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REPORT

ON

SOIL INVESTIGATION FOR CONSTRUCTION OF STUDIO APARTMENT (RESIDENTIAL BUILDING) AT PLOT NO. 378 A, MORAIS CITY, TRICHY

Client

Mrs. Cecilia Edel Priya,
Managing Director,
M/s. Luxica Properties Private Limited,
Plot No. 378 A,
Old Survey No. 205/5A, New Survey No. 205/13,
Keelakurichi Village,
Thiruverumbur Taluk,
Tiruchirapalli District.

By

Time

TIME INSTITUTE FOR MATERIALS TESTING
NO. 25, SANJEEVI NAGAR,
TRICHY - CHENNAI BYEPASS ROAD,
TIRUCHIRAPPALLI,
TAMIL NADU - 620 002.
PH: 0431 2401326

JUNE 2024

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS,MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443076090 Email : senthamilkumar@yahoo.co.in

SUMMARY

Project	:	Construction of Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy
Project Reference	:	Time /30/ Soil Test / June 2024
Owner	:	Mrs. Cecilia Edel Priya, Managing Director, M/s. Luxica Properties Private Limited, Plot No. 378 A, Old Survey No. 205/5A, New Survey No. 205/13, Keelakurichi Village, Thiruverumbur Taluk, Tiruchirapalli District.
Type of Structure	:	R.C.C. Framed construction
Location	:	Plot No. 378 A, Morais City, Trichy
Scope	:	Geotechnical investigation for the entire area of construction
Test conducted	:	Two explanatory bore hole up to 4.5m depth was made and conducted standard penetration tests at every 1.5m depth. The undisturbed soil samples were collected at every 1.5m depth for laboratory test.

FINDINGS

Soil at shallow depth	:	Gravels exists up to 2.5m depth
Hard stratum	:	Weathered rock exists between 2.5m to 4.5m depth in bore hole 1 & 2
Ground water table	:	Ground water table was not encountered during investigation up to 4.5m depth

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443975090 Email : senthamilkumar@yahoo.co.in

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Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2018
703, Plot No. 29, Q.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

SOIL INVESTIGATION

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

ACCREDITED
ISO - 17025:2017
B.N. Krishnaswami, M.E., (Struct Engg.) Ph.D.,
Former Faculty, NIT, Trichy

Time Institute for Materials Testing
टाइम इन्स्टिट्यूट चीज़े शोध केलिए
Soil & Structural Consultant, Construction Materials Testing Lab

Quality is Excellence

June 11, 2024

To

Mrs. Cecilia Edel Priya,
Managing Director,
M/s. Luxica Properties Private Limited,
Plot No. 378 A,
Old Survey No. 205/5A, New Survey No. 205/13,
Keelakurichi Village,
Thiruverumbur Taluk,
Tiruchirapalli District.

REPORT ON SOIL INVESTIGATION

(Ref: TIME/30/ SOIL TEST/ JUNE 2024)

Sub: Soil Investigation for construction of Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy - reg,

Ref: Based on letter dated: 07.06.2024

1.1 Introduction:

It is proposed to construct a **Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy.** A detailed soil investigation was suggested for estimating the safe bearing capacity of the soil, so that suitable type of foundation can be decided for the proposed structure. Time Institute for Materials Testing (TIME) has been requested to undertake the soil investigation at the proposed site. The study was carried out by TIME on **08.06.2024.** This report presents complete investigation data and discusses the results to recommend the bearing capacity values at different depths for the proposed structure.

Section 2 describes the soil profile and bore log details of two exploratory bore holes. Section 3 of this report gives the Grain size distribution curves and its analysis. Section 4 of this report presents the calculated safe Bearing capacity values of soil at various depths. Section 5 of this report reviews the test results and the recommended safe bearing capacity values for design of foundation. Section 6 of this report presents the Soil & Rock sample photos. Section 7 of this report presents site photo.

Dr. Senthamil Kumar, M.E.,Ph.D,FIGS, M.ISTE
Registered Geotechnical Engineer - No. 001/RGTE/2024
203, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

1.2 Investigation Programme, Procedure and Data:

Investigation was carried out in two locations at the site through exploratory bore holes. Soil samples were collected from each bore hole at different depths for conducting laboratory test. Standard Penetration test was conducted at regular intervals and 'N' values were recorded. Undisturbed soil samples were collected and were preserved and transported to the laboratory for detailed identification tests. Based on the field and laboratory tests on the samples collected, the results are furnished in this report.

An exploratory bore hole was advanced from the existing ground level using truck mounted rotary drilling techniques supplemented by Betonies mud circulation. This drilling procedure with mud circulation is found most suitable for making exploratory bore hole. The mud circulation was employed through the drill rods and letting it out though the side jets provided in the cutting tool thus preventing any disturbance at the bore hole bottom. Mud circulation was used to stabilize the sides and the bottom of the bore hole, and then to bring the soil cuts to the surface. It is important to note that the mud jet is not used to cut the soils as in the case of wash boring technique. Use of drilling mud will also help in preventing the disturbance to the soil at the bore hole bottom during drilling operations. Diameter of the bore hole is about 150mm.

Bore hole was always kept full with the drilling mud so that a positive head is maintained in the bore hole thus preventing any disturbance to the soil within the test zone.

The field tests included Standard penetration test, Disturbed and undisturbed soil sampling, identification of different soil layers, Ground water table observation, complete logging of the bore hole, etc.

Laboratory investigation consisted of classification tests like grain size distribution analysis, determination of specific gravity etc. Unconfined Compression test and Direct shear was conducted on preserved soil samples. All the field and laboratory tests were conducted according to the procedures stipulated in relevant IS codes.

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIGE
Registered Geotechnical Engineer - No. 001/RGE/2014
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443970030 Email : senthamilkumar@yahoo.co.in

1.3 Review of Field and Laboratory Results:

Sub soil Profile

The original ground level in the presently investigated area was plain terrain.

Bore Hole 1:

The natural soil below the existing ground level is laterite soil. This layer is extended up to 1.5m depth. Gravels exist from 1.5m to 2.5m depth. Below which weathered rock exists from 2.5m to 4.5m depth from the existing ground level. The soil stratification and its variation under present investigation are available in bore log details. The 'N' value is progressively increasing towards depth, due to the soil stratification.

Bore Hole 2:

The natural soil below the existing ground level is laterite soil. This layer is extended up to 1m depth. Clay with gravels mixed exists from 1m to 1.5m depth. Gravels exist from 1.5m to 2.5m depth. Below which weathered rock exists from 2.5m to 4.5m depth from the existing ground level. The soil stratification and its variation under present investigation are available in bore log details. The 'N' value is progressively increasing towards depth, due to the soil stratification.

Ground Water Table

Ground water table was not encountered during investigation up to 4.5m depth

Shear Strength

Standard Penetration test blow counts 'N' is measured at different levels in the bore hole. Mainly these 'N' values are used to assess the shear strength of different soil layers.

Non - Cohesive Layers: The sand layers towards depth are of residual type and suitable modifications are made to take care of the presence of plastic fines in the residual soil. Conventional method of estimating the angle of shearing resistance ϕ corresponding to the relative density and the grain size distribution as per the classification suggested by Peck and suitably modified by the R.K. Hough to account for the influence of grain size distribution is adopted here.

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIGS
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Laboratory Tests:

The Collected soil samples were tested as per relevant procedure in IS codes. The following parameters are evaluated.

1) **Natural Moisture Content**: This test is conducted in all disturbed samples to find the water content in soil samples as per **IS 2720 (Part 2): 1973**
2) **Specific Gravity:** This test is conducted in all disturbed soil samples to find specific gravity of soil as per **IS 2720 (Part 3): 1980**
3) **Density:** This test is conducted in all disturbed soil samples to find Bulk density and Dry density of soil as per **IS 2720 (Part 8): 1983**
4) **Sieve Analysis: This test is conducted to identify and classify the samples** as per **IS 2720 (Part 4) : 1985**
5) **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**

1.4 Recommended Safe bearing capacity values at different depths

Bore Hole	Depth (m)	Safe Bearing Capacity (t/m²)
BH – 1	1.50	16.99
	3.00	41.63
	4.50	43.33
BH – 2	1.50	20.39
	3.00	40.78
	4.50	41.63

Dr. Senthamil Kumar, ME, Ph.D, FIGS, MISTE
Registered Geotechnical Engineer - No. 001/RGE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

1.4 Conclusions:

The scope of foundation is purely the decision of the structural engineer. However, the following suggestion are furnished for your reference.

1. There are two types of foundation as Open foundation and Deeper foundation.
2. Under Open foundation, there are four types like Isolated, Combined, Raft and Mat Foundation.
3. Under Deeper foundation, it is only Pile foundation.
4. Under which condition we can prefer Open foundation or Pile foundation?
5. In general, to have Open foundation for any type of loading via Light load /Heavy load, symmetrically spaced columns or unsymmetrically spaced columns, it is preferable to have SBC as 20t/m^2 and above at 3m depth and it should continue to increase as proceed down, further it should not increase and decrease after 3m depth to satisfy the settlement criteria.
6. Based on the existing soil condition in this location the above condition to provide open foundation is fully satisfied.
7. **Hence it is Suggested to provide Open foundation at 3m depth by considering SBC values as 30t/m^2.**
8. The minimum width of footing should be maintained as 1.2m x 1.2m to avoid Punching Shear failure and the footing should rest on natural undisturbed soil strata.
9. The Excavated material can be reused for Backfilling since the Bulk density and Permeability values are well within the Permissible limits.

For Time Institute for Materials Testing

Time Institute for Materials Testing Tiruchirappalli-2

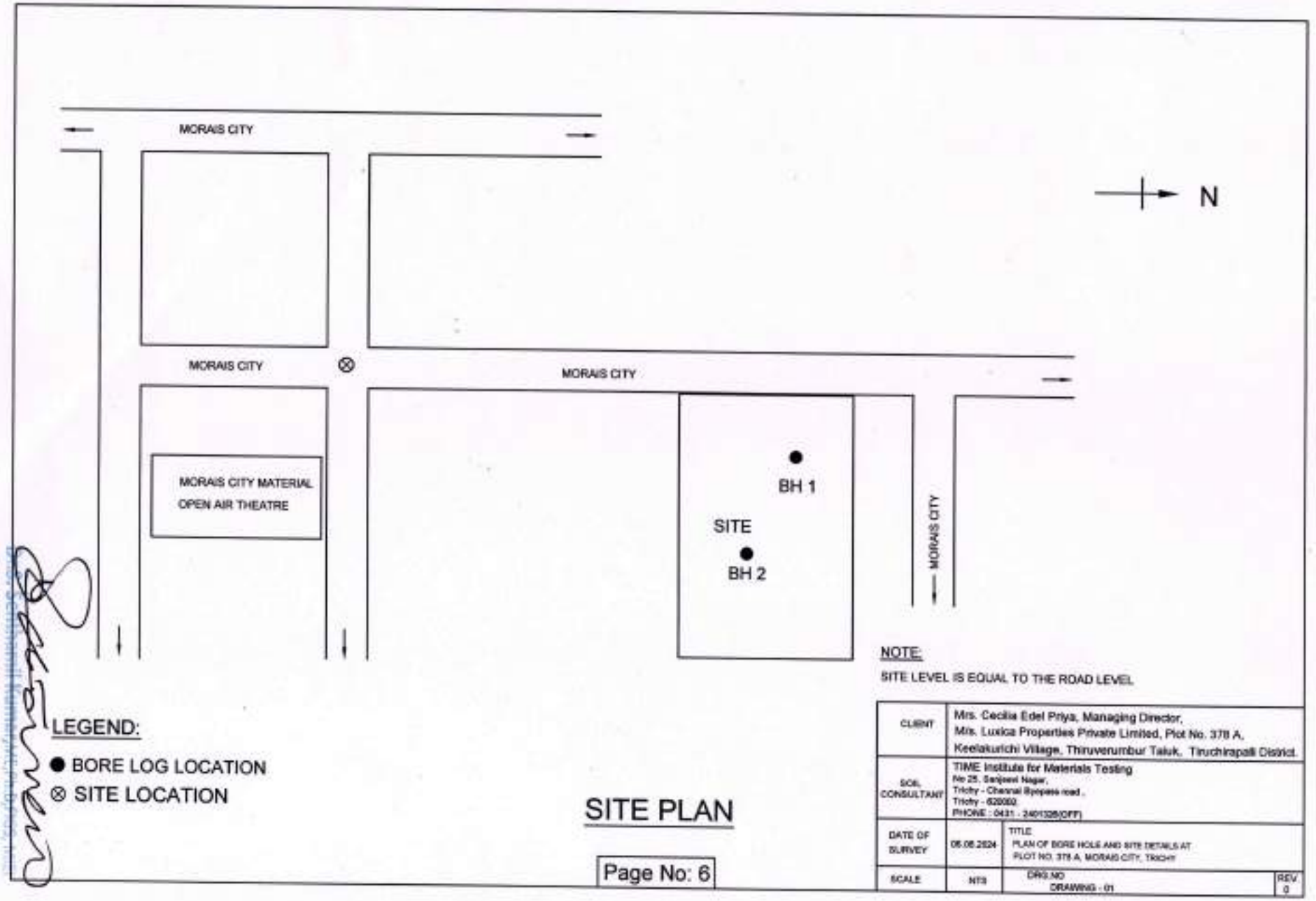
11th June 2024

Dr. B.N. Krishnaswami.

Dr.S. Senthamil Kumar, ME, Ph.D, FIGS, MIGI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

SITE LOCATION PLAN

Dr.S. Senthamil Kumar, ME, Ph.D, FIGS, MISD
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in



LEGEND:

● BORE LOG LOCATION

⊗ SITE LOCATION

NOTE:

SITE LEVEL IS EQUAL TO THE ROAD LEVEL

CLIENT	Mrs. Cecilia Edel Priya, Managing Director, M/s. Luxica Properties Private Limited, Plot No. 378 A, Keelakurichi Village, Thiruverumbur Taluk, Tiruchirapalli District.	
SOIL CONSULTANT	TIME Institute for Materials Testing No 25, Sanjeevi Nagar, Trichy - Chennai Bypass road, Trichy - 620002. PHONE : 0431 - 2401326(OFF)	
DATE OF SURVEY	06.08.2024	TITLE PLAN OF BORE HOLE AND SITE DETAILS AT PLOT NO. 378 A, MORAIS CITY, TRICHY
SCALE	NTS	DRG.NO DRAWING - 01 / REV. 0

SITE PLAN

Registered Geotechnical Engineer - No. 002/AGTG/2024
703, Plot No. 39, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976099 Email : senthamilkumar@yahoo.co.in

BORE LOG DETAILS

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443576090 Email : senthamilkumar@yahoo.co.in

2.2 BORE LOG DETAILS FOR BORE HOLE 1

Project	: Report on soil investigation for Construction of Studio Apartment (Residential Building
Location	: Plot No. 378 A, Morais City, Trichy
Started on	: 08.06.2024 **Ended on** : 08.06.2024
Depth of G.W.T	: Nil
Type of Boring	: Calyx drilling
Site Level	: Equal to the road level

Lithology of Bore Hole			SPT Data					Graphical representation of penetration Resistance ('N' Value)
Depth below G.L. (m)	Profile	Soil Description	Depth of SPT (m)	0-15cm	15-30cm	30-45cm	N Value	0 20 40 60
0 - 1.5m		Laterite soil						
1.5m - 2.5m		Gravels	1.5	7	10	13	23	
2.5m - 4.5m		Weathered rock	3.0	Rebound			52	
			4.5	Rebound			54	

Bore terminated at 4.5m depth from the existing ground level

Dr.S. Senthamil Kumar, M.E., Ph.D, FIGS, MSTE
Registered Geotechnical Engineer No. 001/RGTE/2024
Plot No. 2.3, Govt. Rajaji Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443926050 Email : senthamilkumar@yahoo.co.in

2.3 BORE LOG DETAILS FOR BORE HOLE 2

Project : Report on soil investigation for Construction of Studio Apartment (Residential Building

Location : Plot No. 378 A, Morais City, Trichy

Started on : 08.06.2024 **Ended on** : 08.06.2024

Depth of G.W.T : Nil

Type of Boring : Calyx drilling

Site Level : Equal to the road level

Lithology of Bore Hole			SPT Data					Graphical representation of penetration Resistance ('N' Value)
Depth below G.L. (m)	Profile	Soil Description	Depth of SPT (m)	0-15cm	15-30cm	30-45cm	N Value	0 20 40 60
0 - 1m		Laterite soil						
1m - 1.5m		Clay with gravels mixed						
1.5m - 2.5m		Gravels	1.5	8	12	15	27	
2.5m - 4.5m		Weathered rock	3.0	Rebound			51	
			4.5	Rebound			52	

Bore terminated at 4.5m depth from the existing ground level

Time Institute for Materials Testing, Trichy

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

2.4 Summary of Engineering Geo Properties

Natural Moisture Content:

The natural water content also called the natural moisture content is the ratio of the weight of water to the weight of the solids in a given mass of soil. This ratio is usually expressed as percentage.

$$W = [(W2-W3)/(W3-W1)] \times 100$$

Where,

W_1 = Weight of container gm

W_2 = Weight of container +wet soil gm

W_3 = Weight of container +dry soil

Bulk Density:

The total, or wet, density of soil, γ is the ratio of the total mass of soil to its total volume and can be defined as follows:

$$\gamma_{bulk} = M / V$$

Where

M_t = Total Mass of soil

V_t = Total Volume

Dry Density:

The soil dry density, γ_d is the ratio of the mass of the solid phase of the soil (i.e., dried soil) to its total volume (solid and pore volumes together) and is defined as follows:

$$\gamma_{dry} = M_b / V_b$$

Where

M_b = Total Mass of dried soil

V_b = Total Volume

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, M
Registered Geotechnical Engineer - No. 001/RGTE/202
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co

Specific gravity:

Specific gravity is the ratio of the weight of a given volumeof a material at a standard temperature to the weight of an equal volume of distilled water at the same stated temperature.

The specific gravity G of the soil = $(W_2 - W_1) / [(W_4 - W_1)-(W_3-W_2)]$

Where

W_1 = Weight of density bottle
W_2 = Weight of density bottle + dry soil
W_3 = Weight of bottle + dry soil + water at temperature
W_4 = Weight of density bottle + Water

Void Ratio:

Soil void ratio (e) is the ratio of the volume of voids to the volume of solids:

$$e = (Vv) / (Vs)$$

Where
Vv is the volume of the voids (empty or filled with fluid),
Vs is the volume of solids.

Porosity:

Soil porosity (η) , which is defined as the ratio of the volume of voids to the total volume of the soil.
The porosity and the void ratio are inter-related as follows:

$$\eta = (1 - (\gamma_d/G_s))*100$$

$$e = \eta/(1-\eta) \;\&\; \eta = e / (1+e)$$

Where
γ_d = Dry Density
G_s = Specific gravity

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Summary of Engineering Geo Properties for Bore Holes 1 & 2

Bore hole No.	Depth (m)	Soil Description	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry Density (gm/cc)	Specific gravity	Porosity (%)	Void Ratio
Bore Hole 1	1.5	Gravels	9.87	1.96	1.78	2.66	33	0.49
	3.0	Weathered rock	4.55	2.05	1.96	2.68	27	0.37
	4.5		4.30	2.06	1.98	2.68	26	0.36
Bore Hole 2	1.5	Gravels	9.72	1.97	1.80	2.66	33	0.48
	3.0	Weathered rock	4.65	2.04	1.95	2.68	27	0.37
	4.5		4.40	2.05	1.96	2.68	27	0.36

Dr.A. Santhamil Kumar, M.E., Ph.D.,
Registered Geotechnical Engineer - NA 600/Mar/2004
703, Plot No. 29, D.M.I. Rajeev Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443769099 Email : santhamilkumar@yahoo.co.in

2.5 Summary of Laboratory Test Results for Bore Hole 1 & 2

Bore hole No.	Depth (m)	Soil Description	Gravel (%)	Coarse sand (%)	Medium Sand (%)	Fine sand (%)	Silt (%)	Clay (%)
Bore Hole 1	1.5	Gravels	61.3	27.2	9.6	1.9	0.0	0.0
Bore Hole 2	1.5	Gravels	63.4	25.8	8.3	2.5	0.0	0.0

Dr. S. Senthamil Kumar, M.E., Ph.D., F.I.G.S., M.I.S.T.E.
Registered Geotechnical Engineer - No. 001/RGE/2007
703, Plot No. 29, D.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

2.6 Shear Strength Parameters for Different layers of Bore Holes 1 & 2

Bore Hole No.	Depth below G.L. (m)	Soil Description	N	Shear Strength 'Ø' (in degrees)
Bore Hole 1	1.5	Gravels	23	31.60
	3.0	Weathered rock	52	36.78
	4.5		54	36.99
Bore Hole 2	1.5	Gravels	27	33.24
	3.0	Weathered rock	51	36.35
	4.5		52	36.57

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

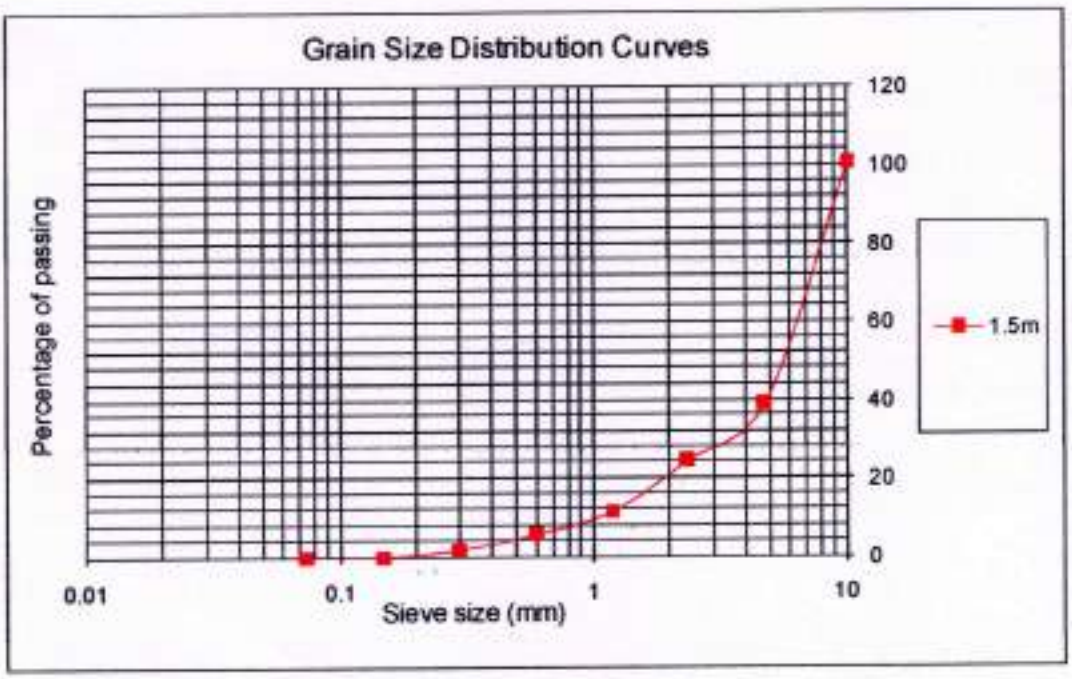
GRAIN SIZE ANALYSIS

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MISTE
Registered Geotechnical Engineer - No. 003/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976000 Email : senthamilkumar@yahoo.co.in

3.1 TEST REPORT ON SIEVE ANALYSIS OF SAMPLE

Bore Hole – 1 @ 1.5m

SIEVE SIZE	PERCENTAGE OF PASSING
	1.5m Depth
10 mm	100
4.75 mm	38.7
2.36 mm	24.2
1.18 mm	11.5
600 micron	5.4
300 micron	1.9
150 micron	0
75 micron	0



Description	1.5m Depth
Fineness modulus	5.183

Observation:

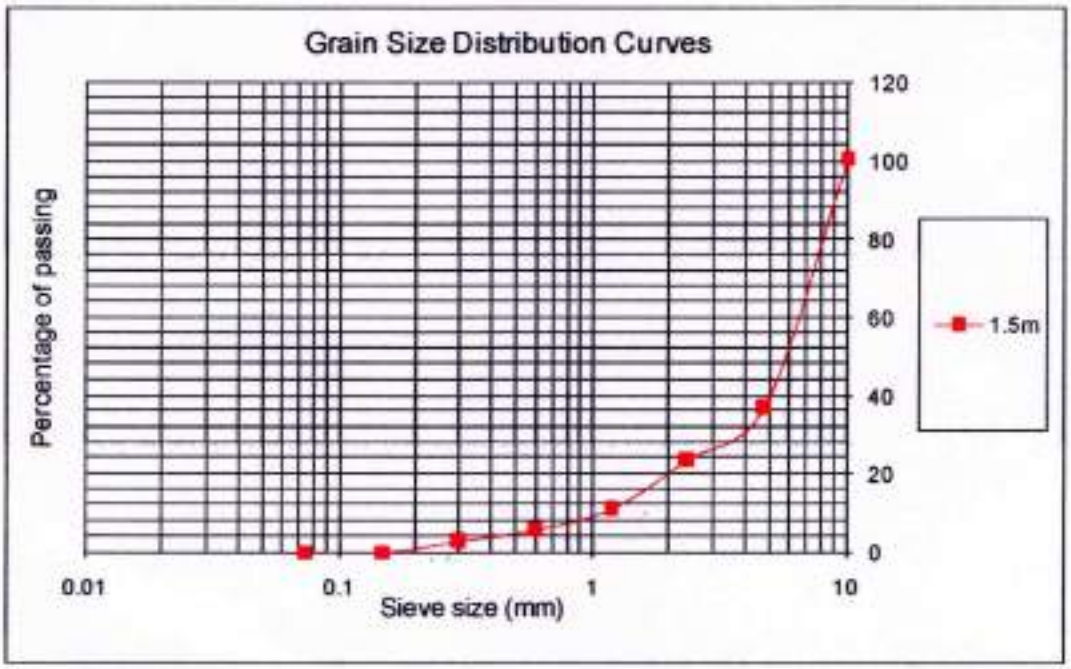
The inference from the graph shows that the gravels exist at 1.5m depth.

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

3.2 TEST REPORT ON SIEVE ANALYSIS OF SAMPLE

Bore Hole – 2 @ 1.5m

SIEVE SIZE	PERCENTAGE OF PASSING
	1.5m Depth
10 mm	100
4.75 mm	36.6
2.36 mm	23.1
1.18 mm	10.8
600 micron	5.6
300 micron	2.5
150 micron	0
75 micron	0



Description	1.5m Depth
Fineness modulus	5.214

Observation:

The inference from the graph shows that the gravels exist at 1.5m depth.

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIG
Registered Geotechnical Engineer - No. 003/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

CALCULATION

OF

SAFE BEARING CAPACITY

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIG
Registered Geotechnical Engineer - No. 001/RGTE/2014
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443926090 Email : senthamilkumar@yahoo.co.in

4. CALCULATION OF SAFE BEARING CAPACITY

4.1 Safe bearing capacity calculation based on settlement and Shear

Safe Bearing Capacity calculations based on settlement consideration (SPT value):

Safe Bearing Capacity calculations for shallow foundation will vary based on the width of foundation.

For example, in the case of Individual footing such as isolated, combined etc., we are supposed to use the formula as mentioned below. (Using Teng's Modified formula)

$$q_{ns} = 51.4 \times (N-3) \times \left(\frac{B+0.3}{2B}\right)^2 \times R_w \times C_d$$

Where,

q_{na}	=	Net safe bearing capacity of soil (kN/m²) (for 2.5cm permissible settlement as per Terzhagi and Peck)
N	=	Corrected SPT values
B	=	Width of foundation (m) (let us assume 2m)
R_w	=	Correction factor for water table level
C_d	=	Correction factor for depth of embedment

For Bore Hole 1 @ 1.5m depth SPT 'N' Value = 23

$\Rightarrow$ **$q_{na} = 51.4 \times (23-3) \times ((2+0.3)/(2 \times 2))^2 \times 0.5 \times 1 = 169.94$ kN/m²**

$\therefore$ **$q_{na} = 16.99$ t/m²**

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MISTE
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, G.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Safe Bearing Capacity calculations based on shear consideration (Direct Shear):

As Per IS 6403:1981

At 1.5m depth (Bore Hole 1)

Proving Ring capacity 200kg = 966.2 division

Area of the shear box = 6cm x 6cm = 36cm²

Normal Stress (kg/cm²)	No. of Division	Stress
0.5	23	0.132
1.0	76	0.437
1.5	130	0.747

Stress = Load / Area

= (200/966.2) * 23* (1/36) = 0.132

Ø = $\tan^{-1}$ (0.747-0.132) = 31.60°

Net safe bearing capacity of the soil (for general shear failure as per IS 6403:1981)

$$q_{ult} = C N_c S_c d_c i_c + q (N_q - 1) S_q d_q i_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma W'$$

Where

C	=	Cohesion in t/m²
N_c, N_q, N_γ	=	Bearing Capacity Factors (From Table 1 of IS 6403 – 1981)
S_c, S_q, S_γ	=	Shape Factors (From Table 2 of IS 6403 – 1981)
d_c, d_q, d_γ	=	Depth Factors
i_c, i_q, i_γ	=	Inclination Factors
q	=	Effective surcharge at the base level of foundation in t/m²
B	=	Width of footing, diameter of circular footing in m
γ	=	Bulk unit weight of soil in t/m³
W'	=	Correction factor for location of water table

At 1.5m depth (Bore hole 1), the Soil profile is Gravels

If	C	=	0 (Since no Cohesion)
	Φ	=	31.60° (based on laboratory test)
Therefore	N_c	=	35.258;
	N_q	=	23.172;
	N_γ	=	30.609

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976050 Email : senthamilkumar@yahoo.co.in

Applying these parameters in the above equation

$q_{ult} = C N_c S_c d_c i_c + q (N_q - 1) S_q d_q i_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma W'$

Where $C = 0$ **(Since no Cohesion)**

Therefore, $q_{ult} = q (N_q - 1) S_q d_q i_q + 0.5 B \gamma N_\gamma S_\gamma d_\gamma i_\gamma W'$

Bearing Capacity calculation through shear density of soil 'γ'

There are two relationships of weight of soil to Volume of soil as

i) Total density or Bulk density

ii) Dry density

Therefore, Total Bulk density, $\gamma_t = \frac{\text{Total Weight of soil}}{\text{Total Volume of soil}} = \frac{W}{V}$

Dry Density $\gamma_d = W_s/V$; Whereas W_s = Total weight of solids

In a particular case the **total density** will be known as **saturated density**, when the soil is saturated.

Another density of soil will be known as submerged or buoyant density, γ_b when the soil is submerged in water.

$\gamma_b = \gamma_t - \gamma_w$

Where γ_w = Density of water = 1 g/cc or 1 t/m³

Mostly soils submerged in water are saturated.

Hence $\gamma_{buoyant} = \gamma_{sat} - \gamma_w$

Based on the above equations,

$\gamma = \gamma_{sat} = 1.8$ t/m³

$d = 1.5$m

Here, $\gamma_b = \gamma_{sat} - 1 = 1.8 - 1 = 0.8$ t/m³

Therefore, $q = \gamma_b \times d = 0.8 \times 1.5 = 1.2$ t/m²

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIE
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

$S_q = S_\gamma$ = Shape factor which is equal to 1

$d_q = d_\gamma$ = $1 + 0.1\frac{df}{B}\sqrt{N\emptyset}$

= 1 (Minimum value of 1 can be taken)

i_q = inclination factor $(1 - \alpha/90)^2$

Where α = inclination of the load to the vertical in degree which is equal to zero

i_q = 1

B = Width of footing (2m)

W' = 0.5

Applying in the above equation

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

= 1.2 x (23.172 - 1) x 1 x 1 x 1 + 0.5 x 2 x 1.8 x 30.609 x 1 x 1 x 1 x 0.5

= 54.154 t/m²

Applying factor of safety as 3

Then allowable bearing capacity

q_{na} = 54.154/ 3

= 18.05 t/m²

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MISTE
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, G.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

SAFE BEARING CAPACITY

RESULTS

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MISTE
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

4. Calculation of Safe bearing capacity of the soil:

4.2 Safe Bearing capacity of soil based on SPT values for Bore Holes 1 & 2

Bore Hole No.	Depth (m)	SPT value	Safe Bearing capacity of soil	
			KN/m²	t/m²
BH – 1	1.50	23	169.94	16.99
	3.00	52	416.35	41.63
	4.50	54	433.35	43.33
BH – 2	1.50	27	203.92	20.39
	3.00	51	407.85	40.78
	4.50	52	416.35	41.63

Dr.S. Senthamil Kumar, ME, Ph.D, FIGS, MIRI
Registered Geotechnical Engineer - No. 001/NGTE/0524
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976050 Email : senthamilkumar@yahoo.co.in

4.3 Safe Bearing capacity of soil based on Shear Failure Criteria:

Direct Shear test for Bore Hole 1 & 2

Bore Hole No.	Depth (m)	Normal Stress (kg/cm²)	Division	Ø (in degrees)	Safe Bearing Capacity of Soil (t/m²)
BH - 1	1.50	0.5 1.0 1.5	23 76 130	31.60°	18.05
	3.00	0.5 1.0 1.5	23 88 153	36.78°	55.58
	4.50	0.5 1.0 1.5	23 89 154	36.99°	75.24
BH - 2	1.50	0.5 1.0 1.5	23 80 137	33.24°	22.54
	3.00	0.5 1.0 1.5	24 88 152	36.35°	51.92
	4.50	0.5 1.0 1.5	24 89 153	36.57°	70.55

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MISTE
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 28, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

4.4 Comparison of Safe bearing capacity of soil through Shear and Settlement consideration:

Bore Hole no.	Depth (m)	Safe Bearing Capacity (t/m²)	
		Shear consideration (Direct Shear)	Settlement consideration
BH – 1	1.50	18.05	16.99
	3.00	55.58	41.63
	4.50	75.24	43.33
BH – 2	1.50	22.54	20.39
	3.00	51.92	40.78
	4.50	70.55	41.63

Dr.S. Senthamil Kumar, ME, Ph.D, FIGS, MISTE
Registered Geotechnical Engineer - No. 002/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443376000 Email : senthamilkumar@yahoo.co.in

5. Result:

5.1 Recommended Safe bearing capacity values at different depths

Considering the lesser value of the above, the Safe Bearing Capacity, values at different depths are recommended below:

Bore Hole	Depth (m)	Safe Bearing Capacity (t/m²)
BH – 1	1.50	16.99
	3.00	41.63
	4.50	43.33
BH – 2	1.50	20.39
	3.00	40.78
	4.50	41.63

The above test data and findings are relevant and applicable only for the soil conditions existing at the test site. Any change in the soil strata observed during excavation may be reported to the laboratory, which will redefine the safe bearing capacity of the soil.

Time Institute for Materials Testing Tiruchirappalli-2

For Time Institute for Materials Testing

Geo. Technical Engineer

Dr.R. Senthamil Kumar,ME,Ph.D,FIGS, MIEI
Registered Consultant Engineer - No.001/R01/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

SOIL & ROCK SAMPLE PHOTOS

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/AGTE/2014
703, Plot No. 29, D.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in



0 4.5m

Bore Hole No: 1

Depth : 0 to 4.5m

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, G.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in



0 4.5m

Bore Hole No: 2

Depth : 0 to 4.5m

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

SITE PHOTO

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
701, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443970090 Email : senthamilkumar@yahoo.co.in



Plot No. 378 A, Morais City, Trichy

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2014
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443979090 Email : senthamilkumar@yahoo.co.in

ANNEXURE

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MIG
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976030 Email : senthamilkumar@yahoo.co.in

Time Institute for Materials Testing
Soil Division,
#25, Sanjeevi Nagar,
Trichy- Chennai Byepass road, Trichy - 620 002.
Phone: 0431 2401326
Fax: 0431 2401596
Email: tmaterialstesting@yahoo.co.in

Annexure - A

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

Project Name : **Report on soil investigation for Construction of Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy**

Bore Hole No. : **1**

Depth : **1.5m**

Trial	Wt of container (W) gm	Wt of container +wet soil (W_1) gm	Wt of container + Dry soil (W_2) gm	Wt of Water ($W_3 = W_1-W_2$) gm	Wt of Dry Soil ($W_4 = W_2-W$) gm	Water Content (%) = (W_3-W_4)*100
1	23.45	51.30	48.80	2.5	25.4	9.86
2	22.05	54.60	51.70	2.9	29.7	9.78
3	22.90	57.10	54.00	3.1	31.1	9.97

Natural Moisture Content = 9.87

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MISTE
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Time Institute for Materials Testing

#25, Sanjeevi Nagar,
Trichy- Chennai Byepass road, Trichy - 620 002.
Phone: 0431 2401326
Fax: 0431 2401596
Email: tmaterialstesting@yahoo.co.in

Annexure - B

SPECIFIC GRAVITY TEST
(As per IS 2720 (Part - 3) - 1980)

Project Name : **Report on soil investigation for Construction of Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy**

Bore Hole No. : **1**

Depth : **1.5m**

Trial	Bottle Wt (W1) gm	Bottle + Sample (W2) gm	Bottle + Sample + Water (W3) gm	Bottle + Water (W4) gm	Specific Gravity
1	32.6	93.2	118.6	80.8	2.658
2	32.6	91.9	117.8	80.8	2.659
3	32.6	92.5	118.2	80.8	2.662

Specific gravity of Fine Aggregate = 2.66

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MISTE
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Time Institute for Materials Testing
Soil Division,
#25, Sanjeevi Nagar,
Trichy- Chennai Byepass road, Trichy - 620 002.
Phone: 0431 2401326
Fax: 0431 2401596
Email: tmaterialstesting@yahoo.co.in

Annexure - C

DENSITY CALCULATION

Project Name : **Report on soil investigation for Construction of Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy**

Bore Hole No. : **1**

Depth : **1.5m**

Sl. No.	Description	Reading
1	Weight of Empty Box (gm)	630.00
2	Weight of Box + Soil (gm)	806.00
3	Weight of Soil (gm)	176.00
4	Volume of Box (cm^3)	90.00
5	**Bulk Density (gm/cm^3)**	**1.96**
6	Weight of Container (gm)	23.45
7	Weight of Container + Wet Soil (gm)	51.30
8	Weight of Container + Dry Soil (gm)	48.80
9	Moisture Content (%)	9.86
10	**Dry Density (gm/cm^3)**	**1.78**

Result

Bulk Density of Soil = 1.96

Dry Density of Soil = 1.78

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Time Institute for Materials Testing
Soil Division,
#25, Sanjeevi Nagar,
Trichy- Chennai Byepass road, Trichy - 620 002.
Phone: 0431 2401326
Fax: 0431 2401596
Email: tmaterialstesting@yahoo.co.in

Annexure - D

POROSITY & VOID RATIO

Project Name : **Report on soil investigation for Construction of Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy**

Bore Hole No. : **1**

Depth : **1.5m**

Sl. No.	Description	Reading
1	Dry Density γ_d (gm/cm^3)	1.78
2	Specific gravity (G_s)	2.66
	Porosity (%)	(1 – (γd/Gs))*100
		(1-(1.78/2.66)) x 100 = 33.08
3	**Porosity (%)**	**33**
	Void Ratio, (e)	η/(1-η)
		0.3308/(1-0.3308)
4	**Void Ratio**	**0.49**

Dr.S. Senthamil Kumar, ME, Ph.D, FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Time Institute for Materials Testing
Soil Division,
#25, Sanjeevi Nagar
Trichy - Chennai Byepass road,
Trichy - 620002
Phone: 0431 2401326
Fax: 0431 2401596
Email: tmaterialstesting@yahoo.co.in

Annexure - E

FINENESS MODULUS TEST

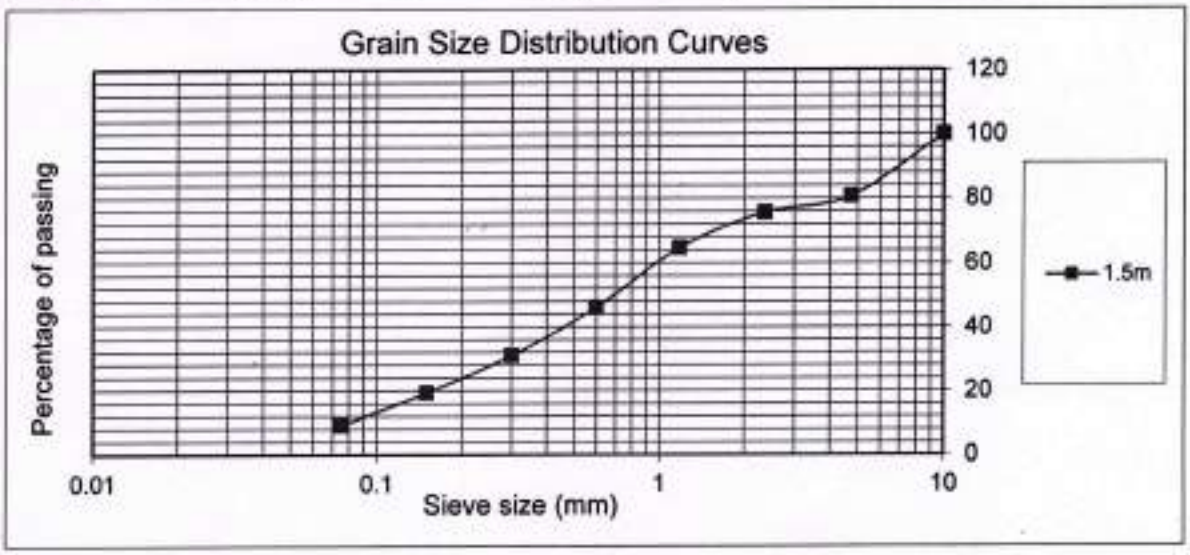
(As per IS 2720 (Part - 4) - 1985)

Project Name : **Report on soil investigation for Construction of Studio Apartment (Residential Building) at Plot No. 378 A, Morais City, Trichy**

Bore Hole No. : **1**

Depth : **1.5m**

Sieve size (mm)	Weight retained	Cumulative Weight retained (gm)	Percentage cumulative weight retained (gm)	Percentage of passing
10	0	0.0	0.0	100.0
4.75	61.3	61.3	61.3	38.7
2.36	14.5	75.8	75.8	24.2
1.18	12.7	88.5	88.5	11.5
0.6	6.1	94.6	94.6	5.4
0.3	3.5	98.1	98.1	1.9
0.15	1.9	100.0	100.0	0.0
0.075	0	100.0	100.0	0.0
Pan	0	100.0	100.0	0.0



Based on Gradation Curve, the percentge component of each materials in the soil sample obtained are as follows (As per IS 1498 - 1970).

Gravel (%)	61.3
Coarse Sand (%)	27.2
Medium Sand (%)	9.6
Fine sand (%)	1.9
Silt & Clay (%)	0.0

Dr.S. Senthamil Kumar, ME,Ph.D,FIGS, MIEI
Registered Geotechnical Engineer - No. 001/RGTE/2004
703, Plot No. 29, O.M. Rajan Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in

Time Institute for Materials Testing
Soil Division,
#25, Sanjeevi Nagar,
Trichy- Chennai Byepass road, Trichy - 620 002.
Phone: 0431 2401326
Fax: 0431 2401596
Email: tmaterialstesting@yahoo.co.in

Annexure - F

Direct Shear Test (IS 2720 - Part 13 -1986)

Bore Hole	1
Depth (m)	1.5m
Date of Test	10.06.2024

L.C. Of Dial Gauge	0.002
Proving ring Constant	0.206996
Area of the specimen (cm^2)	36

Trial 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	9	0.50	0.052
100	11	1.00	0.063
150	13	1.50	0.075
200	15	2.00	0.086
250	17	2.50	0.098
300	19	3.00	0.109
350	21	3.50	0.121
400	23	4.00	0.132

Trial 2

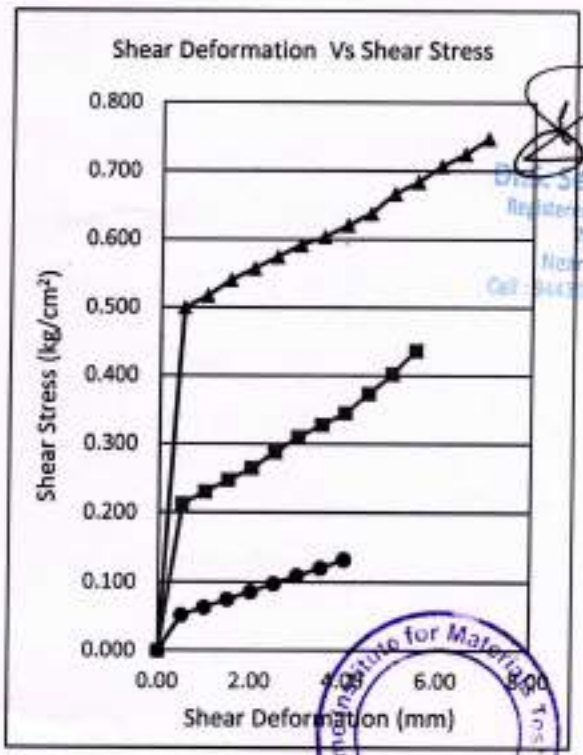
Normal Stress: 1 kg/cm^2

Horizontal Gauge Reading	Proving Ring Reading	Shear Deformation	Shear Stress (kg/cm^2)
0	0	0.00	0.000
50	37	0.50	0.213
100	40	1.00	0.230
150	43	1.50	0.247
200	46	2.00	0.264
250	50	2.50	0.287
300	54	3.00	0.310
350	57	3.50	0.328
400	60	4.00	0.345
450	65	4.50	0.374
500	70	5.00	0.402
550	76	5.50	0.437

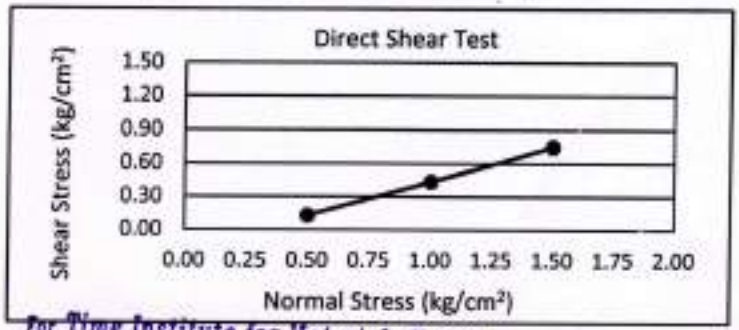
Trial 3

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	87	0.50	0.500
100	90	1.00	0.517
150	94	1.50	0.540
200	97	2.00	0.558
250	100	2.50	0.575
300	103	3.00	0.592
350	105	3.50	0.604
400	108	4.00	0.621
450	111	4.50	0.638
500	116	5.00	0.667
550	119	5.50	0.684
600	123	6.00	0.707
650	126	6.50	0.724
700	130	7.00	0.747



Normal Stress (Kg/cm^2)	Proving Ring Reading at failure	Shear Stress (kg/cm^2)
0.50	23	0.132
1.00	76	0.437
1.50	130	0.747



For Time Institute for Materials Testing

Ø = $\tan^{-1}$ (0.747 - 0.132)

Angle of Shearing Resistance (Ø) = 31.60 °

Geo. Technical Engineer

TOWN AND COUNTRY PLANNING, THANJAVUR DISTRICT
No.5, Ganapathy Nagar, Medical College Road,
Thanjavur
Phone No:04362 270133 E Mail : dtcpthanjavur@gmail.com

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that **the Dr. S SENTHAMIL KUMAR** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with this District Town and Country Planning Office, Thanjavur District who as the qualification of **Master Degree in Geo-Technical Engineering & Degree of Doctor of Philosophy (Civil Engineering)** and experience in the relevant field for 28 years.

He has been given the **Registration No.001 RGTE on 01.8.2024**. He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules 2019 approved vide G.O (Ms) No.18 and 16 MAWS (MA1) Department dated 04.02.2019 and 31.01.2020.

This Registration is valid up to 31.7.2029.



Assistant Director,
District Town and Country Planning office,
Thanjavur

Dr.S. Senthamil Kumar,ME,Ph.D,FIGS, MICI
Registered Geotechnical Engineer - No. 001/RGTE/2024
703, Plot No. 29, O.M. Rajoo Nagar,
Near New Bus Stand, Thanjavur - 613 005.
Cell : 9443976090 Email : senthamilkumar@yahoo.co.in



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Vastu & Property Management Tools

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3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai, India

hello@verified.realestate
+91 9996 12 9996
www.verified.realestate