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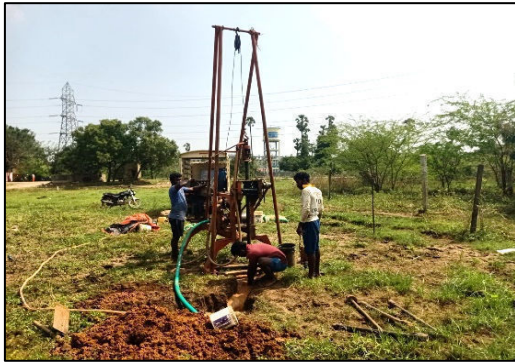


SOIL INVESTIGATION REPORT

Report No : PGC/DEC/2023/49

NAME OF PROJECT :

Construction of (S+5) building at S.No 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100.



BH I



BH II

Builder :



9D, Jeyachandran Nagar 3rd Main Road, Jalladianpet,
Medavakkam, Chennai – 600 100. Mobile: 9865 757474
Email: hanubuilders@yahoo.com
Website: www.hanuhomes.com

Soil Investigation done by :



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Soil Investigation Report

Name of the Project :

Construction of (S+5) building at S.No 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100.



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Report No: PGC/DEC/2023/49

Date: 05-01-2024

Period of field test: 27-12-2023

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1. INTRODUCTION

M/s Hanu Homes has proposed constructing (S+5) building at S.No. 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100. For the construction of any structure a detailed soil investigation is essential for collecting the relevant data required for preparing the design. The sub surface investigation reveals the presence and the extent of soil and rock stratum in the region likely to be affected by the proposed work and determines the nature of each stratum and engineering properties of soil which may affect the design.

In this context the client required to have Preliminary soil investigations to understand the soil conditions for construction of Residential building. The data collected provides reliable, specific and detailed information to facilitate a safe and economic design of the proposed structure.

This report contains the field and laboratory test results along with Design computations and recommendations for suitable foundation systems.

1.1.1 Scope of Work

- ❖ Sinking two standard soil investigations bore holes of 100mm diameter to a depth of 10.00m or up to the depth where the SPT value is >100 or as directed by the engineer-in-charge.

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- ❖ Conducting Standard Penetration Test (SPT) at regular depth intervals.
- ❖ Conducting relevant laboratory test results for the samples recovered.
- ❖ Assessing bearing capacity and allowable bearing pressure based on the field test carried out in the stratum encountered.
- ❖ The type and depth of foundation for the proposed structure has to be recommended for estimation.

1.1.2 Structure of the Report

- ❖ Field and Lab Soil Test Methodology
- ❖ Sub-Surface Stratification
- ❖ Foundation Systems
- ❖ Recommendations

1.1.3 Annexure

- ❖ Design Computations
- ❖ Laboratory Test Results
- ❖ Bore Logs
- ❖ Field Test Location Drawing.




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2. FIELD AND LAB SOIL TEST METHODOLOGY

2.1 Field Testing:

Penetration and sounding tests are the generally adopted field Tests. The Standard Penetration Test is performed as per I.S. 2131-1981 as an in-situ test especially for cohesion less soils. The resistance is empirically correlated with some of the Engineering properties of soil such as density index, consistency, bearing capacity, etc. These tests are useful for general exploration of erratic soil profiles for finding depth to bedrock or hard stratum and to have an approximate indication of the strength and other properties of soils, particularly for cohesion less soil where it is difficult to obtain U.D.S.

The proposed site is situated in the developing area. The exploration was carried out during the period when there was intermittent rainfall in the city. Two boreholes were made at the locations specified by the client. The locations of the boreholes are shown in the site plan attached. The equipment used, and the methodology adopted to carry out the fieldwork is described below.

2.2 Equipment used and Method of Drilling:

2.2.1 Equipment used

The equipment used for performing the drilling operations is a Calyx Rotary Drill Rig using cutting augers with circulating bentonite slurry.

2.2.2 Methodology of drilling

Calyx rotary drilling with auger of 100mm dia has been used for making bore holes duly circulating bentonite slurry. In this method, the advancement of boring is made by the cutting action of a rotating bit that is kept in firm contact with the bottom of the hole. The bit is attached to the lower end of hollow drill rod, which is rotated by a suitable chuck. Drilling mud, (viz) bentonite is continuously forced down the hollow drill rods. The mud returning upward through the annular space between the drill rods and side of the hole brings the soil particles to the surface. Soil exploration consists of three stages i.e., boring, sampling and testing which includes both field and lab tests. Samples were collected at every 1.00 m up to

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6.00m depth and at every 2.00m depth up to the depth of 20.00m and at every 3.00m beyond the depth. Samples were properly labelled for Lab tests. Bore log and location of bore holes are annexed with this report.

2.3 In-Situ Strength Tests:

2.3.1 Standard Penetration Test:

Standard penetration tests were conducted at the borehole locations, in accordance with IS: 2131. Samples were collected at every 1.00 m up to 6.00m depth and at every 2.00m up to the depth of 20.00m and at every 3.00m beyond the depth of the bore hole as directed by the engineer-in-charge.

2.4. Collection of Samples:

2.4.1 Disturbed Soil Samples

The SPT-samples collected were used as disturbed soil samples. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.

2.5 Summary of Field Work

In the field test the Standard Penetration Test sampler is driven by the free fall of a hammer weighing 63.50kg dropped from a height of 76cm. The sampler is initially driven through 15cm as a seating drive. It is further driven through 30cm. The number of blows required to drive the sampler 30cm below the seating drive is termed the penetration resistance 'N'.

2.6 Laboratory Testing:

2.6.1 Coarse Grained Samples:

2.6.1.1 Grain size Analysis Tests:

On the coarse-grained samples, grain size distribution tests were conducted as per I.S.2720 (Part 4)-1985, to know the gradation characteristics and to classify them. These results are presented in Laboratory Test Results.

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2.6.2 Fine Grained Samples:

2.6.2.1 Index Property – Free Swell Tests:

Atterberg's Limits were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally Liquid limits, Plastic limits tests were conducted as per I.S.2720 (Part-5)-1985 and I.S.2720 (Part 6)-1972. On such types of strata encountered at the investigation locations, such tests were conducted, and the test results are presented in tables.



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3. SUB-SURFACE STRATIFICATION

3.0 Preamble

The details of soil conditions encountered at the bore hole locations are presented in this chapter based on visual identification, laboratory testing, and other engineering characteristics derived from SPT-value which are having correlation with strength parameters.

Bore hole No: 1

The soil exploration reveals that there is Clayey sand with gravel layer with medium dense to very dense up to the depth of about 3.00m. From the depth of 3.00m, there is very dense partially to completely weathered rock. From the depth of 4.60m, there is soft rock drilled by T.C Bit. The borehole was terminated at the very dense stratum with N value more than 100.

Bore hole No: 2

The soil exploration reveals that there is Clayey sand with lime layer with medium dense to very dense up to the depth of about 2.00m. From the depth of 2.00m, there is very dense partially to completely weathered rock. From the depth of 4.00m, there is soft rock

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drilled by T.C Bit. The borehole was terminated at the very dense stratum with N value more than 100.

3.1 Water Table

Water level was met at the depth of about 1.00 m from existing ground level during the borehole operations. The site being situated close to the Perumbakkam lake the water table will always be in shallow depth without much fluctuation.




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4. FOUNDATION SYSTEM

4.0 Preamble

The foundation system design is an interface between super structure and the sub soil bearing strata characteristics. A sound foundation system should be safe against bearing strata shear response under the super structure load intensity. Similarly, the stability of the foundation system is governed by the bearing strata deformation response under the super structure load intensity. In addition, as a combined system of super structure and foundation, the overall stability is also governed by the super structure arrangement. Considering the above aspects of foundation design, suitable type of foundation system with respect to the sub soil conditions encountered at the borehole locations is presented in the subsequent sections.

4.1 Bearing Strata Characteristics

At the investigation locations, it can be observed that the top layers are very dense and the sub-soil strata are almost uniformly stratified with some variation. The stratum is with adequate bearing capacity to adopt isolated foundation.

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4.2 Proposed Foundation System

Considering the sub soil conditions encountered at the investigation locations, the foundation system discussed below is technically viable solution. Depending upon the relative economics and construction feasibility the foundation system discussed below can be adopted. The bearing capacity has been assessed as per IS 6403: 1981 based on the field test (SPT) conducted at site as per IS 2131:1981. The allowable bearing pressure is calculated as per IS 8009 (Part I)-1976 (Reaffirmed 1998). A factor of safety of 3 has been adopted to arrive at the safe bearing capacity.

4.3 Assessment of Bearing Capacity:

The top layer from 2.00 m to 3.00m is considered for shallow foundation. The water table is at the depth of ground level in the worst conditions.

The assessed bearing capacity considering Isolated column footing for the maximum size of footing 3.00 m x 3.00 m at the depth of about 3.00m from the existing ground level is 861 kN/m².

Based on the above assessment the conclusion and recommendation are furnished below.




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5. CONCLUSIONS & RECOMMENDATIONS

Foundation Type – I: Isolated square column foundation

- The Safe bearing capacity of **300 kN/m²** for isolated column square maximum footing size 3.00m x 3.00m at the **depth of about 3.00 m** from the existing ground level is recommended for the proposed structure.
- The anticipated settlement due to the load intensity will be 5 mm for 25 years as calculated based on Schmertmann's method. The settlement calculated is within the tolerable limit of 50 mm for isolated column footing on sand as per IS: 1904.
- The size of footing should not be increased, and/or the load capacity should also not be increased than the recommended values.
- The theoretical calculations must be confirmed by conducting a Plate load test on foundation as per IS: 1888.
- The pressure contour from the adjacent foundation should not interfere with each other.
- Since the water table is at the depth of 1.00m continuous dewatering is required with suitable dewatering technique to lower down the existing water table below the excavation level. To ensure dry working conditions during construction it is preferable to maintain the water level below the excavation level of 3.00m till the entire completion of foundation and other construction work reaches above the existing water table.
- For back filling the foundation trench, the excavated soil may be used with proper compaction after mixing with some non-cohesive material.
- Proper shuttering arrangements are required during foundation construction work for the stability of excavation cut and the nearby structure.

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This recommendation is based on the stratum available at the bore hole location. When excavations for foundation are made during execution, it may be verified whether the same stratum is available at almost all the locations. If any change in stratum is observed, it may be brought to our notice for further suggestion or modification of the report.



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BEARING CAPACITY OF SHALLOW FOUNDATIONS

Bearing capacity calculations based on IS : 6403-1981 & Settlement by Schmertmann method

Name of work : Construction of (S+5) building at S.No 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100.

Design particulars

Assumed Foundation size and depth

Isolated Column Square Footing

Depth of foundation (D) =	1.00 m	2.00 m	3.00 m
Foundation width (B) =	3.00 m	3.00 m	3.00 m
Foundation Length (L) =	3.00 m	3.00 m	3.00 m
Foundation Shape =	Square	Square	Square

Shear strength parameters

Data from BH:

1

Design N	34	45	40
angle of internal friction correlated/measured (Φ) =	37 ⁰ (deg)	40 ⁰ (deg)	39 ⁰ (deg)
Cohesion correlated/measured =	kPa	kPa	kPa
Density of soil (γ) =	16.7 kN/m ³	22.0 kN/m ³	22.0 kN/m ³
Depth of water table from EGL (D_w) =	0.00 m	0.00 m	0.00 m

Shear failure criterion

General

General

General

Sc/Sq/Sy

Bearing capacity factors N_c and D_c	56.52	1.13	76.48	1.29	66.63	1.42	1.30
N_q and D_q	43.84	1.07	65.50	1.14	54.61	1.21	1.20
N_y and D_y	67.99	1.07	112.18	1.14	89.49	1.21	0.80

UBC = $CN_cScD_c + q(N_q - 1)D_q + 0.5\gamma N_y D_y RW'$ (General) or $(2/3)CN'cScD_c + q(N'_q - 1)D_q + 0.5\gamma N'_y D_y RW'$ (Local) or interpolating both

Ultimate bearing capacity	959 kPa	2540 kPa	2608 kPa
Factor of Safety	3.00	3.00	3.00

Result

Safe bearing capacity assessed	320 kPa	847 kPa	869 kPa
Allowable bearing pressure		250 kPa	300 kPa
Anticipated Total settlement in 25 years =		6 mm	5 mm

Depending upon anticipated load intensity the foundation may be adopted at suitable depth as recommended below



Depth of foundation (m):	Safe bearing capacity (kPa):
2.00 m	250 kPa 6 mm
3.00 m	300 kPa 5 mm

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Foundation width (B) =	3.00 m	3.00 m	3.00 m
Foundation Length (L) =	3.00 m	3.00 m	3.00 m
Foundation Shape =	Square	Square	Square

Shear strength parameters

Data from BH:	2		
Design N	28	44	40
angle of internal friction correlated/measured (Φ) =	35 ° (deg)	40 ° (deg)	39 ° (deg)
Cohesion correlated/measured =	kPa	kPa	kPa
Density of soil (γ) =	15.3 kN/m ³	22.0 kN/m ³	22.0 kN/m ³
Depth of water table from EGL (D_w) =	0.00 m	0.00 m	0.00 m
Shear failure criterion	Interpolation	General	General
Bearing capacity factors Nc and Dc	38.27 1.13	74.40 1.29	66.63 1.42
Nq and Dq	26.38 1.06	63.17 1.14	54.61 1.21
Ny and Dy	36.87 1.06	107.25 1.14	89.49 1.21

Sc/Sq/Sy

1.30

1.20

0.80

UBC = CNcScDc+q(Nq-1)Dq+0.5ByNyDyRW' (General) or (2/3)CN'cScDc+q(N'q-1)Dq+0.5ByN'yDyRW' (Local) or interpolating both

Ultimate bearing capacity	484 kPa	2406 kPa	2582 kPa
Factor of Safety	3.00	3.00	3.00

Result

Safe bearing capacity assessed	161 kPa	802 kPa	861 kPa
Allowable bearing pressure		250 kPa	300 kPa
Anticipated Total settlement in 25 years =		5 mm	5 mm

Signature

Depending upon anticipated load intensity the foundation may be adopted at suitable depth as recommended below



Depth of foundation (m):	Safe bearing capacity (kPa):
2.00 m	250 kPa 5 mm
3.00 m	300 kPa 5 mm

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Calculation of settlement by Schmertzmann method

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Width (B)	Length (L)	Depth (D _f)	Depth of WT assumed	Q kN/m ²	Period in years (t)	Settlement mm
3.00	3.00	3.00	0.00	300	25	5 mm

This total settlement calculation is valid for the foundation size 3 m x 3 m at the depth of 3 m below the ground level for the proposed SBC of 300 kN/Sq.m as per data from Bore Hole No 1

Top (m)	Bottom (m)	Nature of soil	N _R	qc/N (kN/m ²)	qc (kN/m ²)	E _s = 2qc (kN/m ²)	z _f (m)	z _f / B	I _{z(squ)}	I _{z(con)}	I _{zi}	H _i (m)	I _{zi} H _i / E _s	δ (mm)
3.0	3.2	Gravel	100	900	90000	180000	0.1	0.03	0.1438	0.2174	0.1438	0.20	1.60E-07	0.05820
3.2	3.4	Gravel	100	900	90000	180000	0.3	0.10	0.2313	0.2522	0.2313	0.20	2.57E-07	0.09363
3.4	3.6	Gravel	100	900	90000	180000	0.5	0.17	0.3188	0.2870	0.3188	0.20	3.54E-07	0.12907
3.6	3.8	Gravel	100	900	90000	180000	0.7	0.23	0.4064	0.3218	0.4064	0.20	4.52E-07	0.16450
3.8	4.0	Gravel	100	900	90000	180000	0.9	0.30	0.4939	0.3566	0.4939	0.20	5.49E-07	0.19994
4.0	4.2	Gravel	100	900	90000	180000	1.1	0.37	0.5814	0.3915	0.5814	0.20	6.46E-07	0.23537
4.2	4.4	Gravel	100	900	90000	180000	1.3	0.43	0.6690	0.4263	0.6690	0.20	7.43E-07	0.27081
4.4	4.6	Gravel	100	900	90000	180000	1.5	0.50	0.7569	0.4611	0.7569	0.20	8.41E-07	0.30640
4.6	4.8	Gravel	100	900	90000	180000	1.7	0.57	0.7232	0.4959	0.7232	0.20	8.04E-07	0.29278
4.8	5.0	Gravel	100	900	90000	180000	1.9	0.63	0.6896	0.5307	0.6896	0.20	7.66E-07	0.27916
5.0	5.2	Gravel	100	900	90000	180000	2.1	0.70	0.6560	0.5655	0.6560	0.20	7.29E-07	0.26554
5.2	5.4	Gravel	100	900	90000	180000	2.3	0.77	0.6223	0.6003	0.6223	0.20	6.91E-07	0.25193
5.4	5.6	Gravel	100	900	90000	180000	2.5	0.83	0.5887	0.6351	0.5887	0.20	6.54E-07	0.23831
5.6	5.8	Gravel	100	900	90000	180000	2.7	0.90	0.5551	0.6699	0.5551	0.20	6.17E-07	0.22469
5.8	6.0	Gravel	100	900	90000	180000	2.9	0.97	0.5214	0.7047	0.5214	0.20	5.79E-07	0.21107
6.0	6.2	Gravel	100	900	90000	180000	3.1	1.03	0.4878	0.7134	0.4878	0.20	5.42E-07	0.19746
6.2	6.4	Gravel	100	900	90000	180000	3.3	1.10	0.4541	0.6974	0.4541	0.20	5.05E-07	0.18384
6.4	6.6	Gravel	100	900	90000	180000	3.5	1.17	0.4205	0.6813	0.4205	0.20	4.67E-07	0.17022

Top (m)	Bottom (m)	Nature of soil	N _R	qc/N (kN/m ²)	qc (kN/m ²)	E _s = 2qc (kN/m ²)	z _f (m)	z _f / B	I _{z(squ)}	I _{z(con)}	I _{zi}	H _i (m)	I _{zi} H _i / E _s	δ (mm)
6.6	6.8	Gravel	100	900	90000	180000	3.7	1.23	0.3869	0.6653	0.3869	0.20	4.30E-07	0.15660
6.8	7.0	Gravel	100	900	90000	180000	3.9	1.30	0.3532	0.6493	0.3532	0.20	3.92E-07	0.14298
7.0	7.2	Gravel	100	900	90000	180000	4.1	1.37	0.3196	0.6332	0.3196	0.20	3.55E-07	0.12937
7.2	7.4	Gravel	100	900	90000	180000	4.3	1.43	0.2859	0.6172	0.2859	0.20	3.18E-07	0.11575
7.4	7.6	Gravel	100	900	90000	180000	4.5	1.50	0.2523	0.6012	0.2523	0.20	2.80E-07	0.10213
7.6	7.8	Gravel	100	900	90000	180000	4.7	1.57	0.2187	0.5852	0.2187	0.20	2.43E-07	0.08851
7.8	8.0	Gravel	100	900	90000	180000	4.9	1.63	0.1850	0.5691	0.1850	0.20	2.06E-07	0.07490
8.0	8.2	Gravel	100	900	90000	180000	5.1	1.70	0.1514	0.5531	0.1514	0.20	1.68E-07	0.06128
8.2	8.4	Gravel	100	900	90000	180000	5.3	1.77	0.1177	0.5371	0.1177	0.20	1.31E-07	0.04766
8.4	8.6	Gravel	100	900	90000	180000	5.5	1.83	0.0841	0.5210	0.0841	0.20	9.34E-08	0.03404
8.6	8.8	Gravel	100	900	90000	180000	5.7	1.90	0.0505	0.5050	0.0505	0.20	5.61E-08	0.02043
8.8	9.0	Gravel	100	900	90000	180000	5.9	1.97	0.0168	0.4890	0.0168	0.20	1.87E-08	0.00681
Σtotal δ = 4.753 mm														



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Table of Laboratory Test Results

Name of Project : **Construction of (S+5) building at S.No 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100.**

Bore Hole No	Depth (m)		Type of Soil	Grain Size Analysis (Particle Retained in IS Sieve) %					Atterberg Limits			IS Classification	Natural Moisture Content %	Remarks
	From	To		4.75 mm	2.00 mm	0.425 mm	0.075 mm	Fines	LL	PL	PI			
BH 1	0.00	2.00	Clayey Sand	2.15	18.11	21.07	14.93	43.74				SC	10.61	
	2.00	3.00	Clayey Sand	14.09	10.99	14.91	15.75	44.25	38.0	23.0	15.0	SC	14.33	
	3.00	4.60	Silty Sand	25.05	11.77	13.78	19.30	30.10	Non Plastic			SM	12.02	
BH 2	0.00	1.00	Clayey Sand	16.96	12.05	15.93	14.97	40.09	41.0	25.0	16.0	SC	18.67	
	1.00	3.00	Clayey Sand	13.92	16.04	23.09	19.06	27.89				SC	14.10	
	3.00	4.00	Sandy gravel	43.74	17.78	15.47	12.65	10.35	Non Plastic			GP-SP	11.99	

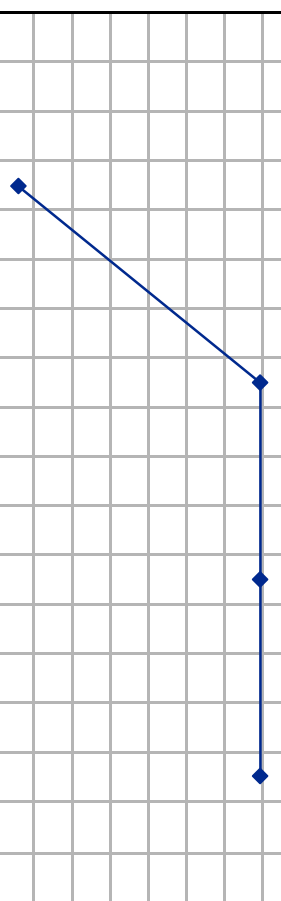


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BORE LOG												
Name of Project: Construction of (S+5) building at S.No 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100.												
BH No	1	RL of the EGL	m		Water level			1.00 m below ground level				
Date of commencement			27-12-2023			Type of Drilling			Calyx Rotary drilling			
Date of completion			27-12-2023			Dia of Bore hole			100 mm			
Depth from RL (m)	Description of soil stratum	Soil profile	Thickness of layer	Standard Penetration Test					Relative density / Consistency	Graphical representation of penetration resistance		
				Depth	Number of blows							
					I	II	III	N		0 20 40 60 80 100		
0.00	Existing ground level											
3.00	Brownish red Clayey sand with gravel		3.00									
				1.00	5	6	15	21	Medium dense			
				2.00	10	25	35	60	Very dense			
4.60	Brown Weathered Rock		1.60	# 50 blows for 14 cm penetration								
				4.00	10 [#]			>100	Very dense			
				# 10 blows for 1 cm penetration								
				4.60	10 [#]			>100	Very dense			
4.80	Soft Rock drilled by T.C bit (Time: 40 mins)		0.20	# 10 blows for No penetration and Hammer Rebounded								
Bore Hole terminated at 4.80 m												
 												



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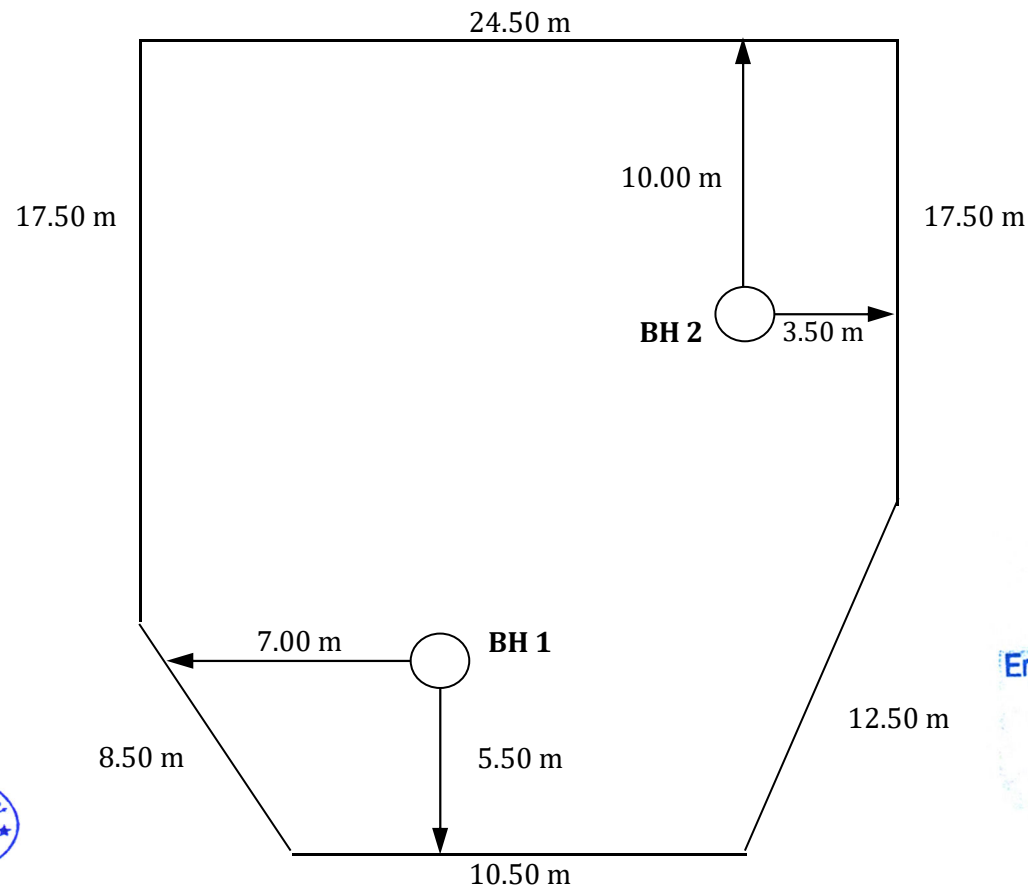
BORE LOG												
Name of Project: Construction of (S+5) building at S.No 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100.												
BH No	2	RL of the EGL	m		Water level			1.00 m below ground level				
Date of commencement		27-12-2023			Type of Drilling			Calyx Rotary drilling				
Date of completion		27-12-2023			Dia of Bore hole			100 mm				
Depth from RL (m)	Description of soil stratum	Soil profile	Thickness of layer	Standard Penetration Test					Relative density / Consistency	Graphical representation of penetration resistance		
				Depth	Number of blows							
					I	II	III	N				
0.00	Existing ground level									0 20 40 60 80 100		
2.00	Brownish Clayey sand with lime		2.00									
				1.00	4	5	7	12	Medium dense			
				2.00	25	50 [#]		>100	Very dense			
4.00	Brownish Weathered Rock		2.00		# 50 blows for 1 cm penetration							
				3.00	50 [#]			>100	Very dense			
					# 50 blows for 6 cm penetration							
4.00			4.00	10 [#]			>100	Very dense				
4.60	Soft Rock drilled by T.C bit (Time: 30 mins)		0.60		# 10 blows for No penetration and Hammer Rebounded							
Bore Hole terminated at 4.60 m												
 PAVITHRA GEO CONSULTANT An ISO 9001 : 2015 Certified Organisation 												



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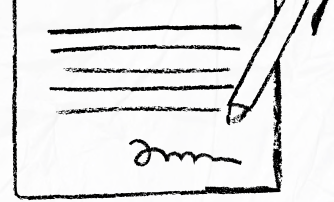
BORE HOLE LOCATION

Name of Project : **Construction of (S+5) building at S.No 344/2A, 2B, South Chennai Co-operative Nagar, Perumbakkam, Chennai - 600 100.**



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Not to scale



our services doesn't just end there



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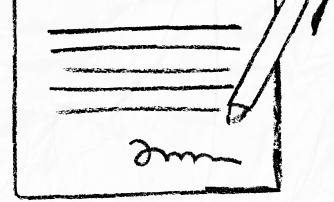
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