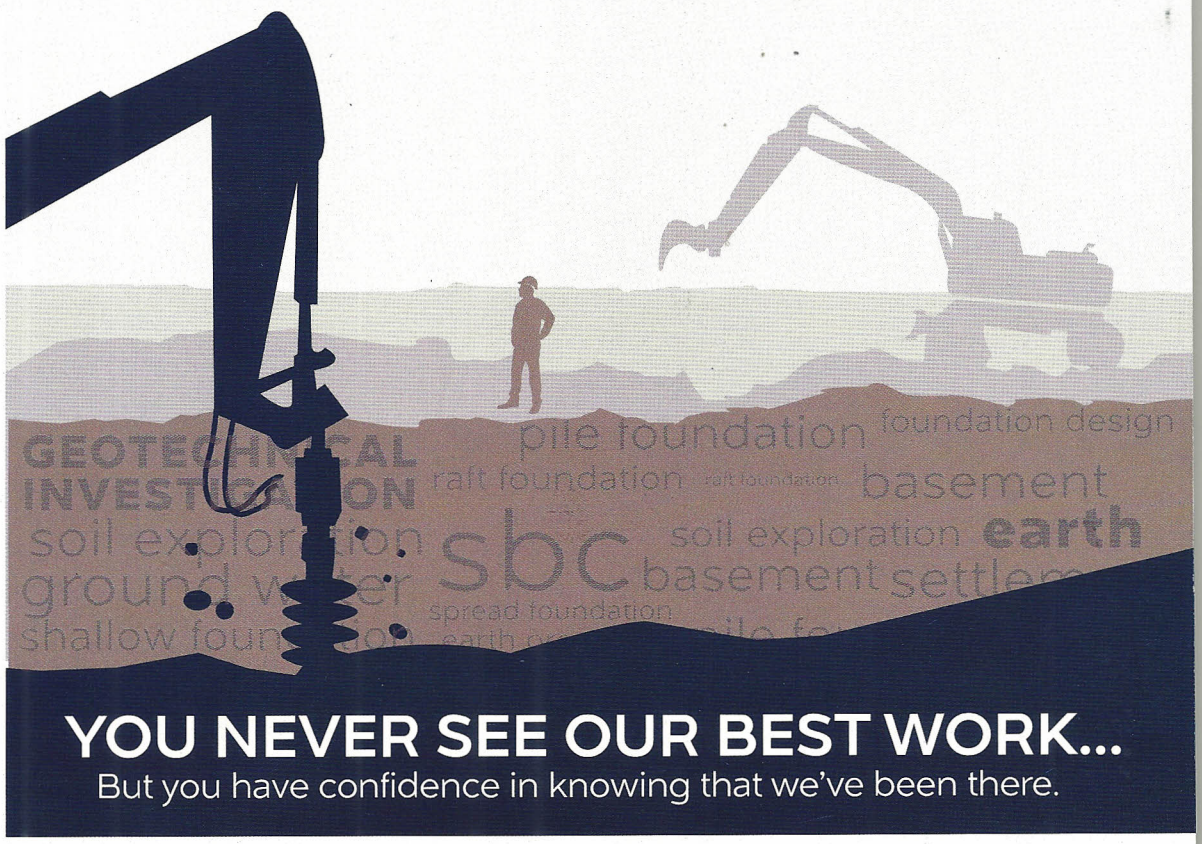

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24,25 , Maruti Paradise, Sector 15, CBD Belapur, Navi Mumbai -400614
Email : manoj@perfectgeotechnics.com
Web : www.perfectgeotechnics.com
Cin No : U74999MH2008PTC182368
Tel : 022 - 27570146
Fax : 022 - 27570147

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Table of Contents

GEOTECHNICAL INVESTIGATION REPORT FOR PROPOSED HADRON BEAM STRUCTURE AT ACTREC, TATA MEMORIAL CENTRE, NAVI MUMBAI FOR HLL LIFECARE LTD.

1.0 INTRODUCTION

HLL Life Care plans construction of a beam structure at ACTREC, Tata memorial center, Kharghar, Navi Mumbai. Proposed beam structure is to be installed at a depth of 4.0m below ground level. The work of Geotechnical Investigation was awarded to Perfect Geotechnics Pvt. Ltd. The field work and laboratory tests for the Geotechnical Investigation were completed by Perfect Geotechnics Pvt. Ltd. in May 2016. This report presents results of the geotechnical investigation along with foundation recommendations for the proposed building.

2.0 EXPLORATION PROGRAM

2.1 Exploration Scope

Five Boreholes (BH-1 to BH-5) were completed for the project as illustrated on the Borehole Location Plan in the Annexure

2.2 Subsurface Conditions

Subsurface profile at this site generally consists of fill overlying completely weathered rock underlain by basalt bedrock. Encountered soil/rock layers are described below;

LAYER I: FILL

Fill, consisting mostly of clay with boulders and concrete were encountered at ground surface in the boreholes. The lower boundary of this layer was encountered at depths of 0.8m to 1.5m below ground surface.

LAYER II: COMPLETELY WEATHERED ROCK

Completely weathered bedrock was encountered at depths of 0.8m to 1.5m below ground surface. This layer is formed by the complete in-place disintegration of parent bedrock material, but still partially retains the original rock mass structure. SPT tests conducted in this layer encountered refusals. Core recoveries were typically less than 30%. The lower boundary of this layer was encountered at depths of 4.5m to 7.5m below ground.

LAYER III: BASALT BEDROCK

Gray basalt bedrock was encountered at depths of 4.5m to 7.5m below ground surface in the boreholes. The bedrock was highly weathered to sound. Core Recoveries varied between 30% and 97%, while Rock Quality Designation (RQD) ranged between nil and

90%. Compressive strength of the rock core sample varied from 115 kg/cm^2 to 378 kg/cm^2. The borehole was terminated in this bedrock layer at depths of 10.0m to 12.0mbelow ground surface.

2.3 Ground water Levels

Groundwater accumulation in boreholes was monitored during and after completion of drilling activities. Groundwater was observed in boreholes at a depth of 4.5m to 4.7m below ground level. Seasonal and annual fluctuations in ground water levels can be expected.

3.0 FOUNDATION RECOMMENDATIONS

Completely weathered bedrock was encountered at depths of 0.8m to 1.5m below ground surface. Spread foundations for proposed building, on this completely weathered bedrock, can be designed for a maximum net allowable bearing capacity of 40 t/m^2. Spread foundations installed at a minimum depth of 3.0m below ground can be designed for a higher net allowable bearing capacity of 50 t/m^2.

Maximum settlement of foundations will be less than 12mm. A modulus of subgrade reaction of 3300 t/m^3 can be utilized for design of foundations.

3.1 Basement Construction

Excavation sides should be sloped at a maximum slope of 1:1 (horizontal: vertical) or flatter within the top 1.5m and 1:2 (horizontal: vertical) below this depth.

Basement floors and walls should be adequately water-proofed. Adequate uplift resistance in the form of dead weight should be provided. Maximum groundwater table for uplift design should be taken at 2.0m ground surface.

3.2 Lateral Earth Pressures

Basement walls and pile shoring walls, if any, will be subjected to lateral earth pressures. A soil submerged unit weight (r_{sub}) and coefficient of lateral earth pressure (k_0) of 0.8 t/m^3 and 0.5, respectively, should be utilized for design of basement walls installed without adjacent pile shoring walls. Lateral earth pressure parameters for design of pile shoring walls are given in Table A below. Hydrostatic pressures and surcharge pressures, if any, should also be considered.

TABLE A
LATERAL EARTH PRESSURE PARAMETERS FOR DESIGN OF PILE SHORING WALLS

Depth	Soil Type	Unit weight	Active earth pressure coefficient	Passive earth pressure coefficient	Cohesion
0.0m- 1.5m	FILL	1.8	0.33	3.0	0 t/m^2
1.5m- 7.5m	CWR	2.2	0.17	7.5	0 t/m^2
Below 7.5m	Basalt Bedrock	2.3	1	1	130 t/m^2

3.1 Foundation Protection

Groundwater samples were collected for chemical analysis from the site. Results of Chemical analysis are enclosed in the Annexure. Based on chemical results, the site falls under Class I for sulphates and chlorides (As per IS456-2000 and as per CIRIA Special Publication No. 31). A 'severe' exposure condition was assigned to this site. Hence, following precautions shall be taken to protect concrete and reinforcement in foundations;

Type of Cement:	**OPC or PPC**
Minimum Grade of Reinforced Concrete	M30
Minimum Cement Content for spread footings	320 kg/m^3
Maximum Water Cement Ratio	0.45
Minimum Cover to Reinforcement	50mm

4.0 FIELD EXPLORATION PROCEDURES

The sub-surface investigation was completed generally as per IS: 1892-1979. The field investigation was carried out using a rotary machine. Casing was used to support sides of borehole until sufficiently stiff strata was encountered. Standard Penetration Tests (i.e. SPT) were carried out in soil in accordance with IS 2131-1981. Using this procedure, a 2" outside diameter split-barrel sampler is driven into the soil by 63.5 kg. weight falling through 75 cm height. After an initial set of 15cm, the number of blows required to drive the sampler an additional 30 cm, is known as the "penetration resistance" or "N value".

When SPT refusal was obtained in hard strata, rock coring was done using diamond bit and double tube core barrel to obtain rock samples. Percent Rock Core Recovery and Rock Quality Designation (%RQD) were determined. % RQD = 100 x Sum of length of rock pieces in cms, each having lengths greater than 10cms/Total length of core run.

Sincerely,

PERFECT GEOTECHNICS PVT. LTD.

JaydeepWagh
B.E., M.S., P.E. (Geotechnical)

REFERENCES AND CALCULATIONS

REFERENCES

1) Foundation Analysis and Design, J.E. Bowles, McGraw Hill Publication, 5th Edition, 1996.

2) Canadian Foundation Engineering Manual.

3) Soil Mechanics in Engineering Practice, 2nd Edition, Terzaghi K. and Peck R. B., John Willey and Sons, 1967.

4) Foundation Design Manual, N. V. Nayak, 5th Edition, 1996.

5) IS:6403-1981, Code of Practice for Design and Construction of Shallow Foundations on Soils.

SAMPLE CALCULATION OF ALLOWABLE BEARING CAPACITY FOR FOUNDATIONS ON COMPLETELY WEATHERED BEDROCK

GL +0.000m

Layer I,	Fill	-0.8m to-1.5m
Layer II,	Completely Weathered rock	-4.5m to -7.5m
Layer III,	Basalt Bedrock	

(Assuming Completely weathered Bedrock to be a very dense granular soil.)

Net Ultimate Bearing Capacity = $q_u = cNcs_c + q\,(N_q - 1)s_q + 0.5\,B\,\gamma N\gamma\, s_\gamma$ (Refn. 5, Table 4-1)

Where,

q = Overburden Pressure (i.e. submerged unit weight x depth of foundation)

c = Cohesion

B = Minimum Width of foundation = 1m

γ' = submerged unit weight of soil = 0.80

N_c, N_q, N_γ= Terzaghi's Bearing capacity factors

Sc, sq, s_γ= Shape factors = Conservatively assumed as 1, 1, and 0.6

D = Depth of Footing = 4.0m

Minimum SPT N value obtained in boreholes = 50
Corresponding friction angle = 40° (Reference No. 5)
Corresponding Nc=75, Nq=64, N_γ=109 (Reference 5, IS:6403-1981);

Substituting these values in the above equation;
q ultimate =q_u =[0x75x1]+[4.0x0.8x(64-1)x1]+[0.5x1x0.8x109x0.6]= 0+201+26=227 t/m^2
q safe = q_u/F.S. = 227/3 = 75 t/m^2

Restricted to 50 t/m^2 to limit settlement as shown below

CALCULATION OF SETTLEMENTS OF FOUNDATIONS (3M X 3M) EXERTING PRESSURE OF 50 T/M^2:

From Reference No. 1:

$$\text{Settlement} = S = q_0 B' \frac{1-\mu^2}{E_s} m I_s I_f$$

Where,
q_0 = Footing Pressure = 50 t/m^2
B' = B/2 (Where B is the width of pressure distribution
μ = Poisson's ratio = 0.3
E = Modulus of Elasticity
I_s = Influence Factor (Obtained from Table 5-2, Reference No. 1)
I_f = Depth Factor (Obtained from Figure 5-7, Reference No. 1)
m = 4 for center of footing

Very conservatively assuming weathered bedrock within the full influence zone of footings:
E value for over-consolidated sand = 105(N)+4000 (Reference No. 1)
Therefore, for a SPT N value of 50, E=9250 t/m^2

L' = 3/2 =1.50, B' = 3/2 = 1.5, H=10m, and D=3.0m
Therefore, M=L/B=1; and N=H/B'=6, and D/B=1.0
Corresponding, I_s = 0.43, Conservative I_f = 1 (From Table 5-2, Reference 1)

Settlement of Layer = $S_1 = 50x1.5x\frac{1-0.3^2}{9250}x4x0.43x1$ = 0.012m = 12mm