INTERIM GEOTECHNICAL INVESTIGATION REPORT
PROPOSED HIGH RISE BUILDINGS "FENELIA & EUCALYPITA"
AT ACME OZONE, THANE (W)
FOR ACME DEVELOPERS

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1.0 INTRODUCTION

Acme Developers plans construction of a High Rise buildings (Fenelia & Eucalypita) in Thane (W). The proposed buildings will consist of Double Basement + 3 Podiums + Stilt + Ground + 36 Upper Floors. The work of geotechnical investigation was awarded to Shree Samarth Krupa Geotechnics. The field work for the geotechnical investigation was completed by Shree Samarth Krupa Geotechnics in June 2019. This interim report prepared by Geocon International Pvt. Ltd. presents results of the geotechnical investigation along with foundation recommendations for proposed building.

2.0 EXPLORATION PROGRAM

2.1 Exploration Scope

Four boreholes (NBH-1 to NBH-3 & NBH-6) are completed till date for the project as illustrated on the Borehole Location Plan in the Annexure. Borehole termination depths are summarized in Table A below.

TABLE A
BOREHOLE TERMINATION DEPTHS

Borehole Number	Borehole Location	Ground Reduced Levels	Borehole Termination Depths
NBH-01	Fenelia Building	+97.90m	20.0m
NBH-02		+100.52m	20.0m
NBH-03		+99.54m	28.0m
NBH-06		+100.94m	20.0m

2.2 Subsurface Conditions

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

LAYER I: RESIDUAL SOILS

Residual soils, consisting mostly of brownish / yellowish clay and sand were encountered at ground surface in the boreholes. Based on Standard Penetration Tests (SPT) conducted within this layer, consistency of cohesive soils (clay) was medium stiff to stiff and the relative density of cohesion less soils (sand) was loose to medium dense. The lower boundary of this layer was encountered at depths of 1.5m to 4.0m below ground.

LAYER II: COMPLETELY WEATHERED ROCK

Completely weathered rock was encountered at a depth of 4.0m below ground surface in the borehole NBH-03. 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 less than 35%. The lower boundary of this layer was encountered at a depth of 5.0m below ground surface.

LAYER III: HARD BASALT BEDROCK

Grey basalt bedrock was encountered at depths of 1.5m to 5.0m below ground surface in the boreholes. The bedrock was moderately weathered to sound, generally improving with depth. Core Recoveries in the bedrock layer varied between 46% and 99%, and Rock Quality Designations (RQDs) varied between Nil and 96%. The boreholes were terminated in this layer at depths of 20.0m to 28.0m below ground surface.

2.3 Ground Water Table

Groundwater accumulation in boreholes was monitored during and after completion of drilling activities. Groundwater was observed in boreholes at a depth of 2.0m below ground level. Seasonal and annual fluctuations in ground water levels can be expected.

3.0 FOUNDATION RECOMMENDATIONS

Hard bedrock was encountered at depths of 1.5m to 5.0m below ground surface in the boreholes. Spread foundations for proposed building with double basement supported on this hard bedrock can be designed for a maximum net allowable bearing capacity of 300 t/m^2. Depths to hard rock are given in Table B below.

TABLE B
DEPTHS TO HARD ROCK

Borehole Numbers	Structure	Ground Reduced Levels	Depths To Hard Rock
NBH-01	Fenelia Building	+97.90m	3.0m (RL +94.90m)
NBH-02		+100.52m	2.0m (RL +98.52m)
NBH-03		+99.54m	5.0m (RL +94.54m)
NBH-06		+100.94m	1.5m (RL +99.44m)

Maximum settlement of foundations will be less than 12mm. A Modulus of subgrade reaction of 25,000 t/m^3 can be utilized for design of foundations

3.1 Basement Consideration

Excavation sides should be sloped at a maximum slope of 1:1 (horizontal: vertical) or flatter within the top 4.0m and 1:2 (horizontal: vertical) upto 7.0m and near verticalbelow this depth. If adequate space is not available for this side sloping then excavation shoring with micro piles should be provided.

Basement floors and walls should be adequately water-proofed. Adequate uplift resistance in the form of dead weight or rock anchors should be provided. An allowable grout/rock bond stress of 40 t/m^2 can be utilized for design of rock anchors. Maximum groundwater table for uplift design should be taken at ground surface.

3.2 Lateral Earth Pressures

Basement walls and pile shoring walls, if any, will be subjected to lateral earth pressures. Lateral earth pressure parameters for design of basement walls and pile shoring walls are given in Table B below. Hydrostatic pressures and surcharge pressures, if any, should also be considered.

TABLE B
LATERAL EARTH PRESSURE PARAMETERS
FOR DESIGN OF PILE SHORING WALLS AND BASEMENT WALLS

Depth	Soil Type	Unit weight	Active earth pressure coefficient	Passive earth pressure coefficient	Cohesion
0.0m – 4.0m	Residual soil	1.8 t/m^3	0.5	2	0 t/m^2
4.0m – 7.5m	CWR	2.1 t/m^3	0.17	7.5	0 t/m^2
Below 7.5m	Hard Basalt Bedrock	2.4 t/m^3	1	1	130 t/m^2

CWR: Completely Weathered Rock

3.3 Foundation Protection

Results of chemical analysis on soil and groundwater samples enclosed in the Annexure, indicate that the site falls under Class 1 for sulphate concentrations and chloride concentrations (As per IS456 and as per CIRIA Sp. Publication No. 31). A 'Moderate' Exposure Condition was assigned to this site. Therefore following precautions are recommended to protect subsurface concrete and reinforcement.

Type of Cement:	OPC or PPC
Minimum Grade of Reinforced Concrete:	M25
Minimum Cement Content for Spread Foundation:	300 kg/m^3
Maximum Water Cement Ratio:	0.50
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 rotary rigs (Calyx, 8 HP, Engine). Casing was used to support sides of borehole until sufficiently stiff strata was encountered. Standard Penetration Tests (i.e. SPT) were carried out at every 1.5m vertical interval up to bedrock, in accordance with IS 2131-1981. Using this procedure, a 5 cm 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”.

After SPT refusal was obtained, NX sized rock coring was done in maximum of 1.5m runs, using diamond bit and double tube core barrel. Percent Rock Core Recovery and percent 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 in cms.

Sincerely,

GEOCON INTERNATIONAL PVT. LTD.

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Jaydeep Wagh
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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.

6) IS 12070: 1987, Code of Practice for Design and Construction of Shallow Foundations on Rocks

SAMPLE CALCULATION OF ALLOWABLE BEARING CAPACITY FOR FOUNDATIONS ON HARD BEDROCK

_____ GL +0.0m

Layer I, Fill

_____ -0.2m to 2.0m

Layer II, Residual Soils

_____-0.5m to 2.5m

Layer III, Weathered Basalt / Breccia Bedrock

_____ -2.5m to -7.0m

Layer IIIB, Hard Basalt / Breccia Bedrock

Allowable bearing capacity = (Nj) x Qu (Ref. 6, Clause 6.2, pg. 7)

Where,

Nj = Joint condition factor = 0.1 to 0.4 (Ref. 6, Table 4, clause 6.2, pg. 9)
Assumed as 0.1 for hard rock

Qu = Rock Compressive strength = minimum of 1240 t/m^2 (Annexure, Laboratory Test Result)

Therefore, Allowable Bearing Capacity = 0.1 x 1240 = 124 t/m^2

B) CALCULATION OF SETTLEMENTS OF SPREAD foundations (3m x 3m) EXERTING PRESSURE OF 200 t/m^2:

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

Where,
q_0 = Footing Pressure = 200 t/m^2
B' = B/2 (Where B is the width of pressure distribution
μ = Poisson's ratio = 0.25
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

E value for Breccia bedrock = 7,00,000 t/m^2 (Reference No. 1)
Using 1/10th of this value, E = 70,000 t/m^2

L' =3/2 =1.5, B' = 3/2 = 1.5, H=15m, and D=8m
Therefore, M=L/B=1; and N=H/B'=10 and D/B=2.67
Corresponding, I_s = 0.53, Conservative I_f = 1.0 (From Table 5-2, Reference 1)

Settlement of Layer = $S_1 = 200 x 1.5 x \frac{1-0.25^2}{70{,}000} x 4 x 0.53 x 1.0$ = 0.009m = 9mm