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# Construction Project Management a special reference to Construction Soil Investigation and Recommendation Processes (Field Tests and Laboratory Tests)

# <sup>1</sup>A.Chandramohan&<sup>2</sup>Dr.RamyaThiyagarajan

1. Research scholar, Department of Management Studies, School of Commerce and Management, Bharath Institute of Higher Education and Research, Agaram Then Main Road, Chennai, Contact No: 09445159528

Mail-id ctechconstruction@gmail.com

2 Associate Professor & Research Supervisor, Dept of Business Administration ,Faculty of Arts and Science,Bharath Institute of Higher Education and Research – BIHER, Selaiyur, Chennai – 73, Mail-id: ramya.bba@bharathuniv.ac.in

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#### **ABSTRACT**

In India more than 50% investment in Infrastructure which includes road infrastructure, bridges, flyovers, ports of sea and air, railways, building of commercial and residential and etc. In these, residential buildings are cover major share because no one can live with out shelter. In that majority of the residential building are done by hard earned money of the middle class and upper middle class people who spent their major life time for repayment of loan which was taken for the purchase of land and for construction of building in the purchased land. There are many big companies who do construction for high rise buildings, they do required planning before construction. But in the small construction done by middle

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https://musikinbayern.com DOI https://doi.org/10.15463/gfbm-mib-2024-356 class level people who are not even aware of problem which cause for the continuous interruption during the entire life of the building. These will lead to severe problems like foundation soil settlement, cracks, damages, sealing tear, water leakage and etc. If such decision making point known by the owners/decision maker in appropriate time with right finding, it will be big saving and support for them and they can protect their dream asset. If required testing not done in pre-construction, and if the problem happens in the post construction in high magnitude, and they will be forced to spend huge amount in rectification works. The appropriate and economic testing methods are available to predict the soil properties to construct the stable building structure. In this research paper with real data such Soil Testing techniques are explained to understand the testing processes and it's importance.

Key words "soil testing, soil investigation, structure, construction project management "

#### **Introduction:**

It was proposed to construct a Residential Building at Royar Thoppu, Srirangam, 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. CTECH GEO WORKS Chennai has been requested to undertake the soil investigation at the proposed site. The study carried out by CTECH on the proposed date. This report presents complete investigation data and discusses the results to recommend the bearing capacity values at different depths for the proposed structure. It describes the soil profile and bore log details of one exploratory bore hole, report gives the Grain size distribution curves and its analysis, report presents the calculated safe Bearing capacity values of soil at various depths, report reviews the test results and the recommended safe bearing capacity values and pile capacity values for design of foundation.

#### 2 Investigation Programme, Procedure and Data:

Investigation was carried out in one location at the site through exploratory bore hole. Soil samples were collected from bore hole at different depths for conducting

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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.

## 3 Review of Field and Laboratory Results:

#### 3.1 Sub soil Profile

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

#### **3.2 Bore Hole 1:**

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The natural soil below the existing ground level is filled up soil. This layer is extended

up to 1m depth. Clay exists from 1m to 7.5m depth. Sand with clay mixed exists from

7.5m to 8.5m depth. Below which sand exists from 8.5m to 10m 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.

3.3 Ground Water Table:

Ground water table exists at 9m depth from ground level during investigation.

3.4 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.

Cohesive layers: The classification of 'N' values in moderate to high plasticity medium

clay deposits developed by Terzaghi is used for estimating the unconfined compression

strength and untrained shear strength of clay and sandy clay layers. The consistency

between the N values and the liquidity index values is reviewed while assigning\

undrained shear strength forsoft to medium clay layers.

3.5 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 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.

3.6 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.

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

Where.

 $W_1$  = Weight of container gm  $W_2$  = Weight of container +wet soil gm $W_3$  = Weight of container +dry soil

### 3.7 Bulk Density:

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

$$\Upsilon_{\text{bulk}} = \mathbf{M} / \mathbf{V}$$

Where  $M_t = Total Mass of soil V_t = Total Volume$ 

## 5.8 Dry Density:

The soil dry density, *b*, 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:

$$\Upsilon_{drv} = M_b / V_b$$

Where  $M_b = \text{Total Mass of dried soil } V_b = \text{Total Volume}$ 

### 3.9 Specific gravity:

Specific gravity is the ratio of the weight of a given volume of 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

## 3.10 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.

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### 3,11 Porosity:

<u>Soil porosity</u>  $(\eta)$ , 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  $I_d = Dry Density G_s = Specific gravity$ 

#### 3.12 Free Swell Index:

Free swell index, is the increase in volume of soil without any external constraint when subjected to submergence in water.

Free swell index = 
$$[V_d - V_k] / V_k \times 100\%$$

where,  $V_d$  = volume of soil specimen read from the graduated cylinder containing distilled water.  $V_k$  = volume of soil specimen read from the graduated cylinder containing kerosene.

## 3.13 Co efficient of Consolidation (C<sub>v</sub>):

The coefficient of consolidation is the parameter used to describe the rate at which saturated clay or other soil undergoes consolidation, or compaction, when subjected to an increase in pressure. It is measure in square centimeters per second or square inches per minute.

$$Cv = {0.848 \text{ X } (Hav/2)^2}/t90$$

Where Hav is the average specimen thickness for the load increment The time required for 90 percent consolidation is read off the curve as t90

### **4.** FIELD TEST - BORE LOG DETAILS

Lithology of Bore Hole			Graphical
	, 		representation
		SPT	of penetration
Depth below	Soil	Data	Resistance (N
_ · · · · · · · · · · · · · · · · · · ·			Corrected)

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G.L.(m)	Profil e	Descriptio n	Depth of SPT (m)	0- 15cm	15- 30cm	30- 45cm	N'	N' Corrected	0 20 40 60
0 - 1m		Filled up							
			1.5	2	2	2	4	4	
			3.0	3	3	3	6	6	
		G!	4.5	3	3	3	6	6	
1m - 7.5m		Clay	6.0	3	4	4	8	8	
7.5m - 8.5m		Sand wit hclay mixed	8.0	9	9	10	19	17	
8.5m - 10m		Sand	10.0	13	13	14	27	21	

Bore terminated at 10m depth from the existing ground level

# **5. LABORATORY RESULTS**

# 5.1 Engineering Geo Properties for Bore Hole

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Bore hole No.	Depth (m)	Soil Description	Natural	Bulk Density (gm/cc)	Dry Density (gm/cc)	Specifi C gravit y	Porosity (%)	Void Ratio
	1.5		21. 40	1.80	1.48	2.61	43	0.76
	3.0		21. 27	1.82	1.50	2.61	42	0.74
	4.5		21. 20	1.83	1.51	2.61	42	0.73
	6.0		21. 12	1.84	1.52	2.61	42	0.72
Bore	8.0	Sand with clay mixed	18. 66	1.88	1.58	2.62	40	0.65
Hole	10.0	Sand	17. 10	1.95	1.67	2.63	37	0.58

# 5,2 Laboratory Test Results for Bore Hole

Bore		Soil	Att	terberg li	mits			Mediu			
hole No.	Depth (m)	Descrip tion	Liquid Limit (%)	Plasti cLimit (%)	Plasticit yIndex (%)	Gravel (%)	Coars e sand (%)	m Sand (%)	Fine sand (%)	Silt (%)	Clay (%)
	1.5	С	34.6	21.5	13.1	0.0	3.2	11.9	31.6	6.2	47.1
	3.0	l a y	34.8	21.4	13.4	0.0	4.6	12.7	30.4	7.3	45.0
	4.5		34.9	21.1	13.8	0.0	5.3	14.0	29.8	6.7	44.2
	6.0		35.3	21.0	14.3	0.0	6.2	15.9	28.6	6.2	43.1
Bore Hole 1	8.0	Sand with clay mixed	35.6	20.9	14.7	0.0	9.1	31.5	27.8	5.6	26.0
	100	Sand	-	-	-	0.0	15.9	39.8	34.1	3.7	6.5

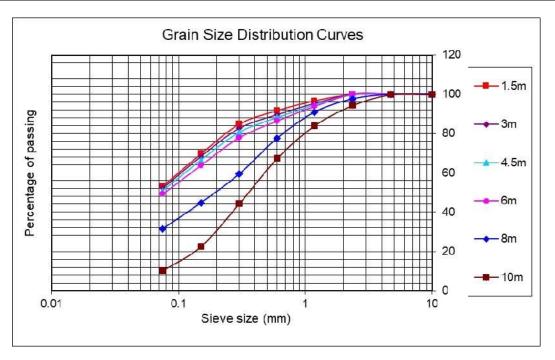
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## 5.3 TEST REPORT ON SIEVE ANALYSIS OF SAMPLE

### Bore Hole – 1 @ 1.5m to 10m

	PERCENTAGE OF PASSING									
SIEVE SIZE	1.5m Depth	3m Depth	4.5m Depth	6m Depth	8m Depth	10m Depth				
10 mm	100	100	100	100	100	100				
4.75 mm	100.0	100.0	100.0	100	100	100				
2.36 mm	100	100	100	100	97.7	94.4				
1.18 mm	96.8	95.4	94.7	93.8	90.9	84.1				
600 micron	91.8	89.7	88.3	86.5	77.7	67.5				
300 micron	84.9	82.7	80.7	77.9	59.4	44.3				
150 micron	69.8	68.4	66.5	63.9	44.8	22.5				
75 micron	53.3	52.3	50.9	49.3	31.6	10.2				



Descri	iption	1.5m Depth	3m Depth	4.5m Depth	6m Depth	8m Depth	10m Depth
Fineness 1	modulus	1.034	1.115	1.189	1.286	1.979	2.770

### Observation:

The inference from the graph shows that the clay exists up to 6m depth, sand with clay mixed exists at8m

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depth and sand exists at 10m depth.

#### 6. CALCULATION OF SAFE BEARING CAPACITY

## 6.1 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 touse the formula as mentioned below. (Using Teng's Modified formula)

$$\Rightarrow q_{na} = 51.4 \text{ x } (6 - 3) \text{ x } ((2 + 0.3)/(2 \text{ x } 2))^2 \text{ x } 0.5 \text{ x } 1 = 25.49 \text{ kN/m}^2$$

$$\therefore q_{na} = 2.54 \text{ t/m}^2$$

## 6.2 Safe Bearing Capacity calculations based on Unconfined Compression Test (UCC):

#### As Per IS 6403:1981

Net safe bearing capacity of the soil,

$$q_{ult} = C N_c S_c d_c i_c + q (N_q-1) S_q d_q i_q + 0.5 B Y N_v S_v d_v i_v W'$$

Where

C \_ Cohesion in Kgf/cm<sup>2</sup>

 $N_c$ ,  $N_q$ ,  $N_1$  = Bearing Capacity Factors

 $S_c, S_q, S_1 = Shape Factors$ 

 $d_c, d_q, d_l = Depth Factors$ 

 $i_c, i_q, i_l$  = Inclination Factors

q = Effective surcharge at the base level of foundation in Kgf/cm<sup>2</sup>

=  $^{\gamma} x d$ 

 $B \hspace{1cm} = \hspace{1cm} Width \ of \ footing, \ diameter \ of \ circular \ footing \ in \ cm$ 

= Bulk unit weight of soil in Kgf/cm<sup>3</sup>

W' = Correction factor for location of water table

#### At 3m depth (Bore Hole 1), the Soil profile is Clay

If  $\Phi = 0$ 

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 $N_c = 5.14$  $N_q = 1$ 

N = 0 (Zero)

and Cohesion C = 2.10 (based on laboratory test)

Applying these parameter in the equation No. 1

$$q_{ult}$$
 =  $C N_c S_c d_c i_c + q (N_{q^-} 1) S_q d_q i_q + 0.5 B Y N_V S_V d_V i_V W'$ 

= 
$$C N_c S_c d_c i_c + q (1-1) S_q d_q i_q + 0.5 B \lor 0 S_v d_v i_v W'$$

 $= \qquad \quad C \; N_c \; S_c \; d_c \; i_c + 0 + 0$ 

 $q_{ult} \hspace{1cm} C \hspace{1cm} N_c \hspace{1cm} S_c \hspace{1cm} d_c \hspace{1cm} i_c$ 

Where  $S_c = Shape factor which is equal to 1$ 

 $d_{c} = 1 + 0.2 \frac{df}{B} \sqrt{Nq}$ 

 $_{1}$  + 0.2  $\frac{$6}{18}$   $\sqrt{tan2(45+0.2)}$ 

= 1.028 (hence considered the minimum value as 1)

= :

 $i_c = (1 + a/90)^2$ 

Where  $\alpha$  = inclination of the load to the vertical in degree which is equal to zero

 $i_c = 1$ 

 $Therefore \qquad \quad q_{ult} \quad \ = \quad \quad C \; N_c \; S_c \; d_c \; i_c$ 

2.10 x 5.14 x 1 x 1 x 1

= 10.79 t/m<sup>2</sup>

Applying factor of safety

as 3 Then allowable

bearing capacity

 $q_{\text{allowable}} = 10.79/3$ 

= 3.60 t/m<sup>2</sup>

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

As Per IS 6403:1981

At 10m depth (Bore Hole 1)

Proving Ring capacity 200kg = 966.2

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divisionArea of the shear box = 6 cm x

 $6cm = 36cm^2$ 

Normal Stress (kg/cm <sup>2</sup> )	No. of Division	Stress
0.5	23	0.132
1.0	72	0.414
1.5	121	0.696

Stress = Load / Area

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

$$\emptyset$$
 =  $\tan^{-1}(0.696-0.132)$  =  $29.40^{\circ}$ 

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

$$q_{ult} = C N_c S_c d_c i_c + q (N_{q}-1) S_q d_q i_q + 0.5 B Y N_V S_V d_V i_V W'$$

Where

 $C = Cohesion in t/m^2$ 

 $N_c$ , Nq,  $N_c$  = Bearing Capacity Factors (From Table 1 of IS 6403 – 1981)

 $S_c$ ,  $S_q$ ,  $S_r$  = Shape Factors (From Table 2 of IS 6403 – 1981)

 $d_c, d_q, d = Depth Factors$ 

 $i_c, i_q, i$  = Inclination Factors

q = Effective surcharge at the base level of foundation in  $t/m^2$ 

B = Width of footing, diameter of circular footing in m

= Bulk unit weight of soil in  $t/m^3$ 

W' = Correction factor for location of water table

## At 10m depth, the Soil profile is Sand

If 
$$C = 0$$
 (Since no Cohesion)

 $\Phi$  = 29.40 (based on laboratory test)

Therefore  $N_c = 29.011;$ 

 $N_q = 17.473;$ 

 $N_{\parallel}$  = 21.020

Applying these parameter in the above equation

$$q_{ult} \hspace{0.5cm} = \hspace{0.5cm} C \; N_c \; S_c \; d_c \; i_c + q \; (N_q \text{--} \, 1) \; S_q \; d_q \; i_q + 0.5 \; B \; \forall \; N_V \; S_V \; d_V \; i_V \; W' 0$$

C \_ (Since no Cohesion)

Where

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Therefore,  $q_{ult} = q (N_q-1) S_q d_q i_q + 0.5 B V N_v S_v d_v i_v W'$ 

# 6.4 Bearing Capacity calculation through shear density of soil 417

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

- i) Total density or Bulk density
- ii) Dry density

Therefore Total Bulk density, 't = Total Weight of soil = W

Total Volume of soil V

Dry Density

 $_{\mathbf{d}}^{\dagger} = W_{s}/V;$ 

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, b when the soil is submerged in water.

 $I_{\mathbf{b}} = I_{\mathbf{t}} - I_{\mathbf{w}}$ 

Where

w =

Density of water = 1 g/cc or  $1 \text{ t/m}^3$ 

Mostly soils submerged in water are

saturated.Hence buoyant = sat - w

Based on the above equations,

 $= 1.8 \text{ t/m}^3$ 

d = 10m

Here,  $\frac{1}{6} = \frac{1}{100} = 1.8 - 1 = 0.8 \text{t/m}^3$ 

Therefore,  $q = \frac{1}{10} x d = 0.8 x 10 = 8 t/m^2$ 

 $S_q = S_0$  Shape factor which is equal to 1

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

= 1 (Minimum value of 1 can be taken)

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

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

 $i_a = 1$ 

B = Width of footing (2m)

W' = 0.5

Applying in the above equation

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 $q_{ult} \qquad = \qquad \quad q \; (Nq\text{-}\;1) \; S_q \; d_q \; i_q + 0.5 \; B \; ^{\intercal} N_{ } \; S_{ } \; d_{ } \; i_{ } \; W' \label{eq:qult}$ 

8 x (17.473 - 1) x 1 x 1 x 1 + 0.5 x 2 x 1.8 x 21.020 x 1 x 1 x 1 x 0.5

= 150.702 t/m<sup>2</sup>

Applying factor of safety

as 3 Then allowable

bearing capacity

 $q_{na} = 150.702/3$ 

= 50.23 t/m<sup>2</sup>

# 7. Calculation of Safe bearing capacity of the soil:

## 7.1 Safe Bearing capacity of soil based on SPT values

Bore Hole No.	Depth (m)	SPT value	Safe Bearing capacity of soil	
			KN/m <sup>2</sup>	t/m²
	1.50	4	8.49	0.84
	3.00	6	25.49	2.54
	4.50	6	25.49	2.54
BH – 1	6.00	8	42.48	4.24
	8.00	17	118.9	11.89
	10.00	21	152.94	15.29

## 7.2 Through Unconfined Compression Test (UCC)

Bore Hole No.	Depth (m)	Max. Load (Div)	Max. Deformation (Div)	Cohesion (t/m²)	Safe Bearing capacity of soil (t/m²)
	1.50	12	55	1.68	2.88
	3.00	15	60	2.10	3.60

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	4.50	17	60	2.38	4.08		
	6.00	25	75	3.49	5.99		
BH – 1	8.00	58	180	7.98	13.67		

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

**Project Name** Soil investigation for construction of Residential

Building

Bore Hole No.

Depth 1.5m

Trial	Wt of container (W) gm	Wt of container +wet soil (W <sub>1</sub> ) gm	Wt of container + Dry soil (W <sub>2</sub> ) gm	Wt of Water (W <sub>3</sub> = W <sub>1</sub> -W <sub>2</sub> ) gm	Wt of Dry Soil (W <sub>4</sub> = W <sub>2</sub> -W) gm	Water Content (%) = (W <sub>3</sub> -W <sub>4</sub> )*100
1	21.80	53.5	47.9	5.6	26.1	21.46
2	21.73	51.9	46.6	5.3	24.9	21.31
3	21.05	52.2	46.7	5.5	25.7	21.44

Natural Moisture Content = 21.40

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

**Project Name** Soil investigation for construction of Residential Building

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	92.6	117.8	80.8	2.609
2	32.6	91.9	117.4	80.8	2.612
3	32.6	93.2	118.1	80.8	2.601

Specific gravity of Fine Aggregate =

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## 7.5 FINENESS MODULUS TEST

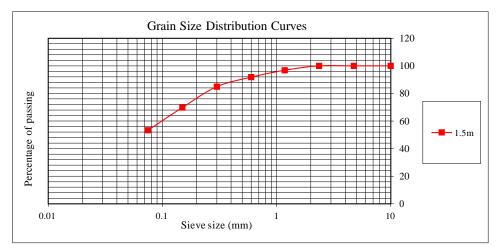
### (As per IS 2720 (Part - 4) - 1985)

Project Name : Soil investigation for construction of Residential

Building

Bore Hole No. : 1
Depth : 1.5m

Sieve	Weight	Cumulative Weight	Percentage cumulative	Percentage of passing			
size (mm)	Retained	retained (gm)	weight retained (gm)	5 p 5			
10	0	0.0	0.0	100.0			
4.75	0	0.0	0.0	100.0			
2.36	0	0.0	0.0	100.0			
1.18	3.2	3.2	3.2	96.8			
0.6	5	8.2	8.2	91.8			
0.3	6.9	15.1	15.1	84.9			
0.15	15.1	30.2	30.2	69.8			
0.075	16.5	46.7	46.7	53.3			
Pan	53.3	100.0	100.0	0.0			



Based on Gradation Curve, the following sizes of Material(As per IS 1498 - 1970)

Gravel	0		
Coarse Sand	3.2		
Medium Sand	11.9		
Fine sand	31.6		
Silt & Clay	53.3		

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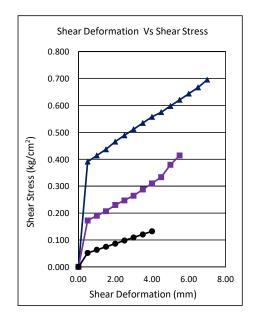
DOI https://doi.org/10.15463/gfbm-mib-2024-356

Bore Hole	1		
Depth (m)	10m		
Date of Test	10.06.2021		

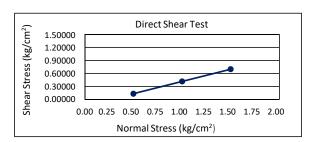
L.C. Of Dial Gauge	0.002
Proving ring Constant	0.206996
Area of the specimen (cm <sup>2</sup> )	36

Trial 1  Normal Stress: 0.5 kg/cm <sup>2</sup>				Trial 2  Normal Stress: 1 kg/cm <sup>2</sup>				Trial 3  Normal Stress: 1.5 kg/cm <sup>2</sup>			
0	0	0.00	0.000	0	0	0.00	0.000	0	0	0.00	0.000
50	9	0.50	0.052	50	30	0.50	0.172	50	68	0.50	0.391
100	11	1.00	0.063	100	33	1.00	0.190	100	72	1.00	0.414
150	13	1.50	0.075	150	36	1.50	0.207	150	76	1.50	0.437
200	15	2.00	0.086	200	40	2.00	0.230	200	81	2.00	0.466
250	17	2.50	0.098	250	43	2.50	0.247	250	85	2.50	0.489
300	19	3.00	0.109	300	46	3.00	0.264	300	89	3.00	0.512
350	21	3.50	0.121	350	50	3.50	0.287	350	93	3.50	0.535
400	23	4.00	0.132	400	54	4.00	0.310	400	97	4.00	0.558
				450	58	4.50	0.333	450	100	4.50	0.575
				500	66	5.00	0.379	500	104	5.00	0.598
				550	72	5.50	0.414	550	108	5.50	0.621
								600	112	6.00	0.644
								650	116	6.50	0.667
								700	121	7.00	0.696

# 7.6 Direct Shear Test (IS 2720 - Part 13 - 1986



Normal Stress (Kg/cm²)	Proving Ring Reading at failure	Shear Stress (kg/cm²)
0.50	23	0.132
1.00	72	0.414
1.50	121	0.696



 $\emptyset = \tan -1 \ (0.696 - 0.132) = 29.40^{\circ}$ 

Angle of Shearing Resistance ( $\emptyset$ ) =

29.40 Degree

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8. OPPORTINITY FOR FUTURE DEVELOPMENT

This paper deals about the construction soil investigation and recommendation process planned at the site and in laboratory alone. Likewise it can be developed for soil ground

improvement works also.

**LIMITATIONS** 

If the testing at site and laboratory are not followed and Corrective Actions are not carried out

properly, the effectiveness and efficiency will be lost.

The recommendation is based on the sample collected and result received from the

laboratory, so the it will not give exactly 100 % accuracy level.

**CONCLUSION & RECOMMENDATION** 

The test at site indicate that the nature of soil is silty sandy clay in nature.

The inference from the test shows that the clay exists up to 6m depth, sand with clay

mixed exists at 8m depth and sand exists at 10m depth.

Shear strength parameters and compressibility parameters of different soil layers are

established from the field and laboratory tests. Based on the existing soil condition, it is

recommended to provide Pile foundation.

This paper gives the information on the various activity of soil investigation, theories &

definitions, practical testing values and recommendations, so definitely it will benefit the

readers about the soil investigation process.

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