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SOIL TESTING REPORT

SOIL INVESTIGATION AND LABORATORY TESTING SERVICES FOR THE PROPOSED CONSTRUCTION OF AN APARTMENT BUILDING AT SURYA NAGAR, MANGALAKUDI VILLAGE, MADURAI EAST TALUK, MADURAI CORPORATION, MADURAI DISTRICT.

REPORT No: 236/2023-24	**DATE** : 16.03.2024

LOCATION : R.S.NO.25/7,
Surya Nagar,
Mangalakudi Village,
Madurai East Taluk,
Madurai Corporation,
Madurai District.

CLIENT : Mr.Jeyakumar,
Madurai Corporation,
Madurai District.

PREPARED BY : Er. A. Victor Samson Raj, M.E,
Registered Geotechnical Engineer,
Techlead Consultant & Engineers,
Madurai.

Report No:236/2023-24/16.03.2024

To

Mr.Jeyakumar,

Madurai Corporation,

Madurai District.

Respected Sir/Madam,

Sub: Submission of Soil Testing Report – Reg.

Name of work: Proposed Construction of Apartment Building at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

* * * * * * * * *

We appreciate the opportunity of service to you on this project and trust these reports meet your needs at this time. This report summarizes the results 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: 23

Respectfully submitted

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Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

REPORT ON SUB-SOIL INVESTIGATION

1. INTRODUCTION

Mr.Jeyakumar from Madurai has proposed to construct a Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District. Based on his reference, we are providing this soil report. In order to get adequate data required for designing the foundations, TECHLEAD CONSULTANT & ENGINEERS Soil Testing Company, conducted THREE trials of bores for collecting the soil samples and handed over to TECHLEAD CONSULTANT & ENGINEERS LAB, Madurai for conducting laboratory testing and preparing report with SBC calculations and test results.

2. SCOPE OF WORK

The scope of work includes the following:

- Making three bore holes of 150 mm dia using rotary driller to a depth of 10m or 1.00m core drilling in hard rock whichever is met earlier.
- Conducting standard penetration test as per IS 2131-1981 at every 1.00m / 1.50m depth intervals or change of soil strata and collecting disturbed / undisturbed soil samples.
- Conducting various laboratory tests on collected soil samples.
- Submitting recommendations for type and depth of foundation.

3. LOCATION & DESCRIPTION OF STRUCTURE

The proposed construction of APARTMENT BUILDING (TITAN CITY) located at T.S.NO.25/7, Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District. As per the details issued by the client, the proposed building is a RCC framed Structure has Stilt, First floor, Second Floor, Third floor, Fourth floor, Fifth floor ($S^{+}5$) and the unit will be comprised of Reinforced concrete elements (Columns, Beams, and Slabs etc.) The total area of the site is 62 Cent.

.

4. SOIL INVESTIGATION

The details of field investigation, tests carried out in the field and laboratory are presented as follows:

4.1 Field Sampling

Three bore hole of 150mm dia was made using rotary drilling machine in the site on 13.03.2024. SPT's were conducted at every 1.0 m / 1.5 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 bore hole was advanced using rotary washing method so that minimum disturbance is attributed to the soil below the boring depth. Bore hole was always kept filled with drilling mud to prevent any negative hydrostatic pressure within the bore hole. Boring through the soil was performed using TC BIT and Diamond drill pit with side jets for drilling mud. Standard penetration test, disturbed sampling, field identification of Soil and rock samples etc.; were carried out in these bore hole.

4.2.2 Standard Penetration test

SPT was conducted at different depths in the bore hole. 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 1.00m / 1.50m 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 during investigation.

6. LABORATORY TESTS

The collected soil samples were tested as per relevant procedures mentioned in Indian Standard codes. The laboratory-testing scheme was 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 (Part2): 1973**
- **Specific Gravity:** This test is conducted in all disturbed soil samples to find Specific gravity of soil as per **IS 2720 (Part3) :1980**
- **Sieve Analysis:** These tests conducted to identify and classify the samples as per **IS 2720 (Part4) :1985**
- **Liquid Limit:** This test conducted in fine-grained soils to find the Liquid Limit of the soil as per **IS 2720 (Part5) :1985**
- **Plastic Limit:** This test conducted in fine-grained soil to find plastic limit of the soil as per **IS 2720 (Part5) :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 (Part13) :1986**
- **Unconfined Compression Test:** This test conducted in fine-grained soil to find Cohesion of the soil as per **IS 2720 (Part10) :1995**

All the detailed test results are presented in **Section 11 (refer Table 11.1, 11.2, 11.3) for THREE SPT soil samples.**

7. SAFE BEARING CAPACITY & SETTLEMENT CALCULATION

Based on the above laboratory test results, the Safe Bearing Capacity calculated as per **IS 6403- 1981** as follows:

$$Q = CN_C S_C d_C + q (N_q - 1) S_q d_q + 0.5 Br N_r S_r d_r$$

Where

Q	= Ultimate Bearing Capacity in Kn/m^2
C	= Cohesion in Kn/m^2
q	= Effective surcharge at the base level of foundation in Kn/m^2
r	= Bulk Density of soil in Kn/m^3
B	= Width of the footing in cm
N_C, Nq, N_r	= Bearing Capacity Factor
S_C, Sq, N_r	= Shape Factor
d_C ,d_q , d_r	= Depth Factor

Safe Bearing Capacity = Ultimate Bearing Capacity / Factor of Safety

= Q / FOS

The Factor of Safety (FOS) is considered as 3.00

The Settlement Calculations done as per IS 8009-part 1-1998 as follows:

$$S_i = Q\ B\ (1-\mu^2)\ I / E_s$$

Where,

S_i= Immediate Settlement in cm

Q= Soil pressure in Kn/m^2

B= Width of foundation in cm

μ= Poisson's ratio

E_s = Influence factor

I = Elastic Modulus in kgf/cm^2

(The Safe Bearing Capacity and Settlement Calculations are done as per above format)

8. DISCUSSION ON SOIL PROFILE

In this corresponding site, three bore holes was executed to soil test for the proposed construction of Apartment Building (Titan City). Based on the field and laboratory test results, it is concluded that:

In BH 1, the sub-soil profile consists of

- **Filled up Soil (Brownish Gravel mixed with Sand) (0.00 – 0.30m),** followed by **Brownish Gravel mixed with Sand (0.30 – 0.60m),** followed by **Brownish Clayey Sand (0.60 – 2.30m)** with a **Very Dense Consistency,** followed by **Soft Disintegrated Rock (2.30 – 7.50m)** with a **Very Dense Consistency,** followed by **Hard Rock (7.50 – 8.50m)** with a **Very Dense Consistency.**

In BH 2, the sub-soil profile consists of

- **Filled up Soil (Brownish Gravel mixed with Sand) (0.00 – 0.30m),** followed by **Brownish Gravel mixed with Sand (0.30 – 0.50m),** followed by **Brownish Clayey Sand (0.50 – 1.90m)** with a **Very Dense Consistency,** followed by **Brownish Medium Sand mixed with Gravel (1.90 – 2.70m)** with a **Very Dense Consistency,** followed by **Soft Disintegrated Rock (2.70 – 7.00m)** with a **Very Dense Consistency,** followed by **Hard Rock (7.00 – 8.00m)** with a **Very Dense Consistency.**

In BH 3, the sub-soil profile consists of

- **Filled up Soil (Brownish Gravel mixed with Sand) (0.00 – 0.15m),** followed by **Brownish Gravel mixed with Sand (0.15 – 0.45m),** followed by **Brownish Clayey Sand (0.45 – 1.50m)** with a **Very Dense Consistency,** followed by **Brownish Medium Sand (1.50 – 2.80m)** with a **Very Dense Consistency,** followed by **Soft Disintegrated Rock (2.80 – 7.50m)** with a **Very Dense Consistency,** followed by **Hard Rock (7.50 – 8.50m)** with a **Very Dense Consistency.**

Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

Report No.	236	**Dia. of Boring**	150 mm
Bore Hole No.	1	**Total Depth**	8.50 m
Type of Boring	Rotary	**Depth of Water Table**	Nil
Started on	13.03.24	**Co-ordinates**	Lat: 9.969345˚
Ended on	13.03.24		Long:78.168789˚

Depth from Ground level		Soil Profiles	Description of Soil (Visual Identification)	SPT Interval (m)	Type	15	30	45	N	Graphical Representation of SPT (N Value) 0 10 20 30 40 50 60 70 80 90 100	Type of Samples
	-0.15 m		**Filled up Soil (Brownish Gravel mixed with Sand)**	-							**DS**
-0.60 m	-		**Brownish Gravel mixed with Sand**								-
	-1.00 m		**Brownish Clayey Sand**	1.00	SPT	2cm for 50 Blows	SPT Rebound (No Penetration)		**>100**		**DS**
	-2.00 m			1.00	SPT	3cm for 50 Blows	SPT Rebound (No Penetration)		**>100**		**DS**
-2.30 m	-			-							-
	-3.00 m		**Soft Disintegrated Rock**	1.00	SPT	SPT Rebound (No Penetration)			**>100**		**WS**
	-4.50 m			1.50	SPT				**>100**		**WS**
	-6.00 m			1.50	SPT				**>100**		**WS**
-7.50 m	-7.50 m			1.50	SPT				**>100**		**WS**
-8.50 m	-8.50 m		**Hard Rock (CR = 16.50%, RQD = 16.50%, Crushing Strength = 7200 KPA)**	1.00	SPT				**>100**		**UDS**

DS = Disturbed Soil sample
UDS = Undisturbed Soil sample
WS = Washing sample

SDR = Soft Disintegrated Rock
CR = Core Recovery
RQD = Rock Quality Designation

Fig - 1: Vertical Soil Profile at Bore Hole 1 Location

Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

Report No.	236	**Dia. of Boring**	150 mm
Bore Hole No.	2	**Total Depth**	8.00 m
Type of Boring	Rotary	**Depth of Water Table**	Nil
Started on	13.03.24	**Co-ordinates**	Lat: 9.969247˚
Ended on	13.03.24		Long: 78.168298˚

Depth from Ground level		Soil Profiles	Description of Soil (Visual Identification)	SPT Interval (m)	Type	15	30	45	N	Graphical Representation of SPT (N Value) 0 10 20 30 40 50 60 70 80 90 100	Type of Samples
	-0.30 m		**Filled up Soil (Brownish Gravel mixed with Sand)**	-							**DS**
-0.50 m	-		**Brownish Gravel mixed with Sand**								-
	-1.50 m		**Brownish Clayey Sand**	1.00	SPT	1cm for 50 Blows	SPT Rebound (No Penetration)		**>100**		**DS**
-1.90 m	-			-							-
	-2.50 m		**Brownish Medium Sand mixed with Gravel**	1.00	SPT	1cm for 50 Blows	SPT Rebound (No Penetration)		**>100**		**DS**
-2.70 m	-			-							-
	-3.50 m		**Soft Disintegrated Rock**	1.00	SPT	SPT Rebound (No Penetration)			**>100**		**WS**
	-4.50 m			1.00	SPT				**>100**		**WS**
	-6.00 m			1.50	SPT				**>100**		**WS**
-7.00 m	-7.00 m			1.00	SPT				**>100**		**WS**
-8.00 m	-8.00 m		**Hard Rock (CR = 22.50%, RQD = 22.50%, Crushing Strength = 4000 KPA)**	1.00	SPT				**>100**		**UDS**

DS = Disturbed Soil sample
UDS = Undisturbed Soil sample
WS = Washing sample
SDR = Soft Disintegrated Rock
CR = Core Recovery
RQD = Rock Quality Designation

Fig - 2: Vertical Soil Profile at Bore Hole 2 Location

Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

Report No.	236	**Dia. of Boring**	150 mm
Bore Hole No.	3	**Total Depth**	8.50 m
Type of Boring	Rotary	**Depth of Water Table**	Nil
Started on	13.03.24	**Co-ordinates**	Lat: 9.969214˚
Ended on	13.03.24		Long: 78.168178˚

Depth from Ground level		Soil Profiles	Description of Soil (Visual Identification)	SPT Interval (m)	Type	15	30	45	N	Graphical Representation of SPT (N Value) 0 10 20 30 40 50 60 70 80 90 100	Type of Samples
	-0.15 m		**Filled up Soil (Brownish Gravel mixed with Sand)**	-							**DS**
-0.45 m	-		**Brownish Gravel mixed with Sand**								-
	-1.00 m		**Brownish Clayey Sand**	1.00	SPT	1cm for 50 Blows	SPT Rebound (No Penetration)		**>100**		**DS**
-1.50 m				-							
	-2.00 m		**Brownish Medium Sand**	1.00	SPT	1cm for 50 Blows	SPT Rebound (No Penetration)		**>100**		**DS**
-2.80 m	-			-							-
	-3.00 m		**Soft Disintegrated Rock**	1.00	SPT	SPT Rebound (No Penetration)			**>100**		**WS**
	-4.50 m			1.50	SPT				**>100**		**WS**
	-6.00 m			1.50	SPT				**>100**		**WS**
-7.50 m	-7.50 m			1.50	SPT				**>100**		**WS**
-8.50 m	-8.50 m		**Hard Rock (CR = 21.50%, RQD = 21.50%, Crushing Strength = 8000 KPA)**	1.00	SPT				**>100**		**UDS**

DS = Disturbed Soil sample
UDS = Undisturbed Soil sample
WS = Washing sample

SDR = Soft Disintegrated Rock
CR = Core Recovery
RQD = Rock Quality Designation

Fig - 3: Vertical Soil Profile at Bore Hole 3 Location

9. ABSTRACT OF SAFE BEARING CAPACITY CALCULATIONS

The summary of Safe Bearing Capacity calculated is presented as follows,

BH No.	Safe Bearing Capacity in kN/m^2 at the depth						
	1.50 m	1.80 m	2.10 m	2.40 m	2.70 m	3.00 m	3.30 m
1	172.91	207.36	249.44	288.13	328.52	425.35	475.68
2	181.11	217.15	254.94	294.50	391.47	441.73	494.07
3	190.95	228.95	272.89	315.23	359.45	465.64	520.81
Recommended SBC in kN/m^2	181.66	217.82	259.09	299.29	359.81	444.24	496.85

10. RECOMMENDATIONS

Based on the SBC and settlement calculations, site investigation recommendation for foundation are as follows:

1. The recommendation is Shallow Foundation out of which **Isolated column footing / Combined footing** at the depth above **2.40 m** is suggested.
2. The recommended safe bearing capacities at every **0.30 m** interval from **1.50 m to 3.30 m** are presented in the above table to design the foundation according to the load conditions and structural requirements.
3. Provide **6" River sand** topped with **6" P.C.C** layer at the bottom of the foundation bed.
4. All columns should be connected with proper **rigid plinth beam** to maintain **even settlement** and rigid condition of the column structure.
5. For these safe bearing capacities, the settlement is also **within** the allowable limits.
6. The foundation concrete shall be laid in **dry condition** if meets the water table during the execution.
7. The excavated soil for foundation is **suitable** for backfilling.

11. RESULT

TABLE 11.1: Summary of Lab Test Results for BH-1

Depth of Soil (m)	Soil Description	Type of sample collected	IS Classification	Grain Size Analysis (%)					Index Properties (%)				Bulk Density (Kn/m^3)	Specific Gravity (G)	Cohesion "C" (Kn/m^2)	Angle of Friction (Ø)
				Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay	NMC	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)				
0.00 to 1.00	Brownish Clayey Sand	DS	SC	28.48	4.34	21.16	20.60	25.42	22	26.40	17.51	8.89	15.48	2.56	0	31
1.00 to 2.00	Brownish Clayey Sand	DS	SC	11.44	1.06	26.95	22.06	38.49	14	33.29	18.04	15.25	15.86	2.53	0	31
2.00 to 3.00	Soft Disintegrated Rock	WS	-	22.53	9.95	59.55	6.50	1.47	17	NP	NP	NP	16.11	2.59	0	32
3.00 to 4.50	Soft Disintegrated Rock	WS	-	21.48	8.76	59.93	7.86	1.97	16	NP	NP	NP	16.57	2.57	0	34
4.50 to 6.00	Soft Disintegrated Rock	WS	-	22.46	7.61	58.95	6.25	4.73	16	NP	NP	NP	16.89	2.55	0	37
6.00 to 7.50	Soft Disintegrated Rock	WS	-	23.46	6.45	58.12	7.40	4.57	13	NP	NP	NP	17.15	2.50	0	38
7.50 to 8.50	Hard Rock	UDS	(CR = 16.50%, RQD = 16.50%, Crushing Strength = 7200 KPA)													

DS – Disturbed Sample, UDS – Undisturbed Sample, WS – Washing Sample, NMC – Natural Moisture Content, NP – Non Plastic
Refer Section-6 for Safe Bearing Capacity values of BH-1 at the depth ranges from 0m to 8.50m.

TABLE 11.2: Summary of Lab Test Results for BH-2

Depth of Soil (m)	Soil Description	Type of sample collected	IS Classification	Grain Size Analysis (%)					Index Properties (%)				Bulk Density (Kn/m^3)	Specific Gravity (G)	Cohesion "C" (Kn/m^2)	Angle of Friction (Ø)
				Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay	NMC	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)				
0.00 to 1.50	Brownish Clayey Sand	DS	SC	3.35	2.70	23.25	38.00	32.70	13	36.86	19.33	17.53	14.35	2.52	0	32
1.50 to 2.50	Brownish Medium Sand mixed with Gravel	DS	SW	19.57	10.60	58.78	8.92	2.13	12	NP	NP	NP	14.78	2.58	0	33
2.50 to 3.50	Soft Disintegrated Rock	WS	-	35.76	12.81	41.29	2.91	7.23	13	NP	NP	NP	15.30	2.54	0	35
3.50 to 4.50	Soft Disintegrated Rock	WS	-	36.20	13.75	44.06	3.77	2.22	10	NP	NP	NP	15.69	2.56	0	36
4.50 to 6.00	Soft Disintegrated Rock	WS	-	36.14	12.78	42.33	3.23	5.52	11	NP	NP	NP	15.93	2.53	0	38
6.00 to 7.00	Soft Disintegrated Rock	WS	-	38.40	11.65	42.04	3.26	4.65	8	NP	NP	NP	16.21	2.55	0	39
7.00 to 8.00	Hard Rock	UDS	(CR = 22.50%, RQD = 22.50%, Crushing Strength = 4000 Kpa)													

DS – Disturbed Sample, UDS – Undisturbed Sample, WS – Washing Sample, NMC – Natural Moisture Content, NP – Non Plastic

Refer Section-6 for Safe Bearing Capacity values of BH-2 at the depth ranges from 0m to 8.00m.

Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

TABLE 11.3: Summary of Lab Test Results for BH-3

Depth of Soil (m)	Soil Description	Type of sample collected	IS Classification	Grain Size Analysis (%)					Index Properties (%)				Bulk Density (Kn/m^3)	Specific Gravity (G)	Cohesion "C" (Kn/m^2)	Angle of Friction (Ø)
				Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt & Clay	NMC	Liquid Limit (W_L)	Plastic Limit (W_P)	Plasticity Index (I_P)				
0.00 to 1.00	Brownish Clayey Sand	DS	SC	4.30	2.60	27.15	36.30	29.65	14	30.19	18.15	12.04	15.13	2.51	0	32
1.00 to 2.00	Brownish Medium Sand	DS	SW	9.09	7.50	68.07	12.83	2.51	17	NP	NP	NP	15.36	2.50	0	32
2.00 to 3.00	Soft Disintegrated Rock	WS	-	15.56	6.89	60.87	14.36	2.32	13	NP	NP	NP	15.58	2.57	0	33
3.00 to 4.50	Soft Disintegrated Rock	WS	-	11.70	5.38	58.39	22.16	2.37	14	NP	NP	NP	15.83	2.54	0	35
4.50 to 6.00	Soft Disintegrated Rock	WS	-	10.80	4.27	60.51	21.78	2.64	11	NP	NP	NP	16.14	2.59	0	36
6.00 to 7.50	Soft Disintegrated Rock	WS	-	11.40	5.20	57.61	22.10	3.69	10	NP	NP	NP	16.52	2.52	0	38
7.50 to 8.50	Hard Rock	UDS	(CR = 21.50%, RQD = 21.50%, Crushing Strength = 8000 Kpa)													

DS – Disturbed Sample, UDS – Undisturbed Sample, WS – Washing Sample, NMC – Natural Moisture Content, NP – Non Plastic

Refer Section-6 for Safe Bearing Capacity values of BH-3 at the depth ranges from 0m to 8.50m.

Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

12. LOCATION MAP

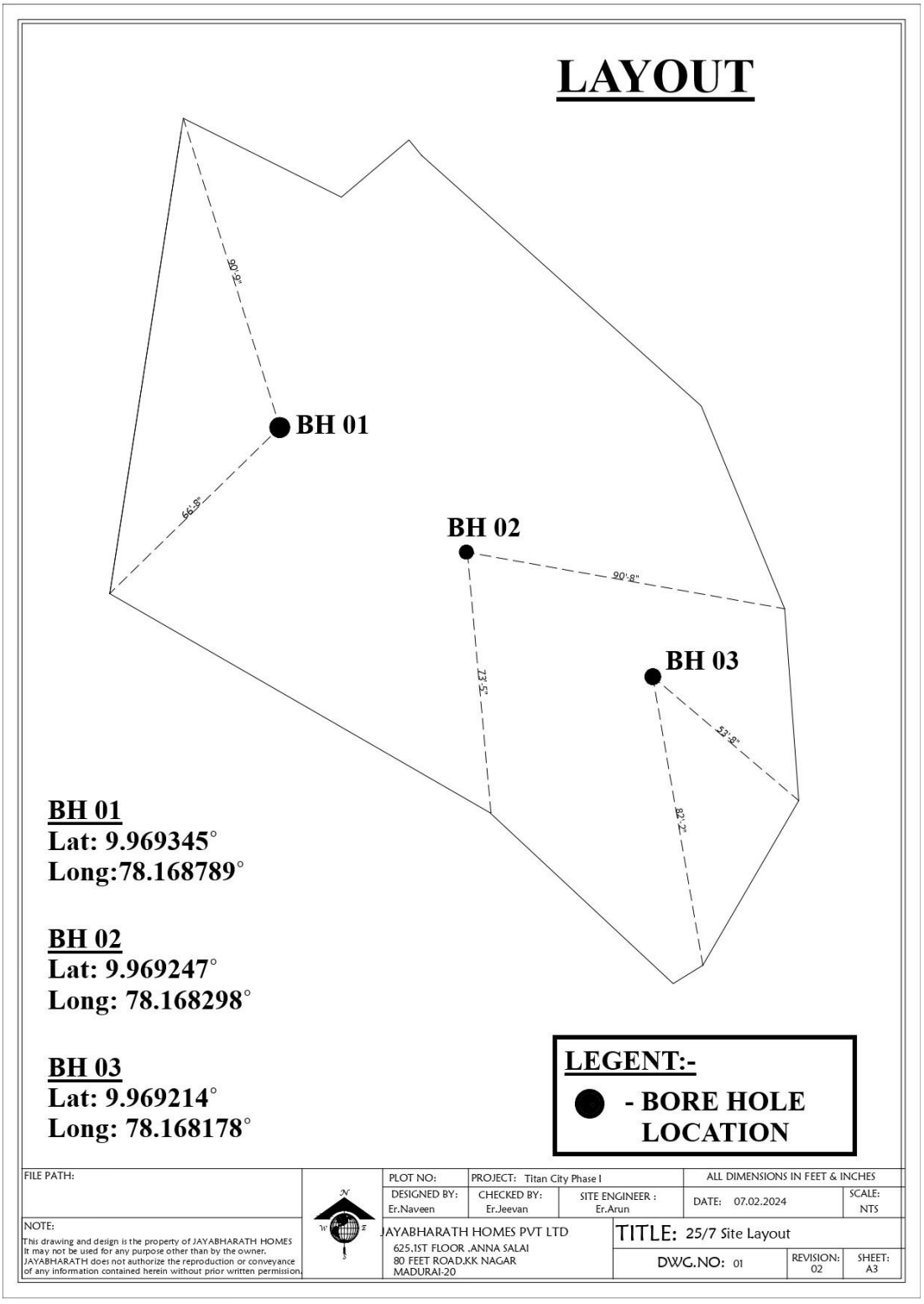


Figure 4: Location Map

13. LOCATION IMAGES

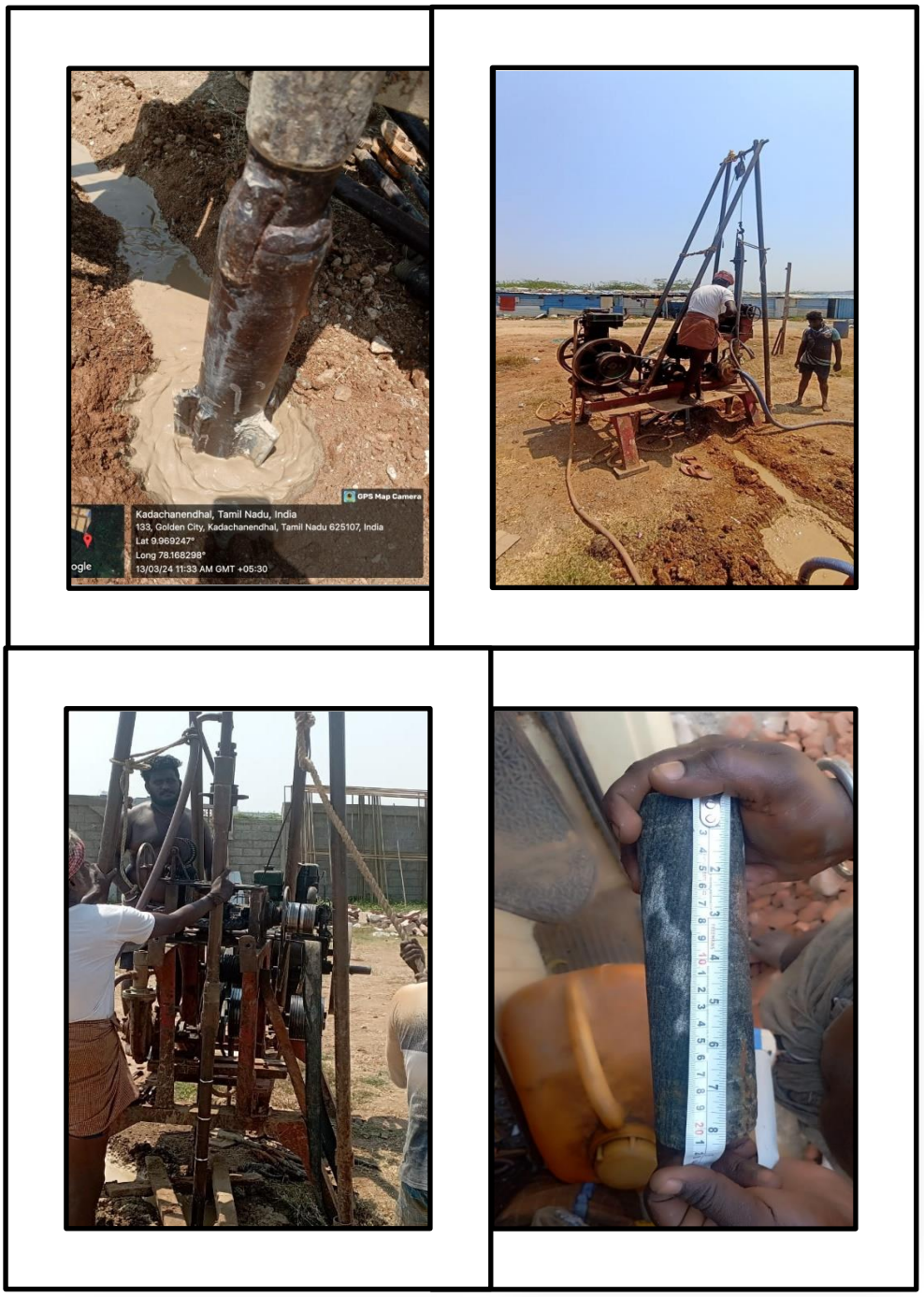


Figure 5: Location images

14. CONCLUSION

As per IS 1498-1970, the soil samples are classified and discussed under the (Section-11). The recommended safe bearing capacities from 1.50m to 3.30m are presented in this report under (Section-9) for the purpose of designing the foundation according to the load conditions and structural requirements. Based on our recommendation, isolated column footing / combined footing is suggested at the depth above 2.40m. Structural Engineer can select the depth of foundation from our recommendation according to Structural requirements.

As per IS 8009 - part-1 -1998 settlement calculations, the maximum allowable limits of differential settlement for Sand & Gravel are 50 mm and for Silt & Clay is 75 mm. For this safe bearing capacity (Section-9), the differential settlement is also within the allowable limits. Hence it is concluded that the soil is safe against differential settlement. The foundation concrete shall be laid in dry condition if meets the water table during the execution.

Date : 16.03.2024
Place : Madurai

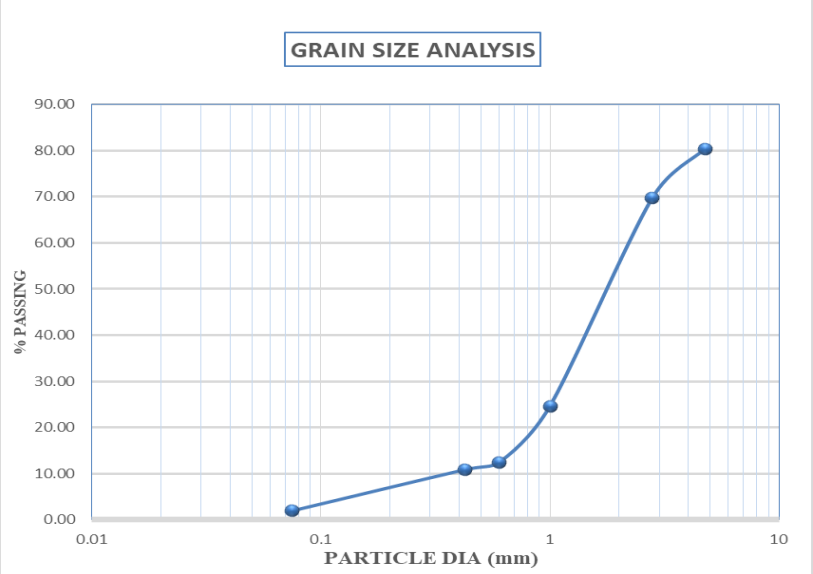
Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

ANNEXURE – A

GRAIN SIZE ANALYSIS **BH No: 2**

(As Per IS 2720 (Part4):1985) **Depth: 2.50 m**

SIEVE ANALYSIS TEST CALCULATIONS AND PARTICLE SIZE DISTRIBUTION CURVE					
S.NO	**SIEVE SIZE (mm)**	**SOIL RETAINED (g)**	**ACCUMULATIVE RETAINED (g)**	**% MASS RETAINED**	**% PASSING**
1	4.75	19.57	19.57	19.57	80.43
2	2.80	10.6	30.17	30.17	69.83
3	1.00	45.07	75.24	75.24	24.76
4	0.6	12.18	87.42	87.42	12.58
5	0.425	1.53	88.95	88.95	11.05
6	0.075	8.92	97.87	97.87	2.13
7	Pan	2.13	100	100.00	0.00



From Grain Size Analysis Graph

% Gravel	19.57
% Coarse Sand	10.6
% Medium sand	58.78
%Fine sand	8.92
% Clay & silt	2.13

Soil Description: Medium Sand mixed with Gravel

ANNEXURE – B

SPECIFIC GRAVITY

(As Per IS 2720 (Part3):1980)

BH. NO	**1**	**1**	**2**	**2**	**3**	**3**
Depth (m)	**1.00 m**	**2.00 m**	**1.50 m**	**2.50 m**	**1.00 m**	**2.00 m**
Weight of empty bottle (W_1) gm	28.56	28.56	28.56	28.56	28.56	28.56
Weight of bottle + sample (W_2) gm	48.30	47.48	48.40	48.43	48.36	51.69
Weight of bottle + sample + water (W_3) gm	91.33	90.75	91.28	91.46	91.20	93.19
Weight of bottle + water (W_4) gm	79.30	79.30	79.30	79.30	79.30	79.30
Weight of Sample (W_2 -W_1) gm	19.74	18.92	19.84	19.87	19.80	23.13
Weight of water (W_4-W_1) gm	50.74	50.74	50.74	50.74	50.74	50.74
Weight of Soil Water (W_3-W_2) gm	43.03	43.27	42.88	43.03	42.84	41.50
Specific Gravity = (W_2-W_1)/((W_4-W_1)-(W_3-W_2))	**2.56**	**2.53**	**2.52**	**2.58**	**2.51**	**2.50**

ANNEXURE – C

NATURAL MOISTURE CONTENT

(As Per IS 2720 (Part2): 1973)

BH.No	**1**	**1**	**2**	**2**	**3**	**3**
Depth (m)	**1.00 m**	**2.00 m**	**1.50 m**	**2.50 m**	**1.00 m**	**2.00 m**
Wt of Tare (W) gm	54.24	84.11	53.17	58.91	59.53	80.96
Tare + Wet soil (W_1) gm	349.25	179.02	102.52	236.50	93.76	253.61
Tare + Dry soil (W_2) gm	296.50	167.11	96.92	217.74	89.51	229.14
Wt of Water $W_3 = (W_1-W_2)$ gm	52.75	11.91	5.60	18.76	4.25	24.47
Wt of Dry soil $W_4 = (W_2 - W)$ gm	242.26	83.00	43.75	158.83	29.98	148.18
Water content (%) = $(W_3/W_4)*100$	**22**	**14**	**13**	**12**	**14**	**17**

ANNEXURE – D

DENSITY CALCULATION

BH NO	**1**	
DEPTH (m)	**2.00**	
SI NO :	**DESCRIPTION**	**READING**
1	Weight of Empty Box (gm)	204.79
2	Weight of Box + soil (gm)	369.94
3	Weight of soil (gm)	165.15
4	Volume of Box (cm^3)	102.14
5	**Bulk Density (gm / cm^3)**	**1.62**
6	Water Content (%)	0.14
7	**Dry Density (gm /cm^3)**	**1.42**

Result:-

Bulk Density (kn/m^3)	**15.86**
Dry Density (kn/m^3)	**13.91**

Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

ANNEXURE – E

DIRECT SHEAR TEST **BH No: 3**

(As Per IS 2720 (Part13):1986) **Depth: 1.00 m**

L.C of Dial Guage	0.01
Proving Ring Constant	0.26

TRAIL NO:1

NORMAL STRESS : 0.5 Kg/cm^2

GUAGE READING (HORIZONTAL) (mm)	PROVING RING READING	SHEAR DEFORMATION	SHEAR STRESS (Kg/cm^2)
0	0	0	0.0000
50	4.6	0.5	0.0332
100	5.8	1	0.0419
150	7.4	1.5	0.0534
200	9.0	2	0.0650
250	11.2	2.5	0.0809
300	13.6	3	0.0982
350	15.8	3.5	0.1141

TRAIL NO:2

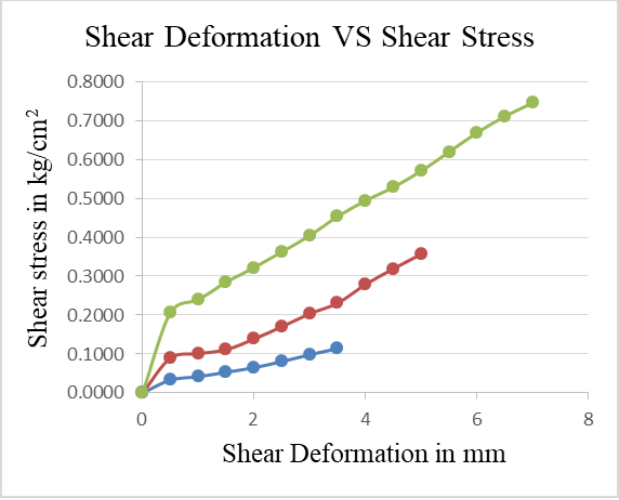
NORMAL STRESS : 1.0 Kg/cm2

GUAGE READING (HORIZONTAL) (mm)	PROVING RING READING	SHEAR DEFORMATION	SHEAR STRESS (Kg/cm^2)
0	0	0	0.0000
50	12.4	0.5	0.0896
100	14.0	1	0.1011
150	15.4	1.5	0.1112
200	19.2	2	0.1387
250	23.6	2.5	0.1704
300	28.2	3	0.2037
350	32.0	3.5	0.2311
400	38.6	4	0.2788
450	44.2	4.5	0.3192
500	49.4	5	0.3568

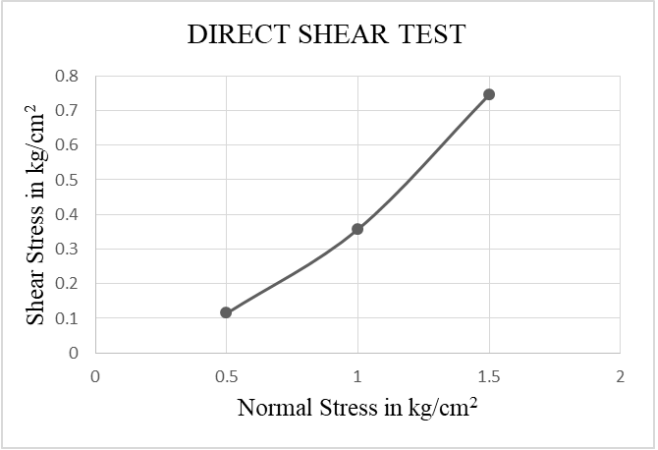
TRAIL NO:3

NORMAL STRESS : 1.5 Kg/cm2

GUAGE READING (HORIZONTAL) (mm)	PROVING RING READING	SHEAR DEFORMATION	SHEAR STRESS (Kg/cm^2)
0	0	0	0.0000
50	28.6	0.5	0.2066
100	33.2	1	0.2398
150	39.4	1.5	0.2846
200	44.6	2	0.3221
250	50.2	2.5	0.3626
300	56.0	3	0.4044
350	62.8	3.5	0.4536
400	68.4	4	0.4940
450	73.2	4.5	0.5287
500	79.0	5	0.5706
550	85.8	5.5	0.6197
600	92.6	6	0.6688
650	98.4	6.5	0.7107
700	103.2	7	0.7453



Normal Stress (kg/cm^2)	Proving Ring Reading at Failure	Shear Stress (kg/cm^2)
0.5	15.8	0.1141
1.0	49.4	0.3568
1.5	103.2	0.7453



Result:-

Cohesion (C)	**0**
Angle of Internal Friction	**32**

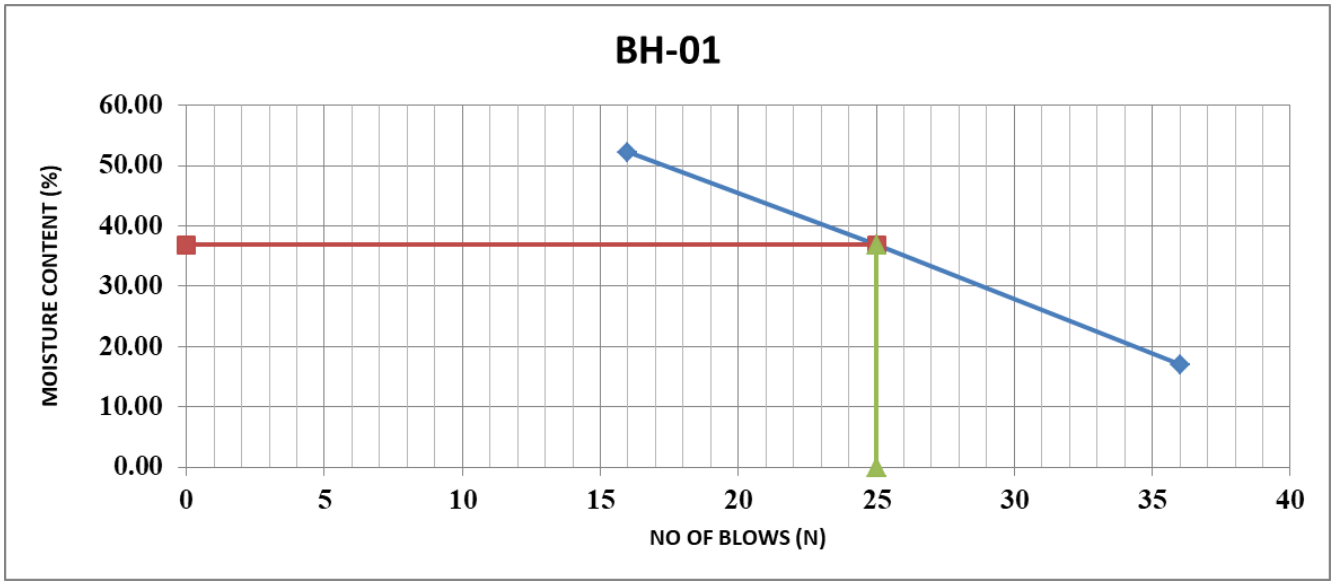
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ANNEXURE – F

LIQUID LIMIT & PLASTIC LIMIT **BH No: 2**

(As Per IS 2720 (Part 5): 1985) **Depth: 1.50 m**

Description			Liquid Limit			Plastic Limit
			BH 01			BH 01
No.of Blows	N		16	25	36	
Weight of Wet Specimen + container	WSC	g	43.60	44.78	45.31	39.86
Weight of Dry Specimen + container	WDC	g	40.12	42.20	43.98	38.29
Weight of container	WC	g	33.46	35.20	36.16	30.20
weight of water	WW	g	3.48	2.58	1.33	1.57
Weight of Dry Specimen	WD	g	6.66	7.00	7.82	8.10
Moisture content	W	%	52.25	36.86	17.01	19.33



Result:-

From Graph, Liquid Limit of Soil =	**36.86%**
Plastic Limit of Soil =	**19.33%**
Plasticity Index, I_P =	**17.53%**

Proposed Construction of Apartment Building (Titan City) at Surya Nagar, Mangalakudi Village, Madurai East Taluk, Madurai Corporation, Madurai District.

ANNEXURE – G

SAFE BEARING CAPACITY CALCULATION ON SHALLOW FOUNDATION

BH NO : 1	CALCULATION - 1

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	Df	=	2.40 m
Correction Factor for Water Table	W'	=	0.5
Unit weight of soil	γsoil	=	15.86 Kn/m^3
Cohesion	"C"	=	0 Kn/m^2
Angle of Shearing resistance (General shear)	Φ	=	31.00°
Angle of Shearing resistance (Local Shear)	Φ’	=	21.83°
Safety Factor	F	=	3.00
Effective Surcharge of soil above Footing Base	q	=	38.064 Kn/m^3
Type of soil		=	Clayey Sand
Mode of failure		=	Mixed Shear Failure
Ground Water Table level			
(Assumed for worst case - at the ground level)		=	0 m From NGL

FOR GENERAL SHEAR FAILURE

$Nq = \tan^2 (45^o + ø/2) (e^{\pi \tan ø})$	=	20.65
$Nc = (Nq - 1) \cot ø$	=	32.70
$N_\gamma = 2 (Nq + 1) \tan ø$	=	26.01

FOR LOCAL SHEAR FAILURE

$N'q = \tan^2 (45^o + ø'/2) (e^{\pi \tan ø'})$	=	7.69
$N'c = (N'q - 1) \cot ø'$	=	16.70
$N'_\gamma = 2 (N'q + 1) \tan ø'$	=	6.96

THE SHAPE FACTOR

Shape of Footing	S_C	S_Q	S_Y
CONTINUOUS STRIP FOOTING	1	1	1
SQUARE FOOTING	1.3	1.2	0.8
RECTANGULAR FOOTING	1+0.2B/L	1+0.2B/L	1+0.2B/L

SQUARE FOOTING	
S_C =	1.300
S_Q =	1.200
S_Y =	0.800

THE DEPTH FACTOR

For General Shear Failure

d_c =	1 + 0.2 D_f / B x tan (45º + ø/2)	=	1.57
$d_q = d_y$ =	1 for ø > 10º	=	1.00
$d_q = d_y$ =	1 + 0.1 D_f / B x tan (45º + ø/2) for ø > 10º	=	1.28

For Local Shear Failure

d_c =	1 + 0.2 D_f / B x tan (45º + ø'/2)	=	1.47
$d_q = d_y$ =	1 for ø' > 10º	=	1.00
$d_q = d_y$ =	1 + 0.1 D_f / B x tan (45º + ø'/2) for ø' > 10º	=	1.24

THE INCLINATION FACTOR

$I_c = I_q$ = 1-α/90) ^2 = 1.00 I_y = 1-α/Ø) ^2 = 1.00

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

Net Ultimate Bearing Capacity, qd = $\frac{(CN_cS_cd_cI_c) + (q(N_q-1)S_q\,d_q\,I_q) + (0.5B\Upsilon N_\Upsilon S_\Upsilon d_\Upsilon I_\Upsilon W') + (2/3)}{(CN_{c'}S_cd_cI_c) + (q\,(N_{q'}-1)S_q\,d_q\,I_q) + (0.5B\Upsilon N_{\Upsilon'}S_\Upsilon d_\Upsilon I_\Upsilon W')/2}$

= 864.402 Kn/m^2

SAFE BEARING CAPACITY:

SBC = qd / FOS = 864.402 / 3 = **288.13 Kn/m^2**

or

29.37 t/m^2



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