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(NABL accredited Laboratory as per ISO / IEC 17025-2017)

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SOIL INVESTIGATION REPORT

SOIL INVESTIGATION WORKS AND LABORATORY TESTING SERVICES FOR THE CONSTRUCTION OF **RESIDENTIAL BUILDING AT MADAKULAM VILLAGE IN THIRUPARANKUNDRAM TALUK OF MADURAI DISTRICT.**

REPORT No: 57 / GRB / GMC / 23-24	DATE : 28.05.2023	REV : 0

LOCATION : **S.WARD NO :22, BLOCK 34, T.S. NO 4/47, 6/64 & S.WARD NO :04, BLOCK 49, T.S. NO 7/1 (OLD RS NO 19/1pt,2pt,3pt & 220/5A) WARD NO.60 ZONE - 3**

VILLAGE : MADAKULAM

TALUK : THIRUPARANKUNDRAM

DISTRICT : MADURAI

CLIENT : **Mrs. S. VASUKI.**

96, THIRUVALLUVAR STREET ,

JEYA NAGAR 4TH STREET, PONMENI,

MADURAI – 625016..

REPORT NO: 57 / GRB /GMC/ 23-24 DATED: 28.05.2023

To

Mrs. S. VASUKI.

96, Thiruvalluvar Street, Jeya Nagar 4th Street,

Ponmeni, Madurai – 625016.

Respected Sir/Madam,

Sub: Submission Soil investigation Report – Reg

Name of work: Conducting Sub soil investigation works for the Construction of **RESIDENTIAL BUILDING** at Madakulam Village in Thiruparankundram Taluk of Madurai District

* * * * * * * * *

We appreciate the opportunity of service to you on this project and trust this reports meet your needs at this time. This report summarizes the result of our investigation and contains geotechnical recommendations for design and construction of this project.

Based on the result of our geotechnical investigation, we believe that the proposed project is feasible from a geotechnical point of concern, provided the recommendations in this report are incorporated in the design and implemented during earthwork and construction of the project.

If you have any queries regarding this report, please contact us. We look forward to being of further assistance as construction begins.

No of Pages in this Report: 34

Respectfully submitted

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REPORT ON SUB-SOIL INVESTIGATION

1. INTRODUCTION:

Mrs. S. VASUKI, residing at 96, Thiruvalluvar Street, Jeya Nagar 4th Street, Ponmeni, Madurai has to construct a **RESIDENTIAL BUILDING** at Ellis Nagar, Madurai. In order to get adequate data required for designing the foundations, they have conducted the sub-soil Investigation and collect the samples to determine the foundation design parameters.

M/S.GEOMATRIX CONSULTANCY, Madurai, were entrusted with the work of conducting Sub-soil investigation, laboratory testing and preparing report with SBC Calculations and test results.

2. SCOPE OF WORK: The Scope of work includes the following:

- Making **four** borehole of 150 mm dia using rotary driller to a depth of **10 m** or up to 1.00 m core drilling in hard rock whichever is met earlier.
- Conducting Standard penetration test as per **IS 2131-1981**(Reaffirmed 2002) at every **1.00 m /1.50m depth** intervals or change of soil strata and collecting disturbed /un disturbed soil samples.
- Conducting various laboratory tests on collected samples.
- Submitting recommendation for type and depth of foundation.
- Submitting report with SBC and settlement Calculations & laboratory test results in **two** hard copies.

3. LOCATION & DESCRIPTION OF STRUCTURE:

The Construction of **RESIDENTIAL BUILDING** located at **S.Ward No :22, Block 34, T.S. No 4/47, 6/64 & S.Ward No:04, Block 49, T.S. No 7/1 (Old Rs No 19/1pt,2pt,3pt & 220/5a) Ward No.60 Zone - 3** Madakulam Village in Thiruparankundram Taluk of Madurai District, Madurai.

As per the details issued by the client, the proposed construction is a RCC structure and the unit will be comprised of reinforced concrete elements (Column, Beam, Slab & etc.)

4. SOIL INVESTIGATION: The details of field investigation, tests carried out in the field & laboratory are presented as follows

4.1 FIELD SAMPLING: **Four** boreholes of 150 mm dia were made using Rotary drilling machine in this site on **28.05.2023 & 29.05.2023.** SPT's was conducted at every 1.00 m / 1.50 m depth intervals and the disturbed and undisturbed samples were collected for identification and testing.

4.2 METHOD OF INVESTIGATION:

4.2.1 EXPLORATORY BORE HOLE:

Exploratory borehole was advanced using rotary washing method so that minimum disturbance is attributed to the soil below the boring depth. Borehole was always kept filled with drilling mud to prevent any negative hydrostatic pressure within the borehole. Boring through the soil was performed using TC bit & diamond drill bit with side jets for drilling mud. Standard penetration tests, disturbed sampling, field identification of soil & rock samples, etc., was carried out in these bore holes.

4.2.2 STANDARD PENETRATION TEST:

PT was conducted at different depth in the borehole. SPT split spoon sampler of standard size was driven into the soil from borehole bottom using 63.5kg hammer falling from 75cm height. Blow counts for the penetration of every 15cm were recorded and the **N** is reported as the blow counts for 30cm penetration of the sampler leaving the first 15cm penetration as seating drive. SPT was conducted at a depth interval of 1.0m below the ground level.

4.2.3 SAMPLING IN BORE HOLES:

Soil collected in the SPT sampler is preserved in polythene covers and transported to laboratory. One more polythene cover was provided to prevent the loss of moisture during the transit period. Rock samples also collected using double tubes core Barrel and preserving in wooden core boxes and transported to laboratory to conduct various tests.

5. DESCRIPTION OF GROUND WATER TABLE:

Ground water table was not encountered at during investigation.

6. LABORATORY TESTS: The collected soil samples were tested in **ISO 17025: 2017, NABL** Quality control Certified Laboratory as per relevant procedure in IS codes. The laboratory-testing scheme is so designed to obtain the design parameters for the foundations. The following parameters are evaluated:

- **Natural Moisture Content:** This test is conducted in all disturbed samples to find the water content in the soil samples as per **IS 2720 (Part 2) : 1973**
- **Specific Gravity:** This test is conducted in all disturbed soil samples to find Specific gravity of Soil as per **IS 2720 (Part 3) : 1980**
- **Sieve Analysis:** These test conducted to identify and classify the samples as per **IS 2720 (Part 4) : 1985**
- **Liquid Limit:** This test conducted in fine-grained soils to find the liquid Limit of the soil as per **IS 2720 (Part 5) : 1985**
- **Plastic Limit:** This test conducted in fine-grained soil to find plastic limit of the soil as per **IS 2720 (Part 5) : 1985**
- **Direct Shear Test:** This test conducted in coarse-grained soil to find the angle of shearing resistance of the soil as per **IS 2720 (Part 13) : 1986**
- **Unconfined Compression Test:** This test conducted in fine-grained soil to find Cohesion of the soil as per **IS 2720 (Part 10): 1991.** All the test results are presented in **Tables 1 to 4.**

7. DISCUSSION ON SOIL PROFILE: Based on the field and Lab test results, it's concluded that,

In **BH-1** the sub soil profile consists of Brown coloured **Clay mixed with Sand** (0.00-4.00), Brown coloured **Sand mixed with Gravel** (4.00-4.13), followed by **Soft Disintegrated Rock**(4.13-10.00). In **BH-2** the sub soil profile consists of Brown coloured **Sand mixed with Clay** (0.00-1.00), Brown coloured **Clay mixed with Sand** (1.00-3.00), Brown coloured **Sand mixed with Clay** (3.00-3.24), Brown coloured **Dense Sand mixed with Clay** (3.24-5.50), followed by **Soft Disintegrated Rock** (5.50-10.00). In **BH-3** the sub soil profile consists of Brown coloured **Clay mixed with Sand** (0.00-1.00), Brown coloured **Sand mixed with Clay** (1.00-2.00), Grey coloured **Clay mixed with Sand** (2.00-3.00), Brown coloured **Sand mixed with Clay** (3.00-4.00), Brown coloured **Sand** (4.00-4.14), followed by **Soft Disintegrated Rock**(4.14-10.00).In **BH-4** the sub soil profile

consists of Brown coloured **Clay mixed with Sand** (0.00-3.25), followed by **Soft Disintegrated Rock**(3.25-10.00).The detailed Layer formations are presented in **Tables 1 to 4** and also in **Fig 2.**

8. ABSTRACT OF SBC CALCULATIONS: The summary of safe bearing capacity calculated is presented as follows:

BH No	Safe Bearing Capacity in kN / m2 at the depth of							
	1.50 m	1.80 m	2.10 m	2.40 m	2.70 m	3.00 m	3.30 m	3.60 m
1	150.72	158.05	169.77	176.41	183.05	189.57	204.29	211.19
2	144.06	151.75	174.02	181.83	189.81	197.75	263.22	277.30
3	163.36	173.24	168.48	176.78	185.04	193.42	269.82	283.43
4	155.24	163.11	153.85	159.72	165.59	171.47	487.17	537.39
Recommended SBC in kN / m2	**144.00**	**151.00**	**153.00**	**159.00**	**165.00**	**171.00**	**204.00**	**211.00**

9. RECOMMENDATIONS: Based on the SBC and settlement calculations, site investigations the recommendations for foundation are as follows:

1) **ISOLATED COLUMN FOOTING** is recommended.
2) The recommended safe bearing capacities at every **0.30 m** interval from **1.50 m to 3.60 m** are presented above to design the foundation according to the load conditions and structural requirements.
3) For these Safe bearing capacity, the settlement also **within** the allowable limits (The SBC and Settlement calculations are presented at the end of this report)
4) Due to presence of Sand in the top layers, there are chances for **Soil sliding** occurs during earthwork excavation, Hence **proper precautions** will be followed during execution of foundation.
5) The foundation concrete shall be laid in dry condition if meets the water table during the execution.
6) The excavated soil for foundation is **suitable** for back filling.

Station: Madurai.

Date : 02.06.2023

LOCATION MAP

LOCATION :

S.WARD NO :22, BLOCK 34, T.S. NO 4/47, 6/64 & S.WARD NO :04, BLOCK 49,

T.S. NO 7/1 (OLD RS NO 19/1pt,2pt,3pt & 220/5A) WARD NO.60 ZONE - 3

VILLAGE : MADAKULAM

TALUK : THIRUPARANKUNDRAM

DISTRICT : MADURAI

GPS COORDINATES

BH-1: N 09^0 54' 42.79", E 78^0 05' 59.12"

BH-2: N 09^0 54' 42.55", E 78^0 05' 59.05"

BH-3: N 09^0 54' 42.71", E 78^0 05' 58.12"&

BH-4: N 09^0 54' 42.54", E 78^0 05' 58.03"

N

NOT TO SCALE

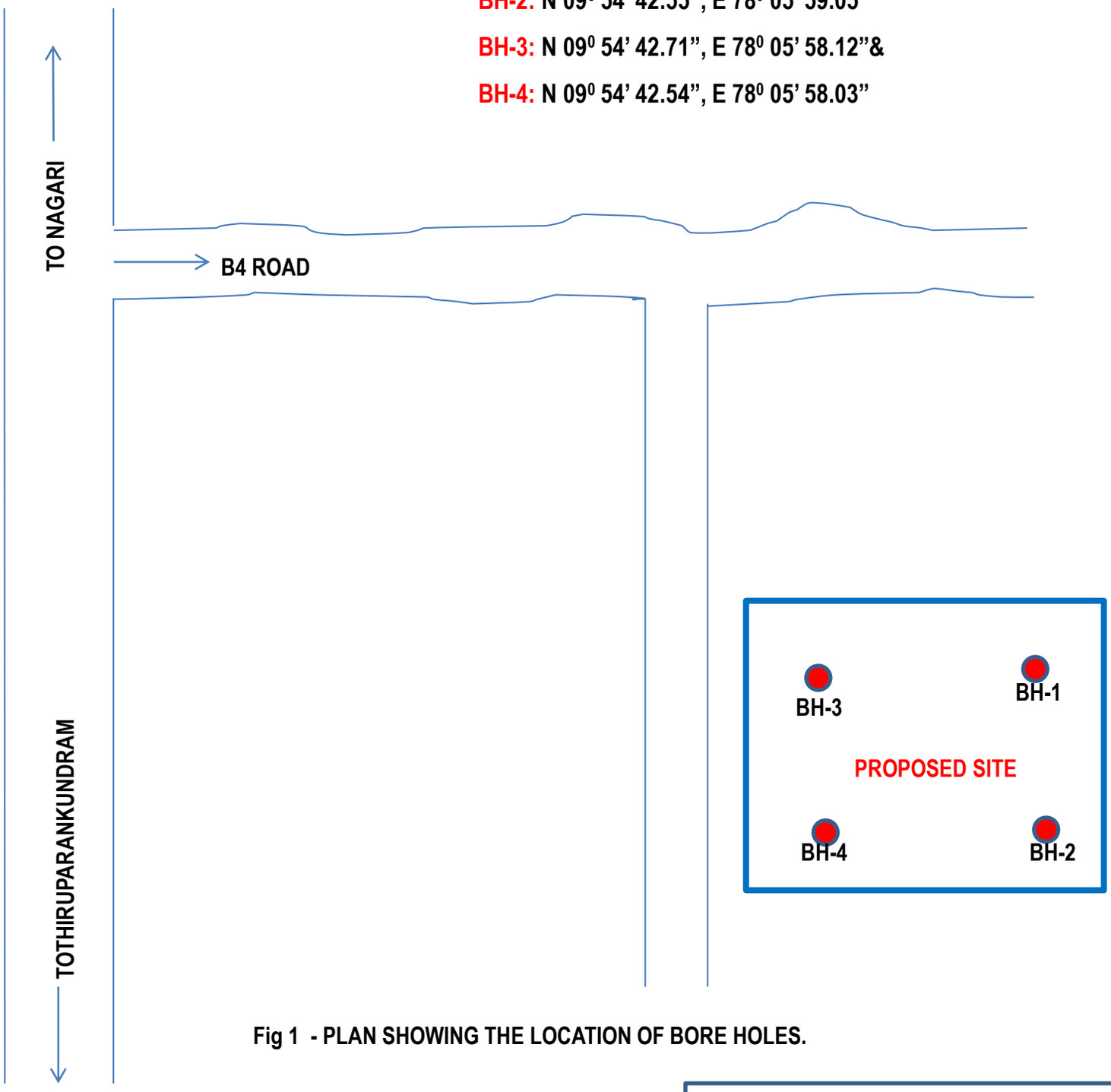


Fig 1 - PLAN SHOWING THE LOCATION OF BORE HOLES.

LEGEND :

— BORE HOLE LOCATION

PREPARED BY

GEOMATRIX CONSULTANCY

(An 17025: 2017, NABL Certified Firm)

No.22, Thomas Street,

Narimedu, Madurai - 625 002.

TITLE OF PROJECT

CONSTRUCTION OF **RESIDENTIAL BUILDING AT MADAKULAM VILLAGE IN THIRUPARANKUNDRAM TALUK OF MADURAI DISTRICT.**

GEOMATRIX CONSULTANCY
Geo-Tech Consultants & Engineers

Fig : 2A- VERTICAL SOIL PROFILE at BOREHOLE-1 LOCATION

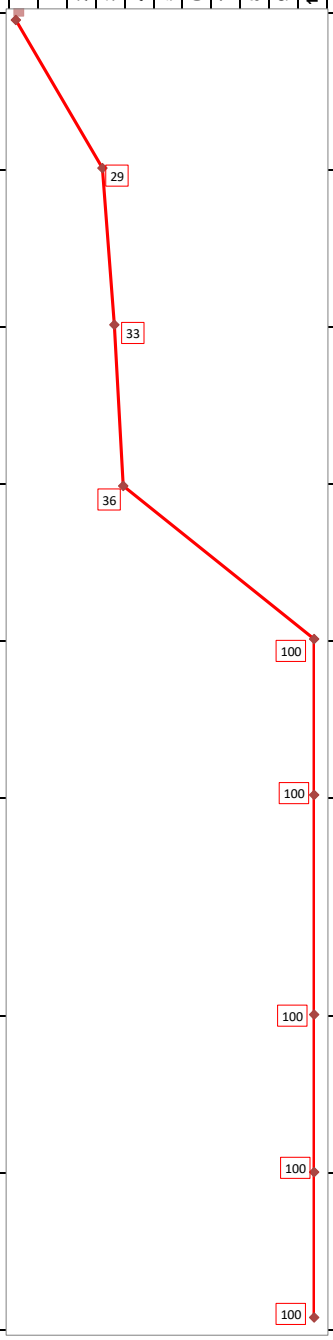
Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District.

Report No	57/ GRB/ 2023-24 Dt :28.05.2023	**Dia of Boring**	150 mm
Bore Hole No.	1	**Total depth**	10.00 m
Type of Boring	Rotary	**Depth of Water Table**	NOT ENCOUNTED
Started on	28.05.2023	**Co - ordinates**	N 09^0 54' 42.79"
Ended on	28.05.2023		E 78^0 05' 59.12"

BORELOG SHEET

Depth from Ground level	Soil Profiles	Description of Soil	Depth (m)	Type	15	30	45	N	Type of Samples
-1.00 m		Brown coloured **Clay mixed with Sand**	1.00	SPT	15	15	14	**29**	DS
-2.00 m			2.00	SPT	12	14	19	**33**	DS
-3.00 m			3.00	SPT	15	17	19	**36**	DS
-4.00 m			4.00	SPT	5 cm for 50 blows			**>100**	DS
-4.10 m		Brown coloured **Sand mixed with Gravel**	4.10	SPT	3 cm for 50 blows			**>100**	DS
-4.13 m			4.13						
-7.00 m		**SOFT DISINTEGRATED ROCK (CR = 0%& RQD = 0%)**	7.00	SPT	2 cm for 50 blows			**>100**	WS
-8.50 m			8.50	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS
10.00 m			10.00	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS

Graphical Representation of SPT (N value)



DS - Disturbed soil sample

WS -Washing Sample

CR = Core Recovary

RQD = Rock Quality Designation

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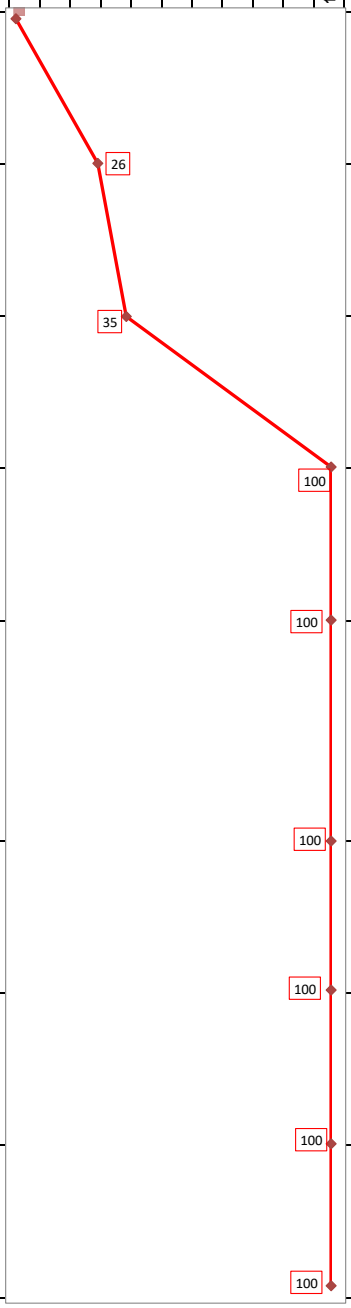
Fig : 2B- VERTICAL SOIL PROFILE at BOREHOLE-2 LOCATION

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District.

Report No	57/ GRB/ 2023-24 Dt :28.05.2023	**Dia of Boring**	150 mm
Bore Hole No.	2	**Total depth**	10.00 m
Type of Boring	Rotary	**Depth of Water Table**	NOT ENCOUNTED
Started on	28.05.2023	**Co - ordinates**	N 09^0 54' 42.55"
Ended on	28.05.2023		E 78^0 05' 59.05"

BORELOG SHEET

Depth from Ground level	Soil Profiles	Description of Soil	Depth (m)	Type	15	30	45	N	Type of Samples
-1.00 m		Brown coloured **Sand mixed with Clay**	1.00	SPT	17	12	14	**26**	DS
-2.00 m		Brown coloured **Clay mixed with Sand**	2.00	SPT	14	17	18	**35**	DS
-3.00 m			3.00	SPT	8 cm for 50 blows			**>100**	DS
-3.20 m		Brown coloured **Sand mixed with Clay**	3.20	SPT	4 cm for 50 blows			**>100**	DS
-3.24 m			3.24						
-5.50 m		Brown coloured **Dense Sand mixed with Clay**	5.50	SPT	2 cm for 50 blows			**>100**	DS
-7.00 m		**SOFT DISINTEGRATED ROCK (CR = 0%& RQD = 0%)**	7.00	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS
-8.50 m			8.50	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS
10.00 m			10.00	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS



DS - Disturbed soil sample

WS -Washing Sample

CR = Core Recovary

RQD = Rock Quality Designation

GEOMATRIX CONSULTANCY
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Fig : 2C- VERTICAL SOIL PROFILE at BOREHOLE-3 LOCATION

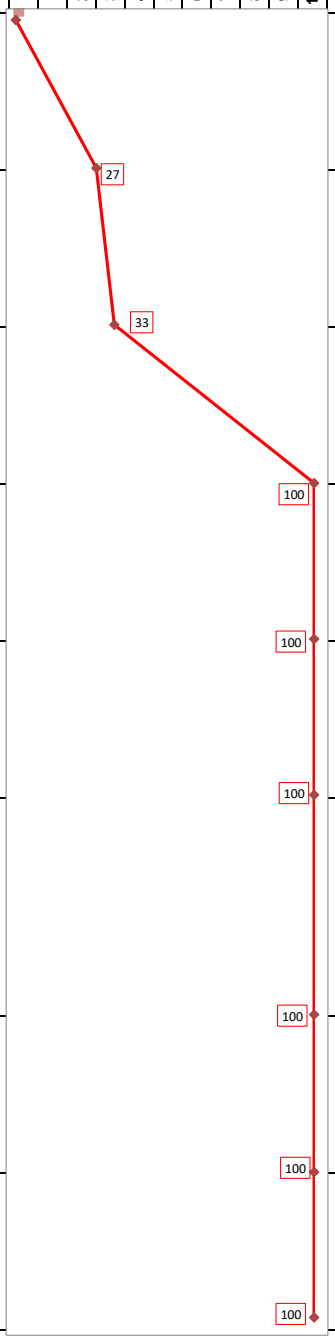
Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District.

Report No	57/ GRB/ 2023-24 Dt :28.05.2023	**Dia of Boring**	150 mm
Bore Hole No.	3	**Total depth**	10.00 m
Type of Boring	Rotary	**Depth of Water Table**	NOT ENCOUNTED
Started on	29.05.2023	**Co - ordinates**	N 09^0 54' 42.71"
Ended on	29.05.2023		E 78^0 05' 58.12"

BORELOG SHEET

Depth from Ground level	Soil Profiles	Description of Soil	Depth (m)	Type	15	30	45	N	Type of Samples
-1.00 m		Brown coloured **Clay mixed with Sand**	1.00	SPT	13	11	16	**27**	DS
-2.00 m		Brown coloured **Sand mixed with Clay**	2.00	SPT	14	15	18	**33**	DS
-3.00 m		Grey coloured **Clay mixed with Sand**	3.00	SPT	18	9 cm for 50 blows		**>100**	DS
-4.00 m		Brown coloured **Sand mixed with Clay**	4.00	SPT	11 cm for 50 blows			**>100**	DS
-4.10 m		Brown coloured **Sand**	4.10	SPT	4 cm for 50 blows			**>100**	DS
-4.14 m			4.14						
-7.00 m		**SOFT DISINTEGRATED ROCK (CR = 0%& RQD = 0%)**	7.00	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS
-8.50 m			8.50	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS
10.00 m			10.00	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS

Graphical Representation of SPT (N value)



DS - Disturbed soil sample

WS -Washing Sample

CR = Core Recovary

RQD = Rock Quality Designation

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Fig : 2D- VERTICAL SOIL PROFILE at BOREHOLE-4 LOCATION

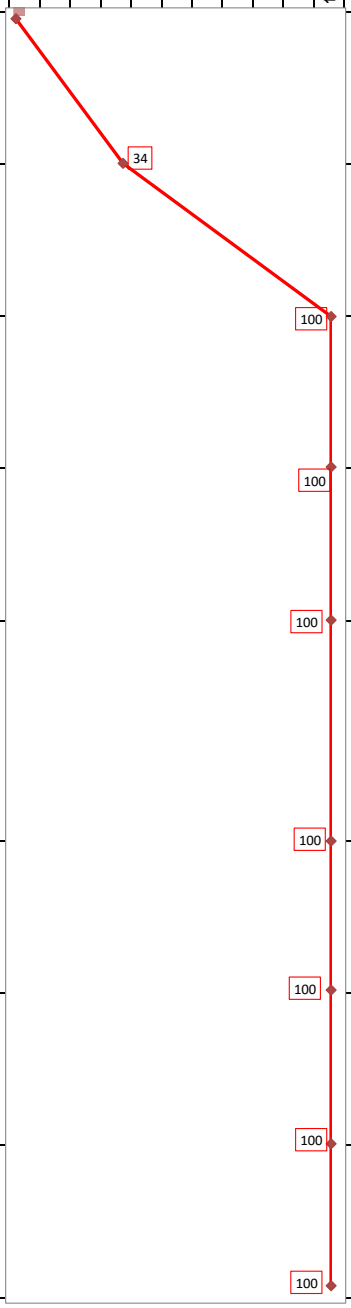
Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District.

Report No	57/ GRB/ 2023-24 Dt :28.05.2023	**Dia of Boring**	150 mm
Bore Hole No.	4	**Total depth**	10.00 m
Type of Boring	Rotary	**Depth of Water Table**	NOT ENCOUNTED
Started on	29.05.2023	**Co - ordinates**	N 09^0 54' 42.54"
Ended on	29.05.2023		E 78^0 05' 58.03"

BORELOG SHEET

Depth from Ground level	Soil Profiles	Description of Soil	Depth (m)	Type	15	30	45	N	Type of Samples
-1.00 m		Brown coloured **Clay mixed with Sand**	1.00	SPT	17	16	18	**34**	DS
-2.00 m			2.00	SPT	13	19	12 cm for 50 blows	**>100**	DS
-3.00 m			3.00	SPT	9 cm for 50 blows			**>100**	DS
-3.20 m			3.20	SPT	5 cm for 50 blows			**>100**	DS
-3.25 m			3.25						
-5.50 m		**SOFT DISINTEGRATED ROCK (CR = 0%& RQD = 0%)**	5.50	SPT	2 cm for 50 blows			**>100**	WS
-7.00 m			7.00	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS
-8.50 m			8.50	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS
10.00 m			10.00	SPT	SPT REBOUND (NO PENETRATION)			**>100**	WS

Graphical Representation of SPT (N value)



DS - Disturbed soil sample

WS -Washing Sample

CR = Core Recovary

RQD = Rock Quality Designation

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SUMMARY OF LAB TEST RESULTS

Report No:57/ GRB/ 2023-24 Dt :28.05.2023

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

TABLE-1

BH No : 1

Depth of soil (m)		Soil Description	Type of sample collected	IS Classification	Grain Size Analysis (%)					Index Properties (%)				Bulk Density (KN/m^3) γ_w	Dry Density (KN/m^3) γ_d	Porosity (%) n	Voids ratio (%) e	Specific Gravity	Cohesion "C" in (Kg/cm^2)	Angle of friction (ø)
From	To				Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay	NMC	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)							
0.00	1.00	Brown coloured **Clay mixed with Sand**	DS	CH	0.00	4.10	14.84	28.73	52.33	12	31.66	15.26	16.40	17.62	15.73	0.40	0.67	2.62	0.28	15.00
1.00	2.00	Brown coloured **Clay mixed with Sand**	DS	CH	0.00	10.39	4.19	21.26	64.16	21	41.32	19.89	21.43	17.69	14.62	0.44	0.79	2.61	0.37	12.00
2.00	3.00	Brown coloured **Clay mixed with Sand**	DS	CH	0.00	1.65	6.44	19.09	72.82	15	43.12	15.26	27.86	17.82	15.50	0.40	0.68	2.60	0.46	9.00
3.00	4.00	Brown coloured **Clay mixed with Sand**	DS	CH	1.24	1.67	6.01	17.83	73.25	19	40.59	24.33	16.26	17.85	15.00	0.43	0.74	2.61	0.48	9.00
4.00	4.13	Brown coloured **Sand mixed with Gravel**	DS	SW	19.23	12.05	43.17	14.96	10.59	30	NP	NP	NP	18.16	13.97	0.47	0.90	2.65	0.00	34.00
4.13	7.00	**Sand mixed with Gravel (Pieces of Soft Disintegrated Rock)**	WS	SW	24.77	17.84	45.27	12.12	0.00	26	NP	NP	NP	19.35	15.36	0.43	0.75	2.68	0.00	37.00
7.00	8.50	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	5.03	15.45	64.59	14.93	0.00	25	NP	NP	NP	19.42	15.54	0.42	0.72	2.67	0.00	37.00
8.50	10.00	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	6.27	12.54	65.65	15.54	0.00	27	NP	NP	NP	19.48	15.34	0.42	0.73	2.66	0.00	37.00

DS = Disturbed Sample NMC = Natural Moisture Content NP = Non Plastic WS= Washing Sample

GEOMATRIX CONSULTANCY
Geo-Tech. Consultants & Engineers

SUMMARY OF LAB TEST RESULTS

Report No:57/ GRB/ 2023-24 Dt :28.05.2023

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

TABLE-2

BH No : 2

Depth of soil (m)		Soil Description	Type of sample collected	IS Classification	Grain Size Analysis (%)					Index Properties (%)				Bulk Density (KN/m^3) γ_w	Dry Density (KN/m^3) γ_d	Porosity (%) n	Voids ratio (%) e	Specific Gravity	Cohesion "C" in (Kg/cm^2)	Angle of friction (ø)
From	To				Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay	NMC	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)							
0.00	1.00	Brown coloured **Sand mixed with Clay**	DS	SC	10.86	2.63	18.33	32.33	35.85	5	22.50	17.41	5.09	17.70	16.86	0.36	0.55	2.62	0.22	20.00
1.00	2.00	Brown coloured **Clay mixed with Sand**	DS	CH	6.15	3.77	11.07	24.36	54.65	19	49.22	18.71	30.51	17.76	14.92	0.43	0.74	2.60	0.31	14.00
2.00	3.00	Brown coloured **Clay mixed with Sand**	DS	CH	1.07	1.39	6.68	24.55	66.31	14	47.89	27.41	20.48	17.85	15.66	0.40	0.67	2.61	0.39	12.00
3.00	3.24	Brown coloured **Sand mixed with Clay**	DS	SC	23.37	2.81	5.70	27.56	40.56	23	22.19	15.47	6.72	17.94	14.59	0.44	0.80	2.62	0.28	18.00
3.24	5.50	Brown coloured **Dense Sand mixed with Clay**	DS	SC	20.38	9.11	12.46	25.18	32.87	20	28.31	14.73	13.58	18.23	15.19	0.42	0.74	2.64	0.24	21.00
5.50	7.00	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	8.55	23.73	52.64	15.08	0.00	27	NP	NP	NP	19.27	15.17	0.43	0.77	2.68	0.00	37.00
7.00	8.50	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	6.51	22.31	58.00	13.18	0.00	25	NP	NP	NP	19.36	15.49	0.42	0.72	2.67	0.00	37.00
8.50	10.00	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	8.61	22.32	53.34	15.73	0.00	20	NP	NP	NP	19.54	16.28	0.39	0.63	2.66	0.00	37.00

DS = Disturbed Sample NMC = Natural Moisture Content NP = Non Plastic WS= Washing Sample

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SUMMARY OF LAB TEST RESULTS

Report No:57/ GRB/ 2023-24 Dt :28.05.2023

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

TABLE-3

BH No :3

Depth of soil (m)		Soil Description	Type of sample collected	IS Classification	Grain Size Analysis (%)					Index Properties (%)				Bulk Density (KN/m^3) γ_w	Dry Density (KN/m^3) γ_d	Porosity (%) n	Voids ratio (%) e	Specific Gravity	Cohesion "C" in (Kg/cm^2)	Angle of friction (ø)
From	To				Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay	NMC	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)							
0.00	1.00	Brown coloured **Clay mixed with Sand**	DS	CH	1.39	1.62	6.38	18.84	71.77	13	35.66	27.41	8.25	17.38	15.38	0.41	0.68	2.59	0.41	9.00
1.00	2.00	Brown coloured **Sand mixed with Clay**	DS	SC	13.90	3.45	13.06	26.67	42.92	19	25.13	16.67	8.46	17.55	14.75	0.44	0.78	2.62	0.27	18.00
2.00	3.00	Grey coloured **Clay mixed with Sand**	DS	CH	4.09	2.94	11.03	26.83	55.11	21	29.49	21.70	7.79	17.69	14.62	0.44	0.79	2.61	0.33	14.00
3.00	4.00	Brown coloured **Sand mixed with Clay**	DS	SC	0.15	3.22	27.30	29.59	39.74	17	23.41	18.10	5.31	17.74	15.16	0.43	0.74	2.64	0.28	20.00
4.00	4.14	Brown coloured **Sand**	DS	SP	2.02	11.19	59.49	23.15	4.15	20	NP	NP	NP	18.23	15.19	0.43	0.75	2.66	0.00	34.00
4.14	7.00	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	6.89	11.41	59.18	22.52	0.00	27	NP	NP	NP	19.49	15.35	0.43	0.75	2.68	0.00	37.00
7.00	8.50	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	8.99	16.21	57.53	17.27	0.00	18	NP	NP	NP	19.63	16.64	0.38	0.60	2.67	0.00	37.00
8.50	10.00	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	9.14	17.05	58.04	15.77	0.00	10	NP	NP	NP	19.74	17.95	0.33	0.48	2.66	0.00	37.00

DS = Disturbed Sample NMC = Natural Moisture Content NP = Non Plastic WS= Washing Sample

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SUMMARY OF LAB TEST RESULTS

Report No:57/ GRB/ 2023-24 Dt :28.05.2023

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

TABLE-4

BH No : 4

Depth of soil (m)		Soil Description	Type of sample collected	IS Classification	Grain Size Analysis (%)					Index Properties (%)				Bulk Density (KN/m^3) γ_w	Dry Density (KN/m^3) γ_d	Porosity (%) n	Voids ratio (%) e	Specific Gravity	Cohesion "C" in (Kg/cm^2)	Angle of friction (ø)
From	To				Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay	NMC	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)							
0.00	1.00	Brown coloured **Clay mixed with Sand**	DS	CH	6.78	0.57	5.00	17.66	69.99	12	33.66	22.53	11.13	17.32	15.46	0.41	0.68	2.60	0.38	9.00
1.00	2.00	Brown coloured **Clay mixed with Sand**	DS	CH	5.81	1.34	11.72	21.34	59.79	13	27.41	16.39	11.02	17.46	15.45	0.41	0.69	2.61	0.36	13.00
2.00	3.00	Brown coloured **Clay mixed with Sand**	DS	CH	4.67	1.39	6.09	13.07	74.78	21	36.77	22.53	14.24	17.52	14.48	0.44	0.79	2.59	0.44	8.00
3.00	3.25	Brown coloured **Clay mixed with Sand**	DS	CH	8.35	1.89	13.14	21.01	55.61	15	26.19	14.73	11.46	17.69	15.38	0.41	0.70	2.61	0.34	14.00
3.25	5.50	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	8.99	17.38	52.06	21.57	0.00	22	NP	NP	NP	19.02	15.59	0.41	0.71	2.66	0.00	36.00
5.50	7.00	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	4.47	14.44	52.82	28.27	0.00	11	NP	NP	NP	19.13	17.23	0.36	0.56	2.68	0.00	36.00
7.00	8.50	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	4.96	13.18	50.21	31.65	0.00	20	NP	NP	NP	19.25	16.04	0.40	0.66	2.67	0.00	37.00
8.50	10.00	**Sand(Pieces of Soft Disintegrated Rock)**	WS	SP	2.94	10.83	55.72	30.51	0.00	13	NP	NP	NP	19.44	17.20	0.35	0.55	2.66	0.00	37.00

DS = Disturbed Sample NMC = Natural Moisture Content NP = Non Plastic WS= Washing Sample

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NATURAL MOISTURE CONTENT TEST
(Test method As per IS 2720 (Part 2) - 1973)

Report No:57/ GRB/ 2023-24 Dt :28.05.2023

ANNEXURE - A

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

BH. No	**4**		**4**		**4**	
Depth	**0.50 m**		**1.00 m**		**2.00 m**	
Wt of Tare (W) gm	75.28	76.98	75.96	76.81	68.52	69.37
Tare + Wet Soil (W_1) gm	435.37	436.82	304.21	305.29	409.55	410.51
Tare + Dry Soil (W_2) gm	398.23	399.53	277.82	278.94	350.63	351.88
Wt of Water ($W_3 = W_1-W_2$) gm	37.14	37.29	26.39	26.35	58.92	58.63
Wt Dry Soil ($W_4 = W_2-W$) gm	322.95	322.55	201.86	202.13	282.11	282.51
Water Content (%) = (W_3 / W_4)*100	11.50	11.56	13.07	13.04	20.89	20.75
Average Water Content (%)	**12**		**13**		**21**	

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Name of Project: Sub Soil Investigation for the

SPECIFIC GRAVITY TEST
(Test method as per IS 2720 (Part 3) - 1980)

Report No:57/ GRB/ 2023-24 Dt :28.05.2023

ANNEXURE - B

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

BH. No	4		4		4	
Depth	**0.50 m**		**1.00 m**		**2.00 m**	
Bottle Number	1	2	1	2	1	2
Weight of empty Bottle (w_1) gm	51.53	51.53	51.53	51.53	51.53	51.53
Weight of bottle + Sample (w_2) gm	88.77	89.67	87.63	88.67	80.30	81.53
Weight of bottle + Sample + Water (w_3)gm	160.12	161.37	159.48	160.28	154.88	156.24
Weight of bottle + Water (w_4) gm	137.20	137.90	137.20	137.38	137.20	137.82
Specific Gravity = $(w_2 - w_1)/ (w_4 - w_1)-(w_3 - w_2)$	2.60	2.60	2.61	2.61	2.59	2.59
Average value for Specific Gravity	**2.60**		**2.61**		**2.59**	

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Report No:57/ GRB/ 2023-24 Dt :28.05.2023

ANNEXURE - C

Na

GRAIN SIZE ANALYSIS TEST

(Test method as per IS 2720 (Part 4) - 1985)

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

Weight of Soil taken for analysis **Ws** : 100.00 g

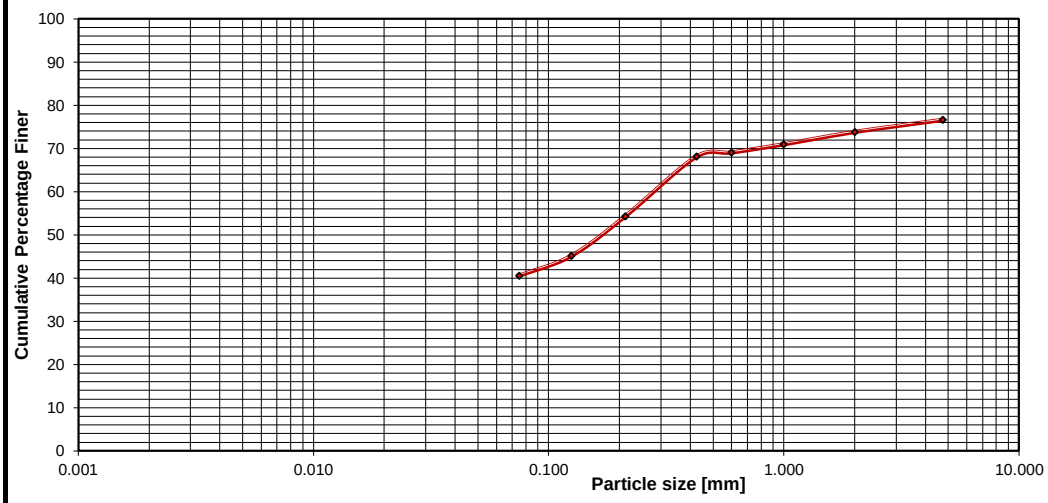
Weight of Soil more than 0.075mm IS Sieve : 59.44 g

Bore Hole No	2
Depth (m)	3.00 m

S.No.	Size of sieves	% Soil PSR % (1)	Cumulative % F % (2)	Average Sieve size (mm) (3)	Product of Columns (1) x (3)
1	4.750	23.37	76.63	4.750	111.01
2	2.000	2.81	73.82	3.375	9.48
3	1.000	2.85	70.97	1.500	4.28
4	0.600	1.90	69.07	0.800	1.52
5	0.425	0.95	68.12	0.513	0.49
6	0.212	13.78	54.34	0.319	4.39
7	0.125	9.18	45.16	0.181	1.66
8	0.075	4.60	40.56	0.113	0.52
9	passing 0.075				133.341

Average Particle Diameter = 1.3890

Clay	Silt			Sand			Gravel
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine



Soil description : Sand mixed with Clay

Based on Gradation Curve, the following sizes of Material (as per **IS 1498 - 1970**) are obtained

Classification of soil	%
Gravel	23.37
Course Sand	2.81
Medium Sand	5.70
Fine Sand	27.56
Silt & Clay	40.56

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ANNEXURE - D

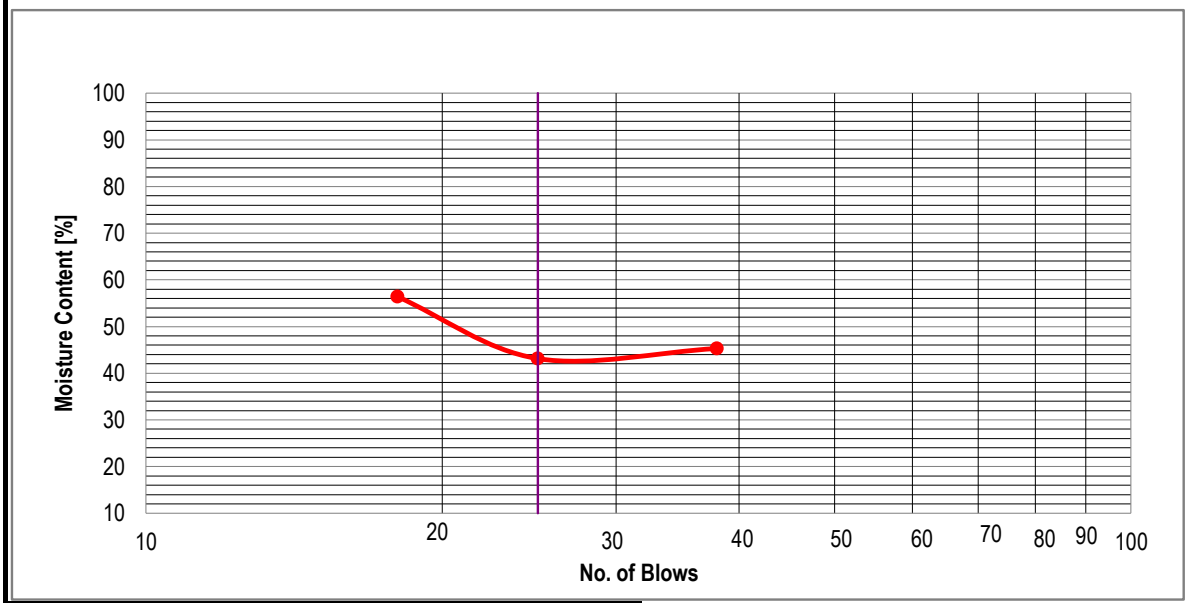
LIQUID LIMIT & PLASTIC LIMIT TEST

(Test method As per IS 2720 (Part 5) - 1985)

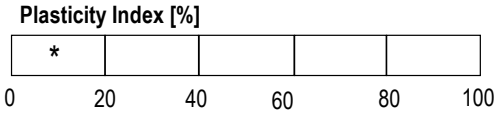
Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

Report No	57/ GRB/ 2023-24 Dt :28.05.2023
Borehole No	1
Depth	2.00 m

Description			Liquid Limit			Plastic Limit	
No. of Blows	N		18	25	38		
Weight of Wet Specimen + Container	WSC	g	66.75	79.38	72.46	77.84	82.87
Weight of Dry Specimen + Container	WDC	g	63.36	76.15	69.76	75.67	80.71
Weight of Container	WC	g	57.35	68.66	63.80	68.20	72.78
Weight of Water	WW	g	3.39	3.23	2.70	2.17	2.16
Weight of Dry Specimen	WD	g	6.01	7.49	5.96	7.47	7.93
Moisture Content	W	%	56.41	43.12	45.30	29.05	27.24



Liquid Limit	W_L	:	43.12 %
Plastic Limit	W_P	:	15.26 %
Plasticity Index	I_P	:	27.86 %



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Report No:57/ GRB/ 2023-24 Dt :28.05.2023

DIRECT SHEAR TEST
(Test method As per IS 2720 (Part 13) - 1986)

ANNEXURE: E

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

Borehole No	3
Depth (m)	4.00 m
Date of Test	31.05.2023

L.C of Dial gauge	:	0.01
Proving Ring Constant	:	0.81421
Area of the Specimen	:	36

Trail-1
Normal Stress:0.5 kg/cm^2

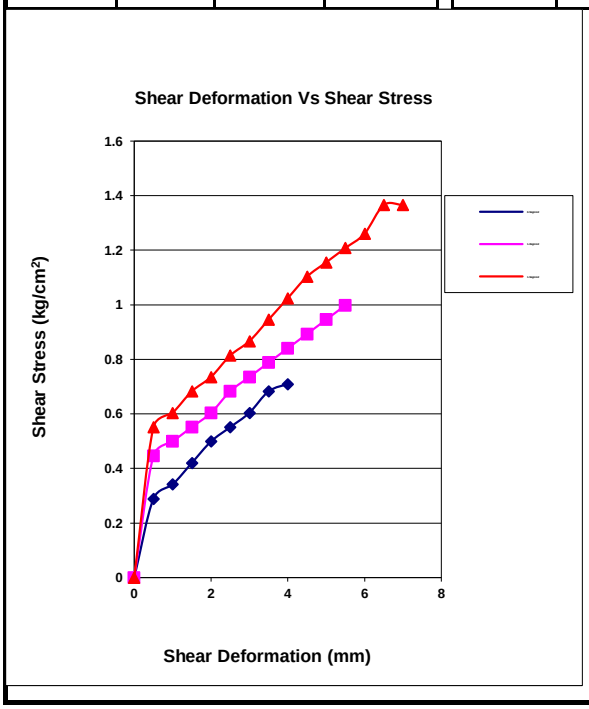
Horizontal Gauge Reading	Proving Ring Reading	Shear deformation	Shear Stress (kg/Cm^2)
0	0	0.00	0.000
50	13.186	0.50	0.298
100	15.5835	1.00	0.352
150	19.1796	1.50	0.434
200	22.7758	2.00	0.515
250	25.1733	2.50	0.569
300	27.5707	3.00	0.624
350	31.1669	3.50	0.705
400	32.3656	4.00	0.732

Trail-2
Normal Stress:1.0 kg/cm^2

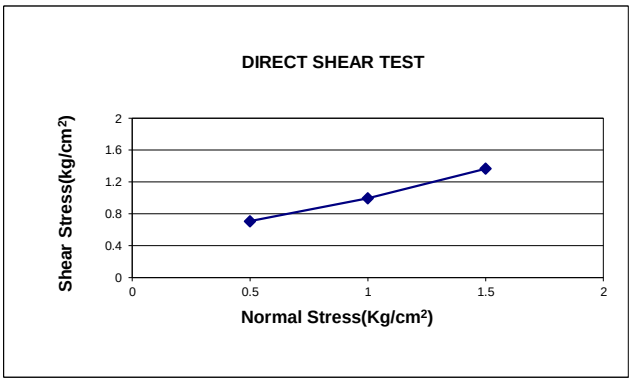
Horizontal Gauge Reading	Proving Ring Reading	Shear deformation	Shear Stress (kg/Cm^2)
0	0	0.00	0.000
50	20.3784	0.50	0.461
100	22.7758	1.00	0.515
150	25.1733	1.50	0.569
200	27.5707	2.00	0.624
250	31.1669	2.50	0.705
300	33.5644	3.00	0.759
350	35.9618	3.50	0.813
400	38.3593	4.00	0.868
450	40.7567	4.50	0.922
500	43.1542	5.00	0.976
550	45.5516	5.50	1.030

Trail-3
Normal Stress:1.5 kg/cm^2

Horizontal Gauge Reading	Proving Ring Reading	Shear deformation	Shear Stress (kg/Cm^2)
0	0	0.00	0.000
50	25.1733	0.50	0.569
100	27.5707	1.00	0.624
150	31.1669	1.50	0.705
200	33.5644	2.00	0.759
250	37.1605	2.50	0.840
300	39.558	3.00	0.895
350	43.1542	3.50	0.976
400	46.7504	4.00	1.057
450	50.3465	4.50	1.139
500	52.744	5.00	1.193
550	55.1414	5.50	1.247
600	57.5389	6.00	1.301
650	62.3338	6.50	1.410
700	62.3338	7.00	1.410



Normal Stress (kg/cm^2)	Proving Ring reading at failure	Shear Stress (kg/cm^2)
0.50	32.36563331	0.732
1.00	45.55163207	1.030
1.50	62.3338123	1.410



1. Angle of Shearing Resistance (Φ) = 34 Degrees
2. Cohesion (C) = 0.00 Kg/cm^2

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Report No:57/ GRB/ 2023-24 Dt :28.05.2023

ANNEXURE - F

DENSITY CALCULATIONS

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

Bore Hole No	1
Depth (m)	0.50

Sl. No.	Description	Reading
1	Weight of Empty Box (gm)	3,393.00
2	Weight of Box + Soil (gm)	3,551.60
3	Weight of Soil (gm)	158.60
4	Volume of Box (cm^3)	90.00
5	Bulk Density (gm /cm^3)	1.762
6	Weight of Container (gm)	41.03
7	Weight of Container + Wet Soil (gm)	63.28
8	Weight of Container + Dry Soil (gm)	61.12
9	Moisture Content (%)	10.75
10	Dry Density (gm /cm^3)	1.591

RESULT

1 WET DENSITY OF SOIL = 1.762 t / m^3

2 DRY DENSITY OF SOIL = 1.591 t / m^3

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Report No:57/ GRB/ 2023-24 Dt :28.05.2023

ANNEXURE - G

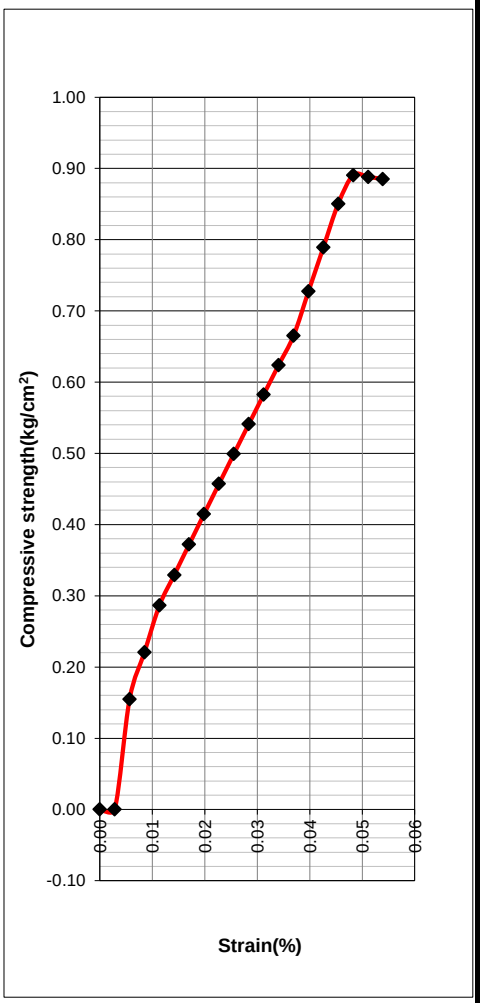
UNCONFINED COMPRESSION TEST
(Test method as per IS 2720 (Part 10) - 1995)

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

Diameter	38 mm
Length	88 mm
Constant	0.31530

Bore Hole No	1
Depth (m)	2.00 m
Date of Test	31.05.2023

Deformation dial Reading	Axial deformation (mm)	Axial Strain (e)	Area (cm^2)	Proving Ring Readings	Axial force N (Kgf)	Compressive strength (kg/cm^2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0.00	0.00	0.00	11.35	0.00	0.000	0.00
25.00	0.25	0.00	11.38	0.00	0.000	0.00
50.00	0.50	0.01	11.41	5.62	1.770	0.16
75.00	0.75	0.01	11.45	8.02	2.529	0.22
100.00	1.00	0.01	11.48	10.43	3.288	0.29
125.00	1.25	0.01	11.51	12.03	3.794	0.33
150.00	1.50	0.02	11.55	13.64	4.300	0.37
175.00	1.75	0.02	11.58	15.24	4.805	0.41
200.00	2.00	0.02	11.61	16.85	5.311	0.46
225.00	2.25	0.03	11.65	18.45	5.817	0.50
250.00	2.50	0.03	11.68	20.05	6.323	0.54
275.00	2.75	0.03	11.72	21.66	6.829	0.58
300.00	3.00	0.03	11.75	23.26	7.335	0.62
325.00	3.25	0.04	11.79	24.87	7.840	0.67
350.00	3.50	0.04	11.82	27.27	8.599	0.73
375.00	3.75	0.04	11.86	29.68	9.358	0.79
400.00	4.00	0.05	11.89	32.09	10.117	0.85
425.00	4.25	0.05	11.93	33.69	10.622	0.89
450.00	4.50	0.05	11.96	33.69	10.622	0.89
475.00	4.75	0.05	12.00	33.69	10.622	0.89



RESULTS

qu = 0.891 kg/cm^2

Cohesion = C = 0.460 kg/cm^2

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Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District.

Report No:57 /GRB/ 2023-24	BH NO : 1	CALCULATION - 1

SAFE BEARING CAPACITY CALCULATIONS on SHALLOW FOUNDATIONS

TYPE OF FOOTING : SQUARE FOOTING

Length of footing	(Assumed Value)	L =	**1.50**	m
Breadth of footing	(Assumed Value)	B =	**1.50**	m
Foundation depth		D_f =	**3.60**	m
Correction Factor for Water Table		W' =	**0.50**	
Unit weight of soil		γ_{soil} =	**1.785**	T/m^3
Cohension		"C" =	**4.80**	T/m^2
Angle of shearing resistance(general shear)	φ =		**9.00°**	
Angle of shearing resistance(Local shear)	φ' =		**6.03°**	(Tan^{-1} (2/3 * tanφ)
Safety factor		F =	**3.00**	
Effective Surcharge of Soil above Footing Base		q =	**2.83**	T/m^2
Type of soil		=	**Dense Clay mixed with Sand**	
Mode of failure		=	**Combined (GSF & LSF) Shear Failure**	
Ground Water Table level (Assumed for worst Case - at the Ground level) =			**0** m	From NGL

The Bearing Capacity Factors are Given by the following equations

For GENERAL SHEAR FAILURE

$Nq = \tan^2(45° + Ø/2)(e^{\pi \tan Ø})$	=	2.26
$Nc = (Nq - 1)\cot Ø$	=	7.92
$N\gamma = 2(Nq + 1)\tan Ø$	=	1.03

For LOCAL SHEAR FAILURE

$N'q = \tan^2(45° + Ø'/2)(e^{\pi \tan Ø'})$	=	1.72
$N'c = (Nq - 1)\cot Ø'$	=	6.83
$N'\gamma = 2(Nq + 1)\tan Ø'$	=	0.58

The Shape Factors

Shape of Footing	S_c	S_q	S_γ
CONTINUOUS STRIP FOOTING	1.0	1.0	1.0
SQUARE FOOTING	1.3	1.2	0.8
RECTANGULAR FOOTING	1+0.2B/L	1+0.2B/L	1-0.4B/L

SQUARE FOOTING	
S_c =	1.300
S_q =	1.200
S_γ =	0.800

The Depth Factor

d_c =	1 + 0.2 D_f / B x tan (45° + Ø'/2) =	1.562
$d_q = d_\gamma$ =	1 for Ø'<10° =	1.281
$d_q = d_\gamma$ =	1+0.1D_f/Bxtan(45°+Ø'/2) for Ø'>10° =	1.000

The Inclination Factor

$i_c = i_q$ = 1 - α /90)^2 = 1.00 i_γ = 1 - α / Ø)^2 1.00

α = Inclination of the load to the vertical in degress = **0**

Net Ultimate Bearing Capacity, **qd** = ((cxNcxScxdcxic) + (qx(Nq -1)xSqxDqxIq) + (0.5xBxγxNγxSγxDγxIγxW')+ (2/3) (cxN'cxScxdcxic) + (qx(N'q -1)xSqxDqxIq) + (0.5xBxγxN'γxSγxDγxIγxW'))/"2

= **64.58** **T/sq.m**

SAFE BEARING CAPACITY :

SBC = qd / F.s = **21.53 T/sq.m** or **211.19 kN/m^2**

SETTLEMENT CALCULATIONS AS PER IS-8009-(part-1) 1998

Q_s = Pressure, S_i = Immediate settlement I = Influence factor

B = width of foundation μ = Poisson's ratio E_s= Elastic Modulus

For,

Dense Clay mixed with Sand E_s= 30625 kN/m^2

(or) E_s= 3062.50 t/m^2

S_i = Immediate settlement = I*Qs*B(1-μ^2) / Es

= 0.95*21.53*(1.5*(1-0.25^2))/3062.5

S_i= 0.0094 m

0.0094 x1000

Settlement = **9 mm** < **50 mm** **Hence SAFE**

The Max Allowable Differential Settlement for **Sand & Gravel is 50mm** and for **Silt & Clay is 75mm.**

GEOMATRIX CONSULTANCY

Geo-Tech. Consultants & Engineers

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

Report No:57 /GRB/ 2023-24	BH NO : 2	CALCULATION - 2

SAFE BEARING CAPACITY CALCULATIONS on SHALLOW FOUNDATIONS

TYPE OF FOOTING : SQUARE FOOTING

Length of footing	(Assumed Value)	L =	**1.50**	m
Breadth of footing	(Assumed Value)	B =	**1.50**	m
Foundation depth		D_f =	**3.60**	m
Correction Factor for Water Table		W' =	**0.50**	
Unit weight of soil		γ_{soil} =	**1.823**	T/m^3
Cohension		"C" =	**2.40**	T/m^2
Angle of shearing resistance(general shear)	φ =		**21.00°**	
Angle of shearing resistance(Local shear)	φ' =		**14.35°**	(Tan^{-1} (2/3 * tanφ)
Safety factor		F =	**3.00**	
Effective Surcharge of Soil above Footing Base		q =	**2.96**	T/m^2
Type of soil		=	**Dense Clay mixed with Sand**	
Mode of failure		=	**Combined (GSF & LSF) Shear Failure**	
Ground Water Table level (Assumed for worst Case - at the Ground level) =			**0** m	From NGL

The Bearing Capacity Factors are Given by the following equations

For GENERAL SHEAR FAILURE

$Nq = \tan^2(45° + Ø/2)(e^{\pi \tan Ø})$	=	7.07
$Nc = (Nq - 1)\cot Ø$	=	15.82
$N\gamma = 2(Nq + 1)\tan Ø$	=	6.20

For LOCAL SHEAR FAILURE

$N'q = \tan^2(45° + Ø'/2)(e^{\pi \tan Ø'})$	=	3.71
$N'c = (Nq - 1)\cot Ø'$	=	10.58
$N'\gamma = 2(Nq + 1)\tan Ø'$	=	2.41

The Shape Factors

Shape of Footing	S_c	S_q	S_γ
CONTINUOUS STRIP FOOTING	1.0	1.0	1.0
SQUARE FOOTING	1.3	1.2	0.8
RECTANGULAR FOOTING	1+0.2B/L	1+0.2B/L	1-0.4B/L

SQUARE FOOTING	
S_c =	1.300
S_q =	1.200
S_γ =	0.800

The Depth Factor

d_c =	1 + 0.2 D_f / B x tan (45° + Ø'/2) =	1.698
$d_q = d_\gamma$ =	1 for Ø'<10° =	1.000
$d_q = d_\gamma$ =	1+0.1D_f/Bxtan(45°+Ø'/2) for Ø'>10° =	1.349

The Inclination Factor

$i_c = i_q$ = 1 - α /90)^2 = 1.00 i_γ = 1 - α / Ø)^2 1.00

α = Inclination of the load to the vertical in degress = **0**

Net Ultimate Bearing Capacity, **qd** = ((cxNcxScxdcxic) + (qx(Nq -1)xSqxDqxIq) + (0.5xBxγxNγxSγxDγxIγxW')+ (2/3) (cxN'cxScxdcxic) + (qx(N'q -1)xSqxDqxIq) + (0.5xBxγxN'γxSγxDγxIγxW'))/"2

= **84.80** **T/sq.m**

SAFE BEARING CAPACITY :

SBC = qd / F.s = **28.27 T/sq.m** or **277.30 kN/m^2**

SETTLEMENT CALCULATIONS AS PER IS-8009-(part-1) 1998

Q_s = Pressure, S_i = Immediate settlement I = Influence factor

B = width of foundation μ = Poisson's ratio E_s= Elastic Modulus

For,

Dense Clay mixed with Sand E_s= 30625 kN/m^2

(or) E_s= 3062.50 t/m^2

S_i = Immediate settlement = I*Qs*B(1-μ^2) / Es

= 0.95*28.27*(1.5*(1-0.25^2))/3062.5

S_i= 0.0123 m

0.0123 x1000

Settlement = **12 mm** < **50 mm** **Hence SAFE**

The Max Allowable Differential Settlement for **Sand & Gravel is 50mm** and for **Silt & Clay is 75mm.**

GEOMATRIX CONSULTANCY

Geo-Tech. Consultants & Engineers

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District

Report No:57 /GRB/ 2023-24	BH NO : 3	CALCULATION - 3

SAFE BEARING CAPACITY CALCULATIONS on SHALLOW FOUNDATIONS

TYPE OF FOOTING : SQUARE FOOTING

Length of footing	(Assumed Value)	L =	**1.50**	m
Breadth of footing	(Assumed Value)	B =	**1.50**	m
Foundation depth		D_f =	**3.60**	m
Correction Factor for Water Table		W' =	**0.50**	
Unit weight of soil		γ_{soil} =	**1.774**	T/m^3
Cohension		"C" =	**2.80**	T/m^2
Angle of shearing resistance(general shear)	φ =		**20.00°**	
Angle of shearing resistance(Local shear)	φ' =		**13.64°**	(Tan^{-1} (2/3 * tanφ)
Safety factor		F =	**3.00**	
Effective Surcharge of Soil above Footing Base		q =	**2.79**	T/m^2
Type of soil		=	**Dense Clay mixed with Sand**	
Mode of failure		=	**Combined (GSF & LSF) Shear Failure**	
Ground Water Table level (Assumed for worst Case - at the Ground level) =			**0** m	From NGL

The Bearing Capacity Factors are Given by the following equations

For GENERAL SHEAR FAILURE

$Nq = \tan^2(45° + Ø/2)(e^{\pi \tan Ø})$	=	6.40
$Nc = (Nq - 1)\cot Ø$	=	14.83
$N\gamma = 2(Nq + 1)\tan Ø$	=	5.39

For LOCAL SHEAR FAILURE

$N'q = \tan^2(45° + Ø'/2)(e^{\pi \tan Ø'})$	=	3.47
$N'c = (Nq - 1)\cot Ø'$	=	10.16
$N'\gamma = 2(Nq + 1)\tan Ø'$	=	2.17

The Shape Factors

Shape of Footing	S_c	S_q	S_γ
CONTINUOUS STRIP FOOTING	1.0	1.0	1.0
SQUARE FOOTING	1.3	1.2	0.8
RECTANGULAR FOOTING	1+0.2B/L	1+0.2B/L	1-0.4B/L

SQUARE FOOTING	
S_c =	1.300
S_q =	1.200
S_γ =	0.800

The Depth Factor

d_c =	1 + 0.2 D_f / B x tan (45° + Ø'/2) =	1.686
$d_q = d_\gamma$ =	1 for Ø'<10° =	1.000
$d_q = d_\gamma$ =	1+0.1D_f/Bxtan(45°+Ø'/2) for Ø'>10° =	1.343

The Inclination Factor

$i_c = i_q$ =	1 - α /90)^2 =	1.00	i_γ =	1 - α / Ø)^2	1.00

α = Inclination of the load to the vertical in degress = **0**

Net Ultimate Bearing Capacity, **qd** = ((cxNcxScxdcxic) + (qx(Nq -1)xSqxDqxIq) + (0.5xBxγxNγxSγxDγxIγxW')+ (2/3) (cxN'cxScxdcxic) + (qx(N'q -1)xSqxDqxIq) + (0.5xBxγxN'γxSγxDγxIγxW'))/"2

= **86.68** **T/sq.m**

SAFE BEARING CAPACITY :

SBC = qd / F.s = **28.89 T/sq.m** or **283.43 kN/m^2**

SETTLEMENT CALCULATIONS AS PER IS-8009-(part-1) 1998

Q_s = Pressure, S_i = Immediate settlement I = Influence factor

B = width of foundation μ = Poisson's ratio E_s= Elastic Modulus

For,

Dense Clay mixed with Sand E_s= 30625 kN/m^2

(or) E_s= 3062.50 t/m^2

S_i = Immediate settlement = $I*Qs*B(1-\mu^2) / Es$

= 0.95*28.89*(1.5*(1-0.25^2))/3062.5

S_i= 0.0126 m

0.0126 x1000

Settlement = **13 mm** < **50 mm** **Hence SAFE**

The Max Allowable Differential Settlement for **Sand & Gravel is 50mm** and for **Silt & Clay is 75mm.**

GEOMATRIX CONSULTANCY

Geo-Tech. Consultants & Engineers

Name of Project: Sub Soil Investigation for the Construction of RESIDENTIAL BUILDING at Madakulam Village in Thiruparankundram Taluk of Madurai District.

Report No:57 /GRB/ 2023-24 | **BH NO : 4** | **CALCULATION - 4**

SAFE BEARING CAPACITY CALCULATIONS on SHALLOW FOUNDATIONS

TYPE OF FOOTING : SQUARE FOOTING

Length of footing	(Assumed Value)	L =	**1.50**	m
Breadth of footing	(Assumed Value)	B =	**1.50**	m
Foundation depth		D_f =	**3.60**	m
Correction Factor for Water Table		W' =	**0.50**	
Unit weight of soil		γ_{soil} =	**1.902**	T/m^3
Cohension		"C" =	**0.00**	T/m^2
Angle of shearing resistance(general shear)	φ =		**36.00°**	
Angle of shearing resistance(Local shear)	φ' =		**25.77°**	(Tan^{-1} (2/3 * tanφ)
Safety factor		F =	**3.00**	
Effective Surcharge of Soil above Footing Base		q =	**3.25**	T/m^2
Type of soil		=	**Soft Disintegrated Rock**	
Mode of failure		=	**Combined (GSF & LSF) Shear Failure**	
Ground Water Table level (Assumed for worst Case - at the Ground level) =			**0** m	From NGL

The Bearing Capacity Factors are Given by the following equations

For GENERAL SHEAR FAILURE

$Nq = \tan^2(45° + Ø/2)(e^{\pi \tan Ø})$	=	37.75
$Nc = (Nq - 1)\cot Ø$	=	50.59
$N\gamma = 2(Nq + 1)\tan Ø$	=	56.31

For LOCAL SHEAR FAILURE

$N'q = \tan^2(45° + Ø'/2)(e^{\pi \tan Ø'})$	=	11.57
$N'c = (Nq - 1)\cot Ø'$	=	21.89
$N'\gamma = 2(Nq + 1)\tan Ø'$	=	12.13

The Shape Factors

Shape of Footing	S_c	S_q	S_γ
CONTINUOUS STRIP FOOTING	1.0	1.0	1.0
SQUARE FOOTING	1.3	1.2	0.8
RECTANGULAR FOOTING	1+0.2B/L	1+0.2B/L	1-0.4B/L

SQUARE FOOTING	
S_c =	1.300
S_q =	1.200
S_γ =	0.800

The Depth Factor

d_c =	1 + 0.2 D_f / B x tan (45° + Ø'/2) =	1.942
$d_q = d_\gamma$ =	1 for Ø'<10° =	1.000
$d_q = d_\gamma$ =	1+0.1D_f/Bxtan(45°+Ø'/2) for Ø'>10° =	1.471

The Inclination Factor

$i_c = i_q$ =	1 - α /90)^2 =	1.00	i_γ =	1 - α / Ø)^2	1.00

α = Inclination of the load to the vertical in degress = **0**

Net Ultimate Bearing Capacity, **qd** = ((cxNcxScxdcxic) + (qx(Nq -1)xSqxDqxIq) + (0.5xBxγxNγxSγxDγxIγxW')+ (2/3) (cxN'cxScxdcxic) + (qx(N'q -1)xSqxDqxIq) + (0.5xBxγxN'γxSγxDγxIγxW'))/"2

= **164.34** **T/sq.m**

SAFE BEARING CAPACITY :

SBC = qd / F.s = **54.78 T/sq.m** or **537.39 kN/m^2**

SETTLEMENT CALCULATIONS AS PER IS-8009-(part-1) 1998

Q_s = Pressure, S_i = Immediate settlement I = Influence factor

B = width of foundation μ = Poisson's ratio E_s= Elastic Modulus

For,

Soft Disintegrated Rock

E_s= 136200 kN/m^2

(or) E_s= 13620.00 t/m^2

S_i = Immediate settlement = I*Qs*B(1-μ^2) / Es

= 0.95*54.78*(1.5*(1-0.25^2))/13620

S_i= 0.0054 m

0.0054 x1000

Settlement = **5 mm** < **50 mm** **Hence SAFE**

The Max Allowable Differential Settlement for **Sand & Gravel is 50mm** and for **Silt & Clay is 75mm.**

BOREHOLE-1 SITE PHOTOS:





BOREHOLE-2 SITE PHOTOS:





BOREHOLE-3 SITE PHOTOS:





BOREHOLE-4 SITE PHOTOS:





O/o. DEPUTY DIRECTOR OF TOWN AND COUNTRY PLANNING,
CHENGALPATTU REGION,
No.124, Municipal Commercial Complex, G.S.T.Raod, Chengalpattu - 603 001
E-mail : ddcglregion@gmail.com, Phone : 044 - 27422144

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that **Mr. K.GANAPATHI** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with Deputy Director of Town and Country Planning, Chengalpattu Region who has the qualification of **M.E (Soil mechanics and foundation Engg.)** and experience in the relevant field for **06 years**.

He has been given the Registration No. **CGLRGN/RGTE/2019/08/012** on **02.08.19**. He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu is 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 **01.08.2024**.

Deputy Director,
Chengalpattu Region





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