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GEOTECHNICAL INVESTIGATION REPORT FOR PROPOSED CONSTRUCTION OF BUILDING

Client	Mr.Sethu Manikkam, S.Nandhini
Project	Proposed Construction of Residential Building
Location	Plot No.A1/54 (Southern Part), Old S.F.No.145, Ward No.09, Block No.06, T.S. No.161/2, Door No.09, 8 th Cross Street, Gandhi Nagar Zone-1, Vellore City Municipal Corporation, Katpadi Taluk, Vellore Dist.
SBC Value	261.00 KN/m ² @ 3.0m Depth for BH1, BH2, BH3,
Foundation Depth N Value	38 @ 3.00m Depth
Water Level	4.33 from G.L
Borehole Final Depth	5.20m
Soil Investigation Date	27.11.2023
Report No & Date	Ref/KPM/GKCEC/57/ST- 30.11.2023



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Project : Residential Building, Gandhi Nagar, Katpadi, Vellore Dist.

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20/11/2023
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1.INTRODUCTION:

The Geotechnical Investigation Report for the Proposed Construction of Residential Building, Plot No.A1/54 (Southern Part), Old S.F.No.145, Ward No.09, Block No.06, T.S. No.161/2, Door No.09, 8th Cross Street, Gandhi Nagar Zone-1, Vellore City Municipal Corporation, Katpadi Taluk, Vellore Dist. Tamil Nadu. In connection there with, the Soil sample was collected and Laboratory test by GK Civil Engineering Consultancy, 6/3B, Chinnakuzanthai Street, Arunachalam Nagar, Kanchipuram, Tamil Nadu, All the laboratory and field tests were conducted as per relevant Indian Standard codes. The foundations have to transfer the load to the sub - soil. The surface conditions at any given site must be adequately explored to obtain information required for the design and construction of foundations. The sub soil exploration is done for the following purpose. For Proposed construction of new structures, the purpose of subsoil exploration, 1). The selection of type and depth of foundation, 2). The determination bearing capacity of the selected foundation, 3). The prediction of settlement of the selected foundation, 4). The determination of ground water level. 5). The evaluation of the earth pressure against walls, basement etc. 6). The suitability of soil and degree of compaction of soil.

Insite reconnaissance-Before conducting SPT test at proposed site, the inspection of site and study of topographical features is often helpful in setting useful information about the soil and ground water condition and in deciding the future programme of exploration.

The fieldwork was investigated on 27.11.2023. This report presents results of the geotechnical investigation along with foundation recommendation for proposed building.

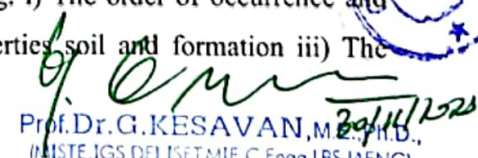
1.2.Object of Exploration:

The object of the site exploration is to provide reliable, specific and detailed information about the soil and ground water conditions of the site which may be required for a safe and economic design of foundations. For the purpose of proposed construction of building, an exploration of the site likely to be affected, the yield precise information about the following. i) The order of occurrence and extent of soil and rock strata. ii) The nature, engineering properties of soil and formation iii) The location of ground water and its variation.

1.3.Scope of Investigation:

The scope of work includes the following:

1. Drilling soil investigation bore hole of 100mm diameter at a depth of 10m from Existing ground level or where the SPT value is >50 at preferably corner along diagonal line or as directed by the engineer-in-charge for proposed construction of site.


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Project : Residential Building, Gandhi Nagar, Katpadi, Vellore Dist.

2. Conducting Standard penetration tests (SPT) at various depths.
3. Collection of disturbed soil samples.
4. Collection of undisturbed soil samples where ever possible
5. Laboratory tests for determination Index and Engineering properties,
6. which influence the design and construction of the proposed structure.
7. Computation of safe bearing capacities and allowable bearing based on the field and Laboratory test carried out in the soil stratum encountered for design of foundations structures.
8. Observation of the water table if encountered.

1.4. Site Investigating Report:

A site investigation report is usually the culmination of the Investigation, Exploration and testing programme. The individual reports vary in form, content and presentation, a typical report will normally include the following.

1. Introduction
2. Field and Laboratory test (Methodology)
3. Sub -Surface Stratification
4. Foundation Analysis
5. Recommendations
6. Reference

Annexure

Design Computations
Laboratory Test Results
Bore Logs
Field Test Location


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2.FIELD INVESTIGATION (METHODOLOGY) AND LABORATORY TEST

2.1 Field testing:

In the field, The method of Exploration should be Conducted by Standard Penetration Test (SPT), The test procedure should be performed as per IS: 2131-1981 (Reaffirmed 2002). This is at the place test (In-situ test) recommended for various type soil. By used this type of test to found out Engineering properties of soil, such as density index of soil, consistency, observed N value overburden pressure, Depth of Exploration and Bearing Capacity of soil. The location of bore hole (Corners along diagonal line) is shown in layout plan. In the field work, Which type of Boring methods and equipments is explained below.

2.2 Boring Methods: The following are the various boring methods commonly used:

i) Auger boring, ii) Auger and shell boring iii) Wash boring iv) Percussion boring and v) **Rotary boring.**

In the proposed site, **PRD Rotary Drill Rig boring are used.** The depth of soil exploration consists of three stages such as boring, collecting sampling and soil testing for field as well as laboratory test. At every 1m depth, the soil samples is collected at a depth of **terminated depth 5.20m.** The collecting samples should be carefully before testing and use the Plastic cover, mention the details of sample and avoid air releasing. The bore log particulars and location of **BH1 – BH3** bore holes are annexed with this report.

2.3 Standard Penetration Test

(At the place bearing test): As per IS: 2131-1981 (Reaffirmed 2002).

1. In This test involves the measurement of the resistance to penetration of a sampling spoon under dynamic loading
2. The resistance is empirically correlated with some of the engineering properties of soil such as density index, consistency, angle of internal friction, bearing capacity etc
3. This test is useful for general exploration of erratic soil profile for finding depth to bed rock or hard stratum and to have an approximate indication of the strength and other properties of soil, particularly the cohesion less soil, from which it is difficult to obtain undisturbed samples.
4. The importance of this test is that, even though empirical, the soil design of foundations in




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gravelly sand is mostly based on the N-value. N value serves as the basic parameter for geotechnical design in gravelly sand.

5. In this test, a thick wall standard split spoon sampler, 50.8 mm outer diameter and 35 mm inner diameter, is driven into the undisturbed soil at the bottom of the auger bore hole under the blows of a 63.5 kg drive weight with 75 cm free fall. The minimum open length of the sampler should be 60 cm. the number of blows required to drive the sampler 30 cm beyond the seating drive of 15 cm, is termed as the **Penetration resistance N**.

2.4 Soil Samples and Samplers:

The soil samples can be of two types

(i) Disturbed samples ii) undisturbed samples

A **disturbed sample** is that in which the natural structure of soil gets partly or fully modified and destroyed although with suitable precautions the natural water content may be preserved. Such a soil sample should be representative of the natural soil by maintaining the original proportion of the various particles intact. In our site, the SPT sample collected were used as disturbed soil samples, in this type of sample, can easily visual and physical identification and for conducting laboratory classification tests as per IS:1498 -1970. An **Undisturbed sample** is that in which the natural structure and properties remain preserved.

2.5 Summary of Field work:

- i. BH1-BH3 bore hole at a terminated depth of 10.0m, noted observed N value and >50nos
- ii. Every 1m depth intervals, disturbed soil sample is collected by Standard Penetration test
- iii. Each bore location, The soil profiles was shown in the tables attached.

2.6 Laboratory Testing: The operation to be performed in the laboratory depends upon the type of the nature of data required. In case of cohesion less material, like sand, The laboratory tests are usually minimum and the design parameters are worked out from field test data such as SPT-N value,

In case of cohesive soils, the programme of laboratory testing can vary from carrying out simple tests as unconfined tests to comprehensive study of behavior shear tests and consolidation tests.



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Following laboratory tests are conducted

For cohesion less soil:

- a) Specific gravity b) Sieve Analysis c) Direct shear test

For cohesive soil

- a) Specific gravity
b) Natural Moisture Content
c) Atterberg' s Limits
d) Sieve Analysis

For Rock:

- a) Core Recovery b) RQD
c) Unconfined compressive strength

2.6.1 Coarse grained samples:

On the coarse grained samples grain size distribution tests were conducted as per IS:2720 (part 4) – 1985, to know the gradation characters and to classify them these results are presented in laboratory test results.

2.6.2 Fine grained Samples:

Consistency index (Atterberg' s Limits) were carried out on fine grained soil samples to evaluate the limits of different consistency states. Generally liquid limits, plastic limits and shrinkages limits were conducted as per IS: 2720 (Part- 5) -1985, and IS:2720 (Part 6) -1972. On such type 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

3.1 Borehole (BH):

In this chapter, the details of soil layer encountered at BH1-BH3 location. The depth of exploration borehole is 5.20m from the ground surface at 1m intervals soil should be collected. The collecting soils are based on visual identification, laboratory testing, and other engineering characteristics derived from SPT- observed N value. Which are having correlation with strength parameters. Borehole was terminated at a Various depth of 5.20m below ground level. The bore logs annotate with laboratory test results show a consistent soil profile.

The Borehole investigation indicates that the general sub soil stratum consist of following types of stratum. **Three Bore Hole (BH1-BH3)** was made at the Proposed site. At the Proposed site for Natural soil was start at a depth of 0.3m from the ground level. The Stratigraphy of the soil in BH1-BH3.

Bore Hole	Layers	Depth (m)	Type of soil
BH1- BH3	Layer -1	0.0 – 1.66	Filled with Black Caly Soil
	Layer-2	1.66 – 2.65	Clay With Sandy Soil
	Layer -3	2.65 – 5.20	Milky Gravelly Soil
		Below 5.20	Weathered Soft Rock

3.2 Water table: Water table was encountered up to depth of 4.30m from the existing ground level. The Bore log details are given in the table.(Annexure)


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4. FOUNDATION SYSTEM

4.1 Basic design of foundation:

When a structure such as Proposed construction of Building is constructed over the ground. Its load has to be transferred to the under ground soil in such a manner that no occurs to the structure. In fact, the two factors that need to be considered, while designing the foundation of the structures, for distributing the load safely on the soil below the structure.

The load applied to the soil should such that induced stress in the soil is lesser than its capacity, as otherwise, soil will fail by shear. The settlement in the soil should be such that it is within the tolerance limit of the super structure. In particular, differential settlement should not cause any unacceptable damages nor interfere with function of the structure. In addition, combined system of super structure and foundation, the overall stability is also governed by the super structure arrangement. Considering the above aspects foundation design, suitable type of foundation system with respect to the sub soil conditions encountered at the borehole location is presented in the subsequent sections.

4.2 Hard stratum Properties:

Investigation of sub soil in location, it can be observed that the sub- soil strata are uniformly stratified with some variation. Below the ground level near by 1m soil is having swelling characteristics at some location, The proposed construction site adopting shallow foundation proper sand cushion has to be provided to reduce the swelling effect.

4.3 Proposed to type of foundation:

An account of subsoil condition encountered at the investigation location. The foundation details finding the more economical and construction feasibility of foundation system discussed below can be adopted. In that location met water 4.33m from the ground level. The bearing capacity calculating as per the IS: 6403.1981. Based on the in-situ test (SPT) conducted at site as per IS: 2131 - 1981. The allowable bearing pressure is calculated as per 8009 (part -1)1976 (Reaffirmed 1998). A factor of safety of 3 has been adopted to arrive at safe bearing capacity.

The Calculated allowable bearing pressure for isolated footing, The maximum footing size 3.00m x 3.00m at the depth of 3.0m from the existing ground level for BH1-BH3. Since the depth of stratum such as Milky Gravelly Soil 2.65 to 5.20m. So SBC value was taken this stratum such as 3.0m for account to Calculating the Safe Bearing Capacity of soil, used as per IS.



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BH.No	Isolated Footing		Calculated Safe allowable bearing pressure – KN/m ²
	Assumed size	Depth (m)	
BH1-BH3	3.0m x 3.0m	3.0	261.00

Net allowable soil pressure for a permissible settlement of 40mm in (kN/ m²) = q_{nu} and calculating the safe bearing capacity as shown in table above.

The proposed construction of Building, the strength of the soil stratum is **Milky Gravelly Soil** for **BH1-BH3**. Verified in relation between angle of internal friction and SPT value. So depth of the foundation mentions the above table. So designed purpose, recommended for shallow foundation should be adopted. Based on the above value, The conclusion and recommendation are mention below.


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5. CONCLUSIONS & COMMENDATIONS

5.1 Types of Foundation:

The recommended safe bearing capacity considering Isolated footing an assumed foundation size of 3.0m x 3.0m and the depth of foundation 3.0m is (BH1-BH3) is 261.00 KN/m², So isolated footing should be suitable for proposed construction of Building at site.

5.2 General Recommendations:

Based on the investigations carried out the following recommendations are made

- ☐ An isolated square footing may be laid at a minimum depth of 2.5m from the ground level.
- ☐ For back filling the foundation trench, the non- swelling soil may be used with proper layer by layer compaction.
- ☐ The foundation system should be care the value of observed N value more than 10
- ☐ To reduce the swelling effect for design of foundation, mixing the sand and Lime spreading all sides.
- ☐ Drainage specialties provide to avoid water logging problem.
- ☐ The Basement area must be raised above the ground surface to avoid the rain season problem.

5.3 Limitation: The soil investigations have been carried out at locations in the client so as to represent the entire site. The recommendations provided in this report are hence valid only for these test locations. However, if there is any change in sub soil condition and properties at site between or beyond chosen test locations. Please contact us for further advice.



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6. REFERENCES

Field Investigation Code

1. IS:3043 -1966: Code practice for earthening (third reprint)
2. IS:1498 – 1970 : Classification and Identification of soil general engineering purpose
3. IS:6953 – 1973 : Determination of water levels in a bore hole
4. IS:1892 – 1979 : Code of practice for sub surface investigation for foundation
5. IS:2131 -1981 : Method of Standard Penetration Test for soils(First Revision)
6. IS:1888 - 1982 - Method of load test on soil (Second Revision)
7. IS:2132 - 1986 : Code of practice for Thin Walled Tube Sampling of Soil
8. IS:5313: Guide for Core Drilling Observations.
9. IS:6953 - 1973: Determination of water levels in a bore hole

Laboratory Tests

1. 2720 – 1977 (Part40) – Method of tests for soils (Determination of free swell index of soils)
2. 2720 – 1977 (Part41) – Method of tests for soils (Determination of free swelling pressure of soil)
3. 2720 – 1980 (Part 2) – Method of tests for soils (Determination of water content)
4. 2720 – 1980 (Part 3/sec-1) – Method of tests for soils (Determination of specific gravity: Fine grained soils)
5. 2720 – 1980 (Part 3/sec-1) – Method of tests for soils (Determination of specific gravity: Fine and coarse grained soils)
6. 2720 – 1983 (Part 1) – Method of tests for soils (Preparation of dry soil samples for various test)
7. 2720 – 1985 (Part 5) – Method of tests for soils (Determination of liquid and plastic limit)


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Foundation design Code

- 1.IS:8009 (Part -1) 1976 - Code of practice for calculation of settlements of foundation: Shallow foundation subject to symmetrical static vertical loads (Amendment 1)
- 2.IS:1893 -1984 :Criteria for Earthquake resistant design of structure (Fourth revision)
- 3.IS:2911 – Design and construction of pile foundations
- 4.IS:8080 – 1986 - Code of practice for Design and construction of shallow foundations on soils (Other than raft, ring and shell)
- 5.IS:6403 -1981 : Code of practice for determination bearing capacity of shallow foundations
6. IS:1904 -1986 : Code of practice for Design and construction of foundations in soils

Books

1. Wayne C.Teng, (1992) foundation design, 13th reprint, Prentice – Hall of india PVT.Ltd
2. Bowles J.E, (1982) Foundation Analysis and design, 3rd edition, McGraw Hill International book
- 3.Tomlinson M.J.(1995) Foundation Design and Construction , 6TH Edition, Longman Group.


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(ANNEXTURE)

Safe Bearing Capacity Calculation





7. SAFE BEARING CAPACITY OF SHALLOW FOUNDATION

Safe Bearing Capacity Calculation based on IS : 6403-1981

Design details (BH1-BH3)

Size and depth of the foundation	
Depth of foundation (D)	3.0m
Width of foundation (B)	3.0m
Length of foundation (L)	3.0m
Foundation Shape	Square
Design N Value	$N_{obs}=38,$
Shear Strength Parameter	
Cohesion (C) kN/m^2	$C_u=0$
Angle of internal friction	$\phi = 37^\circ$
Density of soil (γ) kN/m^3	18.00
Depth of water table from EGL (D_w)	0
Type of Shear failure	Local

Depth of foundation – 3.0m depth

Based on IS: 6403 the Net Safe Bearing Capacity is calculated as follows:

Considering $c = 0$ and $\phi = 37^\circ$ and $\gamma = 18.50 \text{ kN/m}^3$, Assume local shear failure

$$\phi' = \tan^{-1}(2/3 \times \tan 37^\circ) = 28^\circ$$

Bearing Capacity Factors:

$$N'_c \text{ and } d'_c = 0, N'_q \text{ and } d'_q = 11.50, 1.00$$

$$N'_\gamma \text{ and } d'_\gamma = 9.50, 1 \quad i'_q \text{ and } i'_\gamma = 1, S'_q \text{ and } S'_\gamma = 1.2, 0.8$$

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i) Assuming depth of foundation 3.0m depth

Net ultimate Bearing Capacity (permissible settlement of 40mm) in $(\text{kN/m}^2) = q_{nu}$

$$q_{nu} = q (N_q - 1) S_q d_q i_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma w$$

$$= 18.00 \times 3.0 \times (11.50 - 1) 1.20 \times 1 \times 1 + 0.5 \times 18.00 \times 3.0 \times 9.50 \times 0.8 \times 1 \times 1 \times 0.5$$

$$= 783 \text{ kN/m}^2$$

$$\text{Net safe bearing capacity } q_{ns} = 783/3(\text{FS}) = 261.00 \text{ kN/m}^2$$

Result:

The Net Safe Bearing Capacity value of 3.0m depth = 261.00 kN/m² for BH1-BH3 adopted for design of foundations.





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Borelog and Laboratory Test Results



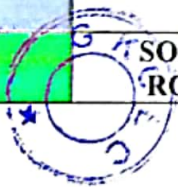
LAB TEST RESULTS

LAB TEST RESULTS																		
Soil Investigation done by: GK CIVIL ENGINEERING CONSULTANCY KANCHEEPURAM					Bore Number BH1-BH3			Location: Mention on Site: Plan			Ground Water Level: NIL		Work Commenced on		27.11.2023			
SOIL PROFILE	DEPTH OF SAMPLING (m)	IS SOIL CLASSIFICATION	NATURAL WET DENSITY (g/cc)	NATURAL MOISTURE CONTENT %									Work Completed on					27.11.2023
					INDEX TEST			SIEVE ANALYSIS			SPECIFIC GRAVITY	SHEAR TEST		STANDARD PENETRATI ON TEST		ROCK PARAMETERS		
					LIQUID LIMIT %	PLASTIC LIMIT %	PLASTICITY INDEX	GRAVEL	SAND	SILT + CLAY		COHESION, KN/m ²	ANGLE OF INTERNAL FRICTION	DEPTH OF TESTING m	OBSERVED N VALUE	CORE RECOVERY	RQD	UCC STRENGTH Mpa
	0.0 - 1.66	CL	17.50	12.65	37	25	12	0	0	100	2.70		28	1.0	31	-	-	-
	1.66 - 2.65	SC	17.75	13.25	32	25	7	0	35	65	2.68		35	2.00	32	-	-	-
	2.65 – 5.20	GC	18.00	13.00	28	23	5	75	5	20	2.65		38	3.00	37			
	5.20 Below	SR	-	-	-			-				-	-	-	50>	-	-	-




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Soil Investigation done by: GKCEC Kancheepuram		CALYEX ROTARY (SPT)							Date of Commencement		27.11.2023				
									Date of Completion		27.11.2023				
Borehole No:		BH1 – BH3		Thickness of Layer (m)	Type of Testing	Standard Penetration Test Data									
Location		Mention on site Plan				N -Value -Depth of Penetration				Relative density/ Consistency	Graphical Representation of Penetration resistance				
Depth below G.L	Soil Profile	Description of Soil				1 st 15 cm	2nd 15 cm	3rd 15 cm	For Last 30cm/ Observed N' Value						
1.00		GW- Milky Gravelly Soil		1	SPT	12	15	15	30	.	10	20	30	40	50
2.00				1	SPT	14	16	19	35	.					
3.00		GW- Milky Gravelly Soil		1	SPT	15	18	20	38	.					
4.00				1	SPT	18	18	22	40						
5.20				1	SPT				50>						
BELOW					SOFT ROCK	1	SOFT ROCK								




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Project : Residential Building, Gandhi Nagar, Katpadi, Vellore Dist.

Chemical Analysis of Water Sample

(IS:3025,P.24:R.2009)

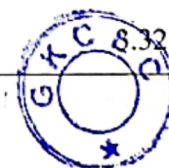
Note: water table was not encountered in the bore hole, so water collected near by bore well)

Sl.No	Parameters	Results
1	pH value @ 25° C	7.25
2	Chlorides at Cl (mg/l)	220
3	Sulphateas SO ₄ (mg/l)	98

Chemical Analysis of Soil Sample

EPA Method IS 2720, P.26:R.2007)

Sl.No	Parameters	Results
1	pH value @ 25° C	9.50
2	Chlorides at Cl (mg/l)	3.50
3	Sulphateas SO ₄ (mg/l)	8.32



G. Kesavan
20/11/2021

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Location/ Photography





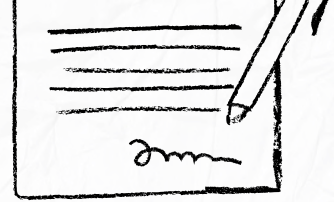
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G. Kesavan 30/11/2023
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Bore Hole-BH1, BH2, BH3



our services doesn't just end there



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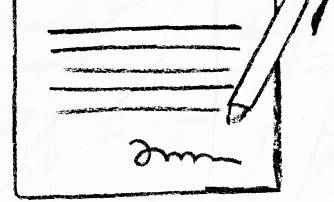
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