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BALA GEOTECH SERVICE

GEO TECHNICAL INVESTIGATION REPORT

COMPANY REG NO:FR/Palayankottai/19/2023
INDIAN GEOTECHNICAL SOCIETY MEMBERSHIP CODE:LM-4585
MSME Registration No:UDYAM-TN-18-0038413



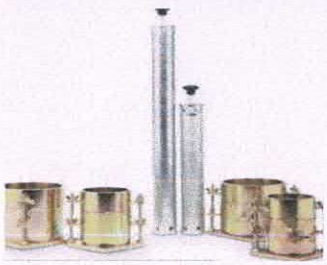
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PROPOSED CONSTRUCTION OF RESIDENTIAL APARTMENT AT TIRUNELVELI

REPORT ON GEOTECHNICAL INVESTIGATION

Client :

M/s.Sharada Estates,

9/1 Madurai road, Junction,

Tirunelveli 627001.

Site Address :

Soil Investigation for the Proposed Construction of Residential Apartment in Plot No.12 B, C Colony Road, Perumalpuram, T.S.No.6/62, Block 6, Ward "BM" Kulavanigarpuram Part-3, Melapalayam Town, Palayamkottai Taluk, Tirunelveli District.

Authorized Signatory

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Ref No: BGS/S146/2023

NOVEMBER-2023

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SOIL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF RESIDENTIAL APARTMENT AT TIRUNELVELI

1.0 INTRODUCTION

The Client **M/s.Sharada Estates,** entrusted **M/s BALA GEO TECH LAB** to carry out the Soil Investigation at various locations involving boreholes at TIRUNELVELI-Tamil Nadu. The purpose of this geotechnical investigation is to determine stratification of the ground, geotechnical properties of substratum, along with recommendations for the proposed construction.

BALA GEO TECH LAB mobilized one set of staging platforms, rotary drilling rig and a team of engineers and drillers. The staging platform was positioned in Plot No.12 B, C Colony Road, Perumalpuram, T.S.No.6/62, Block 6, Ward "BM" Kulavanigarpuram Part-3, Melapalayam Town, Palayamkottai Taluk, Tirunelveli District. **BH-01 (N-8.703831, E-77.735086), BH-02(N-8.7037094, E-77.735044).**

This final report presents the geotechnical information including laboratory test results, bore logs, soil profile, Load bearing capacity results and conclusions based on the field and laboratory test results.

2.0 SCOPE OF WORK

The following scope of work was performed in order to accomplish the foregoing purposes

- Exploring subsurface condition by advancing, sampling and logging of **two (2)** exploratory boreholes of 100mm diameter to the final depth ranging from **1.50m to 7.50m** below the Ground level depending on stratigraphy encountered.
- Conducting Standard Penetration Test (SPT) at every **1.5m** interval in soil.
- Collecting disturbed samples at every **1.5m** interval
- Collecting undisturbed samples wherever possible
- Collecting core samples using core barrels when met with refusal /rock strata.
- Conducting relevant laboratory tests
    1. Water Content
    2. Specific Gravity
    3. Grain Size Analysis
    4. Atterberg limit Test
    5. Direct Shear Test

• Reporting the acquired field information, laboratory test results and conclusions based on the results and analysis.

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3.0 FIELD EXPLORATION

➢ Site	:	Tirunelveli
➢ Type of Building	:	Land is suitable for Proposed Building of Silt + 5 floors with 25 dwelling units
➢ BH Location Depth	:	Up to 7.50m
➢ No. of Bore Holes	:	**2**
➢ Conducted Date	:	20.11.2023
➢ Test Conducted	:	Standard Penetration Test
➢ Water Table Depth	:	Nil
➢ Test Conducted at	:	**Bala Geo Tech Lab, Tirunelveli.**
➢ Assumed Footing	:	**Isolated Footing** at a depth of **2.00m** below G.L.

4.0 GEOGRAPHICAL CO-ORDINATES

Bore Hole No	Latitude (N)	Longitude (E)
BH 1	08°42'13.8"	77°44'06.3"
BH 2	08°42'13.4"	77°44'06.2"

5.0 LIMITATIONS

- The Geotechnical exploration has been carried out at locations in the site chosen by the client / Structural Engineer representing the entire site.
- Uncertainties in the change of sub soil properties are very common.
- The suggestions provided in this report are valid only for the test locations.

6.0DEPTH OF FOUNDATION

In view of the above factors, foundations of the proposed structure can be made to rest at a depth of **2.00m** below the existing ground level.

(or)

According to Structural Engineers recommendations, Loading Condition, Structural Analysis and as per Structural Design.

Note:

This recommendation has been given on the basis of soil investigations only. The Structural Engineer can modify based on Structural Analysis on actual size of the building and as per the Structural Design.

For Bala Geotech Service

Partner

For BALA GEO TECH

TECHNICAL SUPPORT

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7.0 DRILLING

This consists of sinking **two (2)** exploratory bore hole by rotary drilling rig equipment up to the final depth ranging from **1.50m to 7.50m** below the Ground level as per **IS 1892.**

7.1 Standard Penetration Test (SPT): IS 2131

Standard Penetration Test (SPT) was conducted at every **1.5m** interval. This test utilizes a 50 mm OD and 600 mm long thick-walled split sampler tube driven into undisturbed soil under the impact of 63.5 kg weight hammer having a free fall of 750 mm. The penetration resistance of 'N' value is recorded as the number of hammer blows required to achieve a penetration of 300 mm after the initial penetration of 150 mm as a seating drive (to allow for any disturbed materials at the bottom of borehole). After completion of test, the sampler tube is removed & disassembled to provide a disturbed but representative sample.

7.2 Core Recovery

The core recovery is the ratio of the cumulative total length of the rock cores recovered to the drilled core run expressed as percentage. Core samples were collected in each borehole up to termination depth after refusal strata. Core recovery for each drill run is presented in bore logs.

7.3 Rock Quality Designation (RQD %)

The Rock Quality Designation (RQD) is the ratio of the cumulative sum of all the cores larger than 10cm to the drilled core run expressed as percentage. Core lengths are measured along the central line of the cores. A relationship between the RQD and the quality of core is tabulated in **Table 1.0.**

Table 1.0 Classification of Core Quality based on RQD

RQD(%)	Core Quality
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

Rock samples obtained from the boreholes were inspected in the field immediately upon retrieval for type, texture and color. All samples were collected in core boxes without disturbing and transported to the laboratory for testing. The measured RQD values presented in Bore logs in general indicate the rock quality to be good to excellent.

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8.0 LABORATORY TESTING

After the completion of fieldwork, the samples were transported to BALA GEO TECH LAB for further visual-tactile examination, and to select appropriate samples for laboratory analysis.

Table 8.0: Laboratory Tests on oil Samples

Laboratory Tests	Codes
Water Content	IS 2720 Part 2
Specific Gravity	IS 2720 Part 3
Grain Size Analysis	IS 2720 Part 4
Atterberg Limit Test	IS 2720 Part 5
Direct Shear Test	IS 2720 Part 13

8.1 Laboratory Testing Procedures on Soil

8.1.1 Water Content (IS 2720 Part-2)

The test specimen is dried for at least 24 hours in an oven at a temperature of 110 + 5°C to a constant mass. The loss of mass due to drying is attributed to the presence of water. The water content is calculated using the mass of water and the mass of the dry specimen.

8.1.2 Specific Gravity (IS 2720 Part-3)

This test method covers the determination of the specific gravity of soil solids that pass the 2mm IS sieve, by means of using density bottle method. The test is performed by placing slurry of soil suspension in distilled water, removing the entrapped air and measuring the volume of water displaced by the soil. Specific gravity is then determined as the ratio of the mass per weight in air of a given volume of dry soil solids to the mass per weight of equal volume of distilled water.

8.1.3 Particle Size Analysis (IS 2720 Part-4)

This test method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 um is determined by sieving, while the distribution of particle sizes smaller than 75 um is determined by a sedimentation process, using a hydrometer. Sieving is performed by arranging the various sieves one over the other in the order of their mesh openings — the largest aperture sieve being kept at the top and the smallest aperture sieve at the bottom. The percentage of soil retained on each sieve is calculated on the basis of the total mass of soil sample taken and from these results, percentage passing through each sieve is calculated.

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8.1.4 Atterberg Limit Test (IS 2720 Part-5)

This test methods cover the determination of the liquid limit, plastic limit, and the plasticity index of soils that passes the 425-u IS sieve. Liquid limit is that water content at which a part of soil, cut by a groove of standard dimensions, will flow together for a distance of 12mm under an impact of 25 blows in a standard liquid limit apparatus. Plastic limit is that water content at which a soil will just begin to crumble when rolled into a thread 3 mm in diameter. The difference in moisture contents between the liquid and plastic limits is termed as plasticity index.

8.1.6 Direct Shear Test (IS 2720 Part-13)

This test method determines the consolidated drained shear strength of soil specimen under direct shear boundary conditions. The test method consists of placing the test specimen in the direct shear device, applying a predetermined normal stress, providing for wetting or draining of the test specimen, or both, consolidating the specimen under the normal stress, unlocking the shear box halves that hold the test specimen, and shearing the specimen by displacing one shear box half laterally with respect to the other at a constant rate of shearing deformation while measuring the shearing force, relative lateral displacement, and normal displacement.

8.0 SUBSTRATUM

The generalized stratigraphy of the BH-01 & BH-02 borehole locations are presented below

BH No	Depth (m)	Stratigraphy
BH-01	0.00-1.50	Fine to Medium Sand
	1.50-3.00	Gravelly Sand
	3.00-4.50	Gravelly Sand
	4.50-6.00	Soft Disintegrated Rock
	6.00-7.50	Soft Disintegrated Rock
	7.50	Weathered Rock

Table 1.0: Soil Stratigraphy of BH-01

BH No	Depth (m)	Stratigraphy
BH-02	0.00-1.50	Fine to Medium Sand
	1.50-3.00	Fine to Medium Sand
	3.00-4.50	Gravelly Sand
	4.50-6.00	Soft Disintegrated Rock
	6.00-7.00	Soft Disintegrated Rock
	7.00	Weathered Rock

Table 2.0: Soil Stratigraphy of BH-02

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9.0 EVALUATION OF SAFE BEARING PRESSURE BASED ON TOLERABLE SETTLEMENT, N VALUES AND q_c VALUES:

The bearing capacity of Granular soil depends upon the unit weight and angle of internal friction of the soil. These two properties of granular soil are determined by standard penetration tests.

The safe bearing pressure or net soil pressure q_p for specified settlements is the intensity of loading which causes a permissible or specified settlement of the foundation (IS 6403:1981)

The allowable bearing pressure based on tolerable settlement has been established empirically by Terzaghi and Peck, 1948 and may be expressed by,

$$q_p=34.3*(N-3)*\{(B+0.3)/2B)\}^2 * R_{w2} * R_d kN/m^2$$

q_p= allowable net increase in soil pressure over existing soil pressure for settlement of 25mm

N= standard penetration number with applicable corrections.

B= width of footing (or least lateral dimensions), in meters.

P= permissible settlement=25mm

R_{w2}= water reduction factor=$0.5(1+(Z_{w2}/B))$

R_d=depth factor=$(1+(0.2D/B))<= 1.20$

10.0 EVALUATION OF LOAD-CARRYING CAPACITY OF PILES (IS2911 PART-I)-2010

USE OF STANDARD PENETRATION TEST DATA FOR COHESIONLESS SOIL

The correlation suggested by Meyerhof using standard penetration resistance, N in saturated cohesionless soil to estimate the ultimate load capacity of bored pile is given below. The ultimate load capacity of pile (Qu), in kN, is given as:

$$Qu = 13N\frac{L}{B}A_P + \frac{\bar{N}As}{0.50}$$

The first term gives end-bearing resistance and the second term gives frictional resistance.

Where

N= average N value at pile tip;

L = length of penetration of pile in the bearing strata in m

B = diameter or minimum width of pile in m;

Ap = cross-sectional area of pile tip, in m^2;

$\bar{N}$= average N along the pile shaft; and

As = surface area of pile shaft, in m^2.

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NOTE — The end-bearing resistance should not exceed 130 NA_p.

For non-plastic silt or very fine sand the equation has been modified as:

$$Qu = 10N\frac{L}{B}A_P + \frac{\bar{N}As}{0.60}$$

The meaning of all terms is same as above equation

11.0 CONCLUSIONS

The geotechnical field investigation conducted at BH-01, BH-02 location revealed that the intact bed rock formation is at an average depth of below **7.50m.**

Note: Structural Capacity of foundation shall also be verified by the structural designer and allowable load on foundation should be limited to the minimum of geotechnical and structural capacities.

12.0 REFERENCES

- IS 1892-1979 (Reaffirmed 2002): Code of Practice for subsurface Investigation for foundation.
- IS 2131-1981 (Reaffirmed 2002): Method of Standard Penetration Test for soil.
- IS 1498-1970 (Reaffirmed 2007): Classification and identification of sample for general engineering purpose
- IS 2720 Part 2-1973 ((Reaffirmed 2015): Method of test for soils-Determination of water content.
- IS 2720 Part 3-1980 ((Reaffirmed 2011): Method of test for soils-Determination of specific gravity-Fine, Medium and Coarse-grained soil.
- IS 2720 Part 4-1985 (Reaffirmed 2015): Method of test for soils-Grain size analysis
- IS 2720 Part-5 (Reaffirmed-2015): Method of test for soils- Atterberg limit tests on soil
- IS 2720 Part 13: Method of test for soil- Direct shear test
- IS 11315 Part 11- Core Recovery & Rock Quality Designation
- IS 9179 — Method for Preparation of rock specimen for laboratory testing
- IS 14593: 1998(Reaffirmed 2003): Design and construction of bored cat-in situ piles founded on Rocks-Guidelines
- IS 2911 Part-1:2010: Design and construction of pile foundations.

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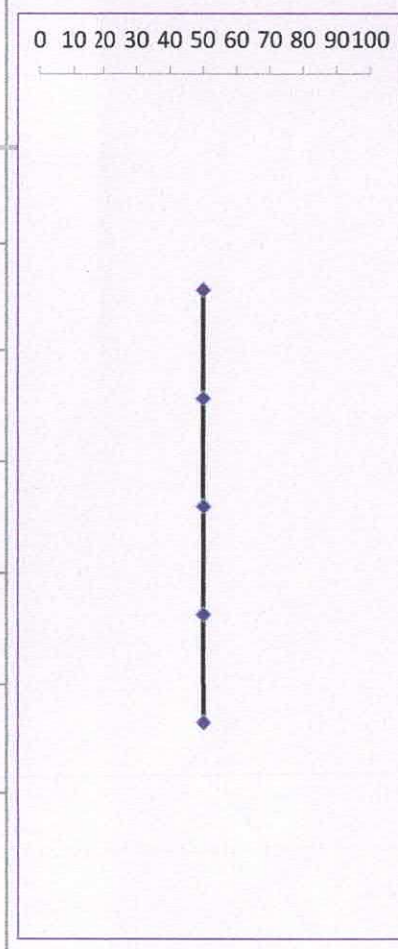
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BORE LOG SHEET

Reference	**:S146-BH 1**	**Total Depth**	**:7.50m**
Type of Boring	**:ROTARY**	**Start Date**	**:20.11.2023**
Dia of Boring	**:100mm**	**End Date**	**:20.11.2023**
Depth of GWT	**:Not Encountered**		

Depth from Ground Level	Description of Soil (Visual Identification)	SPT Details						Graphical Representation of SPT
		Soil Profile	Type	15	30	45	N	
0.00m	Fine to Medium Sand		SPT	–	–	–	–	
1.50 m	Gravelly Sand		SPT	>50	-	-	>50	
3.00 m	Gravelly Sand		SPT	>50	-	-	>50	
4.50 m	Soft Disintegrated Rock		SPT	>50	-	-	>50	
6.00 m	Soft Disintegrated Rock		SPT	>50	-	-	>50	
7.50 m	Weatheared Rock		SPT	>50	-	-	>50	



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BORE LOG SHEET

Reference	**:S146-BH 2**	**Total Depth**	**:7.00m**
Type of Boring	**:ROTARY**	**Start Date**	**:20.11.2023**
Dia of Boring	**:100mm**	**End Date**	**:20.11.2023**
Depth of GWT	**:Not Encountered**		

Depth from Ground Level	Description of Soil (Visual Identification)	SPT Details						Graphical Representation of SPT
		Soil Profile	Type	15	30	45	N	0 10 20 30 40 50 60 70 80 90100
0.00m	Fine to Medium Sand		SPT	–	–	–	–	
1.50 m	Fine to Medium Sand		SPT	>50	-	-	>50	
3.00 m	Gravelly Sand		SPT	>50	-	-	>50	
4.50 m	Soft Disintegrated Rock		SPT	>50	-	-	>50	
6.00 m	Soft Disintegrated Rock		SPT	>50	-	-	>50	
7.00 m	Weatheared Rock		SPT	>50	-	-	>50	

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TEST REPORT

Test Report No: S146-2023 | **BH-1** | **Date:** :20.11.2023

Sample ID	Depth (m)	Soil Parameters: Grain Size Analysis: Gravel %	Sand %	Silt & Clay %	Atterberg Limits: Liquid Limit %	Plastic Limit %	Plasticity Index %	Physical Parameters: Density kN/m^3	Water Content %	Specific Gravity	Free Swell Index %	Standard Penetration Test: Depth of Testing	Observed N Value	Corrected N Value	SBC (T/m^2)
S146-23/ BH1	0.00	-	-	-	-	-	-	-	-	-	-	0.00	-	-	-
S146-23/ BH1	1.50	28.29	68.29	3.41	NP	NP	NP	18	13.58	2.76	-	1.50	50	50	34.82
S146-23/ BH1	3.00	-	-	-	-	-	-	19	-	-	-	3.00	50	50	34.82
S146-23/ BH1	4.50	-	-	-	-	-	-	21	-	-	-	4.50	50	50	34.82
S146-23/ BH1	6.00	-	-	-	-	-	-	21	-	-	-	6.00	50	50	34.82
S146-23/ BH1	7.50	-	-	-	-	-	-	23	-	-	-	7.50	50	50	34.82

		Depth	Core Recovery (%)	Rock Quality Designation	Allowable Bearing Pressure (T/m^2)
S146-23/ BH1	7.50	7.50 m	13	-	-

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TEST REPORT

Test Report No: S146-2023 | **BH-2** | **Date:** :20.11.2023

Sample ID	Depth (m)	Soil Parameters						Physical Parameters				Standard Penetration Test			
		Grain Size Analysis			Atterberg Limits			Density kN/m^3	Water Content %	Specific Gravity	Free Swell Index %	Depth of Testing	Observed N Value	Corrected N Value	SBC (T/m^2)
		Gravel %	Sand %	Silt & Clay %	Liquid Limit %	Plastic Limit %	Plasticity Index %								
S146-23/ BH2	0.00	-	-	-	-	-	-	-	-	-	-	0.00	-	-	-
S146-23/ BH2	1.50	3.79	94.58	1.62	NP	NP	NP	18	16.82	2.76	-	1.50	50	50	34.82
S146-23/ BH2	3.00	-	-	-	-	-	-	19	-	-	-	3.00	50	50	34.82
S146-23/ BH2	4.50	-	-	-	-	-	-	21	-	-	-	4.50	50	50	34.82
S146-23/ BH2	6.00	-	-	-	-	-	-	21	-	-	-	6.00	50	50	34.82
S146-23/ BH2	7.00	-	-	-	-	-	-	23	-	-	-	7.00	50	50	34.82

		Depth	Core Recovery (%)	Rock Quality Designation	Allowable Bearing Pressure (T/m^2)
S146-23/ BH2	7.00	7.00 m	17.5	-	-

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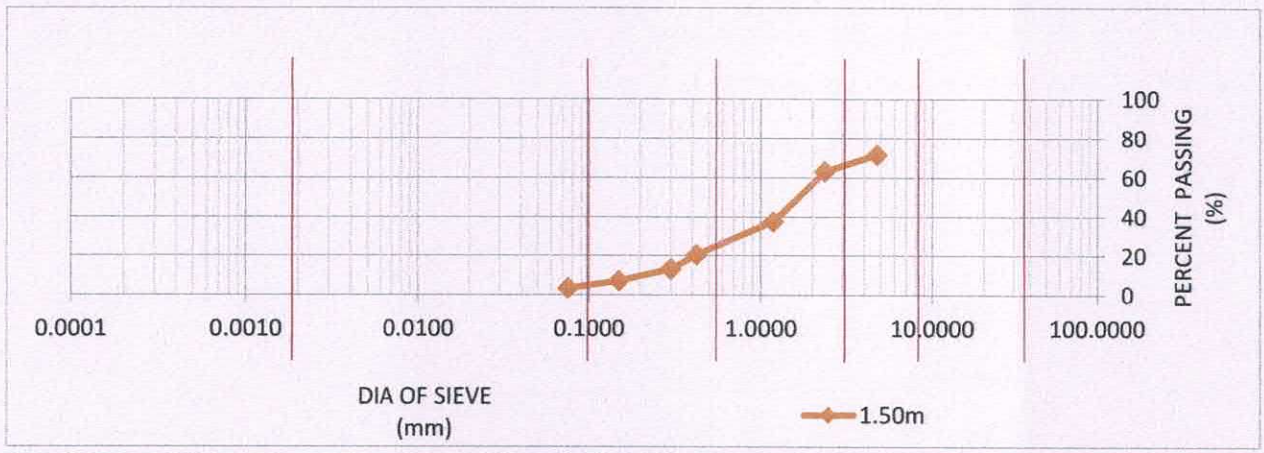
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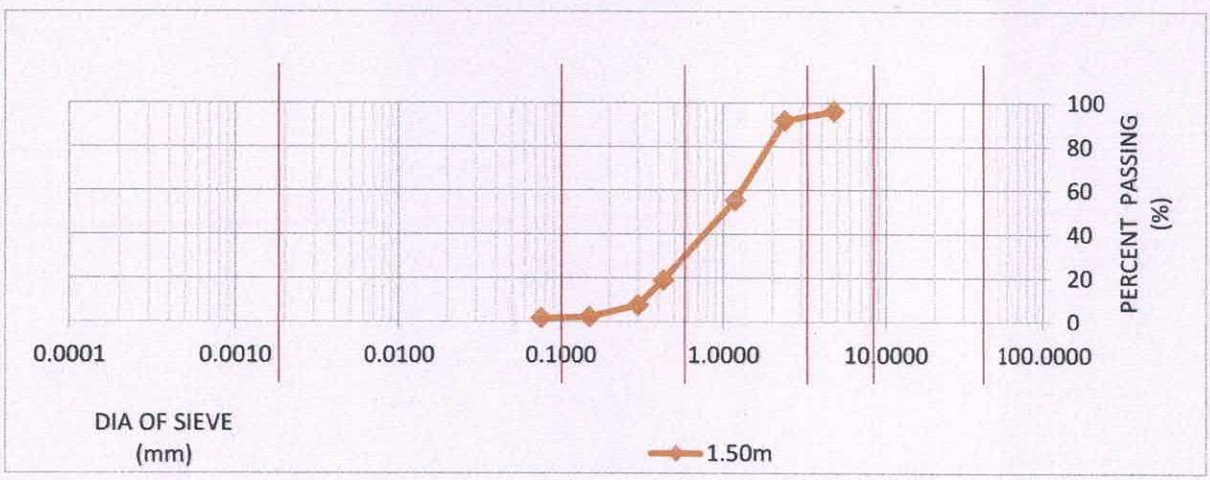
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MSME Registration No: UDYAM-TN-18-0038413
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GRAIN SIZE ANALYSIS (IS 2720 PART IV - 1985-(REAFFIRMED 2015)

REFERENCE						BH : 1	
Depth	**Gravel(%)**	**Coarse Sand(%)**	**Medium Sand(%)**	**Fine Sand(%)**	**Silt & Clay (%)**	**CU**	**CC**
1.50m	28.3	8.6	42.6	17.1	3.41	14.893	2.887



REFERENCE						BH : 2	
Depth	**Gravel(%)**	**Coarse Sand(%)**	**Medium Sand(%)**	**Fine Sand(%)**	**Silt & Clay (%)**	**CU**	**CC**
1.50m	3.8	4.3	72.9	17.3	1.62	7.898	1.789



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NATURAL MOISTURE CONTENT TEST (AS PER IS 2720 PART 2 - 1973)

Reference	BH :1	
Depth	**1.50m**	
Specimen Number	**A**	**B**
Mc = Mass Of Empty, Clean Can+Lid (Grams)	52	91
Mcms = Mass Of Can,Lid,And Moist Soil(Grams)	138	357
Mcds = Mass Of Can,Lid And Dry Soil(Grams)	129	322
Ms = Mass Of Soil Solids(Grams)	77	231
Mw = Mass Of Pore Water(Grams)	9	36
W = Water Content, W%	11.76	15.40
Average Water Content=(%)	**13.58**	
Reference	**BH :2**	
Depth	**1.50m**	
Specimen Number	**A**	**B**
Mc = Mass Of Empty, Clean Can+Lid (Grams)	14	83
Mcms = Mass Of Can,Lid,And Moist Soil(Grams)	179	242
Mcds = Mass Of Can,Lid And Dry Soil(Grams)	158	217
Ms = Mass Of Soil Solids(Grams)	144	134
Mw = Mass Of Pore Water(Grams)	22	25
W = Water Content, W%	14.98	18.66
Average Water Content=(%)	**16.82**	

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SPECIFIC GRAVITY TEST (AS PER IS 2720 (PART 3)- 1980)

Reference	**BH:1**	
Depth	**1.50m**	
Specimen Number	A	B
Wp= Mass Of Empty, Clean Pycnometer(Grams)	18	38
Wps= Mass Of Emplty Pycnometer+Dry Soil (Grams)	38	58
Wb=Mass Of Pycnometer+Dry Soil+Water(Grams)	91	103
Wa= Mass Of Pycnometer + Water (Grams)	78	90
Specific Gravity(Gs)=	2.67	2.86
Average Value, (Gs)=	**2.76**	
Reference	**BH:2**	
Depth	**1.50m**	
Specimen Number	A	B
Wp= Mass Of Empty, Clean Pycnometer(Grams)	38	18
Wps= Mass Of Emplty Pycnometer+Dry Soil (Grams)	58	38
Wb=Mass Of Pycnometer+Dry Soil+Water(Grams)	103	91
Wa= Mass Of Pycnometer + Water (Grams)	90	78
Specific Gravity(Gs)=	2.67	2.86
Average Value, (Gs)=	**2.76**	

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SAFE BEARING CAPACITY BASED ON SPT

Reference		**S146-23 BH 1**			
Starting Depth		**1.50 m**			
Ending Depth		**6.00 m**			
Depth (m)	**Profile**	**N Values**	**FOS**	**Density (kN/m^3)**	**SBC (kN/m^2)**
1.50	**Gravelly Sand**	50	3	18	**348**
3.00	**Gravelly Sand**	50	3	19	**348**
4.50	**Soft Disintegrated Rock**	50	3	21	**348**
6.00	**Soft Disintegrated Rock**	50	3	21	**348**
7.50	**Weatheared Rock**	50	3	23	**348**
Reference		**S146-23 BH 2**			
Starting Depth		**1.50 m**			
Ending Depth		**7.00 m**			
Depth (m)	**Profile**	**N Values**	**FOS**	**Density (kN/m^3)**	**SBC (kN/m^2)**
1.50	**Fine to Medium Sand**	50	3	18	**348**
3.00	**Gravelly Sand**	50	3	19	**348**
4.50	**Soft Disintegrated Rock**	50	3	21	**348**
6.00	**Soft Disintegrated Rock**	50	3	21	**348**
7.00	**Weatheared Rock**	50	3	23	**348**

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BH1





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BH-2





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Our services go beyond

Buying & Selling Services

Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.

Smarter Tools, Stronger Decisions

Property Valuation & Cost Estimation

Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

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