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Geotechnical Investigation to Assess Sub-Surface Stratigraphy in Kandivali East, Mumbai-A Case Study

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Abstract **-** *A case study on geotechnical investigation carried out in Mumbai in India for single basement plus forty storied residential building project is presented here. 9 boreholes were drilled in soil and rock to assess the geotechnical parameters along a proposed residential building on Kadivali East of Mumbai. The crucial task of drilling boreholes was achieved using rotary wash drilling technique. A geophysical study using a sub-surface profile was also carried out to supplement the geotechnical observations between boreholes. The field data obtained from drilling and in-situ testing is presented and correlations with laboratory test results and geophysical data have allowed on evaluation of geological properties of project site. The data available from this investigation is interpreted to reveal the local geology in general and rock mass characteristics and classification based on Rock Mass Rating. It has been observed from these investigations, in conjunction with other literature, that the subsurface stratum of Kandivali east, Mumbai consists predominantly of fine grained greenish basalt to black coursed Aphastilite. Characteristics of Deccan trap associated with acidic and basic tuffs, volcanic breccia with fullaceous matrix. Laboratory tests reveal a wide range of strength and other engineering parameters for the characteristics materials types present throughout the site area.*

Key Words*: *Engineering geology, engineering properties, laboratory tests, rock description and soil description, Soil investigation

1.INTRODUCTION

Mumbai city is the money related capital of India which is situated in the western piece of India and it is the capital of Maharashtra. The peninsular city arranged about halfway on the western shore of stable mainland area of peninsular India. For urban areas with high populace, the infrastructural development requests a few skyscraper developments which are provoking assignments for structural specialists to give protected and financial plan to such structures.

For the current investigation, the region of Mumbai city limited between 19°12'16.24" N scope and 72°50'15.5"E longitude is picked. Mumbai city covers a territory of around 437 sq. Km. with the number of inhabitants in about 12.5 million according to enumeration information of 2011. In India, Mumbai is the most crowded city being the budgetary center point of the nation. This city is exposed to tropical atmosphere with normal yearly precipitation of about 250cm yet thought during a quarter of a year of the year and thus substantial precipitation power is knowledgeable about the city.

Being the most crowded and money related center point of India, Mumbai city is having greatest number of tall structures in India because of shortage of empty land. All these skyscraper structures are for the most part established on heap establishment because of run of the mill delicate nature of soil layers in Mumbai which is common beach front city. Additionally all methods of transport framework like transport, train, metro, transport, planes, vehicles and so forth are accessible in Mumbai for workers. Every one of these qualities of the city as of now show the measure of potential dangers which may happen because of any tremor catastrophe in the city

The present study investigates the potential of evolutionary optimization techniques to solve a geotechnical engineering problems with a high degree of possible cost savings namely the optimal design of the foundation of a multi-story building that is expected to be based on a raft foundation and on a pile group.

A methodology for the streamlining of the establishment of a multi-story building is introduced for dirt with multi layers. Other structure thought that is examination in how much the dirt will experience improvement

2. OBJECTIVE OF STUDY

In a Consumer's adviser to Site Inquisition that the ample site assessment is of essentialness to the auxiliary fashioner for the accomplishment full satisfaction of any structure adventure. The arrangement of a formation which is moderate and safe to create, is strong and low help price, turn on an acceptable perception of the possibility of the ground. This comprehension begins from

a valuation for the scattering of the materials in the ground, and their assets and leads under diverse effects and curb during the turn of events and existence of the structure. A palatable and suitably sorted out site assessment is in this way a principal bit of any deferential structuring or building adventure.

1. The environment and progression of layers

2. The lagoon circumstances at the site

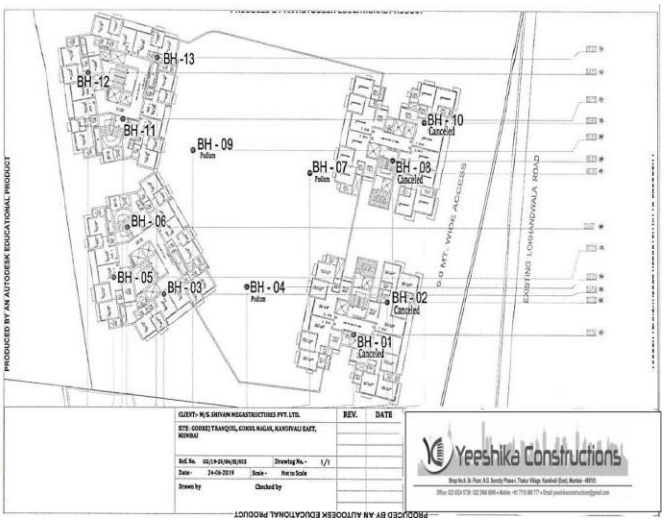
3. The material attributes of soil and rock shrouded the plot

4. The instinctive nature, for instance, quality and compressibility of non-identical soil or rock layers

5. Area assessment should be sifted through to get every possible datum toward a rigorous cognizance of the subsurface state and conceivable foundation direct

3. ABOUT THE PROJECT:

M/s. Shivam Mega structure pvt. Ltd. Propose to construct eight podiums plus single basement plus forty storied residential building at Godrej Tranquil, Gokul Nagar, Kandivali East, Mumbai 400101. The architect for the project is M/s. Ingrain.



3.1 Regional and local geology at site:

Geographically, Mumbai and close by district presents a complex lithological mix demonstrating huge heterogeneity. Significant stone sorts happening in the region are fine grained, greenish basalt to dark pursued, aphastillite. Conservative basalt and endured amygdaloidal basalt are likewise discovered, normal for the Deccan trap. They are related with acidic and essential tuffs, volcanic breccia with fullaceous network. trachyte and furthermore sporadically rhyolites. Between caught beds speaking to breaks in the structural volcanic exercises are found in the western edges. Basaltic streams and between caught beds show westerly plunge of 50 to 120.these streams and pyroclasmistic rocks have been interrupted by doteritic and basaltic dykes.

Local geology at site is generally consistent with the overall geology of Mumbai region. Weathered compact basalt was mostly observed in the boreholes, though a few locations also exhibited amygdaloidal basalt. Pattern of joints observed in the rock was more or less regular indicating that these were formed as a result of geo-dynamically induced movement in the compacted rock mass. Annexure C shows the sub-surface profile of the proposed site.

4. METHODOLOGY OF INVESTIGATION:

The work all in all was done as per the accompanying Indian standard determination.

a. I.S. – 1892-code of training for sub surface examinations for establishments

b. I.S. – 1498 – arrangement and recognizable proof of soils for general building reason.

c. I.S. – 2131 – strategy for standard entrance test for soils

d. I.S. 6926 – code of training for precious stone center penetrating for site examination

e. I.S. 5313 – direct for center penetrating perceptions

f. I.S. – 12070 – plan and development of shallow establishment on rock

Crafted by geotechnical examination including nine preliminary boreholes created by utilizing turning wash penetrating strategies is done nearby. The sub soil profile uncovered by these boreholes is portrayed in the accompanying passages followed by conversation on establishment viewpoints and proposals. Research center testing was directed on different examples and scopes of delegate building properties of soil and rock have been determined.

Point by point center logging was completed to survey geographical boundaries, for example, petrography and crack examination. Information from bathymetry and geophysical reviews was likewise used to enhance the discoveries from the geotechnical examinations. A general understandings of the topography of the ocean interface venture site zone has been gotten from a work area study survey of different distributed references with the derived model being approved against borehole data.

It may please be noted that the detailed structural design of the foundation, slope stability scheme, ground improvement program or shoring system is not contemplated in the report. The data presented in this

report may be subsequently used in the preparation of structural designs of the foundations

4.1 SBC OF SOIL

In geotechnical building comportment breaking point is the restriction of soil to aid the stores applied to the deck. The bearing outermost reaches of soil are the best representative contact pressure linking the substructure and the earth which should not fetch shear frustration in the earth.

A foundation is the bit of structure which transmits the largeness of the structure to the ground. All structure fabricated shore wards are maintained on foundation. A foundation is an interfacing join between the structure authentic and ground which reinforces it. The bearing characteristics of foundation soil are noteworthy structure rules for auxiliary planning, bearing control of soil to help the array applied on ground. To develop eight platforms in addition to single storm cellar in addition to forty celebrated private structure at Godrej Tranquil, Gokul Nagar, Kandivali East, Mumbai we need to check the SBC of soil.

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5. RESULTS AND DISCUSSION:

5.1 Index properties of soil:

Several tests had been conducted to notice the assets of soil. The result evaluated has the MDD of 1.62gm/cc and the corresponding OMC 25.76%. the liquid limit of 45.35%, plastic limit of 27.73%. the shear parameters are tested for the UU condition and the obtained cohesion is.13kg/cm^2 and angle of friction of 22.44˚. the UCS of 0.235kg/cm^2.

Bore Hole No.	Type / Sample No.	Depth in m	Density		Natural Moisture Content (%)	Specific Gravity	Grain Size Analysis			Atterbergs Limit			Shear Parameters			Unconfined Compressive Strength (kg/cm^2)
			Field Density (gm/cc)	Dry Density (gm/cc)			Gravel (%)	Sand (%)	Silt & Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Type	Cohesion (kg/cm^2)	Angle of Internal Friction (˚)	
BH-13	UDS-1	1.30 to 1.75 m	2.038	1.62	25.76	2.554	20.20	47.61	32.19	45.35	27.73	17.62	UU	0.013	22.44	0.235

5.2 Soil profile:

Site shows the presence of basaltic under a layer of overburden. The overburden comprise of filling and brownish sandy gravely clay with small rock fragments (locally known as murrum formation). Thickness of the overburden layer was observed to vary from 1.30 m to

3.50 m. the refusal SPT values notes at this layer. At borehole BH-7 the filled up soil deeps up to 6.00m depth. The bed rock which was encountered at 1.30 m to 3.50 m depths shows variable morphology and geological features such as variable weathering grades and fractured condition. At commencement recovery of 7% to 53% and RQD nil to 18%. The recuperation and RQD values show an improvement along penetrated profundity. Bores were ended in the rough layer after setting up its congruity. Complete profundity bored was around 15.00 m to 33.00 m beneath existing ground level.

5.3 Rock test results

Chosen rock tests from boreholes were exposed to lab tests.Samples from around 3.00 m to 22.50 m depth were available for UCS tests. Rock test results indicate crushing strength vales from 143.50kg/cm^2 to 107.80 kg/cm^2. The point load strength vales varies between 2.02 kg/cm^2 and 54.29kg/cm^2. Table shows the rock classes with respect to dry density and porosity.

Table 5.3: Rock test results

Class	Dry density (gm/cm^3)	Description	Porosity (%)	Description
1	Less than 1.80	Very low	Over 30	Very high
2	1.80-2.20	Low	30-15	High
3	2.20-2.55	Moderate	15-5	Medium
4	2.55-2.75	High	5-1	Low
5	Over 2.75	Very high	Less than 1	Very low

The IAEG (Anon 1979a) has proposed a table gathering the layers on quality of dry thickness and porosity in five classes (Table No. 1). According to this table, the stone at the site has low to extremely high dry thickness (2.179 gm/cc - 2.905 gm/cc) and low to high porosity (1.53% to 16.71%). The ground water table is noted from 2.00 m to 7.90 m from existing ground level.

5.4 Water sample test results:

Test results on samples reveal that water is closer to neutral (PH = 6.74 to 7.30).

The chlorides (40 ppm to 70 ppm), sulfates (43.67 ppm to 58 ppm) and natural issue (25 ppm to 55 ppm) are inside the cutoff points endorsed by IS-456:2000.

Sample Details	Water Level (m)	pH by Digital pH meter	Chloride As Cl (ppm)	Sulphate As SO_4 (ppm)	Organic Matter (ppm)
BH-03	7.10	7.09	70.00	58.93	25
BH-04	5.20	7.30	50.00	45.00	55
BH-07	2.00	7.13	60.00	43.67	30
BH-09	2.00	6.74	40.00	45.00	40
Limits as per IS 456 - 2000		*6.50 - 8.30*	*2000 PPM*	*400 PPM*	*200 PPM*

s single basement plus forty storied residential building in the property. The loads on the individual columns shall be quite heavy. The suitable founding stratum in the form of weathered rock is available at depth of around 6.00 m to

7.00 m profundity underneath existing ground level. The Safe Bearing Capacity at 6.00 m to 7.00 m depth is as below.

5.5 SBC Calculations:

SPT results are available from the investigation and the same are being used to obtain projected SPT values. The cohesion and friction angle values inferred from these projected SPT values are used for calculating the SBC. It is learned that 50 blows from the SPT hammer resulted in 10 cm penetration in to the rock. When calculated for a penetration of 30 cm, the projected SPT value is obtained as 150. SBC is worked out using the projected SPT value of 150 and three methods viz. IS code Method, Meyerhof's method and the method suggested by Cole & Stroud.

The safe load carrying capacity is worked out by the following two methods:

5.5.1 Indian Standards method (IS-12070)

5.5.2 Ganpule's method

Table.5.6 : SBC by different methods

Sr. no.	Method	Depth (m)	SBC (t/m^2)
1	IS code	6.00 m - 7.00 m	357
2	Ganpule's method (2006)	6.00 m – 7.00 m	509
3	Recommended value	6.00 m – 7.00 m	300

The capacity by Ganpule's method is $509t/m^2$ while by IS code method gives $357t/m^2$. However, for our analysis consider a lower value of $300t/m^2$.

5.6 Settlement Analysis

The settlement of the rock mass under loading intensity corresponding to S.B.C. namely $300t/m^2$ can be assumed by resorting to following equation.

$$S=PxL/AxE$$

Where,

$P/A = 300t/m^2 = 30kg/cm^2$

L = Significant depth say 6m = 600 cm

E = 1000 x c (National Research Council Of Canada, 1975)

$=1000x35.75 = 35.75 \times 10^3 kg/cm^2$ (c as obtained in Ganpule's method)

Settlement = $30x600/35.75x10^3$ = 0.5035 cm = 5.035 mm

The feasibility of a conventional open excavation to the tune of 6.00 m 7.00 m needs to be established on site and if it seems infeasible due to the limited available open spaces and crowded neighborhoods in the area where the site is situated, it is suggested that some temporary enabling scheme shall be adopted.

These days pressure driven excavators are utilized for mass unearthing and the current case isn't probably going to be any extraordinary. Anyway it is prescribed to practice alert in the utilization of the equivalent and abstain from releasing of the establishing layers by the sharp teeth of the excavator.

5.7 Summed up subsurface stratigraphy

In view of the field and research center information and the different boreholes penetrated opposite to the proposed site of kandivali east, the general stratigraphy of site has been deciphered to comprise prevalently of basalt rock with next to no or no overburden. The subsurface layers manily comprise of basalt rock with volcanic breccia with intertrappean such an acidic and fundamental tuffs. The basalt rock acquired all through the examination is greenish to dark colured and exceptionally reduced and endured. Basaltic stone was seen in various phases of weatering, from profoundly endured to marginally endured. The general inclination of enduring watched all through the examination is an upper layer comprising of exceptionally to tolerably endured basalt with the seriousness of enduring changing to reasonably and somewhat endured with expanding profundity. The crack planes in the basalt are typically loaded up with minerals

including FeO, chlorophaite, zeolite, calcite, chalcopyrite and pyrite.

6. CONCLUSIONS

The economy of any venture relies on the quantum and the nature of fundamental examinations did. The information along these lines assembled through different examinations, including geotechnical examinations, builds the certainty level in the translation of the establishment conditions and encourages the plan of suitable establishment frameworks. The data presented here is part of preliminary investigation, part of the development process that plays a very important role in deciding the approach for the detailed investigations to meet the engineering requirements of the project. It is very important to decide the type and amount of detailed investigation required when such complex rock structures are present.as the settlement of foundation is governed by the intensity of jointing, allowable bearing pressure can be assessed as a function of RQD.

1. The open foundation may be designed with S.B.C. of 300t/m^2on basaltic rocky formation at 6.00 meters to 7.00 meters depth.

2. The evaluated settlement under stacking power of 300t/m2 won't surpass more than 12mm which is well inside the breaking point workableness perspective.

3. The feasibility of open excavation should be verified by taking sample trial pits in the light of available open spaces and crowed neighborhood. If sufficient open spaces are not available then some temporary enabling system shall be adopted.

4. It is desirable that the founding strata be verified by a competent geotechnical professional before foundation PCC is laid.

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REFERENCES

1. Soil Mechanics and Foundations sixteenth Edition, Creators: Dr. B. C. Punmia, Er .Ashok.K. .Jain, Dr. Arun. K..Jain

2. **DK. Buckley, D. Oliver 1900**, "Geophysical logging of water exploration boreholes in the Deccan Traps, Central India", geological society, London.

3. **TG Sitharam, P Anabazhagan, G.U. Mahesh, K. BHarathi, P. NIchala Reddy 2005**, " Seismic hazard studies using geotechnical borehole data and GIS".

4. **Kumara Sudha, M Israil, S Mittal, J Rai 2009**, "soil characterization using electrical resistivity tomography and geotechnical investigation".

5. Ravi Sundaram, Sanjay Gupta 2015, "Geotechnical investigation in gravel-boulder deposits".