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REPORT ON

SOIL INVESTIGATION FOR THE CONSTRUCTION OF MULTISTOREYED TENEMENTS (STILT+9 FLOORS) AT DR.THOMAS ROAD (PHASE I), CHENNAI

CLIENT

THE EXECUTIVE ENGINEER, DIVISION V,

TAMILNADU URBAN HABITAT DEVELOPMENT BOARD (TNUHDB), CHENNAI.

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GEOTECHNICAL ENGINEERING DIVISION
DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY MADRAS
CHENNAI - 600 036

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REPORT ON SOIL INVESTIGATION FOR THE CONSTRUCTION OF MULTI-STOREYED TENEMENTS (STILT+9 FLOORS) FOR AT DR.THOMAS ROAD, PHASE I, CHENNAI.

1. INTRODUCTION

On a request from the Executive Engineer, Division- V, Tamil Nadu Urban Habitat Development Board (TNUHDB), Chennai, the Geotechnical Engineering Division of Indian Institute of Technology Madras undertook the consultancy for Geotechnical Investigation to determine the soil properties and recommend a suitable type of foundations for the construction of multi-storeyed tenements (stilt+9 floors) at Dr. Thomas Road, Phase I, Chennai.

The field investigation consists of drilling boreholes, carrying out standard penetration tests in the boreholes, collecting soil samples, and groundwater table observation. The drilling of boreholes at the site was carried out from 22nd March 2022 to 11th April 2022 by M/s. Geotechnical Solutions, Chennai under the guidance of the undersigned in the presence of Engineers from Tamil Nadu Urban Habitat Development Board. This report presents the details of the field and laboratory investigations carried out for this project scheme, evaluation of design soil parameters, recommendations on the capacity of soil strata and the type of foundations to be adopted for the proposed buildings.

2. FIELD INVESTIGATIONS

2.1 Drilling of Boreholes and SPT Test

The investigation program comprises drilling six (6 Nos.) exploratory boreholes at the locations shown in **Figure 1**. These boreholes were advanced up to a maximum depth of about 21.8 m below the ground level. Exploratory boreholes were advanced from the existing ground level using a rotary drilling technique supplemented by bentonite

mud circulation. Mud circulation was used to stabilise the sides and the bottom of the boreholes, and then to bring the soil cuts to the surface. The use of drilling mud will also help in preventing the disturbance to the soil at the borehole bottom during drilling operations.

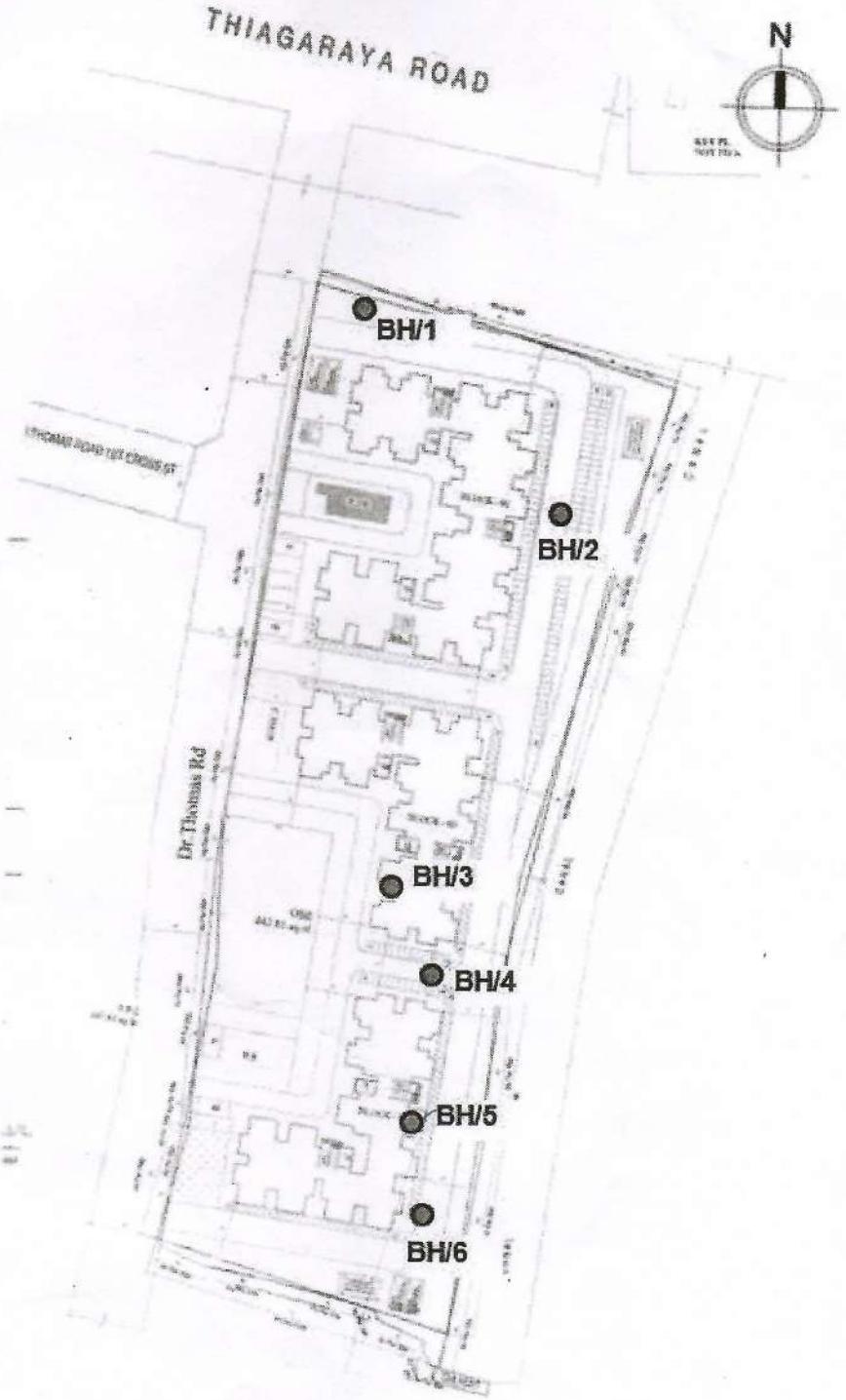


Figure 1: Site plan showing location of boreholes

Part I: 2016. According to that, a moderate level earthquake may be expected at the site. The very soft/soft clay layers may not liquefy but undergo strain-softening behaviour. Some loose sand layers present at deeper depths may liquefy. In view of that, the pile foundations shall be adopted and the piles shall be anchored into the hard strata.

5.0. SELECTION OF TYPE OF FOUNDATION AND ESTIMATION OF FOUNDATION CAPACITY

5.1. Selection of Type of Foundation

The subsoil of the site consists of alternate layers of very soft/soft /medium stiff clay and very loose/loose/medium dense sand layers up to a depth of about 16m from the ground level. Therefore, it is not feasible to adopt shallow foundations because of higher settlement caused by the loose sand/soft clay layers present within the zone of influence. Further, the weathered shale layers are encountered from a depth of about 16.6m up to the borehole termination depth. Hence considering the anticipated load intensity induced by the proposed buildings and the nature of the soil strata at the site, it is recommended to adopt bored cast-in-situ piles to support the proposed buildings.

5.2. Bored cast-in-situ piles

5.2.1. Safe compression and Uplift Load Capacity of piles

The ultimate end bearing capacity of the bored cast in-situ pile, Q_b is calculated using the following formula as per IS: 2911(Part I/ Sec 2) –2010.

$$Q_b = A_p N_c c_p$$

Where,

D = Stem diameter in m.

A_p = Cross sectional area of pile toe in m^2

c_p = Average cohesion at pile tip in kN/m^2

N_c = Bearing capacity factor = 9

The ultimate frictional resistance of the pile in cohesionless soil is calculated using the following formula,

$$Q_{f1} = \sum_{i}^{n} KP_{Di} tan\delta A_{si}$$

Where,

K = Coefficient of earth pressure,

P_{Di} = Effective overburden pressure in kN/m^2 for the ith layer where I varies from 1 to n

δ = Angle of wall friction between pile and soil

A_{si} = Surface area of pile stem in m^2 in the ith layer where i varies from 1 to n.

The frictional resistance of the cohesive soil, Q_{f2} is calculated using the following equation,

$$Q_{f2} = \alpha C A_S$$

α = Reduction factor

C = Average cohesion throughout the length of pile in kN/m^2

A_S = Surface area of pile stem in m^2

Negative skin friction is considered for soft clay and loose sand layers. The parameters used to estimate the bearing capacity of pile were considered based on the corrected SPT N values. Factor of safety of 2.5 is used in the estimation of safe load carrying capacity of the piles.

The uplift capacity of the pile is calculated with a factor of safety of 4 against the positive skin friction. The safe compression and uplift capacity is estimated and the details are presented in **Appendix A**. The bearing stratum for the piles is considered as the weathered shale layer. The safe compression and uplift capacities of piles are calculated based on the soil profile of the boreholes BH1. The estimated pile capacities are presented in **Table 1**.

Table 1: Safe compression and uplift capacity of piles

Pile diameter (mm)	500	600	750
Safe compression capacity, kN	910	1265	1900
Safe Uplift capacity, kN	290	370	505

5.2.2. Lateral Load Capacity of the piles

The safe lateral capacity of piles is governed by the shear strength and modulus of the soil below the pile cut-off level. Generally, soil for a depth of five to seven times the pile diameter influences the resistance to lateral loading. Thus, the safe lateral capacity of piles will depend on the soil present at shallow depth. The safe lateral capacity of pile is estimated restricting the pile head deflection at the cut-off level embedded in soil as 5mm. The equivalent cantilever procedure suggested in IS 2911 (Latest revision) is used for estimating the safe lateral capacity corresponding to 5mm deflection at the pile head.

The safe Lateral Load carrying capacity of piles is calculated using the following formula as per IS 2911 (Part I/ sec 2):2010:

$$H = y * \frac{3EI}{(e + Z_f)^3} \quad for\ Free\ head\ pile$$

$$H = y * \frac{12EI}{(e + Z_f)^3} \quad for\ Fixed\ head\ pile$$

Where,

H = Lateral capacity in kN

E = Young's Modulus of the pile material in kN/m^2

I = Moment of Inertia of the pile cross section in m^4

y = Permissible deflection in m

Z_f = Depth to point of fixity in m

e = Cantilever length above ground to the point of load application

A typical estimation of safe lateral capacities corresponding to 5mm allowable deflection at the pile head is presented in **Appendix B.** The estimated lateral load capacity of the piles is summarized in **Table 2.**

Table 2: Lateral load capacity of the Pile

Pile diameter in mm	500	600	750
Safe lateral capacity (Fixed head) in kN	13.9	18.6	26.6
Depth to point of fixity in m (Fixed head)	6.9	8	9.5
Safe lateral capacity (Free head) in kN	5	6.6	9.5
Depth to point of fixity in m (Free head)	6.1	7	8.4

5.2.3. Pile Termination Depth

In view of the occurrence of the weathered shale layer below 16.6 m, it is desirable to terminate at the pile at a depth of 18.5 m from the existing ground level.

6. SUMMARY AND RECOMMENDATIONS

It is proposed to construct multi-storeyed tenements for TNUDB at Dr.Thomas Road, Phase 1, Chennai. A detailed subsoil investigation using six exploratory boreholes was carried out to access the subsoil profile. The site's top layer predominantly consists of a filled-up layer up to a depth of 2 m from the ground level. The subsoil of the site consists of alternate layers of very soft/soft /medium stiff clay and very loose/loose/medium dense sand layers up to a depth of 14 to 16 m from the ground level. It is followed by the hard clay and the jointed weathered shale layer up to a depth of the termination of the boreholes of 21.8 m from the EGL.

In view of the presence of weak soil layers at shallow depths and considering the anticipated load intensity, it is recommended to adopt bored cast-in-situ concrete piles to support the proposed buildings.

a) The following type of foundation is recommended to support the proposed buildings:

- Type of foundation – Bored cast-in-situ pile
- Pile termination depth – 18.5 m below E.G.L
- Pile cut off level – 2 m below the existing ground level
- Type of soil at pile termination – Jointed Weathered Shale layer

- Recommended pile capacities

Pile diameter (mm)	500	600	750
Safe compression capacity, kN	910	1265	1900
Safe uplift capacity, kN	290	370	505
Safe lateral capacity (Fixed head) in kN	13.9	18.6	26.6
Depth to point of fixity in m (Fixed head)	6.9	8	9.5
Safe lateral capacity (Free head) in kN	5	6.6	9.5
Depth to point of fixity in m (Free head)	6.1	7	8.4

b) Pile capacities are calculated by using the static formula as per IS 2911-Part 1/Sec 2 (2010).

c) The recommended safe load-carrying capacities of the piles shall be confirmed by carrying out initial load tests (compression and lateral) on piles before the construction of piles and routine load tests as per 2911-Part 4 (1985).

d) It is recommended to carry out pile integrity tests on working piles a minimum 25 per cent of the total number of piles in each block.

e) It is recommended to provide at least two or more piles per pile group using a suitable pile diameter instead of a single pile–single column by selecting the appropriate pile diameter to provide better resistance to bending forces from the column loads. All the pile caps must be rigidly interconnected with each other in both directions.

f) Good quality of bentonite with a liquid limit of approx. 350 is recommended to be used as the drilling mud in boring operations. Proper cleaning of the borehole bottom after lowering the reinforcement cage shall be strictly employed as quality control measures.

7. ACKNOWLEDGEMENT

The support and assistance provided by Er. T. Murugesan, Executive Engineer, Er. Suresh Kumar, Assistant Executive Engineer, Division V, Tamil Nadu Urban Habitat Development Board (TNUHDB), Chennai for the execution of the above investigation is greatly appreciated and acknowledged.

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FIELD BORE LOG

ANNEXURE 1

BORE HOLE NO:	BH/1
Date of start	9-Apr-2022
Date of finish	11-Apr-2022
GWL from GL	1.70m
Ground level RL	100.180m

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	Blow Counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Reddish brown sandy silty clay with stones, 150mm PCC at top		0.50							Fill
2.0	1.3	Brownish grey clayey silty fine to medium sand with gravel and stones									Fill
3.0	2.1 3.0	Brownish grey sandy silty clay		2.25	2.25	3	4	6	8	10	Stiff
4.0		Light greyish brown fine to medium sand		3.00	3.00	8	8	10	12	18	Medium stiff
				3.75	3.75	10	10	12	17	22	
5.0	4.4	Greyish sandy silty clay		4.50	4.50	3	2	3	4	5	Medium stiff
6.0	5.4	Greyish silty clay with fine sand		5.50	5.50	1	1	2	1	3	Soft
7.0				6.50	6.50	1	2	1	1	3	
8.0	7.3	Greyish silty clay with fine sand and mica		7.50	7.50	1	1	1	1	2	Soft
9.0				8.50	8.50	1	1	2	1	3	
10.0	9.7										
11.0		Greyish clayey silty fine to medium sand with brown patches		10.00	10.00	6	3	3	4	6	Loose
12.0				11.50	11.50	4	4	3	4	7	
13.0	12.8										
14.0		Light grey and brown silty fine to medium sand with stones and clay		13.00	13.00	7	10	10	11	20	Medium dense
15.0				14.50	14.50	6	10	15	13	25	
16.0	15.8										
17.0		Light grey and brown sandy silty clay with weathered shale		16.00	16.00	50/7cm				>100	Hard clay
	16.7				16.70	Rebound				RB	
		Light grey and brown weathered shale			17.10	Rebound				RB	Very weak
18.0	17.1	Light greyish brown and light grey severely jointed weathered shale	17.10-18.10		DC core drilling					R 35% Q nil	Very weak soft rock
19.0			18.10-19.10		DC Core drilling					R 39% Q nil	
20.0			19.10-20.10		DC Core drilling					R 49% Q nil	
	20.1										
		Continued in the next sheet	Borehole terminated at 20.10m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

BORE HOLE NO:	**BH/2**
Date of start	: 22-Mar-2022
Date of finish	: 23-Mar-2022
GWL from GL	: 1.40m
Ground level RL	: 99.730m

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	Blow Counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Reddish brown and light grey clayey silty fine to medium sand with brick pieces (100mm PCC at top)		0.50							Fill
2.0	1.3	Brownish and grey sandy silty clay/ clayey silty fine to medium sand with organic patches		1.50	1.50	1	0	0	0	0	Very soft to soft
3.0	2.9			2.25	2.25	1	0	1	0	1	
4.0		Greyish fine to medium sand with brown patches		3.00	3.00	3	5	5	7	10	Loose to medium dense
5.0	4.4			3.75	3.75	4	5	7	7	12	
		Dark grey silty clay		4.50	4.50	1	1	0	1	1	Soft
6.0				5.50	5.50	1	0	1	0	1	
7.0				6.50	6.50	1	1	1	1	2	
8.0				7.50	7.50	1	1	1	1	2	
9.0	8.4	Greyish silty clay with fine sand		8.50	8.50	1	1	1	2	2	Soft
10.0	9.6	Greyish dirty fine to medium sand		10.00	10.00	4	5	6	6	11	Loose to medium dense
11.0											
12.0				11.50	11.50	5	6	7	6	13	
13.0	12.7	Greyish clayey fine to medium sand		13.00	13.00	2	4	5	5	9	Loose to medium dense
14.0											
15.0	14.2	Light grey clayey silty fine to medium sand		14.50	14.50	4	5	6	8	11	Loose to medium dense
16.0	15.7	Light grey and brown sandy silty clay with small stones		16.00	16.00 16.50	50/10cm Rebound				>100 RB	Hard
17.0	16.6	Brownish and light grey severly jointed weathered shale with black patches	16.50-17.50		DC core drilling					R 20% Q nil	Very weak soft rock
18.0			17.50-18.50		DC Core drilling					R 30% Q nil	
19.0			18.50-19.50		DC Core drilling					R 32% Q nil	
20.0	19.6 20.0	Dark greenish grey weathered jointed rock (siltstone)	19.50-20.50		DC core drilling					R 46%	Moderate
		Continued in the next sheet	Borehole terminated at 20.50m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{55}

FIELD BORE LOG

BORE HOLE NO:	BH/2

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 22-Mar-2022
Date of finish : 23-Mar-2022
GWL from GL : 1.40m
Ground level RL : 99.730m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
		Dark gr grey weathered jointed rock (siltstone)	19.00-20.50		DC core drilling					Q 31%	Moderate
21.0											
22.0											
23.0											
24.0											
25.0											
26.0											
27.0											
28.0											
29.0											
30.0											
31.0											
32.0											
33.0											
34.0											
35.0											
36.0											
37.0											
38.0											
39.0											
40.0		TC core drillin from 16.00m to 16.50m DC core drilling from 16.50m to 20.50m									
		Continued from sheet 1	Borehole terminated at 20.50m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{55}

FIELD BORE LOG

BORE HOLE NO:	BH/3
Date of start	24-Mar-2022
Date of finish	26-Mar-2022
GWL from GL	1.50m
Ground level RL	100.210m

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	Blow Counts 15	30	45	60	N**	RD / Consistency
1.0		Greyish brown clayey silty fine to medium sand with 100mm PCC at the top		0.50							Fill
1.3											
2.0		Greyish brown clayey silty sand/sandy silty clay		1.50	1.50	2	3	3	5	6	Medium stiff
3.0	2.9			2.25	2.25	4	3	3	3	6	
4.0		Light greyish brown clayey silty fine to medium sand		3.00	3.00	4	4	5	6	9	Loose to medium dense
				3.75	3.75	4	4	4	5	8	
4.5											
5.0		Light greyish brown medium sand with fine sand		4.50	4.50	6	8	8	10	16	Medium dense
6.0				5.50	5.50	7	9	9	11	18	
7.0				6.50	6.50	7	10	13	14	23	
7.3											
8.0		Dark grey silty clay with mica		7.50	7.50	1	2	1	2	3	Soft
9.0			8.50	Collected							
10.0	9.8			9.00	9.00	1	1	2	2	3	
11.0		Greyish silty clay with medium sand		10.00	10.00	1	1	1	1	2	Soft
11.2											
12.0		Greyish dirty fine to medium sand		11.50	11.50	4	4	7	6	11	Loose to medium dense
12.5											
13.0		Greyish brown clayey fine to medium sand		13.00	13.00	4	7	7	8	14	Medium dense
14.0											
15.0				14.50	14.50	4	7	8	10	15	
15.6											
16.0		Light grey and brown sandy silty clay with small stones		16.00	16.00	50/5cm				>100	Hard
16.6					16.70	Rebound				RB	
17.0		Brownish severely jointed weathered claystone with black interface	16.70-17.70		DC Core drilling					R 23% Q nil	Weak soft rock
17.7											
18.0		Brownish severely jointed weathered claystone / shale with black interface	17.70-18.70		DC Core drilling					R 24% Q nil	
19.0			18.70-19.70		DC Core drilling					R 43% Q11%	
20.0	20.0		19.70-20.70		DC Core drilling						

Continued in the next sheet

Borehole terminated at 20.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

BORE HOLE NO:	BH/3
Date of start	24-Mar-2022
Date of finish	26-Mar-2022
GWL from GL	1.50m
Ground level RL	100.210m

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Depth from GL(m)		Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
				UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
21.0	20.7		Brownish severely jointed weathered claystone / shale with black interface	19.70-20.70		DC core drilling					R 52% Q 11%	Weak soft rock
22.0												
23.0												
24.0												
25.0												
26.0												
27.0												
28.0												
29.0												
30.0												
31.0												
32.0												
33.0												
34.0												
35.0												
36.0												
37.0												
38.0												
39.0												
40.0			TC core drillin from 16.30m to 16.70m DC core drilling from 16.70m to 20.70m									
			Continued from sheet 1	Borehole terminated at 20.70m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

BORE HOLE NO:			**BH/4**
Project	: Tenement Buildings for TNSCB	Date of start	: 29-Mar-2022
Site	: Dr. Thomas Road, off South West Boag Road, Chennai	Date of finish	: 30-Mar-2022
Location	: As shown in Figure 1	GWL from GL	: 1.20m
Dia and type of boring	: 150mm Rotary boring with drilling mud circulation	Ground level RL	: 99.750m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	Blow Counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Greyish brown sandy silty clay (fill) with 100mm PCC		0.50							Fill
2.0				1.50	1.50	2	1	1	1	2	
3.0	2.2 2.9	Greyish brown clayey silty fine to medium sand		2.25	2.25	2	1	2	2	3	Loose
4.0		Light greyiish brown clayey fine to medium sand		3.00	3.00	2	3	2	4	5	Loose to medium dense
				3.75	3.75	2	4	6	10	10	
5.0	4.5	Light greyiish brown fine to medium sand		4.50	4.50	5	6	7	6	13	Medium dense
6.0				5.50	5.50	6	7	10	10	17	
7.0	6.3	Dark grey silty clay with mica and sand patches		6.50	6.50	1	1	1	1	2	Soft
8.0				7.50		1	1	1	1	2	
9.0	8.3	Greyish clayey silty fine sand with brown patches		8.50	8.50	2	3	3	3	6	Loose
10.0	9.5	Greyish soft sandy silty clay / clayey sand		10.00	10.00	1	0	1	1	1	Soft
11.0											
12.0	11.3	Greyish clayey silty fine to medium sand with brown patches		11.50	11.50	1	1	1	2	2	Loose
13.0											
14.0				13.00	13.00	1	1	2	2	3	
15.0	14.4	Light grey and brown sandy silty clay		14.50	14.50	23	33	41		74	Hard
16.0	15.5	Brownish weathered claystone		16.00	16.00	50/4cm				>100	Very weak
17.0					16.80	Rebound				RB	
	17.5		16.80-17.50		TC core drilling					R 12.8%	
18.0		Light grey and brown severely jointed weathered shale with black patches	17.50-18.50		DC core drilling					R 25% Q nil	Weak soft rock
19.0			18.50-19.50		DC Core drilling					R 35% Q nil	
20.0	19.4	Light grey and brown severely jointed shale	19.50-20.50		DC Core drilling					R 46% Q nil	
		Continued in the next sheet	Borehole terminated at 21.50m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

BORE HOLE NO:	**BH/4**
Date of start	: 29-Mar-2022
Date of finish	: 30-Mar-2022
GWL from GL	: 1.20m
Ground level RL	: 99.750m

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
21.0		Light grey and brown severely jointed shale									Soft rock
21.5			20.50-21.50		DC Core drilling					R 55% Q 13%	
22.0											
23.0											
24.0											
25.0											
26.0											
27.0											
28.0											
29.0											
30.0											
31.0											
32.0											
33.0											
34.0											
35.0											
36.0											
37.0											
38.0											
39.0											
40.0		TC core drillin from 16.80m to 17.50m DC core drilling from 17.50m to 21.50m									

Continued from sheet 1 — Borehole terminated at 21.50m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

BORE HOLE NO:	BH/5

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 31-Mar-2022
Date of finish : 1-Apr-2022
GWL from GL : 1.30m
Ground level RL : 99.750m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	Blow Counts 15	30	45	60	N**	RD / Consistency
1.0		Greyish brown fine to medium sand with brick pieces		0.50							Fill
1.4											
2.0		Brownish grey clayey silty fine to medium sand		1.50	1.50	1	1	1	2	2	Loose
3.0	2.9			2.25	2.25	1	2	1	2	3	
3.5		Brownish grey fine sandy silty clay		3.00	3.00	3	5	5	13	10	Med stiff
4.0	3.8	Brownish grey clayey silty fine sand									Loose
5.0		Light greyish brown medium sand with fine sand		3.75	3.75	7	7	5	7	12	Medium dense
				4.50	4.50	6	7	7	10	14	
5.3											
6.0		Light greyish brown fine to medium sand		5.50	5.50	7	7	8	8	15	Medium dense
7.0				6.50	6.50	7	8	9	10	17	
7.7			7.50	Collected							
8.0		Dark grey and grey silty clay with mica		8.00	8.00	1	1	2	1	3	Soft
9.0				9.00	9.00	1	2	1	1	3	
9.8											
10.0		Greyish silty clay with mica and brown sand patches		10.00	10.00	1	1	1	2	2	Soft
11.0											
11.4											
12.0		Greyish and brownish clayey silty fine to medium sand		11.50	11.50	1	2	3	4	5	Loose
13.0											
14.0				13.00	13.00	2	2	3	5	5	
14.2											
15.0		Brownish and light grey sandy silty clay		14.50	14.50	23	36	40		76	Hard
15.6											
16.0		Light grey and brown weathered claystone		16.00	16.00	50/7cm				>100	Very weak
17.0					17.00	Rebound				RB	
17.8			17.00-17.80		TC core drilling					R nil	
18.0		Brownish severely jointed weathered claystone with black patches	17.80-18.80		DC Core drilling					R 35% Q nil	Weak soft rock
18.8											
19.0		Brownish and light grey severely jointed weathered shale with black patches	18.80-19.80		DC Core drilling					R 35% Q 12%	
20.0	20.0										
		Continued in the next sheet	Borehole terminated at 21.80m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

BORE HOLE NO:	BH/5
Date of start	31-Mar-2022
Date of finish	1-Apr-2022
GWL from GL	1.30m
Ground level RL	99.750m

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Depth from GL(m)		Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
				UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
21.0			Brownish and light grey severely jointed weathered shale with black patches	19.80-20.80		DC Core drilling					R 43% Q nil	Weak soft rock
22.0	21.8			20.80-21.80		DC Core drilling					R 52% Q 15%	
23.0												
24.0												
25.0												
26.0												
27.0												
28.0												
29.0												
30.0												
31.0												
32.0												
33.0												
34.0												
35.0												
36.0												
37.0												
38.0												
39.0												
40.0			TC core drillin from 17.00m to 17.80m DC core drilling from 17.80m to 21.80m									
			Continued from sheet 1	Borehole terminated at 21.80m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

BORE HOLE NO:	**BH/6**
Date of start	: 2-Apr-2022
Date of finish	: 5-Apr-2022
GWL from GL	: 1.00m
Ground level RL	: 99.540m

Project : Tenement Buildings for TNSCB
Site : Dr. Thomas Road, off South West Boag Road, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	Blow Counts 15	30	45	60	N**	RD / Consistency
1.0		Greyish brown fine to medium sand with concrete pieces with PCC		0.50							Fill
2.0	1.2	Brownish grey sandy silty clay		1.50	1.50	2	1	2	2	3	Soft
3.0	2.2 2.9	Light greyish brown fine sandy silty clay		2.25	2.25	3	5	5	6	10	Medium stiff
4.0		Light greyish brown fine sand with medium sand		3.00	3.00	3	4	8	8	12	Medium dense
				3.75	3.75	4	5	8	10	13	
5.0				4.50	4.50	7	6	8	11	14	
6.0				5.50	5.50	6	7	8	13	15	
7.0	6.3	Dark grey silty clay with mica		6.50	6.50	1	1	1	2	2	Soft
8.0	7.5	Greyish silty clay with mica		7.50	7.50	1	0	1	1	1	Very soft
9.0	8.3	Greyish clayey silty fine sand		8.50	8.50	sunk@spt wt				0	Very loose
10.0	9.5	Greyish clayey silty fine to medium sand with brown patches		10.00	10.00	1	1	1	1	2	Very loose
11.0											
12.0				11.50	11.50	1	1	2	2	3	
13.0	12.7	Light grey and brown clayey silty fine to medium sand with stones		13.00	13.00	3	7	8	10	15	Medium dense
14.0											
15.0	14.3	Light grey and brown clayey silty fine to coarse sand with weathered shale		14.50	14.50	23	50/10cm			>100	Very dense
16.0	15.7	Light grey and yellowish brown sandy silty clay with stones (weathered shale)		16.00	16.00	50/9cm				>100	Very weak soft rock
17.0					16.80	Rebound				RB	
	17.4		16.80-17.40		17.40	DC Core drilling Rebound				RB	
18.0		Light grey and brown severely jointed weathered shale with black patches	17.40-18.40		DC Core drilling					R 38% Q nil	Very weak soft rock
19.0			18.40-19.40		DC Core drilling					R 20% Q nil	
20.0			19.40-20.40		DC Core drilling					R 44% Q nil	
	20.4	Continued in the next sheet	Borehole terminated at 21.40m								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

FIELD BORE LOG

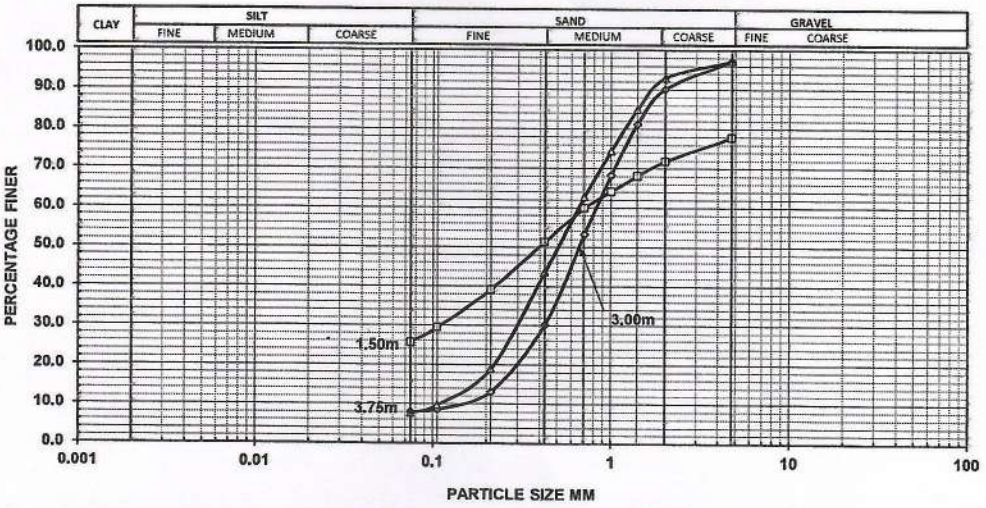
		BORE HOLE NO:	BH/6
Project	: Tenement Buildings for TNSCB	Date of start	: 2-Apr-2022
Site	: Dr. Thomas Road, off South West Boag Road, Chennai	Date of finish	: 5-Apr-2022
Location	: As shown in Figure 1	GWL from GL	: 1.00m
Dia and type of boring	: 150mm Rotary boring with drilling mud circulation	Ground level RL	: 99.540m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
21.0		Light grey and brown severely jointed weathered shale with black patches	20.40-21.40		DC Core drilling					R 48% Q nil	Very weak soft rock
21.4											
22.0											
23.0											
24.0											
25.0											
26.0											
27.0											
28.0											
29.0											
30.0											
31.0											
32.0											
33.0											
34.0											
35.0											
36.0											
37.0											
38.0											
39.0											
40.0		TC core drillin from 16.80m to 17.40m DC core drilling from 17.40m to 21.40m									
		Continued from sheet 1	Borehole terminated at 21.40m								

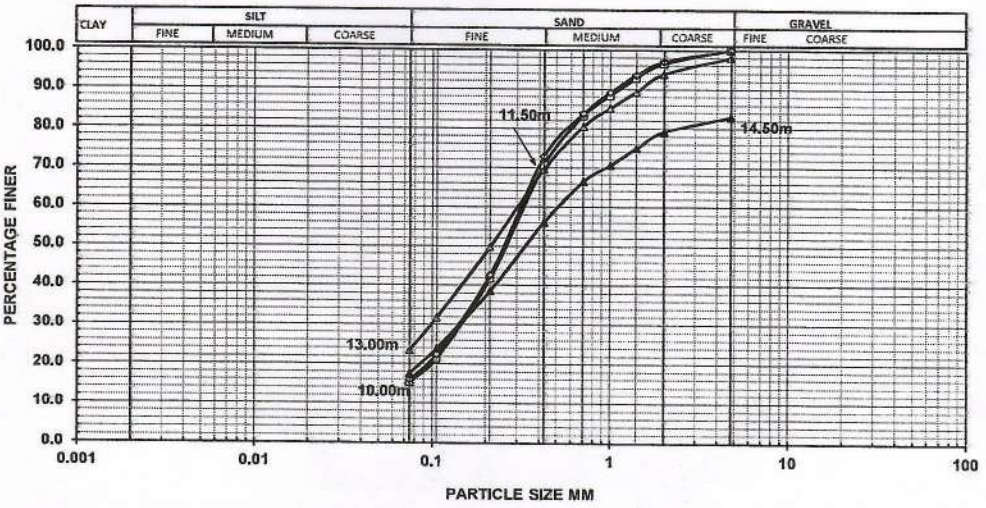
**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai**



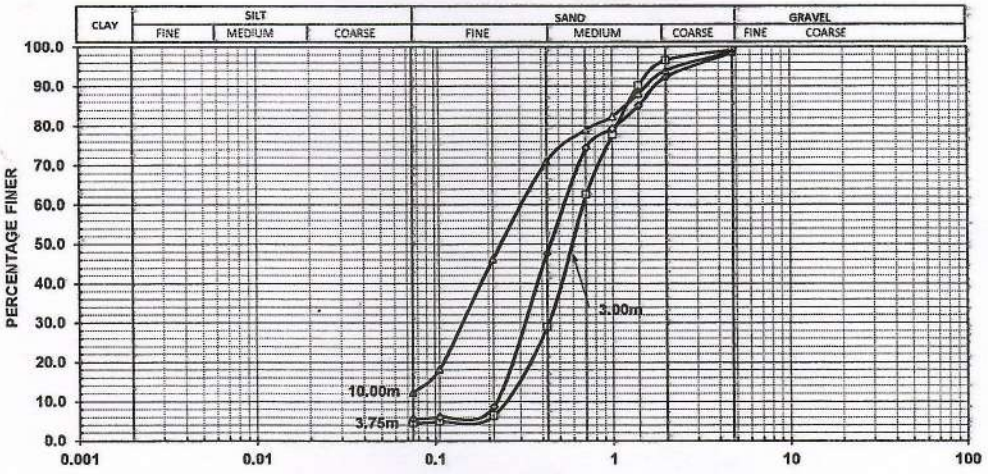
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	1.50m		100.0	77.9	71.8	51.3	25.6		22.1	6.1	20.5	25.7	25.6		GC-SC	0.395	12.515	0.519
BH/1	3.00m		100.0	97.2	90.1	30.1	8.0		2.8	7.1	60.0	22.1	8.0		SP	0.660	3.550	1.032
BH/1	3.75m		100.0	97.2	92.9	43.5	7.6		2.8	4.3	49.4	35.9	7.6		SP	0.505	3.939	0.876



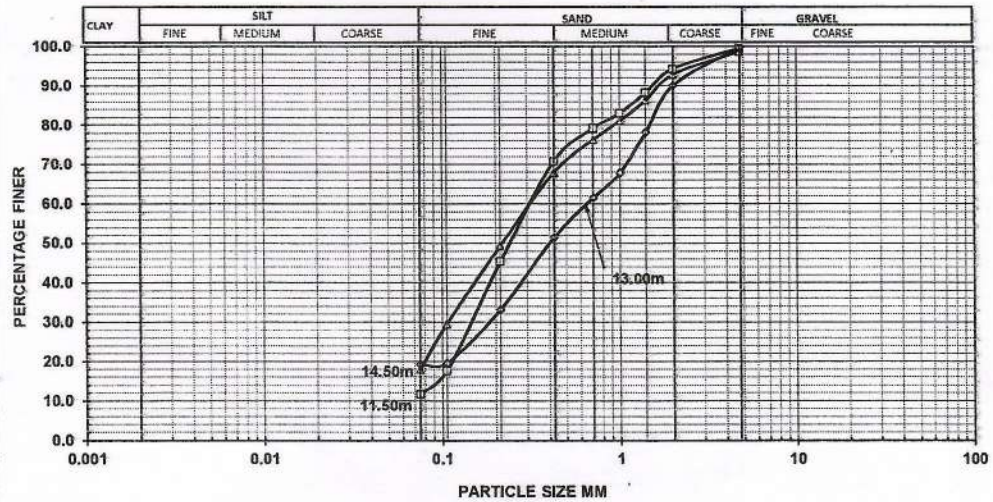
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	10.00m		100.0	100.0	96.6	70.7	15.4		0.0	3.4	25.9	55.3	15.4		SC-SP	0.258	3.307	0.956
BH/1	11.50m		100.0	100.0	97.0	72.9	16.0		0.0	3.0	24.1	56.9	16.0		SC-SP	0.251	3.234	0.985
BH/1	13.00m		100.0	98.1	93.9	69.6	23.5		1.9	4.2	24.3	46.1	23.5		SC-SP	0.214	4.089	0.797
BH/1	14.50m		100.0	83.0	79.2	56.1	17.7		17.0	3.8	23.1	38.4	17.7		SC-SP	0.334	6.406	0.702

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Tenements for TNSCB, Habitat, Dr Thomas Road, off South West Boag Road, Chennai



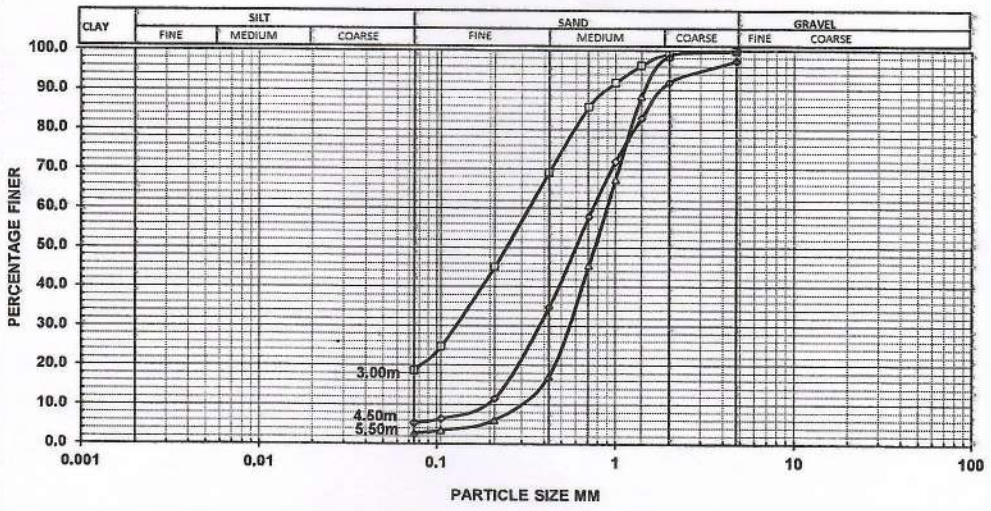
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	3.00m		100.0	99.1	96.6	29.0	4.5		0.9	2.5	67.6	24.5	4.5		SP	0.586	2.614	1.089
BH/2	3.75m		100.0	98.4	92.3	47.6	5.6		1.6	6.1	44.7	42.0	5.6		SP	0.445	2.367	0.830
BH/2	10.00m		100.0	98.7	94.0	71.0	12.2		1.3	4.7	23.0	58.8	12.2		SP	0.236	3.151	0.756



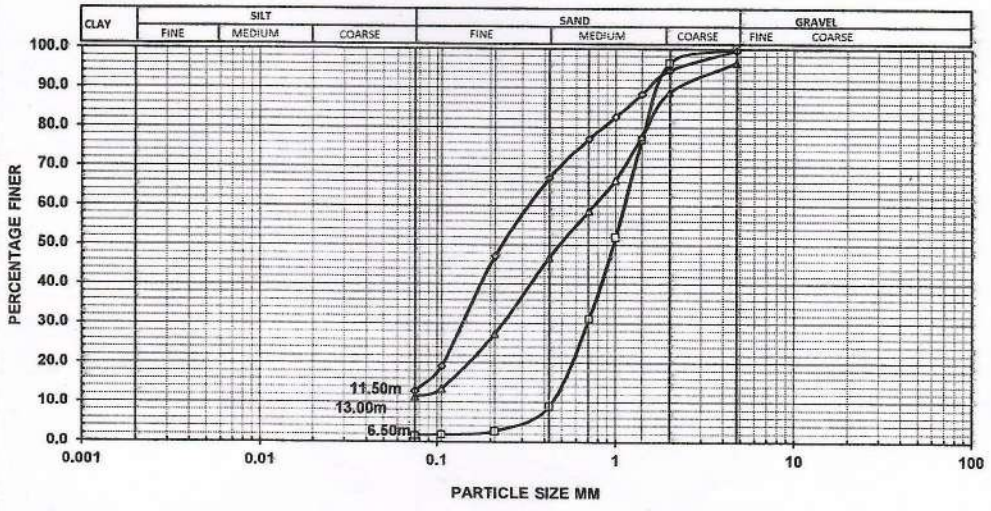
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	11.50m		100.0	99.6	94.3	70.9	11.7		0.4	5.3	23.4	59.2	11.7		SP	0.240	3.152	0.767
BH/2	13.00m		100.0	99.7	90.1	51.5	19.3		0.3	9.6	38.6	32.2	19.3		SC-SP	0.401	6.300	0.632
BH/2	14.50m		100.0	98.7	92.9	68.0	18.0		1.3	5.8	24.9	50.0	18.0		SC-SP	0.217	4.306	0.707

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Tenements for TNSCB, Habitat, Dr Thomas Road, off South West Boag Road, Chennai**



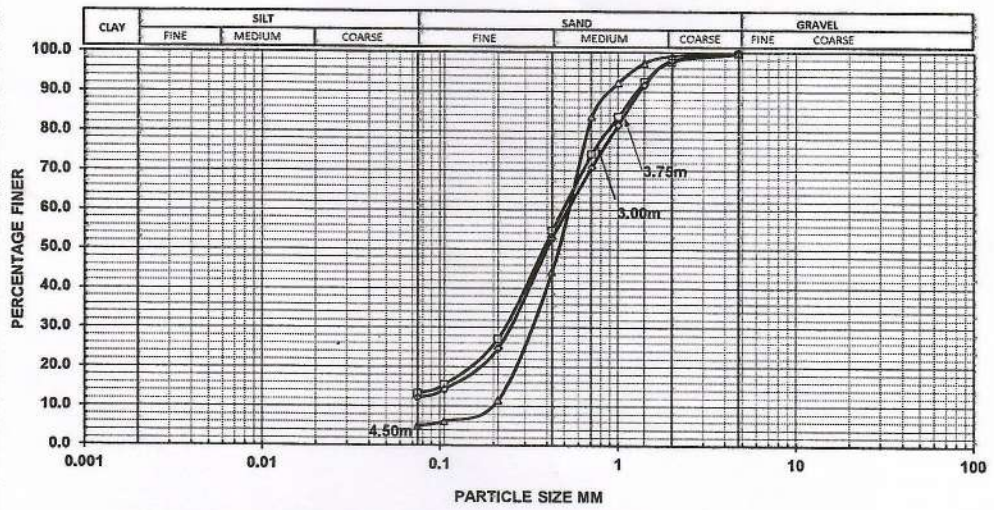
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/3	3.00m		100.0	99.8	99.0	69.0	18.7		0.2	0.8	30.0	50.3	18.7		SC-SP	0.245	3.567	0.846
BH/3	4.50m		100.0	97.3	91.9	34.7	5.3		2.7	5.4	57.2	29.4	5.3		SP	0.596	3.376	0.927
BH/3	5.50m		100.0	100.0	98.5	17.2	2.8		0.0	1.5	81.3	14.4	2.8		SP	0.762	2.860	1.073



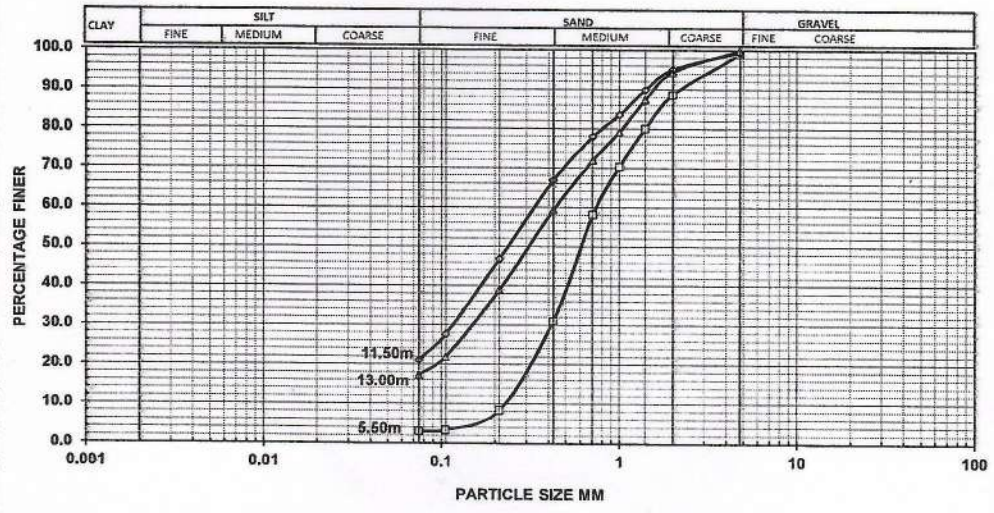
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/3	6.50m		100.0	100.0	96.3	9.0	1.7		0.0	3.7	87.3	7.3	1.7		SP	0.968	2.496	0.990
BH/3	11.50m		100.0	99.5	94.4	67.0	12.9		0.5	5.1	27.4	54.1	12.9		SP	0.234	3.541	0.669
BH/3	13.00m		100.0	96.4	88.9	46.9	11.4		3.6	7.5	42.0	35.5	11.4		SP	0.486	6.181	0.703

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai**



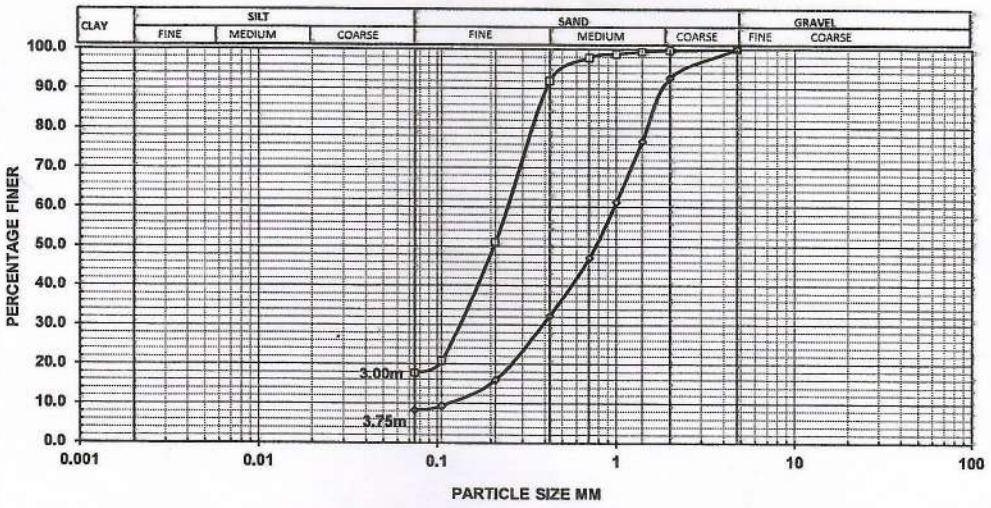
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/4	3.00m		100.0	99.5	97.6	54.6	13.2		0.5	1.9	43.0	41.4	13.2		SC-SP	0.378	3.618	0.948
BH/4	3.75m		100.0	100.0	97.9	52.7	12.2		0.0	2.1	45.2	40.5	12.2		SP	0.397	3.621	0.898
BH/4	4.50m		100.0	100.0	99.1	44.2	5.0		0.0	0.9	54.9	39.2	5.0		SP	0.458	2.371	0.946



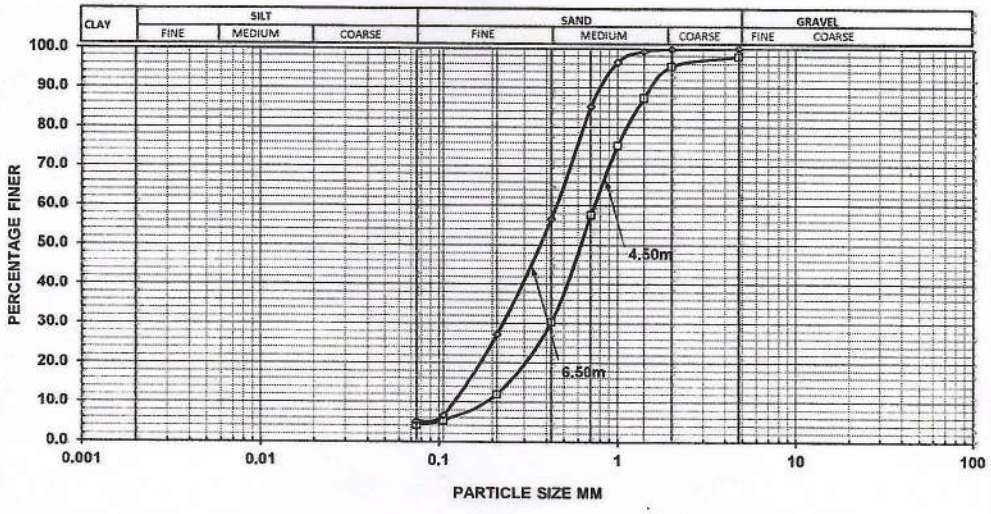
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/4	5.50m		100.0	99.0	88.7	31.1	3.1		1.0	10.3	57.6	28.0	3.1		SP	0.608	3.189	1.003
BH/4	11.50m		100.0	99.4	95.1	66.8	21.1		0.6	4.3	28.3	45.7	21.1		SC-SP	0.237	4.124	0.762
BH/4	13.00m		100.0	100.0	94.4	59.3	17.3		0.0	5.6	35.1	42.0	17.3		SC-SP	0.309	4.716	0.784

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Tenements for TNSCB, Habitat, Dr Thomas Road, off South West Boag Road, Chennai**



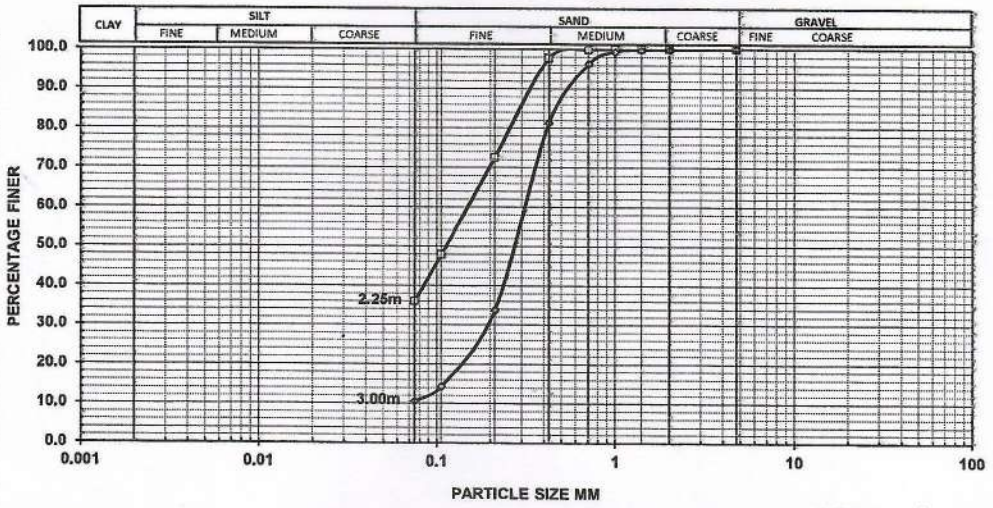
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/5	3.00m		100.0	100.0	99.7	91.9	17.7		0.0	0.3	7.8	74.2	17.7		SC-SP	0.207	2.336	0.909
BH/5	3.75m		100.0	100.0	92.8	32.3	8.3		0.0	7.2	60.5	24.0	8.3		SP	0.760	4.602	0.973



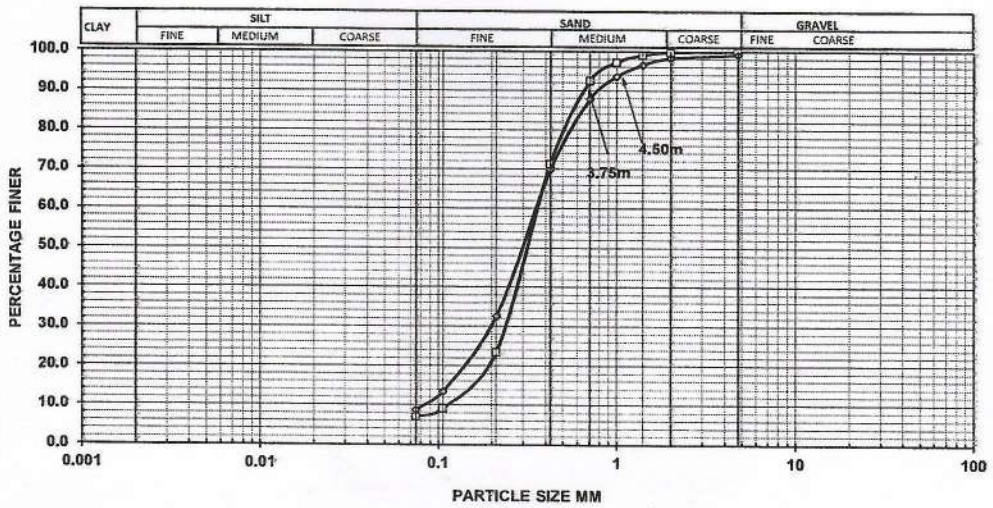
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/5	4.50m		100.0	97.9	95.4	30.4	4.4		2.1	2.5	65.0	26.0	4.4		SP	0.614	3.376	1.144
BH/5	6.50m		100.0	100.0	99.8	56.6	5.1		0.0	0.2	43.2	51.5	5.1		SP	0.363	3.391	0.934

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Tenement Buildings for TNSCB, Dr. Thomas Road, off South West Boag Road, Chennai**



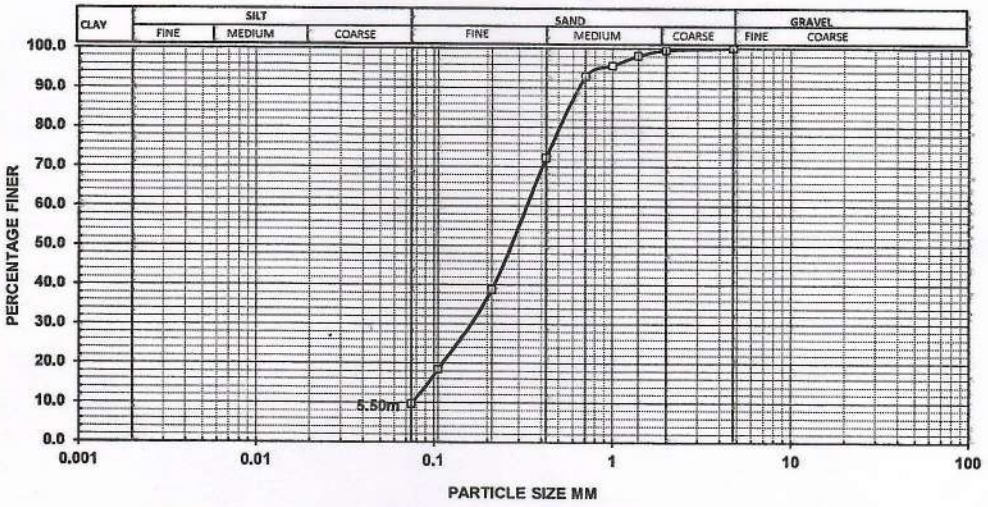
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	2.25m		100.0	100.0	100.0	97.7	36.0				2.3	61.7	36.0		SC	0.113	2.462	0.843
BH/6	3.00m		100.0	100.0	99.9	81.4	10.6			0.1	18.5	70.8	10.6		SP	0.269	2.589	1.184



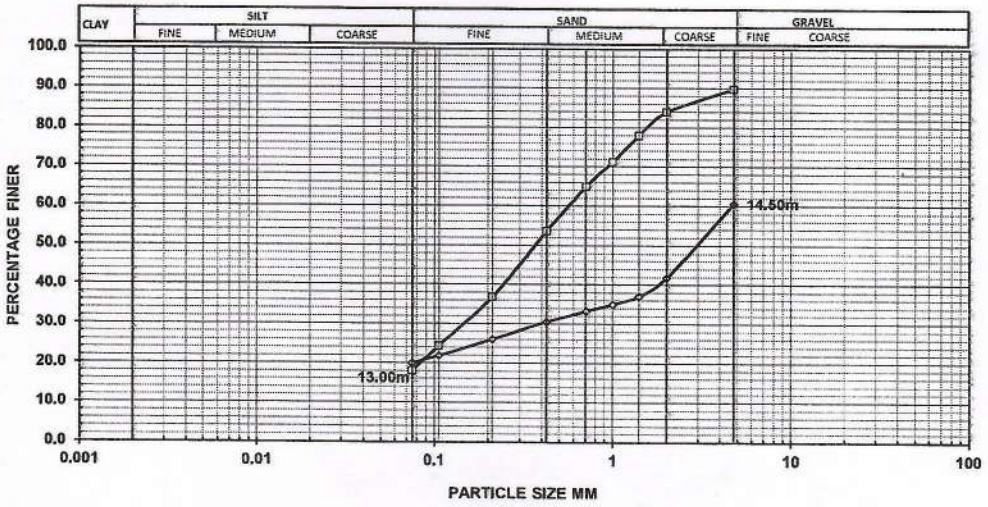
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	3.75m		100.0	100.0	99.8	71.4	7.1		0.0	0.2	28.4	64.3	7.1		SP	0.312	2.492	1.109
BH/6	4.50m		100.0	99.1	98.2	69.8	8.8		0.9	0.9	28.4	61.0	8.8		SP	0.294	3.038	1.092

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Tenement Buildings for TNSCB, Dr. Thomas Road, off South West Boag Road, Chennai**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	5.50m		100.0	100.0	99.5	72.3	9.7		0.0	0.5	27.2	62.6	9.7		SP	0.268	3.328	1.025



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	13.00m		100.0	89.8	84.0	53.6	18.1		10.2	5.8	30.4	35.5	18.1		GC-SP	0.366	6.813	0.770
BH/6	14.50m		100.0	60.6	41.8	30.5	20.0		39.4	18.8	11.3	10.5	20.0		GC-SW	2.917	10.312	5.052

ONE DIMENSIONAL CONSOLIDATION TEST RESULTS
strain - log p curve

Test Data

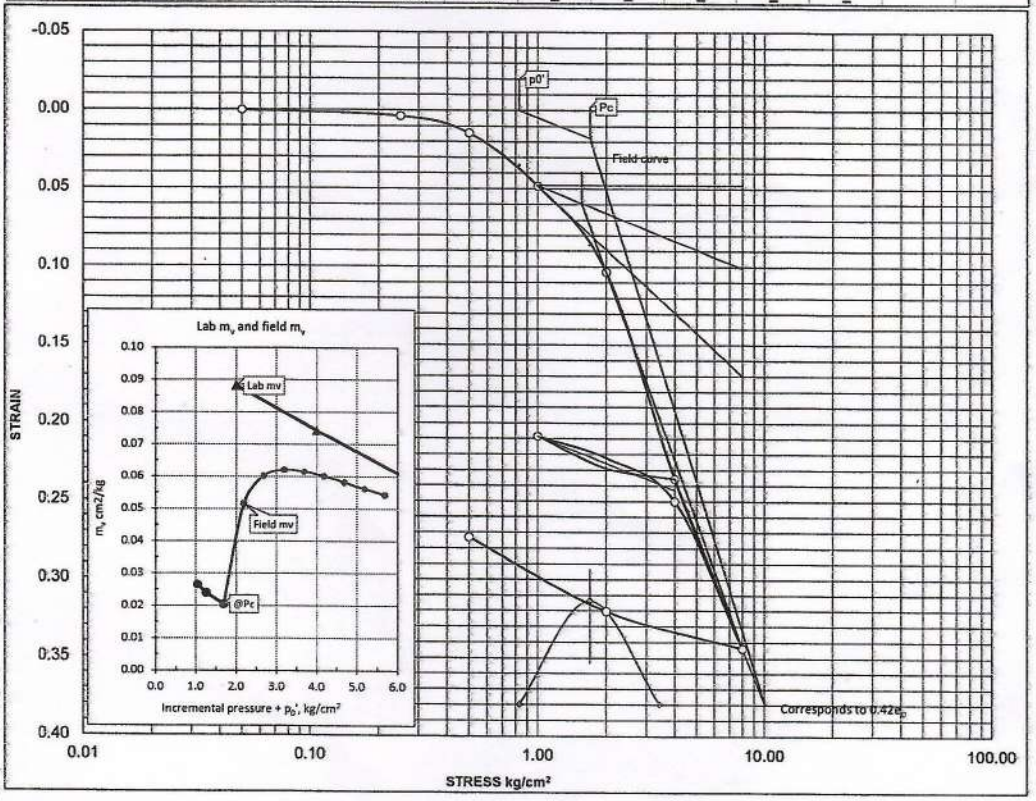
Wt of Consolidation Ring gm :	188.80	Diameter of ring mm :	59.85
Wt of Ring + wet Soil gm :	273.68	Height of ring mm :	19.40
Wt of Wet Soil gm :	84.88	Volume of Ring :	54.60
Wt of Wet Soil after test gm :	74.92	Specific Gravity :	2.617
Wt of ring + Dry Soil gm :	238.00	Initial Void Ratio :	1.90
Wt of Dry soil gm :	49.20	Moisture Content % :	72.52
Wet Density gm/cc :	1.555	Moisture after Test %:	52.28
Dry Density gm/cc :	0.901	Height of Solids mm :	6.680
Liquid Limit %	114.10	Saturated Moisture %:	72.76
Plastic Limit %	34.00	Per cent Saturation :	99.66
Plasticity Index	80.10		
Liquidity Index	0.481		

PROJECT: Tenements for TNSCB,Dr. Thomas Road, off South West Boag Road,

BH NO: BH/3 DEPTH 8.50m

SOIL: Dark grey silty clay

Stress kg/cm²	Dial div	Incr div	Comp mm	Strain	Height mm	Void ratio	T_{90} min	$C_{v(90)}$ m^2/yr	T_{50} min	$C_{v(50)}$ m^2/yr	Δ_p kg/cm²	m_v cm^2/kg	E_c kg/cm²
0.00	5226	0	0.000	0.0000	19.40	1.904	–	–	–	–	–		
0.05	5223	3	0.006	0.0003	19.39	1.903	–	–	–	–	–		
0.25	5188	38	0.076	0.0039	19.32	1.893	–	–	–	–	–		
0.50	5085	141	0.282	0.0145	19.12	1.862	–	–	–	–	–	–	–
1.00	4756	470	0.940	0.0485	18.46	1.764	49.0	0.80	11.4	0.81	0.17	0.2850	3.5
2.00	4225	1001	2.002	0.1032	17.40	1.605	53.6	0.67	16.4	0.51	1.17	0.0882	11.3
4.00	2939	2287	4.574	0.2358	14.83	1.220	189.1	0.15	38.1	0.18	3.17	0.0744	13.4
1.00	3203	2023	4.046	0.2086	15.35	1.299	–	–	–	–	–	–	–
4.00	2802	2424	4.848	0.2499	14.55	1.178	50.0	0.50	–	–	3.00	0.0138	72.6
8.00	1890	3336	6.672	0.3439	12.73	0.905	172.9	0.12	42.2	0.11	7.17	0.0480	20.8
2.00	2119	3107	6.214	0.3203	13.19	0.974	–	–	–	–	–		
0.50	2575	2651	5.302	0.2733	14.10	1.111	–	–	–	–	–		
0.00	2890	2336	4.672	0.2408	14.73	1.205	–	–	–	–	–		



Compression Ratio CR [= cc/(1+e0)]		0.4670*	0.3998^	
Re-compression ratio RR [= cr/(1+e0)]		0.0569	0.0569	
Effective overburden presure			0.830	kg/cm²
Pre-consolidation Pressure P_c	(Schmertmann)		1.689	kg/cm²
Pre-consolidation Pressure P_c	(Casagrande)		1.554	kg/cm²
Coefficient of secondary consolidation $C_{\alpha\varepsilon}$			4.19E-03 up to 200 kN/m²	2.01E-02 up to 800 kN/m²

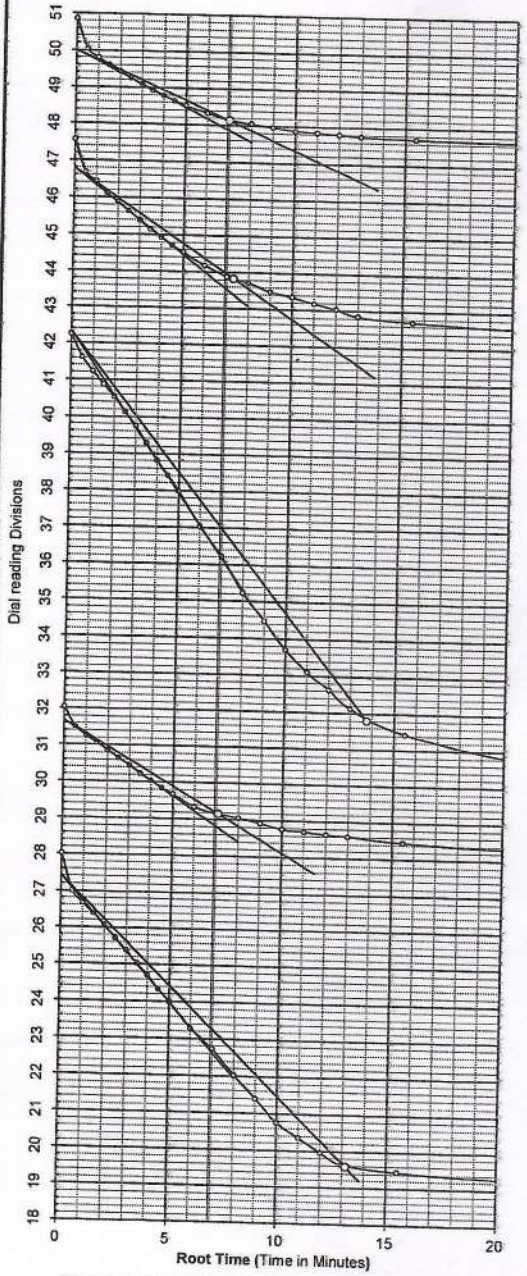
OCR	1.95	* Schmertmann, ^ Casagrande	
CR/RR	7.03	from	to
Lab m_v	(cm^2 /kg)	0.0480	0.2850
Field m_v	(cm^2 /kg)	0.0204	0.0621
Note: for settlement estimations, use field m_v			

Note: mv values are from effective overburden pressure only

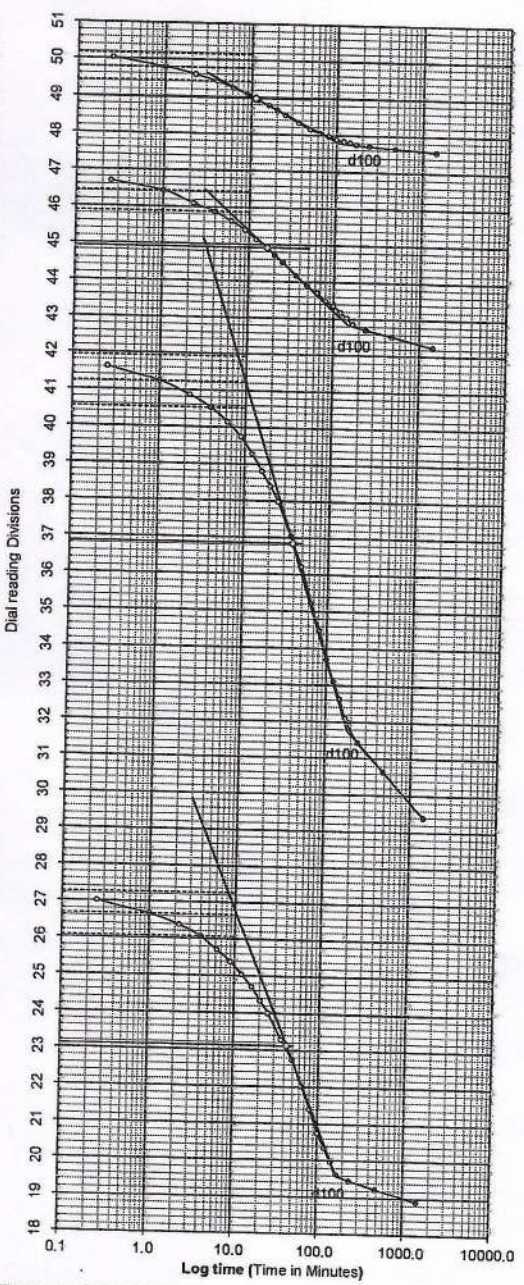
Date April 9, 2022

ONE DIMENSIONAL CONSOLIDATION TEST RESULTS

Project: Tenements for TNSCB,Dr. Thomas Road, off South West Boag Road, Chennai
Bore hole: BH/3 Depth 8.50m
Soil: Dark grey silty clay



Range kg/cm^2	t_{90} min	Coefficient of cons c_{v1} m^2/year
0.50 to 1.00	49.00	0.803
1.00 to 2.00	53.60	0.668
2.00 to 4.00	189.10	0.153
1.00 to 4.00	50.00	0.498
4.00 to 8.00	172.90	0.120



Range kg/cm^2	t_{50} min	c_{v2} m^2/year	Coefficient of sec. consolidation $C_{\alpha\varepsilon}$
0.50 to 1.00	11.35	0.805	1.97E-03
1.00 to 2.00	16.41	0.507	6.42E-03
2.00 to 4.00	38.05	0.177	3.03E-02
	-	-	-
4.00 to 8.00	42.16	0.114	9.85E-03

ONE DIMENSIONAL CONSOLIDATION TEST RESULTS
strain - log p curve

Test Data

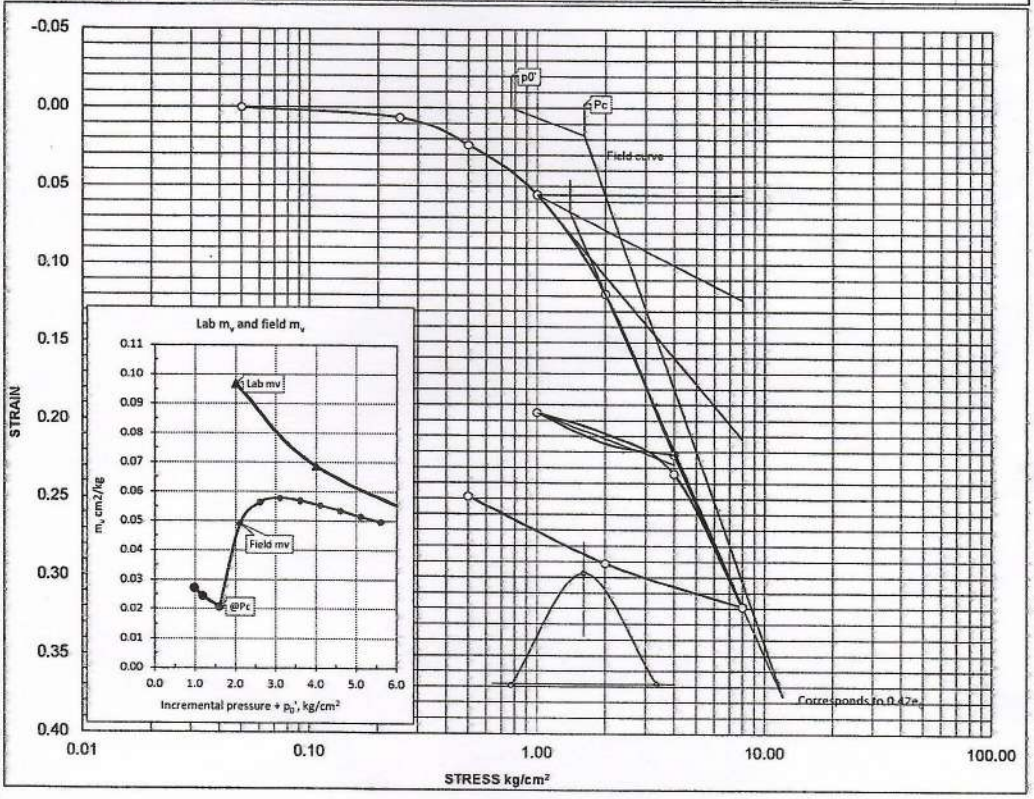
Wt of Consolidation Ring gm :	184.28	Diameter of ring mm :	59.85
Wt of Ring + wet Soil gm :	269.25	Height of ring mm :	19.32
Wt of Wet Soil gm :	84.97	Volume of Ring :	54.38
Wt of Wet Soil after test gm :	72.85	Specific Gravity :	2.617
Wt of ring + Dry Soil gm :	234.24	Initial Void Ratio :	1.85
Wt of Dry soil gm :	49.96	Moisture Content % :	70.08
Wet Density gm/cc :	1.563	Moisture after Test %:	45.82
Dry Density gm/cc :	0.919	Height of Solids mm :	6.783
Liquid Limit %	121.70	Saturated Moisture %:	70.63
Plastic Limit %	33.40	Per cent Saturation :	99.22
Plasticity Index	88.30		
Liquidity Index	0.415		

PROJECT: Tenements for TNSCB, Dr. Thomas Road, off South west Boag, Chennai

BH NO: BH/5 DEPTH 7.50m

SOIL: Dark grey and grey silty clay with mica

Stress kg/cm²	Dial div	Incr div	Comp mm	Strain	Height mm	Void ratio	T_{90} min	$C_{V(t90)}$ m^2/yr	T_{50} min	$C_{V(t50)}$ m^2/yr	Δ_p kg/cm²	m_v cm^2/kg	E_c kg/cm²
0.00	4918	0	0.000	0.0000	19.32	1.848	–	–	–	–	–		
0.05	4914	4	0.008	0.0004	19.31	1.847	–	–	–	–	–		
0.25	4853	65	0.130	0.0067	19.19	1.829	–	–	–	–	–		
0.50	4688	230	0.460	0.0238	18.86	1.780	–	–	–	–	–	–	–
1.00	4381	537	1.074	0.0556	18.25	1.690	51.1	0.75	12.5	0.71	0.23	0.2417	4.1
2.00	3768	1150	2.300	0.1190	17.02	1.509	109.0	0.32	23.3	0.35	1.23	0.0968	10.3
4.00	2776	2142	4.284	0.2217	15.04	1.217	147.9	0.19	32.3	0.21	3.23	0.0686	14.6
1.00	3033	1885	3.770	0.1951	15.55	1.292	–	–	–	–	–	–	–
4.00	2656	2262	4.524	0.2342	14.80	1.181	43.7	0.59	–	–	3.00	0.0130	76.9
8.00	1837	3081	6.162	0.3189	13.16	0.940	136.0	0.16	32.7	0.15	7.23	0.0441	22.7
2.00	2105	2813	5.626	0.2912	13.69	1.019	–	–	–	–	–		
0.50	2515	2403	4.806	0.2488	14.51	1.140	–	–	–	–	–		
0.00	2540	2378	4.756	0.2462	14.56	1.147	–	–	–	–	–		



Compression Ratio CR [= cc/(1+e0)]		0.4103*	0.3320^		OCR	1.94
Re-compression ratio RR [= cr/(1+e0)]		0.0545	0.0545		CR/RR	6.09
Effective overburden presure			0.770	kg/cm²	Lab m_v	(cm^2 /kg)
Pre-consolidation Pressure P_c	(Schmertmann)		1.608	kg/cm²	Field m_v	(cm^2 /kg)
Pre-consolidation Pressure P_c	(Casagrande)		1.386	kg/cm²	Note: for settlement estimations, use field m_v	
Coefficient of secondary consolidation $C_{\alpha\varepsilon}$			8.51E-03 up to 200 kN/m²		1.86E-02 up to 800 kN/m²	

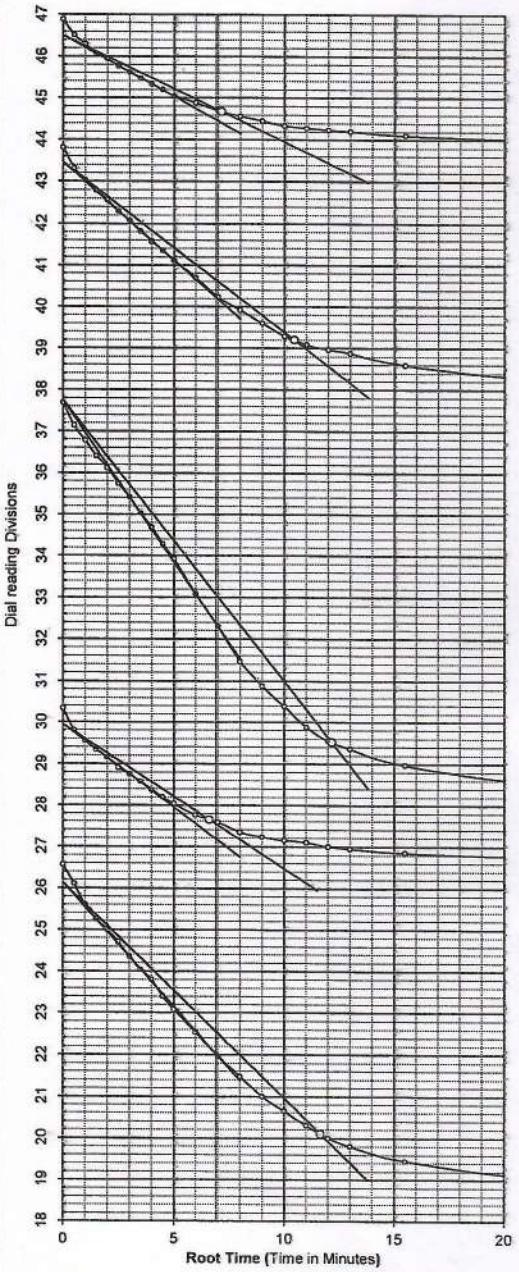
* Schmertmann, ^ Casagrande

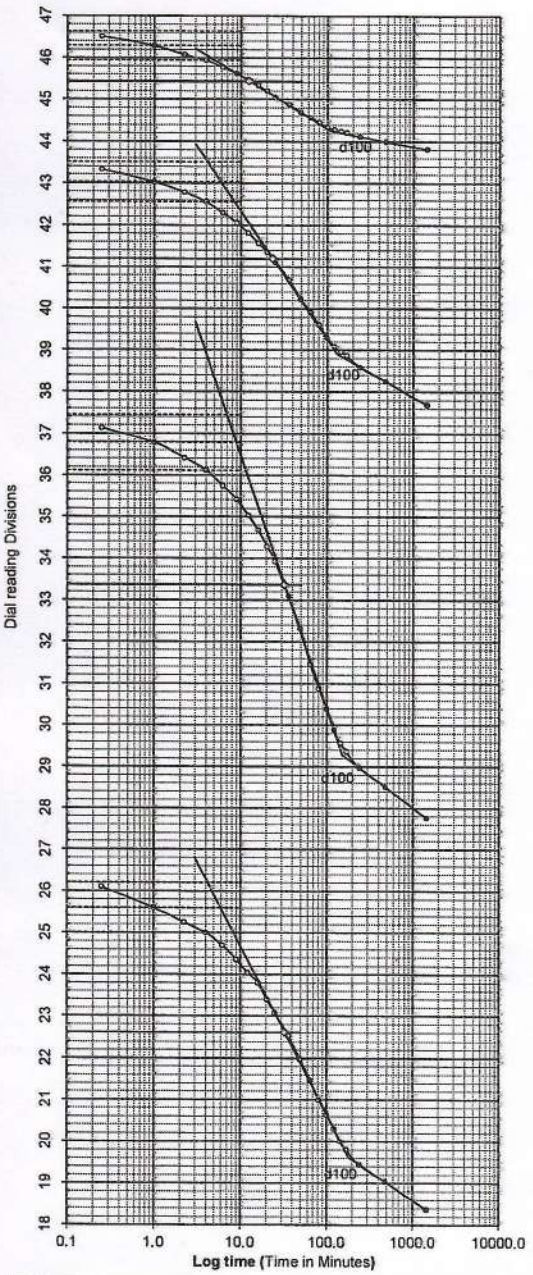
from	to	Note: mv values are from effective overburden pressure only
0.0441	0.2417	
0.0208	0.0577	

Date April 1, 2022

ONE DIMENSIONAL CONSOLIDATION TEST RESULTS

Project: Tenements for TNSCB, Dr. Thomas Road, off South west Boag, Chennai
Bore hole: BH/5 Depth 7.50m
Soil: Dark grey and grey silty clay with mica





Range kg/cm^2	t_{90} min	Coefficient of cons C_{v1} m^2/year
0.50 to 1.00	51.10	0.751
1.00 to 2.00	109.00	0.318
2.00 to 4.00	147.90	0.194
1.00 to 4.00	43.70	0.587
4.00 to 8.00	136.00	0.160

Range kg/cm^2	t_{50} min	c_{v2} m^2/year	Coefficient of sec. consolidation $C_{\alpha c}$
0.50 to 1.00	12.47	0.715	4.09E-03
1.00 to 2.00	23.26	0.346	1.29E-02
2.00 to 4.00	32.30	0.206	1.84E-02
	-	-	-
4.00 to 8.00	32.66	0.155	1.88E-02

Unconfined Compression Strength Test UCC on soil sample

Project:

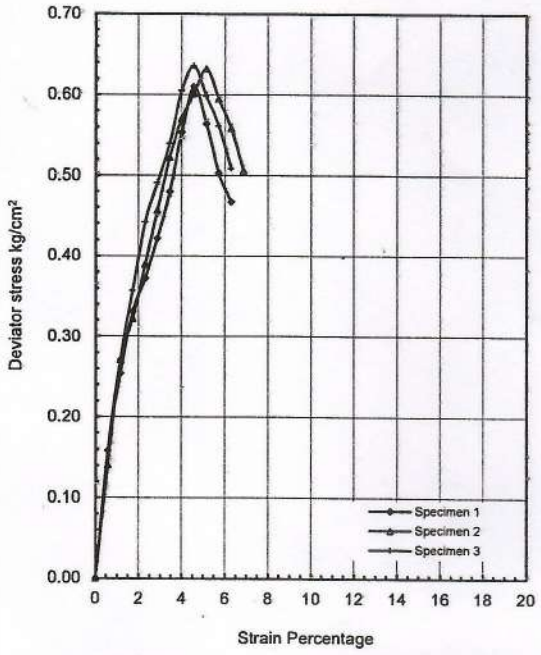
Tenement Building for TNSCB, Dr. Thomas Road, off South West Boag Road, Chennai

Date of Test	**09-Apr-22**
Borehole	**BH/3**
Depth	**8.50m**

Soil

Greyish silty clay

Insitu bulk density	1.570 gm/cc
Insitu Dry Density	0.934 gm/cc
Water Content	68.13 %
Liquid Limit %	114.10
Plastic Limit %	34.00
Plasticity Index %	80.10
Liquidity Index	0.43

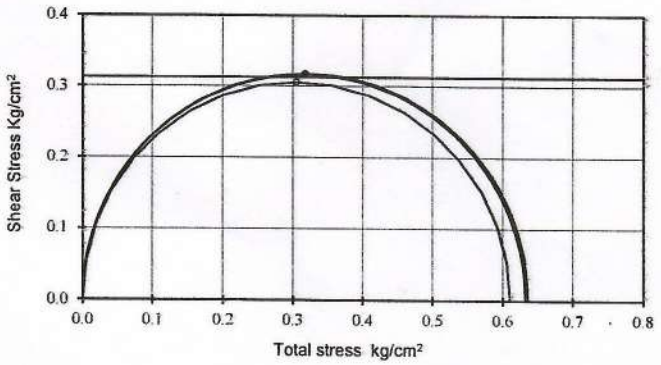


Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.610	0.305
Specimen 2	0.632	0.316
Specimen 3	0.636	0.318

Results

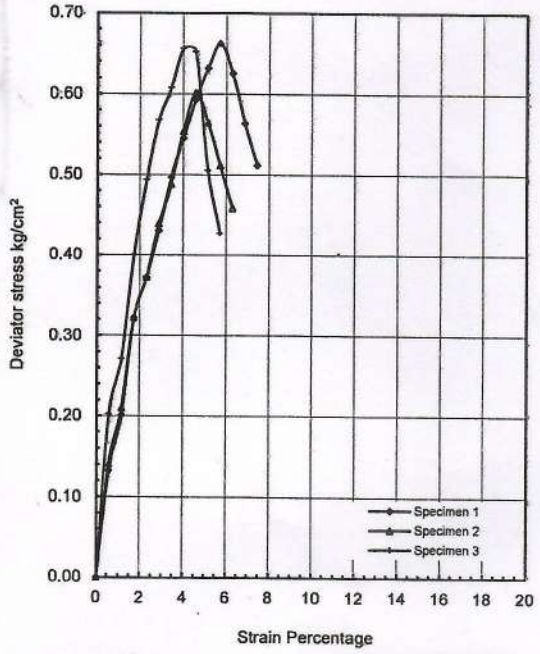
Unconfined compression strength q_u	0.626 kg/cm²
Undrained Cohesion c_u	0.313 kg/cm²
Secant Modulus (undrained)	23.26 kg/cm²



Unconfined Compression Strength Test UCC on soil sample

Project:

Tenement Building for TNSCB, Dr. Thomas Road, off South West Boag Road, Chennai



Date of Test	01-Apr-22
Borehole	BH/5
Depth	7.50m

Soil

Dark grey silty clay

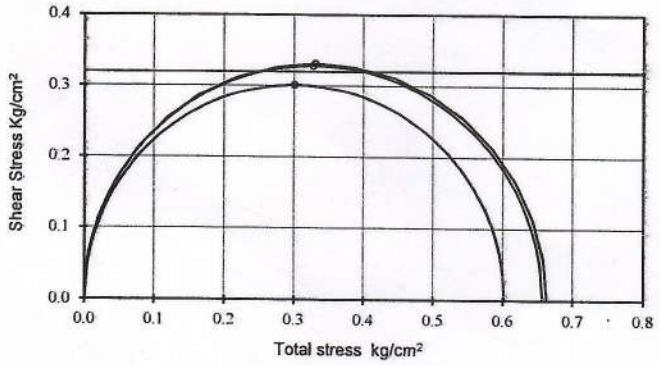
Insitu bulk density	1.572 gm/cc
Insitu Dry Density	0.935 gm/cc
Water Content	68.13 %
Liquid Limit %	121.70
Plastic Limit %	33.40
Plasticity Index %	88.30
Liquidity Index	0.39

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.662	0.331
Specimen 2	0.602	0.301
Specimen 3	0.656	0.328

Results

Unconfined compression strength q_u	0.640 kg/cm²
Undrained Cohesion c_u	0.320 kg/cm²
Secant Modulus (undrained)	20.11 kg/cm²



SUMMARY OF LABORATORY TEST RESULTS

Project: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai**
Borehole Nos: **BH/1, BH/2, BH/3, BH/4, BH/5 and BH/6**

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation
Ground Water Table: 1.50m to 1.60m (Boreholes)

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Differential Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/1															
0.75	DS	Reddish brown sandy silty clay with stones			11.3												
1.50	DS	Brownish grey clayey silty fine to medium sand with gravel and stones		SC-SP	18.0							22.1	6.1	20.5	25.7	25.6	
2.25	SPT	Brownish grey sandy silty clay	10	SC-CH	27.7	53.1	20.1	33.0	0.230	60.0							
3.00	SPT	Light greyish brown fine to medium sand	18	SP	17.3							2.8	7.1	60.0	22.1	8.0	
3.75	SPT	Light greyish brown fine to medium sand	22	SP	14.8							2.8	4.3	49.4	35.9	7.6	
4.50	SPT	Greyish sandy silty clay	5	SC-CI	38.9	47.9	19.2	28.7	0.686	50.0							
5.50	SPT	Greyish silty clay with fine sand	3		41.6												
6.50	SPT	Greyish silty clay with fine sand	3	CH	47.1	57.2	21.0	36.2	0.721	41.6							
7.50	SPT	Greyish silty clay with fine sand and mica	2	CH	48.2	62.3	24.4	37.9	0.628								
8.50	SPT	Greyish silty clay with fine sand and mica	3	CH	56.8	66.8	25.7	41.1	0.757								
10.00	SPT	Greyish clayey silty fine to medium sand with brown patches	6	SC-SP	18.2								3.4	25.9	55.3	15.4	
11.50	SPT	Greyish clayey silty fine to medium sand with brown patches	7	SC-SP	18.4								3.0	24.1	56.9	16.0	
13.00	SPT	Light grey silty fine to medium sand with brown patches with clay	20	SC-SM	16.3							1.9	4.2	24.3	46.1	23.5	
14.50	SPT	Light grey and brown silty fine to medium sand with stones and clay	25	SC-SM	16.6							17.0	3.8	23.1	38.4	17.7	
16.00	SPT	Light grey and brown sandy silty clay with weathered shale	>100		14.6												
17.10-18.10		Light greyish brown and light grey severely jointed weathered shale															

Project: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai** SHEET 2 OF 6

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
18.10-19.10		Light greyish brown and light grey severely jointed weathered shale															
19.10-20.10		Light greyish brown and light grey severely jointed weathered shale															
		BOREHOLE BH/2															
0.50-0.75	DS	Reddish brown and light grey clayey silty fine to medium sand with brick pieces			9.4												
1.50	SPT	Brownish and grey sandy silty clay/ clayey silty fine to medium sand	0	SC-CI	37.1	44.8	18.3	26.5	0.709	21.0							
2.25	SPT	Brownish grey sandy silty clay (organic)	1	SC-CH	61.5	91.7	35.9	55.8	0.459	12.5							
3.00	SPT	Greyish fine to medium sand with brown patches	10	SP	26.9							0.9	2.5	67.6	24.5	4.5	
3.75	SPT	Greyish fine to medium sand with brown patches	12	SP	27.5							1.6	6.1	44.7	42.0	5.6	
5.50	SPT	Dark grey silty clay	1	CH	47.7	67.8	23.5	44.3	0.546								
6.50	SPT	Dark grey silty clay	2		47.6												
7.50	SPT	Dark grey silty clay	2	CH	56.8	83.3	26.8	56.5	0.531								
8.50	SPT	Greyish silty clay with fine sand	2	SC-CH	55.8	59.5	20.0	39.5	0.906								
10.00	SPT	Greyish dirty fine to medium sand	11	SP	16.9							1.3	4.7	23.0	58.8	12.2	
11.50	SPT	Greyish dirty fine to medium sand	13	SP	17.2							0.4	5.3	23.4	59.2	11.7	
13.00	SPT	Greyish clayey fine to medium sand	9	SC-SP	15.0							0.3	9.6	38.6	32.2	19.3	
14.50	SPT	Light grey clayey silty fine to medium sand	11	SC-SP	15.8							1.3	5.8	24.9	50.0	18.0	
16.00	SPT	Light grey and brown sandy silty clay with small stones	>100		16.4												
16.50-17.50		Brownish and light grey severly jointed weathered shale with black patches															
17.50-18.50		Brownish and light grey severly jointed weathered shale with black patches															
18.50-19.50		Brownish and light grey severly jointed weathered shale with black patches															
19.50-20.50		Dark greenish grey weathered jointed rock (siltstone)															

Project: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai** SHEET 3 OF 6

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/3															
0.50-0.75		Greyish brown clayey silty fine to medium sand			12.9												
1.50	SPT	Greyish brown clayey silty sand/sandy silty clay	6	SC-CL	25.6	34.9	15.9	19.0	0.511	7.6							
2.25	SPT	Greyish brown clayey silty sand/sandy silty clay	6	SC-CL	20.0	27.9	0.0	27.9	0.717	30.0							
3.00	SPT	Light greyish brown clayey silty fine to medium sand	9	SC-SP	21.0							0.2	0.8	30.0	50.3	18.7	
3.75	SPT	Light greyish brown clayey silty fine to medium sand	8	SC-CL	21.4	29.8	0.0	29.8	0.718	15.0							
4.50	SPT	Light greyish brown medium sand with fine sand	16	SP	17.3							2.7	5.4	57.2	29.4	5.3	
5.50	SPT	Light greyish brown medium sand with fine sand	18	SP	18.1								1.5	81.3	14.4	2.8	
6.50	SPT	Light greyish brown medium sand with fine sand	23	SP	18.8								3.7	87.3	7.3	1.7	
7.50	SPT	Dark grey silty clay with mica	3	CH	68.5	84.8	22.7	62.1	0.738								
8.50	UDS	Greyish silty clay		CH	68.4	114.1	34.0	80.1	0.429								
9.00	SPT	Greyish silty clay with organic patches	3		62.4												
10.00	SPT	Greyish silty clay with medium sand	2		22.7												
11.50	SPT	Greyish dirty fine to medium sand	11	SP	17.5							0.5	5.1	27.4	54.1	12.9	
13.00	SPT	Greyish brown clayey fine to medium sand	14	SP	15.0							3.6	7.5	42.0	35.5	11.4	
14.50	SPT	Greyish brown clayey fine to medium sand	15		15.7												
16.00	SPT	Light grey and brown sandy silty clay with small stones	>100		24.0												
16.70-17.70		Brownish severely jointed weathered claystone with black interface															
17.70-18.70		Brownish severely jointed weathered claystone / shale with black interface															
18.70-19.70		Brownish severely jointed weathered claystone / shale with black interface															
19.70-20.70		Brownish severely jointed weathered claystone / shale with black interface															

Project: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai** **SHEET 4 OF 6**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
4.00		**BOREHOLE BH/4**															
0.50-0.75	DS	Greyish brown sandy silty clay			14.6												
1.50	SPT	Greyish sandy silty clay with brown patches	2	SC-CH	38.8	68.3	24.3	44.0	0.330	14.2							
2.25	SPT	Greyish brown clayey silty fine to medium sand	3	SC-CL	19.7	25.3	LSL-6.8%			9.0							
3.00	SPT	Light greyiish brown clayey fine to medium sand	5	SC-SP	16.2							0.5	1.9	43.0	41.4	13.2	
3.75	SPT	Light greyiish brown clayey fine to medium sand	10	SC-SP	16.5								2.1	45.2	40.5	12.2	
4.50	SPT	Light greyiish brown fine to medium sand	13	SP	19.1								0.9	54.9	39.2	5.0	
5.50	SPT	Light greyiish brown fine to medium sand	17	SP	16.5							1.0	10.3	57.6	28.0	3.1	
6.50	SPT	Dark grey silty clay with mica and sand patches	2	CH	60.1	80.9	22.7	58.2	0.643								
8.50	SPT	Greyish clayey silty fine sand with brown patches	6	SC-CL	23.7	23.9	LSL-2.1%										
10.00	SPT	Greyish soft sandy silty clay / clayey sand	1		28.0												
11.50	SPT	Greyish clayey silty fine to medium sand with brown patches	2	SC-SP	21.6							0.6	4.3	28.3	45.7	21.1	
13.00	SPT	Greyish clayey silty fine to medium sand with brown patches	3	SC-SP	19.5							0.0	5.6	35.1	42.0	17.3	
14.50	SPT	Light grey and brown sandy silty clay	74	SC-CH	16.8	69.5	21.9	47.6	<0.00								
16.00	SPT	Brownish weathered claystone	>100		15.2												
16.80-17.50		Brownish severely jointed weathered shale with light grey & black patches															
17.50-18.50		Light grey and brown severely jointed weathered shale with black patches															
18.50-19.50		Light grey and brown severely jointed weathered shale with black patches															
19.50-20.50		Light grey and brown severely jointed shale															
20.50-21.50		Light grey and brown severely jointed shale															

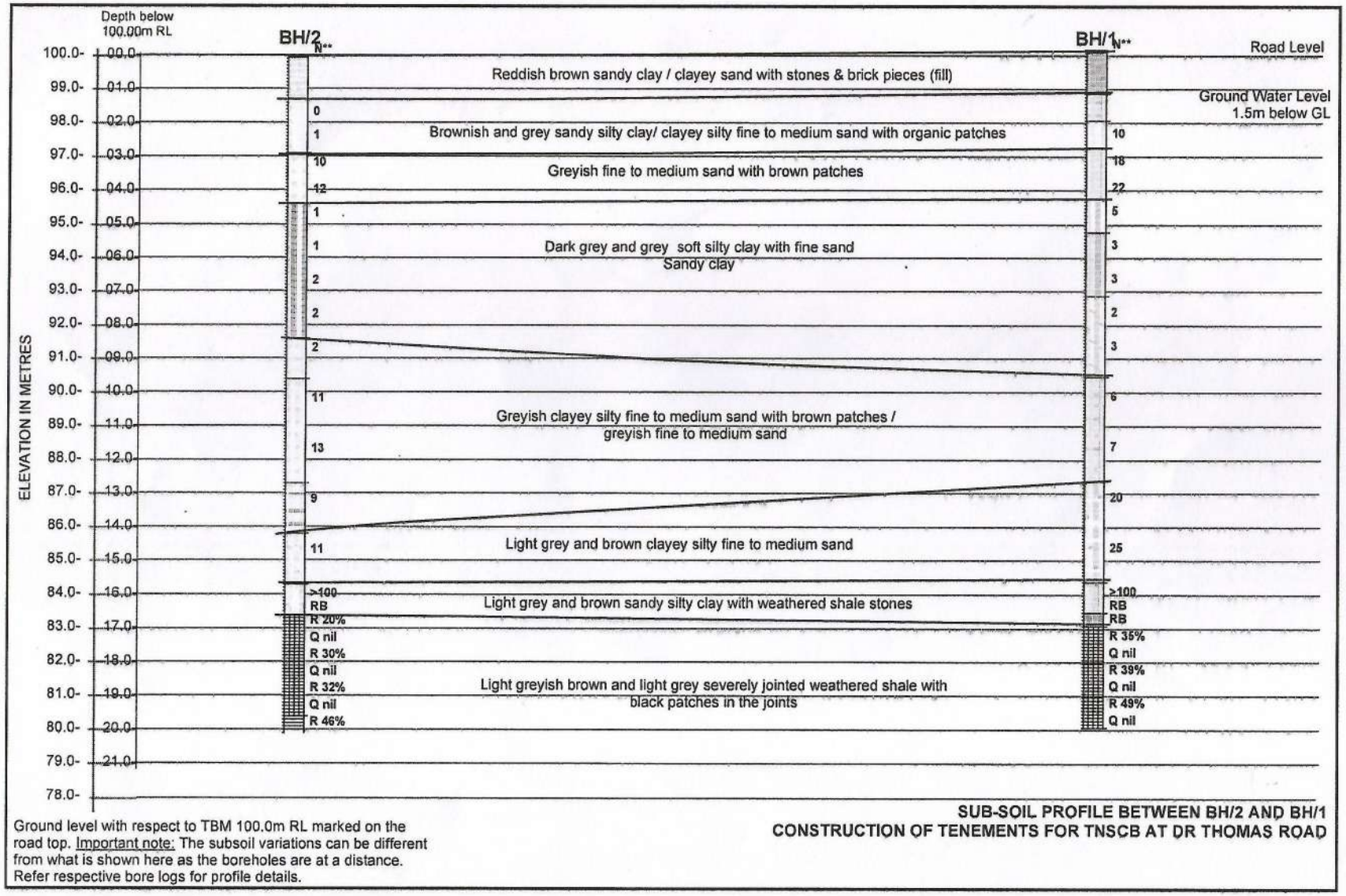
Project: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai** **SHEET 5 OF 6**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/5															
0.50-0.75	DS	Greyish brown fine to medium sand with brick pieces			11.1												
1.50	SPT	Brownish grey clayey silty fine to medium sand	2	SC-CL	22.9	25.2	LSL-3.7%			8.3							
2.25	SPT	Brownish and grey clayey silty fine sand with medium sand	3	SC-CL	22.3	29.4	LSL-7.1%			12.5							
3.00	SPT	TOP: Brownish grey fine sandy silty clay	10	SC-CH	25.0	51.5	18.8	32.7	0.190	25.0							
		BOT: Brownish grey clayey silty fine sand		SC-CP	19.0							0.0	0.3	7.8	74.2	17.7	
3.75	SPT	Light greyish brown medium sand with fine sand	12	SP	15.9							0.0	7.2	60.5	24.0	8.3	
4.50	SPT	Light greyish brown medium sand with fine sand	14	SP	20.9							2.1	2.5	65.0	26.0	4.4	
5.50	SPT	Light greyish brown fine to medium sand	15		19.4												
6.50	SPT	Light greyish brown fine to medium sand	17	SP	20.9							0.0	0.2	43.2	51.5	5.1	
7.50	UDS	Dark grey silty clay with mica		CH	70.4	121.7	33.4	88.3	0.419								
8.00	SPT	Greyish silty clay with mica	3		56.1												
9.00	SPT	Greyish silty clay with mica	3	CH	67.2	91.6	26.5	65.1	0.625								
10.00	SPT	Greyish silty clay with mica and brown sand patches	2	CH	55.8	77.0	21.8	55.2	0.616								
11.50	SPT	Greyish clayey silty fine to medium sand with sandy clay patches	5	SC-CL	21.3	25.9	LSL-4.4%										
13.00	SPT	Greyish and brownish clayey silty fine to medium sand	5		17.5												
14.50	SPT	Brownish and light grey sandy silty clay	76		13.9												
16.00	SPT	Light grey and brown weathered claystone	>100		7.7												
17.80-18.80		Brownish severely jointed weathered claystone with black patches															
18.80-19.80		Brownish and light grey severely jointed weathered shale with black patches															
19.80-20.80		Brownish and light grey severely jointed weathered shale															
20.80-21.80		Brownish and light grey severely jointed weathered shale with black patches															

Project: **Tenement Building for TNSCB, Dr. Thomas Road off South Boag Road, Chennai** **SHEET 6 OF 6**

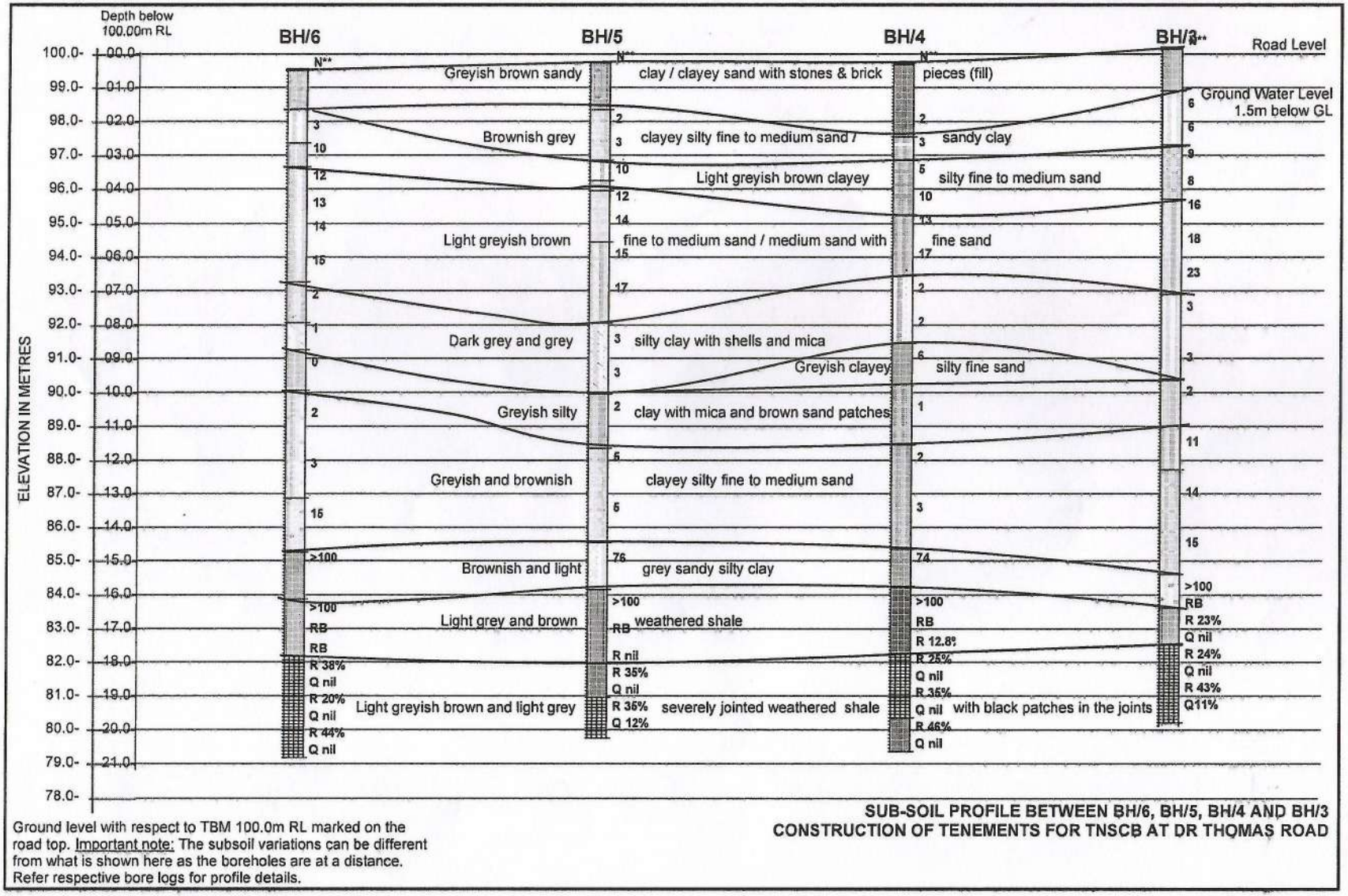
Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/6															
GL-0.75	DS	Greyish brown fine to medium sand with concrete pieces			7.7												
1.50	SPT	Brownish grey sandy silty clay	3	SC-CH	44.7	54.9	24.4	30.5	0.666	15.3							
2.25	SPT	Light greyish brown fine sandy silty clay	10	SC	22.4								0.0	2.3	61.7	36.0	
3.00	SPT	Light greyish brown fine sand with medium sand	12	SP	21.9								0.1	18.5	70.8	10.6	
3.75	SPT	Light greyish brown fine sand with medium sand	13	SP	20.5								0.2	28.4	64.3	7.1	
4.50	SPT	Light greyish brown fine sand with medium sand	14	SP	18.6							0.9	0.9	28.4	61.0	8.8	
5.50	SPT	Light greyish brown fine sand with medium sand	15	SP	17.8								0.5	27.2	62.6	9.7	
6.50	SPT	Dark grey silty clay with mica	2	CH	71.9	109.5	29.8	79.7	0.528								
7.50	SPT	Greyish silty clay with mica	1	CH	56.0	80.2	26.7	53.5	0.548								
8.50	SPT	Greyish clayey silty fine sand	0		36.7												
10.00	SPT	Greyish clayey silty fine to medium sand with brown patches	2	SC-CL	31.6	27.5	LSL-2.1%										
11.50	SPT	Greyish clayey silty fine to medium sand with brown patches	3	SC-CL	22.6	25.2	LSL-3.9%										
13.00	SPT	Light grey and brown clayey silty fine to medium sand with stones	15	SC-SP	14.6							10.2	5.8	30.4	35.5	18.1	
14.50	SPT	Light grey and brown clayey silty fine to coarse sand with weathered shale	>100	GC-SP	20.5							39.4	18.8	11.3	10.5	20.0	
16.00	SPT	Light grey and yellowish brown sandy silty clay with stones	>100		21.6												
17.40-18.40		Light grey and brown severely jointed weathered shale with black patches															
18.40-19.40		Light greyish brown severely jointed weathered shale															
19.40-20.40		Light grey and brown severely jointed weathered shale with black patches															
20.40-21.40		Light grey and brown severely jointed weathered shale with black patches															

ANNEXURE - 3



Ground level with respect to TBM 100.0m RL marked on the road top. Important note: The subsoil variations can be different from what is shown here as the boreholes are at a distance. Refer respective bore logs for profile details.

SUB-SOIL PROFILE BETWEEN BH/2 AND BH/1
CONSTRUCTION OF TENEMENTS FOR TNSCB AT DR THOMAS ROAD



Ground level with respect to TBM 100.0m RL marked on the road top. Important note: The subsoil variations can be different from what is shown here as the boreholes are at a distance. Refer respective bore logs for profile details.

SUB-SOIL PROFILE BETWEEN BH/6, BH/5, BH/4 AND BH/3
CONSTRUCTION OF TENEMENTS FOR TNSCB AT DR THOMAS ROAD

Load carrying capacity of piles **Reference BH 2**

APPENDIX A

Soil Description	Layers		Thickness	SPT N value	γ'	Relative Density/Consitency	Eff. over burden pressure	N'	N''	k	α	ϕ	δ	C	Ultimate unit skin friction
	from(m)	to(m)	(m)		kN/m3		kN/m2					Degree	Degree	kPa	kPa
Fill	0.00	1.00	1.0		5.0	Fill	5.00								
	1.00	1.30	0.3		5.0	Fill	6.50								
Clay	1.30	1.50	0.2	0	4.0	Very soft	7.30	0	0		1.00			10	10.00
	1.50	2.90	1.4	1	4.0	Very soft	12.90	1	1		1.00			10	10.00
Sand	2.90	3.00	0.1	10	7.0	Medium dense	13.60	27	21	1.2		34	22.7		6.81
	3.00	4.40	1.4	12	7.0	Medium dense	23.40	25	20	1.15		33	22.0		10.87
Clay	4.40	4.50	0.1	1	4.0	Very soft	23.80	1	1		1.00			10	10.00
	4.50	5.50	1	1	4.0	Very soft	27.80	1	1		1.00			10	10.00
	5.50	6.50	1	2	4.0	Very soft	31.80	2	2		1.00			10	10.00
	6.50	8.40	1.9	2	4.0	Very soft	39.40	2	2		1.00			10	10.00
	8.40	9.60	1.2	2	4.0	Very soft	44.20	2	2		1.00			10	10.00
Sand	9.60	10.00	0.4	11	7.0	Medium dense	47.00	16	16	1.1		32	21.3		20.18
	10.00	12.70	2.7	13	7.0	Medium dense	65.90	16	16	1.1		32	21.3		28.30
	12.70	14.20	1.5	9	5.0	Loose	73.40	11	11	1		30	20.0		26.70
	14.20	15.70	1.5	11	7.0	Medium dense	83.90	12	12	1.05		31	20.7		33.21
Clay	15.70	16.60	0.9	100	10.0	Hard	92.90	100	100		0.25			200.0	50.00
Weathered Shale Sediments	16.60	17.00	0.4	100	12.0	Very weak					0.25			550.0	137.50
Weathered Shale	17.00	18.00	1	100	12.0	Very weak					0.25			1000	250.00

Pile Diameter (m)	0.5	0.6	0.75
C/S Area (sq.m)	0.196	0.283	0.442
Bearing capacity factor Nc	9	9	9
Cohesion at pile tip kPa	1000	1000	1000
Ultimate End bearing capacity of the pile (kN)	1767	2545	3976
Safe End bearing capacity of the pile (kN)	707	1018	1590
Total Negative Skin friction (kN)	-107	-128	-160
Total Positive skin friction (kN)	786	943	1179
Positive skin friction with FOS (kN)	314	377	471
Safe Bearing Capacity of the pile (kN)	914	1267	1902
Safe Bearing Capacity of the pile (T)	**91**	**127**	**190**
Weight of pile, (kN)	94	136	212
Uplift Capacity of pile (kN)	291	371	507
Uplift Capacity of pile (T)	**29**	**37**	**51**

Note: Pile capacities are estimated based on the procedure suggested in IS:2911 (Part1/Sec 2)-2010 with suitable modifications and Cole and Stroud recommendations.

ESTIMATION OF SAFE COMPRESSION CAPACITY OF BORED CAST-IN-SITU PILES

Appendix B

Lateral Load Carrying capacity of the pile (IS 2911)

Project: Thomas Road
Loading Type = Normal
Type of pile = Bored cast-in-situ piles
Grade of Concrete = M25
fck = 25 N/mm2
Elastic modulus of concrete, Ec = 5000 √fck Mpa
Coefficient of modulus variation = 25 MN/m3
Allowable deflection at pile head = 5 mm

	Fixed head	Free head
Diameter of the pile (cm)	75	75
Characteristic strength of concrete (MPa)	25	25
Characteristic strength of concrete (kg/sq.cm)	255	255
E (MPa)	25000	25000
E (kg/sq.cm)	250000	250000
I (cm^4)	1553155.5	1553155.5
ηh (kN/m^3) x 10^3	0.25	0.25
ηh (kg/cm^3) *	0.025	0.025
T (cm)	434.75	434.75
L1	0.00	0.00
Lf/T **	2.20	1.95
Lf (cm)	956.46	847.77
Y (permissible deflection) cm	0.50	0.50
H (kg)	2662.62	955.90
H in kN	26.63	9.56
H in tons	2.66	0.96

Pile Dia (m)	Lateral Load Capacity of the piles (kN)		Lateral Load Capacity of the piles (tons)	
	Fixed Head	Free Head	Fixed Head	Free Head
0.5	13.92	5	1.39	0.50
0.6	18.63	6.69	1.86	0.67
0.75	26.63	9.56	2.66	0.96

**Lf/T, ratio between depth of fixity and T read from IS 2911 corresponding to the ratio L1/T, L1 being the free standing length
*ηh , modulus of subgrade reaction as per IS 2911

NOTE: The total depth of fixity below the pile head is sum of cantilevel length L1 and Lf



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