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GEOTECHNICAL INVESTIGATION REPORT

PROJECT: GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED
CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+G+5) AT
OLD S.NO: 132 PART &139/1, T.S.NO: 15/2-2,15/4-2/2,15/4-1, BLOCK
NO-22, WARD- G, OF ATHIPATTU VILLAGE, VANAGARAM-
AMBATTUR ROAD, CHENNAI -600 058.

CLIENT: M/s. Nature Residences Development Pvt Ltd.,

GBEI/22-23/064	28.09.2022	Submission for Design of Foundation		
REV	DATE	Description	GT ENG.	P.G.T ENG.



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INTRODUCTION

This report presents the results of the geotechnical investigations carried out by Geo Build Engineering India Private Limited - Geotechnical & Foundation Engg Division. A detailed soil investigation was suggested by the client for obtaining the soil profile and recommendation of the most suitable foundation system for the proposed construction of the Residential Building. This report comprises the details of soil investigation, analysis of field and lab test results and recommendation of the most suitable foundation system. The site is for the Geotechnical Investigation Report For The Proposed Construction Of Residential Building (Basement+G+5) At Old S.No: 132 Part &139/1, T.S.No: 15/2-2,15/4-2/2,15/4-1, Block No-22, Ward- G, Of Athipattu Village, Vanagaram-Ambattur Road, Chennai -600 058.

This work was authorized by. *M/s. Nature Residences Development Pvt Ltd.,*

Standard Penetration Testing boreholes were drilled at the site up to a maximum depth of 23.0 m below existing ground level. The investigation consists of drilling three boreholes, soil sampling, field and laboratory testing and preparation of a Geotechnical Investigation report

The proposed site has plain terrain in which the borehole has been tested. The site was cleaned while the start of a geotechnical investigation. The total number of boreholes has been decided as three numbers as agreed by the Client and the Consultant. The borehole has been located in the maximum loaded area of the proposed site; the locations of the borehole were chosen by the Client. The location of a borehole is shown in the borehole location drawing. The nature of field tests includes standard penetration tests, disturbed sampling through split spoon sampler as per GBEI/QSP/08, identification of different soil layers and location of groundwater table complete logging of the borehole etc. The depth of the borehole terminated to a maximum depth of 23.0m from EGL.

SCOPE OF WORK

The scope of this investigation is to:

- i) To determine the probable subsurface conditions such as stratification, denseness or hardness of the strata, the position of the groundwater table etc.
- ii) To give a probable range of safe bearing capacity for the structure. To accomplish these purposes, the study was conducted in the following phases.
- iii) Drilling boreholes in order to determine site stratification and to collect disturbed & undisturbed soil samples for laboratory testing.

- iv) Testing on selected soil samples in the laboratory to determine the physical and engineering properties of the soil samples.
- v) Analysing all field and laboratory data in order to develop engineering recommendations for foundation design.

Three boreholes were drilled to a maximum depth of 23.0 m. Soil samples were collected for visual identification, classification and laboratory testing. The Key Plan of the borehole is presented in Appendix ~A~, the bore log subsoil profile is presented in Appendix ~B~, the laboratory test results are given in Appendix ~C~

EXPLORATION PROGRAM & TECHNIQUES

After the visual inspection of the site, the subsurface investigation was carried out as mentioned below:

Three exploration boreholes were drilled to a maximum depth of 23.0 m.

BH - 1 was started on 18.09.2022 and completed on 20.09.2022

BH - 2 was started on 19.09.2022 and completed on 20.09.2022

BH - 3 was started on 20.09.2022 and completed on 21.09.2022

Rotary drilling was performed using water as drilling fluid in the subsoil with a casing pipe to stabilize the borehole up to the required depth. Field testing and sampling were conducted in accordance with IS: 2131-1981. Standard Penetration Test (SPT) was performed on the subsoil. In this test, a standard split spoon length of about 450 mm and cutting-edge diameter of 51/35 mm initially penetrates the soil for 15cm to bypass the expected accumulated sludge at the bottom of the hole by means of a 63.5 kg (140 lb) hammer falling freely along with a guide from a height of 750 mm. The total number of rows of blows (N) required, advancing the spoon into the bore, for another two successive 15cm (a total of 30 cm) is recorded as a measure of the soil relative density or consistency as given in Table ~A~ Along with, for further drilling using NX impregnated Tungsten Carbide cutter to be used to a depth till Weathered rock and NX impregnated Diamond cutter to be used in case of hard rock.

The fieldwork was carried out under Geo Build Engineering India Pvt Ltd. and a representative from the client in accordance with Indian Standard mentioned earlier. The drilling rig was used for the exploration of a calyx rig with the hand-operated machine, so the SPT was done manually on inspection of our engineer.

Soil Conditions at the site for proposed buildings were explored by BH 1, BH-2 and BH-3. Boring location details are presented on bore log. The boring's number and location was selected to cover the proposed building area with due consideration to the presence of basement+G+5 floors buildings BH 1, 2 and 3 were drilled in the front open space of the site. BH 1, 2 and 3 were drilled 20.0 m, 20.0 m and 23.0 m below EGL and terminated at confirmed hard strata weathered rock with SPT "N" $\geq$ 100 in three successive tests. Here we conformed BH-1, BH-2 & BH-3 the SPT "N" $\geq$ 100 in three successively. Tests were conducted to determine the pertinent index and engineering analyses to develop the required design data.

LABORATORY TESTING PROGRAM

All the extracted soil samples were brought to the Geotechnical & Materials Testing Laboratory of Geo Build Engineering for further examination in accordance with IS: 1498-1970. Collected samples were subjected to the following physical tests.

Disturbed soil samples (DS):

1. Natural Moisture Content (IS: 2720 Part 2)-1973
2. Atterberg Limits (IS: 2720 Part V — 1985
3. Grain Size Analysis (IS: 2720 Part IV — 1985)
4. Differential Free Swell Test (IS: 2720 part 40 -1977)
5. Specific gravity (IS: 2720 part 3/sec1)-1980

Undisturbed soil samples (UDS):

1. Unconfined Compression Test (IS 2720 (Part 10): 1991)
2. Direct Shear Test (IS-2720-PART-13-1986)
3. Tri-axial Shear Test (IS 2720-11 (1993)
4. Consolidation Test on Clay (IS:2720(Part 15)-1986)

LABORATORY TESTS ON ROCKS

1. Bulk Density
2. Point Load Test
3. Unconfined compressive strength
4. Brazilian Test

CHEMICAL ANALYSIS ON SOIL (IS 2720:P-26) AND WATER (IS 3025:P-11)

1. Sulphate Content (SO₄)
2. Chloride Content (Cl)
3. pH Value

The laboratory test results are given in Appendix ~C~.

SUBSURFACE SOIL DESCRIPTION

Borehole no: 1

In the case of BH-1, Brownish silty sand is followed by Brownish clay. The index and shear strength properties of soil collected at BH 1 in different depths were listed in the Laboratory test results. The borehole was terminated at 20.0m depth from the existing ground level (EGL). The groundwater table was located at a depth of 5.0 m below the existing ground level. The stratum is medium at the top and hard at a maximum depth of 20.0 m.

Borehole no: 2

In the case of BH-2, Brownish silty sand followed by brownish clay. The index and shear strength properties of soil collected at BH 2 in different depths were listed in the Laboratory test results. The borehole was terminated at 20.0 m depth from the existing ground level (EGL). The groundwater table was located at a depth of 5.0 m below the existing ground level. The stratum is medium at the top and hard at a maximum depth of 20.0 m.

Borehole no: 3

In the case of BH-3, Brownish silty sand followed by brownish clay. The index and shear strength properties of soil collected at BH 3 in different depths were listed in the Laboratory test results. The borehole was terminated at 23.0 m depth from the existing ground level (EGL). The groundwater table was located at a depth of 5.0 m below the existing ground level. The stratum is firm at the top and very dense at a maximum depth of 23.0 m.

GROUNDWATER

A groundwater table was observed at the depth of 5.0 m for all the boreholes from the existing ground level during the time of field investigation. However, it will fluctuate due to seasonal variations

and local sewerage disposal practices. Groundwater level at the ground surface is assumed in the design of the foundation to consider the worst conditions (submerged Conditions).

FOUNDATION RECOMMENDATIONS

Based on the borehole information and laboratory test results in addition to the nature of the structure, the recommendations for the proposed structure are given below. The following is a summary of recommendations for a suitable type of foundation. One of the important aspects of any foundation system is to satisfy the settlement criteria apart from bearing capacity criteria. As per IS 8009 (part I) 1976 Sec 9.1.1 De Beer for the calculation of Immediate and Consolidation Settlement.

COMPUTATION OF BEARING CAPACITY AND SETTLEMENT

Bearing capacity and settlement of the proposed Residential building are computed by assuming the depth of the foundation as 3 m, from the existing ground level. Among the one borehole data, the least 'N' values were observed in this location; hence, attempts are made to determine the bearing capacity and settlement for borehole data. The bearing capacity and settlement calculations are carried out to suggest the most suitable foundation system for the proposed Residential building, keeping the depth of the foundation as 3 m and, the width of the foundation as 1.5 m.

OPEN FOUNDATIONS (Isolated, combined or raft foundation)

The following is a summary of recommendations for the suitable type of foundations for the Geotechnical Investigation Report For The Proposed Construction Of Residential Building (Basement+G+5) At Old S.No: 132 Part &139/1, T.S.No: 15/2-2,15/4-2/2,15/4-1, Block No-22, Ward-G, Of Athipattu Village, Vanagaram-Ambattur Road, Chennai -600 058.

Depth of Foundation (m)	Type of Foundation	Safe Bearing Capacity (tons/m ²)
3.0	Isolated	14.0

Note:

- Existing raft foundation constructed before during the soil investigation work.
- The bore hole level is the same as the existing foundation level as basement level.
- During work execution, From BH- 1 at depth 15.0 m to 15.50 m we get rock layer, as well as BH-2 & BH-3 the same depth during soil investigation found that sand and clay layer.

PILE FOUNDATION

For this site it was recommended to provide 18.0 m and 16.0 m total and effective length piles below EGL with a top 1-M pile cut-off for pile caps and tie beams. All piles should have at least 1.5-M embedment into hard stratum weathered rock with SPT "N" >> 100.

PILE CAPACITY SPECIFICATION				
Pile Length (m)	Effective Pile length below cut off level (m)	Pile diameter (mm)	Safe Load Carrying Capacity (kN)	Uplift Resistance (kN)
18	16	500	525	386
18	16	600	594	422
18	16	750	711	478

Note:-

1. Pile Load Test must be conducted as per relevant IS Code to confirm the above-estimated pile capacities before completion of the installation of all piles.
2. Pile Installation must be done with extreme care to prevent "Necking" and "Bulging" problems due to the presence of thick very soft to soft clay layers
3. Groundwater level was assumed to rise to ground level in worst-case conditions.
4. Limiting AA. End Bearing Pressure in "Hard Rock" as per IRC code was 500 tons/m². Therefore q_b (all) is limited to 300 tons/m² in shale

UPLIFT CAPACITY

The uplift capacity of piles shall be considered as per IS 2911-1-1, Clause 6.3.2

PILE GROUPING

The group efficiency shall be worked out based on the number of Piles in a group. Piles shall have a minimum spacing of 2.5 times diameter centre to centre or a minimum of 1.5 times diameter as clear spacing in order to mobilise frictional resistance, which is a key factor in achieving better Pile capacities. Larger spacing is always preferable, in case of bored piles.

PILE TESTING

The group efficiency shall be worked out based on the number of Piles in a group. However, Pile load tests are recommended to observe the performance of the Piles and to re-confirm the theoretical Pile capacities. Load tests are to be carried out after a minimum period of 1 week after driving Pile.

Pile load tests should be conducted by loading up to 1.5 times the service load on the working Pile, while a minimum of two (2) times the service load on Pilot Piles. A pile load test can be conducted for a minimum of 2 % of the total number of piles for the project.

DESCRIPTION OF PILE SOCKETING

- The pile is to be socketed into a minimum depth of 1.5 D in solid rock or weathered rock or as per IS 14593:1998 standards.
- Extreme care should be taken to wash the base of a borehole clean before depositing concrete.
- In the case of socketing in the fractured rock or weak rocks, it is possible to develop the full structural capacity of the pile by providing greater penetration into such rocks in order to carry some load in shear between concrete and the rock.
- Apart from the calculation for pile carrying capacities, a pile load test is to be conducted for accurate results.
- Beyond the critical depth, the values of overburden pressure are constant but we are restricted to a depth to critical depth alone so that the shaft resistance is very less when compared to end resistance.
- The skin friction in a clay layer might be developed completely after a certain period of time.
- In this, pile depth and distance vary from various boreholes so that the pile carrying capacities are calculated separately.
- The pile carrying capacities significantly implies that frictional resistance is greater than end bearing resistance which implies that it is a Bored cast in situ -friction pile.

GENERAL GUIDELINES IN SOIL FILLING

If the foundation material is fine soil (clay and silt) it should be stiff. If the foundation soil is coarse-grained (sand or gravel) it should be dense. Soft, loose, compressible, or organic topsoil is not acceptable for foundation soil and in such cases, the existing weak soil should be replaced up to stiff or dense soil strata below the foundation with well compacted good quality granular soil. The minimum width of a replacement shall be the length of reinforcement plus 1 meter and this will ensure

that the foundation soil has sufficient bearing capacity to withstand bearing pressures in both static and as well as seismic conditions. The foundation may be located on the compacted granular soil fill.

GENERAL COMMENTS

The recommendations for foundation design and construction are based on the information obtained from the boreholes drilled at the site. When foundation construction is underway, the recommendations of this report should be checked through field inspection, to validate the information for use during the construction stage. Any variation in underground conditions revealed by the borehole should be brought to our attention for alternate recommendations if needed. The Professional Services performed for the preparation of a report were accomplished in accordance with current and locally accepted geotechnical engineering principles and practices. The recommendations presented in this report are based upon the data obtained from the borings at the indicated locations and/or from other information discussed in this report. In the case of pile foundation, the pile must be rested on the harder rock stratum, if the depth of 1.00m is not strong the pile has to be advanced to till the harder rock stratum.

EXCAVATION

Excavation through the overburdened soil can be carried out by conventional equipment such as dozers and poclain excavators. Under-excavation shall not be done, thereby not disturbing the existing foundation. Since the proposed structure is nearby the existing building it should be careful that the existing foundation not be disturbed by any causes

DRAINAGE

It is recommended to design an effective rainwater drainage system to get rid of the consequences of the rainwater percolation into these layers. The site should be graded so as to direct rainwater and water away from all planned structures.

FOUNDATIONS ON FILLS

In such cases, the foundations have to be built under controlled conditions with proper compaction that can be designed as a normal foundation. Uncontrolled fills should be excavated and they should be either refilled with controlled fill or foundation should commence from Natural ground level. The Report and SBC calculation were completely based on the boreholes terminated; apart from this, any weak layer encountered during excavations should also be reported to Geo build engineering India Pvt Ltd

CERTIFICATION

This report is issued with the design of Open and Pile Foundation along with The Geotechnical Investigation Report For The Proposed Construction Of Residential Building (Basement+G+5) At Old S.No: 132 Part &139/1, T.S.No: 15/2-2,15/4-2/2,15/4-1, Block No-22, Ward-G, Of Athipattu Village, Vanagaram-Ambattur Road, Chennai -600 058. At this site, the number of a borehole (Three boreholes) and depth of exploration are also terminated to a maximum depth of 22.0 m. The report (Safe Bearing capacity) is mainly based on the investigation done in and around boreholes explored for Residential Building. The method to adopt a suitable method of Ground improvement techniques as per IS 13094:1992, before laying the foundation System. Enough care may be taken to design a suitable dewatering system while the construction of the foundation is in progress so that the bottom of the excavation and foundation layer shall be relatively dry. The water seeking trees around the proposed structure is also to be removed to avoid shrinkage cracks.

Yours Truly,

For GEO BUILD ENGINEERING INDIA PVT LTD

Er.S.Sakthi Raja, M.E (Geotech)
(Senior Engineer - Design)
CMDA Reg No - GTE/19/04/018

Er.B.Prakash, M.E (Geotech)
(Engineer - Design)



CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
‘ThalamuthuNatarajan Building’, No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru S.SAKTHI RAJA** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Soil Mechanics & Foundation Engg.)** and experience in the relevant field for 7 years.

He has been given the Registration No.**GTE/19/04/018** on **08.04.2019**. He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, “Registration of Professionals”, Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **07.04.2024**.



(Handwritten Signature)
(R.SHIVAKUMAR)

APPENDIX - A

KEY PLAN OF BORE HOLES



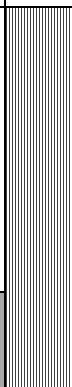
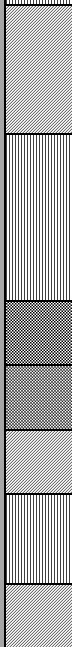
TYPICAL SECOND FLOOR PLAN

APPENDIX - B

BORE LOG & SUB SOIL PROFILE

SOIL BORE LOG PROFILE FOR BORE HOLE: 1

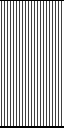
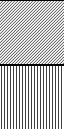
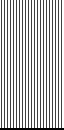
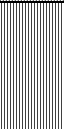
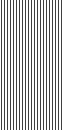
PROJECT: GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+G+5) AT AYANAMBAKKAM, CHENNAI -600 058.

BH NO			1		Ground water level				-5.0 m from EGL
Site			Ayanambakkam		Reduced level				-2.0 m from EGL
Dia of boring			150 mm		Date of starting				18.09.2022
Type of boring			Rotary (Calyx) – Wash Boring		Date of completion				20.09.2022
Drilling Depth below EGL (m)	Ground water level	Soil Profile	Description / Classification of Soil	Depth of Samples Collected (m)	Standard Penetration Test (SPT) In cm				Relative Density / Consistency
					15	30	45	N	
0.0-1.0			Brownish silty sand	1.0	4	5	6	11	Medium
1.0-2.0			Brownish silty sand	2.0	4	6	7	13	Medium
2.0-3.0			Brownish silty sand	3.0	5	7	7	14	Medium
3.0-4.5			Greyish clay	4.5	4	7	9	16	Very stiff
4.5-6.0			Greyish silty sand	6.0	3	5	7	12	Medium
6.0-7.5			Brownish silty sand	7.5	16	22	30	52	Very dense
7.5-9.0			Brownish silty clay	9.0	8	10	13	23	Very stiff
9.0-10.5			Brownish silty clay	10.5	10	13	17	30	Hard
10.5-12.0			Brownish silty sand	12.0	28	34	45	79	Very dense
12.0-13.5			Brownish silty sand	13.5	53	74	Hammer Rebound for 50 No of Blows With 5 cm	>100	Very dense
13.5-15.0		Brownish SDR	15.0	SPT Rebound			>100	Very dense	
15.0-15.5		Whitish soft rock	15.5	RQD-24%, CR- 48%			>100	-	
15.5-16.5		Brownish clay	16.5	36	40	54	94	Hard	
16.5-18.0		Brownish silty sand	18.0	41	58	Hammer Rebound for 50 No of Blows With 5 cm	>100	Very dense	
18.0-20.0		Brownish clay	20.0	Hammer Rebound for 100 No of Blows With 2 cm			>100	Hard	
Bore hole termination depth at = 20.0 m from Existing ground level									

Bore hole termination depth at = 20.0 m from Existing ground level

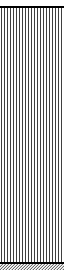
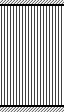
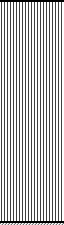
SOIL BORE LOG PROFILE FOR BORE HOLE: 2

PROJECT: GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+G+5) AT AYANAMBAKKAM, CHENNAI -600 058.

BH NO			2		Ground water level				-5.0 m from EGL
Site			Ayanambakkam		Reduced level				-2.0m from EGL
Dia of boring			150 mm		Date of starting				19.09.2022
Type of boring			Rotary (Calyx) – Wash Boring		Date of completion				20.09.2022
Drilling Depth below EGL (m)	Ground water level	Soil Profile	Description / Classification of Soil	Depth of Samples Collected (m)	Standard Penetration Test (SPT)				Relative Density / Consistency
					In cm				
					15	30	45	N	
0.0-1.0	-5.0 m		Brownish silty sand	1.0	5	7	7	14	Medium
1.0-2.0			Brownish silty sand	2.0	5	5	6	11	Medium
2.0-3.0			Greyish silty clay	3.0	4	6	6	12	Stiff
3.0-4.5			Greyish silty sand	4.5	6	7	8	15	Medium
4.5-6.0			Greyish silty sand	6.0	6	7	10	17	Medium
6.0-7.5			Brownish silty sand	7.5	26	29	36	65	Very dense
7.5-9.0			Greyish clay	9.0	11	12	14	25	Very stiff
9.0-10.5			Brownish silty clay	10.5	10	13	17	30	Hard
10.5-12.0			Brownish silty sand	12.0	30	44	59	103	Very dense
12.0-13.5			Brownish silty sand	13.5	63	79	Hammer Rebound for 28 No of Blows With 21 cm	>100	Very dense
13.5-15.0			Brownish silty sand	15.0	58	72	Hammer Rebound for 28 No of Blows With 10 cm	>100	Very dense
15.0-16.5				Greyish clay	16.5	69	Hammer Rebound for 50 No of Blows With 5 cm		>100
16.5-18.0		Greyish clay		18.0	76	Hammer Rebound for 50 No of Blows With 4 cm		>100	Hard
18.0-20.0		Greyish clay		20.0	Hammer Rebound for 100 No of Blows With 3 cm			>100	Hard
Bore hole termination depth at = 20.0 m from Existing ground level									

Bore hole termination depth at = 20.0 m from Existing ground level

SOIL BORE LOG PROFILE FOR BORE HOLE: 3

PROJECT: GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+G+5) AT AYANAMBAKKAM, CHENNAI -600 058.									
BH NO			3			Ground water level			-5.0 m from EGL
Site			Ayanambakkam			Reduced level			-2.0 from EGL
Dia of boring			150 mm			Date of starting			20.09.2022
Type of boring			Rotary (Calyx) – Wash Boring			Date of completion			21.09.2022
Drilling Depth below EGL (m)	Ground water level	Soil Profile	Description / Classification of Soil	Depth of Samples Collected (m)	Standard Penetration Test (SPT)				Relative Density / Consistency
					In cm				
					15	30	45	N	
0.0-1.0			Brownish silty sand	1.0	4	5	6	11	Medium
1.0-2.0			Brownish sand	2.0	4	6	7	13	Medium
2.0-3.0			Brownish sand	3.0	8	9	9	18	Medium
3.0-4.5			Greyish silty sand	4.5	2	2	4	6	Loose
4.5-6.0			Brownish clay	6.0	2	2	3	5	Firm
6.0-7.5			Brownish silty sand	7.5	19	27	32	59	Very dense
7.5-9.0			Brownish clay	9.0	4	4	7	11	Stiff
9.0-10.5			Brownish silty clay	10.5	5	9	11	20	Very stiff
10.5-12.0			Brownish clay	12.0	9	11	16	27	Very stiff
12.0-13.5			Brownish silty sand	13.5	44	61	Hammer Rebound for 39 No of Blows With 8 cm	>100	Very dense
13.5-15.0			Brownish silty clay	15.0	32	39	47	86	Hard
15.0-16.5		Brownish silty sand	16.5	57	70	Hammer Rebound for 28 No of Blows With 10 cm	>100	Very dense	
16.5-18.0		Brownish silty sand	18.0	62	84	Hammer Rebound for 28 No of Blows With 10 cm	>100	Very dense	
18.0-20.0		Brownish clay	20.0	36	49	55	104	Hard	
20.0-22.0		Brownish clay	22.0	4	59	Hammer Rebound for 28 No of Blows With 10 cm	>100	Hard	
Bore hole termination depth at = 22.0 m from Existing ground level									

APPENDIX - C

LABORATORY TEST RESULTS

TABLE NO: 1

LABORATORY TEST RESULTS														
Client (^)		M/s. Nature Residences Development Pvt Ltd.,		Project (^)	GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+G+5) AT AYANAMBAKKAM, CHENNAI -600 058									
Bore Hole No		1	Sampled date	20-09.-2022		Tested Date		22-09-2022		Reporting Date			28-09-2022	
Drilling Depth below EGL (m)	Soil Description / Classification		Is classification	Index Properties					Specific Gravity	Grain Size Analysis (%) Wet / Dry				
				(NMC) %	Liquid Limit, %	Plastic Limit %	Plasticity Index	Free Swell Index %		Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt & Clay %
0.0-1.0	Brownish silty sand		SM-SP	18	Non - Plastic			0	2.65	2	4	67	21	6
1.0-2.0	Brownish silty sand		SP	17				0	2.65	3	5	66	21	5
2.0-3.0	Brownish silty sand		SM-SP	17				0	2.65	1	5	64	21	9
3.0-4.5	Greyish clay		CL	27	27	15	12	10	2.70	0	0	13	17	70
4.5-6.0	Greyish silty sand		SM	34	Non - Plastic			0	2.67	0	0	11	41	48
6.0-7.5	Brownish silty sand		SM	15				0	2.66	25	16	11	22	26
7.5-9.0	Brownish silty clay		MH	38	59	32	27	90	2.71	0	1	3	10	86
9.0-10.5	Brownish silty clay		MH	33	53	30	23	0	2.71	1	1	3	6	89
10.5-12.0	Brownish silty sand		SM	16	Non - Plastic			0	2.66	0	0	2	53	45
12.0-13.5	Brownish silty sand		SM	23				0	2.65	1	5	54	21	19

13.5-15.0	Brownish SDR	-	SPT Sample Recovery Nil										
15.0-15.5	Whitish soft rock	-	RQD- 0 to 10 %,										
15.5-16.5	Brownish clay	CL	34	32	18	14	30	2.68	1	1	21	22	55
16.5-18.0	Brownish silty sand	SM	34	Non - Plastic			0	2.67	11	1	11	46	31
18.0-20.0	Brownish clay	CH	33	53	22	31	70	2.72	0	0	3	2	95

Er. S. Sakthi Raja, M.E (Geotech)
(Technical Manager)

TABLE NO: 2

LABORATORY TEST RESULTS														
Client (^)	M/s. Nature Residences Development Pvt Ltd.,			Project (^)	GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+G+5) AT AYANAMBAKKAM, CHENNAI -600 058									
Bore Hole No	2	Sampled date	20-09-2022		Tested Date	22-09-2022		Reporting Date			28-09-2022			
Drilling Depth below EGL (m)	Soil Description / Classification		Is classification	Index Properties					Specific Gravity	Grain Size Analysis (%) Wet / Dry				
				(NMC) %	Liquid Limit, %	Plastic Limit %	Plasticity Index	Free Swell Index %		Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt & Clay %
0.0-1.0	Brownish silty sand		SM-SP	16	Non - Plastic			0	2.65	4	11	60	18	7
1.0-2.0	Brownish silty sand		SM-SP	20				0	2.65	14	11	55	13	7
2.0-3.0	Greyish silty clay		CL-ML	22	23	17	6	20	2.68	5	3	10	24	58
3.0-4.5	Greyish silty sand		SM-SP	22	Non - Plastic			0	2.65	19	6	58	11	6
4.5-6.0	Greyish silty sand		SM-SP	19				0	2.65	5	5	64	18	8
6.0-7.5	Brownish silty sand		SM	13				0	2.68	26	16	20	17	21
7.5-9.0	Greyish clay		CI	31	36	22	14	40	2.69	2	0	3	29	66
9.0-10.5	Brownish silty clay		MH	35	53	30	23	70	2.70	1	2	6	14	77
10.5-12.0	Brownish silty sand		SM	21	Non - Plastic			0	2.68	0	0	8	68	24
12.0-13.5	Brownish silty sand		SM	25				0	2.65	2	3	21	58	16

13.5-15.0	Brownish silty sand	SM	23	Non - Plastic			0	2.67	0	1	32	37	30
15.0-16.5	Greyish clay	CI	24	35	16	19	30	2.68	1	1	19	20	59
16.5-18.0	Greyish clay	CL	23	28	16	12	0	2.68	0	0	20	22	58
18.0-20.0	Greyish clay	CI	24	40	18	22	0	2.68	0	0	14	34	52

Er. S. Sakthi Raja, M.E (Geotech)
(Technical Manager)

TABLE NO: 3

LABORATORY TEST RESULTS														
Client (^)		M/s. Nature Residences Development Pvt Ltd.,		Project (^)	GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (BASEMENT+G+5) AT AYANAMBAKKAM, CHENNAI -600 058									
Bore Hole No		3	Sampled date	21-09-2022		Tested Date		22-09-2022		Reporting Date		28-09-2022		
Drilling Depth below EGL (m)	Soil Description / Classification		Is classification	Index Properties				Specific Gravity	Grain Size Analysis (%) Wet / Dry					
				(NMC) %	Liquid Limit, %	Plastic Limit %	Plasticity Index		Free Swell Index %	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt & Clay %
0.0-1.0	Brownish silty sand		SM-SP	18	Non - Plastic				2.65	1	4	68	19	8
1.0-2.0	Brownish sand		SP	21					2.65	4	5	68	19	4
2.0-3.0	Brownish sand		SP	19					2.65	1	6	82	8	3
3.0-4.5	Greyish silty sand		SM	28					2.67	2	1	13	40	44
4.5-6.0	Brownish clay		CI	35	46	22	24	70	2.72	0	0	2	1	97
6.0-7.5	Brownish silty sand		SM	13	Non - Plastic				2.68	25	19	20	15	21
7.5-9.0	Brownish clay		CH	30	69	31	38	80	2.69	7	3	10	11	69
9.0-10.5	Brownish silty clay		MH	30	66	37	29	50	2.70	4	4	8	9	75
10.5-12.0	Brownish clay		CH	37	58	33	25	50	2.71	0	1	5	9	85
12.0-13.5	Brownish silty sand		SM	16	Non - Plastic			30	2.67	5	8	37	20	30

13.5-15.0	Brownish silty clay	MH	31	63	33	30	80	2.71	1	2	4	11	82
15.0-16.5	Brownish silty sand	SM	19	Non - Plastic			0	2.67	2	2	14	52	30
16.5-18.0	Brownish silty sand	SM	26				0	2.67	0	2	6	65	27
18.0-20.0	Brownish clay	CH	32	50	24	26	80	2.72	0	0	1	2	97
20.0-22.0	Brownish clay	CH	33	53	37	26	80	2.72	0	0	3	6	91

Er. S. Sakthi Raja, M.E (Geotech)
(Technical Manager)

**CERTIFICATION**

The total no of pages in this report is 28; this report is issued by Geo Build Engineering India Pvt Ltd for the project, **Geotechnical Investigation Report For The Proposed Construction Of Residential Building (Basement+G+5) At Old S.No: 132 Part &139/1, T.S.No: 15/2-2,15/4-2/2,15/4-1, Block No-22, Ward- G, Of Athipattu Village, Vanagaram-Ambattur Road, Chennai -600 058.** All the above tests were done within our laboratory.

Yours Truly,

For GEO BUILD ENGINEERING INDIA PVT LTD

Er. S. Sakthi Raja, M. E (Geotech)
(Senior Engineer - Design)
CMDA Reg No - GTE/19/04/018

Er. B.Prakash, M.E(Geotech)
(Engineer - Design)

NOTE:

- 1. The results enclosed are only related to the sample tested by us.**
- 2. The report shall not be reproduced in full or part without written permission from Geo Build Engineering India Pvt Ltd.**
- 3. All the lab related tested values are as per the standard conditions followed by the lab.**
- 4 Symbol (^) indicates details given by client.**
- 5. Samples will be disposed after 30 days from sample receipt date at lab.**
- 6. Statement of conformity not reported, so Decision rule is not applicable**

**LIST OF METHOD USED AS FOLLOWED**

- IS 2720 (Part 2);1973 Natural moisture content
- IS 2720 (Part 3);1980 Specific Gravity test on Soils
- IS 2720: Part 4 :1985 Grain size Analysis Dry Sieve Analysis
- IS 2720: Part 4 :1985 Grain size Analysis Wet Sieve Analysis
- IS 2720 (Part 5):1958 Liquid limit test
- IS 2720 (Part 5):1985 Plastic limit test
- IS 2720 (Part 7);1980 Proctor density-Light (standard) compaction
- IS 2720 (Part 8);1983 Proctor density-Heavy (modified) compaction
- IS 2720 (Part 16);1987 Laboratory California Bearing ratio
- IS 2720 (Part 28);1974 Dry density Determination by Sand Replacement method
- IS 2720 (Part 29);1975 Dry density Determination by Core cutter method
- IS 2720 (Part 40);1977 Free Swell Index
- Is 6403:1981 code of practice for determination of bearing capacity of shallow foundation
- IS:2911 -1980 code of practice for design and construction of pile foundation - part iii – Bored cast in situ pile
- Is 8009 (part I)-1878 code of practice for calculations of settlements of foundations
- IS 14593:1998 Pile foundation on Rock



NOTE

ABBREVIATION:

WN	=	Natural Moisture content (%)
WL	=	Liquid limit (%)
WP	=	Plasticity Limit (%)
IP	=	Plasticity Index (%)
F.S.I	=	Free Swell Index (%)
IS	=	Indian Standard Classification
ML	=	Inorganic clay
CL	=	Low compressibility Clay of WL < 35%
CI	=	Inorganic Clay of 35% < WL < 50%
CH	=	High Compressibility Clay of WL > 50%
SW	=	Well graded sand
SP	=	Poorly graded sand
SM	=	Silty Sand
GW	=	Well graded gravel
GP	=	Poorly graded gravel
SDR	=	Soft Disintegrated Rock
RQD	=	Rock Quality Designation
CR	=	Core recovery
RMR	=	Rock Mass Rating



Table No: ~A~.

Correlations of SPT N values with Common properties of soils**A) Granular Soil**

Standard Penetration No., SPT N	Description	Relative Density, Dr %	Approx. Angle of Internal Friction, ϕ°	Approx. Rang of Most. Unit Wt., γ kN/m ³
< 4	Very loose	< 20	< 29	11-16
4-10	Loose	20-40	29-30	14-18
10-30	Medium	40-60	30-36	17-20
30-50	Dense	60-80	36-41	17-22
> 50	Very Dense	> 80	> 41	20-29

B) Cohesive Soil

Standard Penetration No., SPT N	Description	Unconfined Compressive Strength, kPa	Approx. Rang of Most. Unit Wt., γ kN/m ³
< 2	Very Soft	0-25	14.4-16
2-4	Soft	25-50	16-17.4
4-8	Firm (medium)	50-100	17.6-19.2
8-15	Stiff	100-200	19.2-20.8
15-30	Very Stiff	200-400	20.8-22.4
> 30	Hard	> 400	> 20

Note: These values are most appropriate values in general. However, the soil properties vary between sites to site and hence it shall be used only for guidance



COMPUTATION OF BEARING CAPACITY AS PER IS: 6403-1981 for Bore hole at 3.0 m

1 Geometrical Data:

Client	M/s. Nature Residences Development Pvt Ltd
Location	Ayanambakkam
Shape of the Foundation	Isolated footing
Breadth of Footing (B)	1.5 m
Depth of Footing (D _f)	3.0
Specific Gravity of soil, G	2.71
Water Table Correction factor, W'	0.5
Density	18
Factor of safety	3.0

Location : Ayanambakkam

Bearing Capacity Calculation	D _f :	2 m	SPT (N) :	23
	B :	1.5 m	SPT (N) value Based on BH-3	

Type of soil starta : **Caly**

Undrained shear strength C_u = 120

Bearing Capacity Factors

(IS 6403: 1981) Pg.no :8, Table :8

N _c	5.14	S _c	=	1.3
----------------	------	----------------	---	-----

N _q	1	S _q	=	1.2
----------------	---	----------------	---	-----

N _γ	0	S _γ	=	0.8
----------------	---	----------------	---	-----

Water table correction W' = 0.5

Net Ultimate bearing Capacity

$q_{nu} = c * N_c * s_c * d_c * i_c$

for Clay soil (Φ) = 0

q_{nu} = 802 KN-m²

Net safe Bearing Capacity

q_u/3

q_{nt} = 267 KN-m²

Net safe bearing capacity : 267 KN-m²

: 26.7 ton/m²



Settlement Calculation as per IS 8009-part1 for Isolated footing in reference J.Bowles.

Client	=	M/s. Nature Residences Development Pvt Ltd
Location	=	Ayanambakkam
Shape of the Foundation	=	Isolated footing
Depth	=	3.0
Immediate settlement, Si	=	$q \times B'' \times (1-\mu^2) \times I_f / E_s$
Safe bearing pressure, q	=	140 KN/m ²
B - width of foundation	=	1.5 m
m - poison's ratio of soil	=	0.5
If =Influence factor	=	0.9
Es-Modulus of Elasticity of Soil	=	300(N+6)
Rigidity Factor	=	0.7
Depth factor	=	0.8

settlement calculation :

Depth of Foundation @ 3.0 m

Bearing Capacity	14	23 N value
Poissons ratio	0.75	
Influence factor	0.85	
EI	870 Clay	
Width of foundation	1500	1.5 Width of foundation
Si	15.39 mm	

Consoildation Settlement

depth of clay layer	1.5 H/2	0.75
liquud limit	64	
Cc	0.49	
SBC	140 KN-m ²	
Breath	3 m	
del p	15.6	
efftive overburden	37.5	
log (del P+ PO)/PO)	0.15	
void ratio (e)	1.4	
Sc	0.05 *1000	47 mm

Total settlement

(Si +Sc)*Depth factor *Rigity factor	
Rigity factor	0.8
Depth factor	0.7
Si	15
Sc	47
Total Settelement (St)	35 mm

Settlement is calculated as per the bore log

Result final:

Safe bearing capacity recommended is = 14.0 tn/m² at a depth of 3.0 m with settlement of 35 mm maximum for Open foundation.

**PILE FOUNDATION**

BH NO: 3 **Location** Ayanambakkam
1.0 Type of Installation of Pile Bored cast in situ Pile

1.1 Geometrical Data

Assumed Diameter of pile(D) : 0.5 m
Effective Length of Pile : 16 m

1.2 Design of Pile for Vertical Compression**1.2.1 Computation of Skin Resistance:****Layer-I (2.0 m - 4.5 m)**

Type of Strata	:	Sand
Average SPT of the strata,N	:	12
Bulk Density of the strata, γ	:	17 kN/m ³
Angle of internal friction	:	30 Deg
tan phi	:	0.58
Top of Strata	:	2 m
Bottom of Strata	:	4.5 m
Average Thickness of Strata, l_c	:	2.5 m
Effective overburden pressure at the middle of the strata, σ middle	:	8.75 kN/m ²
Earth pressure co-efficient (K)	:	0.5
Skin Resistance of the pile,q_{s1}	:	9.91 kN
$(q_s: \sigma * k * \tan \phi * \pi * d * l_c)$		

Layer- II(4.5 m - 6.0 m).

Type of Strata	:	Clay
Top of Strata	:	4.5 m
Bottom of Strata	:	6 m
Average Thickness of Strata, l_c	:	1.5 m
Average SPT of the strata,N	:	5
Bulk Density of the strata, γ	:	17 kN/m ³
Undrained Shear Strength (Cu)	:	33.33 kN/m ²
Adhesion, σ	:	1 kN/m ²
Skin Resistance of the pile,q_s	:	78.49 kN

Layer-III (6.0 m - 7.5 m)

Type of Strata	:	Sand
Average SPT of the strata,N	:	50
Bulk Density of the strata, γ	:	18 kN/m ³
Angle of internal friction	:	34 Deg
tan phi	:	0.67
Top of Strata	:	6 m
Bottom of Strata	:	7.5 m
Average Thickness of Strata, l_c	:	1.5 m
Effective overburden pressure at the middle of the strata, σ middle	:	34 kN/m ²
Earth pressure co-efficient (K)	:	0.5
Skin Resistance of the pile,q_{s1}	:	26.99 kN
$(q_s: \sigma * k * \tan \phi * \pi * d * l_c)$		

**Layer- IV(7.5 m - 12.0 m).**

Type of Strata	:	Clay
Top of Strata	:	7.5 m
Bottom of Strata	:	12 m
Average Thickness of Strata, I_c	:	4.5 m
Average SPT of the strata,N	:	19
Bulk Density of the strata, γ	:	18 kN/m ³
Undrained Shear Strength (Cu)	:	126.67 kN/m ²
Adhesion, σ	:	0.38 kN/m ²
Skin Resistance of the pile,q_s	:	680.14 kN

Layer-V (12.0 m - 13.5 m)

Type of Strata	:	Sand
Average SPT of the strata,N	:	50
Bulk Density of the strata, γ	:	18 kN/m ³
Angle of internal friction	:	34 Deg
tan phi	:	0.67
Top of Strata	:	12 m
Bottom of Strata	:	13.5 m
Average Thickness of Strata, I_c	:	1.5 m
Effective overburden pressure at the middle of the strata, σ middle	:	64.5 kN/m ²
Earth pressure co-efficient (K)	:	0.5
Skin Resistance of the pile,q_{s1}	:	51.19 kN
$(q_s: \sigma * k * \tan \phi * \pi() * d * I_c)$		

Layer- VI (13.5 m - 15.0 m).

Type of Strata	:	Clay
Top of Strata	:	13.5 m
Bottom of Strata	:	15 m
Average Thickness of Strata, I_c	:	1.5 m
Average SPT of the strata,N	:	30
Bulk Density of the strata, γ	:	18 kN/m ³
Undrained Shear Strength (Cu)	:	180 kN/m ²
Adhesion, σ	:	0.25 kN/m ²
Skin Resistance of the pile,q_s	:	105.98 kN

Layer-VII (15.0 m - 18.0 m)

Type of Strata	:	Sand
Average SPT of the strata,N	:	50
Bulk Density of the strata, γ	:	18 kN/m ³
Angle of internal friction	:	34 Deg
tan phi	:	0.67
Top of Strata	:	15 m
Bottom of Strata	:	18 m
Average Thickness of Strata, I_c	:	3 m
Effective overburden pressure at the middle of the strata, σ middle	:	112 kN/m ²
Earth pressure co-efficient (K)	:	0.45



Skin Resistance of the pile, q_{s1} : 160.01 kN
 $(q_s: \sigma * k * \tan \phi * \pi() * d * l_c)$

TOTAL SKIN FRICITONAL RESISTANCE = 1112.71 kN

1.2.2 Computation of End Bearing Resistance:

Type of Bearing Strata	:	CLAY
Dia of pile	:	0.5 m
Cross-Sectional Area of pile, A_p	:	0.20 m ²
Minimum SPT-value of the Bearing Strata	:	50
bearing factors	:	9
Undrained Shear Strength (C_u)	:	180
Bulk Density of the strata, γ	:	20
Ultimate End Bearing Resistance (Q_p)	:	317.925

1.3.0	Ultimate Load Carrying Capacity (Q_s+Q_p)	:	1430.6 kN
	Safe Load Carrying Capacity ($Q_{safe} = Q_u/2.5$)	:	572.3
	Q_{safe} - self weight of pile		525.2 kN

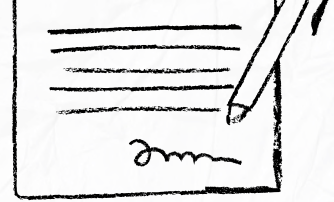
Self weight of pile		
Dia of pile	:	0.5 m
Cross-Sectional Area of pile, A_p	:	0.20 m ²
Length of Pile	:	16 m
Unit weight of pile	:	15
Self weight of pile	:	47.10

13.1 Uplift capacity of pile

	:	1112.71 kN
Total Skin friction	:	1112.71 kN
Total Uplift resistance ($Q_{skin} + \text{self weight of pile}$)	:	1159.81 kN
Safe Q_{up}	$Q_{uplift} / FOS=3$	386.60 kN

Recommenderd pile capcaity	
Capacity of Pile	525.15 KN
Uplift capacity of Pile	386.60 KN

← End of Report →



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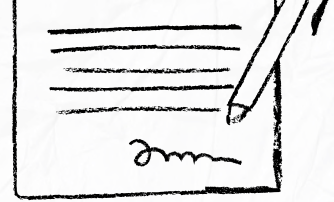
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