JAHANGIRNAGAR UNIVERSITY

REPORT ON SUB-SOIL INVESTIGATION FOR THE CONSTRUCTION OF THE PROPOSED SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT AT JAHANGIRNAGAR UNIVERSITY, SAVAR, DHAKA.

AUGUST - 2022

COMPILED BY :

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Notations and Symbols

BH	=	Borehole
D_f	=	Depth of the foundation
C	=	Cohesion
N_f	=	Field SPT value
F.S.	=	Factor of Safety
D	=	Disturbed sample
EGL	=	Existing ground level
f_{sa}	=	Allowable value of skin friction
q_{pa}	=	Allowable value of pile point bearing capacity
GWT	=	Ground water table
q_a	=	Allowable bearing capacity
q_u	=	Unconfined compression strength value
SPT	=	Standard penetration test
	=	Clay
	=	Silt
	=	Sand

CHAPTER-1: GENERAL

1.1. INTRODUCTION

This soil test report has been prepared on the basis of an agreement in between the authority of the proposed six storied social science faculty building with one basement of **Jahangirnagar University** at Savar, Dhaka and the **"Creative Soil Investigation"**, a subsurface investigation firm in Dhaka. On the basis of this agreement, a detail subsoil investigation programme has been undertaken and carried out by the **"Creative Soil Investigation"**, during the month of **August 2022**. The subsurface investigation work includes execution of nine borings extending to a variable depth of 60'-0" to 100'-0", performance of the required field and the laboratory tests, evaluation of the bearing capacity and finally recommending for the safe and the appropriate type of foundation suited to the subsoil conditions. The information, so far have been obtained from carrying out the above subsurface investigation programme, are provided in detail, in the following articles.

1.2. LOCATION

The construction project of the proposed six storied social science faculty building with one basement of **Jahangirnagar University** situates at Jahangirnagar University, Savar, Dhaka.

1.3. OBJECTIVES

The purposes of subsoil investigation programme are to obtain the following information.

I. To stratify the formation of soil.

II. To record the level of the ground water.

III. To evaluate the safe bearing capacities of the foundation at the different layers, encountered at the different Borehole positions.

IV. Finally, to suggest for the safe and appropriate type of foundation for the prevailing subsoil condition.

1.4. SCOPE OF THE WORK

Nine borings, out of which six extending to the depth of 60'-0", two to the depth of 80'-0" and the remaining one to the depth of 100'-0", have been selected and executed as per direction of the authority. The method of wash boring was followed in drilling the boreholes after driving a 0'-4" diameter casing pipe. The soil samples, in the disturbed state, usually have been extracted from each of the 5'-0" depth of investigation in the case of each borehole using the split spoon sampler along with the performance of the Standard Penetration Test (SPT). The Standard Penetration Test (SPT) includes dropping of a hammer weighing 140 lbs. and falling freely over a constant height of 30" along the drill pipe in order to drive the sampler attached at the end of the same. The number of the blows necessary to produce the penetration was recorded in three different stages, each at six inches of interval. The number of the blows required in the 2nd & 3rd six inches of the penetration of the sampler is called the SPT value and is represented by `N'. The above `N' values are shown in the bore-log chart against the respective interval of the depth.

1.5. DISTURBED SOIL SAMPLES

The disturbed soil samples are generally collected during the operation of Standard Penetration Test. These samples are those in which the natural soil structure gets disturbed during sampling. However, these samples represent the composition and the mineral content of the soil. The soil samples, in the disturbed state, usually have been extracted from each of the 5'-0" depth of investigation in the case of each borehole using the split spoon sampler along with the performance of the Standard Penetration Test (SPT). The soil samples were collected by split spoon sampler and duly preserved in polythene bags and properly leveled with job designation and date.

1.6. STANDARD PENETRATION TEST (SPT)

The Standard Penetration Test (SPT) is a commonly used as an in situ test in order to determine the consistency / Relative density of the investigated site within the shortest possible period of time. The test includes dropping of a hammer weighing 140 lbs (63.5 kg) and falling freely over a constant height of 30" (76cm) along the drill pipe in order to

drive the sampler attached at the end of the same. The number of the Blows, necessary to produce the penetration was recorded in three different stages each at six inches of interval. The number of the Blows required in the 2nd and 3rd six inches of the penetration of the sampler is called the SPT value (N) and is represented by "N". The above 'N' values are shown in the Bore-log chart against the respective interval of the depth, in the case of each Boring.

The term consistency of the cohesive soil is generally used on the basis of the SPT values (N) in the following way.

N	...	...	0-2	...	...	Very Soft
N	...	...	2-4	...	...	Soft
N	...	...	4-8	...	...	Medium
N	...	...	8-15	...	...	Stiff
N	...	...	15-30	...	...	Very Stiff
N	...	...	30-50	...	...	Hard
N	...	...	>50	...	...	Very Hard

The term relative density for the non-cohesive soil is based on the SPT values (N) in the following way.

N	...	...	0-4	...	...	Very loose
N	...	...	4-10	...	...	Loose
N	...	...	10-30	...	...	Medium dense
N	...	...	30-50	...	...	Dense
N	...	...	>50	...	...	Very dense

1.7. EMPIRICAL RELATIONSHIP OF VARIOUS SOIL PARAMETERS ON THE BASIS OF SPT (N)

a. Empirical Relationships of ϕ, D_r & γ of Non-cohesive Soil on the basis of SPT (N) Value

The empirical correlations in between N (SPT value after necessary corrections) and various soil parameters such as angle on internal friction (φ), unit weight (γ) & relative density (D_r) for cohesive less soils may be obtained from the Table values (Ref: Table No: 3-2), Page No- 100, Foundation analysis & Design by J.E. Bowles, 3rd edition).

Table 1.1. Empirical values for ϕ D_r and unit weight of granular soils based on the Standard Penetration number with corrections for depth and for fine saturated sands.

Description	Very loose	Loose	Medium	Dense	Very dense
Relative density D_r*	0 – 0.15	0.15 – 0.35	0.35 – 0.65	0.65 – 0.85	0.85 – 1.00
Standard penetration no. N	5-10	8-15	10-40	20-70	> 35
Approx. angle of internal fiction ϕ †	25 – 30°	27-32°	30-35°	35-40°	38-43°
Approx. range of moist unit weight γ, pcf (kN/m^3)	70-100 ‡ (11-16)	90 – 115 (14 – 18)	110-130 (17-22)	110-140 (17-22)	130-150 (20-23)

b. Empirical Relationships of q_u, & Consistency of Cohesive soil on the basis of standard penetration number

The empirical correlations in between N (SPT value & various soil parameters for cohesive soil such as consistency & q_u may be obtained from the Table values (Ref: Table No: 3-3, Page No- 101, Foundation analysis & Design by J.E. Bowles, 3rd edition).

Table 1.2. Empirical values for q_u and consistency of cohesive soils based on the standard penetration number.

Consistency	Very soft	Soft	Medium	stiff	Very stiff	Hard
q_u, ksf	0 – 0.5	0.5 – 1.0	1.0 – 2.0	2.0 – 4.0	4.0 – 8.0	
(k Pa)	(25)	(50)	(100)	(200)	(400)	
N, standard penetration resistance	0 – 2	2 – 4	4 – 8	8 – 16	16 – 32	
γsat, pcf (kN/m^3)	100–120 (16-19)		110 – 130 (17-20)		120 – 140 (19-22)	

1.9. LABORATORY SOIL TESTS

Al laboratory tests were conducted on soil samples collected either in the disturbed or in the undisturbed state. All tests were done as per ASTM procedures, are as follow:

a. Particle Size Distribution

The object of grain size analysis is to determine the size of the soil grains, and the percentage by weight of soil particles of different particles size, comprising a soil sample. The process consists of either sieve analysis or hydrometer analysis or both. The hydrometer analysis is adopted for sample passing sieve No. 200. For hydrometer analysis, 50 gm of the oven dry sample is thoroughly mixed with required quantity of water in a calibrated glass cylinder. In order to avoid flocculation, a little dispersing agent is adding. The density of the suspension is measured at specified time intervals, by means of a hydrometer or special design. At any particular time the size of largest particle remounting in suspension at the level of the hydrometer can be computed by means of Stocks law, whereas the weight of the particles finer then size, can be computed from the density of the suspension at the sample level. The mixture is washed through U.S standard sieve no. 200 and the fraction retained are dried. The friction retained of each sieve is weighted for calculation of the percentage of different friction. The results are represented by cumulative curves plotted on semi logarithmic graph paper.

b. Specific Gravity Test

The specific Gravity of a solid defined as the rate of the unit weight of the solid in air to the unit weight of water. To determine the specific gravity of soil sample, 25 grams of oven dried soil sample is thoroughly pulverized and is placed in a calibrated pycnometer. Water is poured inside the pycnometer until its top is slightly bellows the calibrated mark. The mixture is then belled thoroughly in order to eliminate the air baubles. More water is then added to mixture till overnight, the temperature is then recorded and the bottle is weighted. The specific gravity Gs is given by:

$$G_s = (G_t \times W_s) \div (Ws \square W_1 \square W_2)$$

Where,

G_t = Specific gravity of water at T^oC.

W_s= The weight of over dry soil (25 gms)

W_1= Weight of flask + soil + water

W_2= Weight of flask + water

c. Direct Shear Test

Direct Shear test can be Performed for both cohesion less & cohesive soil to determine shear strength, angle of internal friction, cohesion c, volume change etc. The test is done in a direct shear machine which consists of a normal loading device, shearing device having diameter 6.35 cm and height 2.54 cm, circular box, etc. The rate on shearing displacement of sample approximately 10 mm per minute is determined. The results of a direct shear test on a cohesion less & cohesive soil can be presented in a summary table & by stress-strain curve. A stress- strain curve normally consists of shear stress; various shear displacement for both the undisturbed and the remolded tests under a specified normal load. The normal load usually varies from 1/3 kg/cm^2 to 1 kg/cm^2. Another curve of normal stress verses shearing stress will give angle of internal friction and cohesion for cohesive soil.

d. Laboratory Tests

The following soil tests have been done in the laboratory:

i.	Grain size analysis	…	…	…	41 Nos.
ii.	Specific gravity	…	…	…	41 Nos.
iii.	Atterberg Limit	…	…	…	18 Nos.
iv.	Direct shear	…	…	…	8 Nos.

The Grain size analysis and the specific gravity tests have been carried out in order to classify/stratify the subsoil formation of the investigated site. The atterberg limit test help to classify/grouping of the investigated soil. Moreover, the atterberg limit tests determine the consistency of soil. The Direct shear tests serve data on the shear parameters such as the cohesion and the angle of the internal friction for both of the cohesive and the non-cohesive group of soil.

CHAPTER-2: GEOTECHNICAL PROPERTIES

2.1. INTRODUCTION

The Geo-technical properties i.e. the physical as well as the engineering properties of the investigated soil have been determined on the basis of executing nine nos. of 60'-0" to 100'-0" deep borings and subsequent performance of the laboratory tests. These are discussed in detail in the following subheadings.

2.2. PHYSICAL PROPERTIES

The physical properties i.e. the colour, odour and texture and the general index properties such as specific gravity and plasticity have been determined by visual inspection and from the subsequent performance of the certain laboratory tests. These may be summarized as follows:

a. Subsoil stratification

The top layer of the soil, as investigated existing roughly to the depth of 17'-0"/ 18'-0" (BH-1, BH-2, BH-3, BH- 6 & BH-7) 23'-0" (BH-4, BH-5 & BH-9) to 28'-0" (BH-8) is plastic by nature consisting of pale Yellow, pale Red to reddish Yellow silty clay. The underlying layers of soil existing roughly to the depth of 37'-0"/38'-0" (BH-2, BH-3, BH-5, BH-6, BH-7, BH-8 & BH-9), 43'-0" (BH-1 & BH-4) are slightly plastic by nature consisting of pale Yellow, pale Red to reddish Yellow clayey silt. Further below, a layer of pale Yellow, pale Red to reddish Yellow sandy silt exists roughly up to the depth of 43'-0" (BH-3 & BH-5), 47'-0"/48'-0" (BH-7 & BH-8) to 52'-0" (BH-1) measured from the EGL. The subsequent layers of soil existing to the depth of the investigation are non-plastic by nature consisting of pale Red to reddish Yellow and Yellow very fine sand with little/trace silt (Ref: Bore-logs).

b. Consistency/Relative density

The consistency of the top layer of silty clay existing roughly to the depth of 6'-6" to 8'-0", particularly at and around BH-1, BH-2, BH-3, BH-4, BH-6 & BH-7) is usually very soft. Further below, the consistency of the layer of silty clay existing roughly to the depth of 17'-0"/18'-0" (BH-1, BH-2, BH-3, BH-6 & BH-7), 23'-0" (BH-4) gradually

increases to medium & stiff. The consistency of the top layer of silty clay existing roughly to the depth of 23'-0" (BH-5, BH-8 & BH-9) is usually stiff & very stiff. Further below, the consistency of the layer of clayey silt existing roughly to the depth of 37'-0"/38'-0" (BH-2, BH-5, BH-6, BH-7 & BH-8), 43'-0" (BH-3) to 47'-0" (BH-1) usually varies from medium to stiff and occasionally vary stiff. The subsequent deep layers of non-plastic soil is sandy silt and fine sand existing roughly to the depth of the investigation generally have been observed in a medium to dense state.

c. Specific Gravity

The Specific gravity of the investigated soil usually varies from 2.60 to 2.68.

2.3. ENGINEERING PROPERTIES

The engineering properties of the investigated layers of soil, particularly, the values of the angle of the Internal friction, obtained from the performance of the Direct shear tests, vary from 20.0^{o} to 33.4^{o}.

2.4. GEOLOGY OF THE AREA

The project area situates in the middle part of the Bengal Fore deep, which is surrounded on its north by the Shilling Plateau in Assam in India and on its west side by the Rajmahal Hills in India. The eastern limits of the Bengal Fore deep are the Tripura Hills to the east and the Chittagong Hills to the south- east. The Bengal Fore deep is floored with Quaternary sediments deposited by the rivers of the Brahammaputra, the Meghna and their numerous associated streams and distributaries. The Bengal Basin is subsiding owing mainly to compaction of the recent sediments and is possibly due to structural down warping.

Concerning tectonics and seism city, Bangladesh situates in one of the most active tectonic region of the world where three plates - The Indian plate, the Tibet and the Burmese Sub plates are colliding and thrusting against each other. Consequently, tremendous seismic activities have been resulted in the north and east of Bangladesh and caused some major earthquakes within and outside the country. As the earthquake epicenter in Assam in India is not far from Bangladesh, it is suggested to provide sufficient margin of safety, in designing the structure.

CHAPTER-3: ANALYSIS OF THE BEARING CAPACITY

3.1. INTRODUCTION

The Bearing capacities of the foundation including both of the shallow and the deep have been evaluated for the existing subsoil condition. In doing so, the overall field SPT values have been corrected due to the effect of the overburden pressure at the different layers of investigation in the case of each borehole.

3.2. CORRECTION OF THE FIELD SPT VALUES

The overall field SPT values (N_f) have been corrected due to the effect of the Overburden pressure at the different layers of investigation in the case of each Borehole. The above corrections have been done according to the following equations as suggested by Bazaraa (1967) (Ref: Table No: 3-2, Page No-99, Foundation analysis & Design by J.E. Bowles, 3rd edition).

$$N' = \frac{4N}{1+\chi_{1_1} P_o} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{For } P_o \leq 75 \text{ k Pa (1.5 ksf),}$$

$$N' = \frac{4N}{3.25+\chi_2 P_o} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{For } P_o > 75 \text{ kPa,}$$

Where,

N	=	field SPT value.
N′	=	Corrected value of the field SPT due to overburden pressure.
$\chi_{_1}$	=	0.04 for SI units; = 2.0 for Fps units
χ_2	=	0.01 for SI units; = 0.5 for Fps units
$\bar{P}_o$	=	Effective overburden pressure, (in kPa or ksf)

The field SPT values as corrected due to overburden pressure (according to the above equation) the details of the correction of the field SPT values are given in the following table.

Table No-3.1: Correction of the field SPT values due to the effect of the overburden pressure.

Depth (ft.)	BH-1						BH-2					
	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N'	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N'
5′-0″	100.0	37.5	0.19	2.00	2	4	100.0	37.5	0.19	2.00	2	4
10′-0″	120.0	57.5	0.48	1.98	6	12	125.0	62.5	0.50	1.98	8	16
15′-0″	130.0	67.5	0.81	1.49	14	21	125.0	62.5	0.81	1.49	11	16
20′-0″	120.0	57.5	1.10	1.28	7	9	125.0	62.5	1.13	1.28	8	10
25′-0″	125.0	62.5	1.41	1.08	8	9	120.0	57.5	1.41	1.08	7	8
30′-0″	130.0	67.5	1.75	0.97	16	16	130.0	67.5	1.75	0.97	14	14
35′-0″	130.0	67.5	2.09	0.94	20	19	130.0	67.5	2.09	0.94	17	16
40′-0″	120.0	57.5	2.38	0.90	21	19	120.0	57.5	2.38	0.90	22	20
45′-0″	130.0	67.5	2.71	0.87	14	12	130.0	67.5	2.71	0.87	19	17
50′-0″	130.0	67.5	3.05	0.84	24	20	120.0	57.5	3.00	0.84	20	17
55'-0"	130.0	67.5	3.39	0.81	30	24	125.0	62.5	3.31	0.81	26	21
60'-0"	135.0	72.5	3.75	0.78	36	28	120.0	57.5	3.60	0.79	29	23
65'-0"	130.0	67.5	4.09	0.76	34	26	125.0	62.5	3.91	0.77	28	22
70'-0"	120.0	57.5	4.38	0.74	23	17	125.0	62.5	4.23	0.75	28	21
75'-0"	120.0	57.5	4.66	0.72	24	17	120.0	57.5	4.51	0.73	24	18
80'-0"	125.0	62.5	4.98	0.70	28	20	125.0	62.5	4.83	0.71	27	19
85'-0"							130.0	67.5	5.16	0.69	30	21
90'-0"							130.0	67.5	5.50	0.67	34	23
95'-0"							135.0	72.5	5.86	0.65	37	24
100'-0"							140.0	77.5	6.25	0.63	41	26

Table No-3.1: (Continued).

Depth (ft.)	BH-3						BH-4					
	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N'	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N'
5′-0″	110.0	47.5	0.24	2.00	3	6	110.0	47.5	0.24	2.00	3	6
10′-0″	120.0	57.5	0.53	1.98	5	10	125.0	62.5	0.55	1.98	12	24
15′-0″	130.0	67.5	0.86	1.45	17	25	130.0	67.5	0.89	1.45	19	28
20′-0″	125.0	62.5	1.18	1.18	8	9	130.0	67.5	1.23	1.18	13	15
25′-0″	120.0	57.5	1.46	1.00	7	7	125.0	62.5	1.54	1.00	8	8
30′-0″	125.0	62.5	1.78	0.96	10	10	115.0	52.5	1.80	0.96	13	12
35′-0″	130.0	67.5	2.11	0.93	16	15	130.0	67.5	2.14	0.93	17	16
40′-0″	120.0	57.5	2.40	0.90	20	18	130.0	67.5	2.48	0.90	19	17
45′-0″	125.0	62.5	2.71	0.87	26	23	120.0	57.5	2.76	0.86	23	20
50′-0″	130.0	67.5	3.05	0.84	30	25	125.0	62.5	3.08	0.84	29	24
55'-0"	130.0	67.5	3.39	0.81	32	26	130.0	67.5	3.41	0.81	34	28
60'-0"	125.0	62.5	3.70	0.78	29	23	130.0	67.5	3.75	0.78	33	26
65'-0"	125.0	62.5	4.01	0.75	25	19						
70'-0"	120.0	57.5	4.30	0.71	20	14						
75'-0"	120.0	57.5	4.59	0.69	22	15						
80'-0"	125.0	62.5	4.90	0.67	27	18						

Note:

a. ***γ = Unit weight of soil (lb/cft), $\bar{\gamma}$ = Effective unit weight of soil (lbs/cft), $\bar{P}_o$ = Effective Overburden pressure at the depth under consideration (in Ksf).***

b. ***N_f = Field SPT value, N' = Corrected value of the field SPT due to overburden pressure.***

c. ***C_N = Correction factor due to overburden pressure at the depth of consideration (Limited to 2.00).***

Table No-3.1: (Continued).

Depth (ft.)	BH-5						BH-6					
	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N′	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N′
5′-0″	125.0	62.5	0.31	2.00	11	22	100.0	37.5	0.19	2.00	1	2
10′-0″	130.0	67.5	0.65	1.82	14	25	120.0	57.5	0.48	1.98	7	14
15′-0″	130.0	67.5	0.99	1.37	17	23	130.0	67.5	0.81	1.49	14	21
20′-0″	130.0	67.5	1.33	1.09	14	15	120.0	57.5	1.10	1.28	5	6
25′-0″	125.0	62.5	1.64	0.98	10	10	125.0	62.5	1.41	1.08	9	10
30′-0″	125.0	62.5	1.95	0.95	8	8	130.0	67.5	1.75	0.97	14	14
35′-0″	125.0	62.5	2.26	0.91	9	8	130.0	67.5	2.09	0.94	17	16
40′-0″	115.0	52.5	2.53	0.89	17	15	125.0	62.5	2.40	0.90	25	23
45′-0″	115.0	52.5	2.79	0.87	19	17	125.0	62.5	2.71	0.87	27	23
50′-0″	120.0	57.5	3.08	0.83	20	17	130.0	67.5	3.05	0.84	32	27
55'-0"	120.0	57.5	3.36	0.80	24	19	130.0	67.5	3.39	0.81	30	24
60'-0"	120.0	57.5	3.65	0.77	27	21	125.0	62.5	3.70	0.78	28	22

Table No-3.1: (Continued).

Depth (ft.)	BH-7						BH-8					
	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N′	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N′
5′-0″	100.0	37.5	0.19	2.00	1	2	130.0	67.5	0.34	2.00	12	24
10′-0″	115.0	52.5	0.45	1.98	4	8	130.0	67.5	0.68	1.80	13	23
15′-0″	125.0	62.5	0.76	1.49	8	12	130.0	67.5	1.01	1.30	16	21
20′-0″	120.0	57.5	1.05	1.29	6	8	130.0	67.5	1.35	1.08	19	21
25′-0″	125.0	62.5	1.36	1.09	8	9	130.0	67.5	1.69	0.98	14	14
30′-0″	130.0	67.5	1.70	0.98	13	13	120.0	57.5	1.98	0.95	7	7
35′-0″	130.0	67.5	2.04	0.94	15	14	125.0	62.5	2.29	0.91	8	7
40′-0″	120.0	57.5	2.33	0.90	22	20	125.0	62.5	2.60	0.88	18	16
45′-0″	115.0	52.5	2.59	0.88	25	22	120.0	57.5	2.89	0.85	23	20
50′-0″	125.0	62.5	2.90	0.85	28	24	130.0	67.5	3.23	0.82	30	25
55'-0"	125.0	62.5	3.21	0.82	27	22	120.0	57.5	3.51	0.79	27	21
60'-0"	130.0	67.5	3.55	0.79	33	26	125.0	62.5	3.83	0.76	29	22

Note:

a. ***γ = Unit weight of soil (lb/cft), $\bar{\gamma}$ = Effective unit weight of soil (lbs/cft), $\bar{P}_o$ = Effective Overburden pressure at the depth under consideration (in Ksf).***

b. ***N_f = Field SPT value, N' = Corrected value of the field SPT due to overburden pressure.***

c. ***C_N = Correction factor due to overburden pressure at the depth of consideration (Limited to 2.00).***

Table No-3.1: (Continued).

Depth (ft.)	BH-9					
	γ	$\bar{\gamma}$	$\bar{P}_o$	C_N	N_f	N′
5′-0″	130.0	67.5	0.34	2.00	18	36
10′-0″	130.0	67.5	0.68	1.80	17	31
15′-0″	130.0	67.5	1.01	1.30	20	26
20′-0″	130.0	67.5	1.35	1.08	15	16
25′-0″	125.0	62.5	1.66	0.98	10	10
30′-0″	125.0	62.5	1.98	0.95	9	9
35′-0″	125.0	62.5	2.29	0.91	10	9
40′-0″	120.0	57.5	2.58	0.88	21	18
45′-0″	125.0	62.5	2.89	0.85	26	22
50′-0″	130.0	67.5	3.23	0.82	34	28
55'-0"	135.0	72.5	3.59	0.79	37	29
60'-0"	130.0	67.5	3.93	0.77	32	25

Note:

- ***a. γ = Unit weight of soil (lb/cft), $\bar{\gamma}$ = Effective unit weight of soil (lbs/cft), $\bar{P}_o$ = Effective Overburden pressure at the depth under consideration (in Ksf).***
- ***b. N_f = Field SPT value, N' = Corrected value of the field SPT due to overburden pressure.***
- ***c. C_N = Correction factor due to overburden pressure at the depth of consideration (Limited to 2.00).***

3.3. SHALLOW FOUNDATION

A. COMBINED & ISOLATED FOOTING

The bearing capacities of the shallow foundation have been evaluated at each of the 5'-0" depth up to the depth of 15'-0", in the case of each borehole. As the layers of soil, existing to the depth of 20'-0" is plastic by nature, the criteria for the determination of the bearing capacities of the shallow foundation is based on the cohesion (C) parameters of soil obtained either from the laboratory tests or estimated for the field SPD values. This has been done considering the general equation for the bearing capacity of the shallow foundation accordingly to Terzaghi & Hansen. These details of the evaluation are discussed as follows.

Terzaghi's equations

The Bearing capacities of the shallow foundation particularly of the Raft foundation may be evaluated according to the following formulae as suggested by Terzaghi.

$$q_{ult} = C \times N_c \times (1 + 0.3 \frac{B}{L})$$

Where,

q_{ult} = Ultimate Bearing capacity

C = $q_u/2.0$ = Cohesion

N_c = Bearing capacity factor = 5.7 (for saturated clay)

B = Width of the Raft

L = Length of the Raft

Hansen's equations

$q_{ult} = C \times N_{cr} S_c \times d_c$ S_c = Shape Factor = $1.0 + \frac{N_c}{N_c} X \frac{B}{L}$

d_c = Depth factor = $1+0.40 \times D_f/B$ .... $\frac{D_f}{B} \leq 1.0$

$= 1+0.40 \tan^{-1} D_f/B$ .... $\frac{D_f}{B} > 1.0$

Where,

q_{ult} = Ultimate Bearing capacity of the foundation

C = $q_u/2.0$ = Cohesion, obtained from the laboratory test or estimated from the field SPT values (N).

N_c , N_q = Bearing capacity factors for the shallow foundations.

B = Width of the raft foundation,

L = Length of the raft foundation

D_f = Depth of the raft foundation and the corresponding values have been assumed.

[N.B: In the above bearing capacity equations, the depth and the width term has been dropped from the considerations].

Table No-3.2: The allowable values of the Bearing capacity for the shallow foundation in Psf (F.S. = 3.0).

BH	D_f (ft.)	N_f	N'	q_u (psf)	Continuous footing		Isolated footing	
					Terzaghi	Hansen	Terzaghi	Hansen
BH-1	5'-0"	2	4	500	450	600	600	611
	10′-0″	6	12	1500	1350	1854	1800	2141
	15′-0″	14	21	3500	4150	4496	4200	4971
BH-2	5′-0″	2	4	500	450	600	600	611
	10′-0″	8	16	2000	1800	2472	2400	2854
	15′-0″	11	16	2750	2475	3533	3300	906
BH-3	5′-0″	3	6	750	675	899	900	918
	10′-0″	5	10	1250	1125	1545	1500	1784
	15′-0″	17	25	4250	3825	5460	5100	6036
BH-4	5′-0″	3	6	750	675	899	900	918
	10′-0″	12	24	3000	2700	3708	3600	4282
	15′-0″	19	28	4750	4275	6102	5700	6746
BH-5	5′-0″	11	22	2750	2475	3298	3300	3364
	10′-0″	14	25	3500	3150	4326	4200	4995
	15′-0″	17	23	4250	3825	5460	5100	6036
BH-6	5′-0″	1	2	250	225	300	300	306
	10′-0″	7	14	1750	1575	2163	2100	2498
	15′-0″	14	21	3500	3150	4496	4200	4971
BH-7	5′-0″	1	2	250	225	300	300	306
	10′-0″	4	8	1000	900	1236	1200	1427
	15′-0″	8	12	2000	1800	2569	2400	2840
BH-8	5′-0″	12	24	3000	2700	3598	3600	3670
	10′-0″	13	23	3250	2925	4017	3900	4638
	15′-0″	16	21	4000	3600	5139	4800	5680
BH-9	5′-0″	18	36	4500	4050	5397	5400	5505
	10′-0″	17	31	4250	3525	5253	5100	6066
	15′-0″	20	26	5000	4500	6423	6000	7100

Note:

a. ***The above values (q_a) are the Net Allowable Bearing capacities of the shallow foundation in PSF.***

b. ***The above allowable bearing capacities (q_a) stand for (F.S. = 3.0) for the cohesive soil.***

c. ***N_f = Field SPT, N' = Corrected value of the field SPT (N_f) due to over burden pressure.***

$Navg_1$ & $Navg_2$ = Average values of the corrected values of the field SPT within the influence zone of pressure bulb measured at a level 0.75 D_f above & 2B below the depth under consideration.

d. ***The Width B = 5'-0" & 10'-0" have been considered respectively as the width of the continuous and the isolated type footing foundation.***

e. ***The position of the ground water level has been considered to be at the surface level i.e. the water table correction factor (C_w) comes to 0.50.***

B. RAFT FOUNDATION

Alternatively, the Raft foundation may also be considered for the existing subsoil condition. As the layers of soil, existing to the depth of 15'-0", is plastic by nature, the criteria for the determination of the bearing capacities of the shallow foundation is based in the cohesion parameters of soil (C) obtained either from the laboratory tests or estimated from the field SPT values. This has been done consisting the General equations for the bearing capacity of the shallow foundation according to Terzaghi & Hansan are as follows.

Terzaghi's equations

The Bearing capacities of the shallow foundation particularly of the Raft foundation may be evaluated according to the following formulae as suggested by Terzaghi.

$$q_{ult} = C \times N_c \times (1 + 0.3 \frac{B}{L}) \, C \times Nc \quad \ldots \quad \ldots \quad \ldots \quad (i)$$

Where,

q_{ult} = Ultimate Bearing capacity

C = $q_u/2.0$ = Cohesion

N_c = Bearing capacity factor = 5.7 (for saturated clay)

B = Width of the Raft foundation

L = Length of the Raft foundation

[N.B: In the above bearing capacity equations, the depth and the width term has been dropped from the considerations].

Hansen's equations

$$q_{ult} = C \times N_c \, S_c \times d_c \quad \ldots \quad \ldots \quad \ldots \quad (ii)$$

$$S_c = \text{Shape Factor} = 1.0 + \frac{N_c}{N_c} \, X \, \frac{B}{L}$$

$$d_c = \text{Depth factor} = 1+0.40 \times D_f/B \ \ldots \ \ldots \ \frac{D_f}{B} \leq 1.0$$

$$= 1+0.40 \tan^{-1} D_f/B \quad \ldots \ \ldots \ \frac{D_f}{B} > 1.0$$

Where,

q_{ult} = Ultimate Bearing capacity of the foundation

C = $q_u/2.0$ = Cohesion, obtained from the laboratory test or estimated from the field SPT values (N).

N_c , N_q = Bearing capacity factors for the shallow foundations.

B = Width of the raft foundation,

L = Length of the raft foundation

D_f = Depth of the raft foundation and the corresponding values have been assumed.

[N.B: In the above bearing capacity equations, the depth and the width term has been dropped from the considerations].

Table No- 3.3: The Allowable values of the Bearing Capacities of the Raft Foundation in PSF (F.S. = 3.0)

BH	D_f ft.)	B (avg)	L (length)	N_f (Avg)	q_u (Avg)	Allowable Bearing Capacity (q_a)	
						Terzaghi	Hansen
BH-1, BH-2, BH-3, BH-4, BH-5, BH-6, BH-7, BH-8 & BH-9	5'-0"	104'-0"	282'-0"	3	750	790	700
BH-1, BH-2, BH-3, BH-4, BH-5, BH-6, BH-7, BH-8 & BH-9	10'-0"	104'-0"	282'-0"	8	2000	2110	1904
BH-1, BH-2, BH-3, BH-4, BH-5, BH-6, BH-7, BH-8 & BH-9	15'-0"	104'-0"	282'-0"	10	2500	2638	2424

Note:

a. ***q_a = The Net allowable Bearing capacity of the Raft foundation in PSF (F.S. = 3.0).***

b. ***D_f = Depth, B = Width, L = Length of the Raft foundation.***

c. ***N_f = Statistical average of the SPT values at the depth under consideration.***

d. ***q_u = Unconfined Compression Strength, estimated from the value of the average SPT at the depth under consideration.***

3.4. DEEP FOUNDATION

The deep foundation particularly of the piles may also be considered. As the layers of soil existing to the depth of the investigation consists both of the cohesive & the non-cohesive group of soil, the criteria from the determination of the bearing capacities of the deep foundation varies. These are discussed in detail in the following subheadings.

a. Cohesive Soil

The skin friction and the end bearing capacities of the Pile may be evaluated by the following formulae.

(Ref: Foundation Analysis and Design by J.E. Bowels, 2nd Editions, P-599 & P-600).

$$f_{sa} = \alpha.C_u + k\ \bar{q}\ \tan\delta \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(i)}$$

$$q_{pu} = CN'c + \eta\ \bar{q}\ (Nq - 1) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(ii)}$$

Where,

f_{su} = Ultimate Skin friction

α = Adhesion factor

k = Lateral Earth Pressure Coefficient $\approx 1 - k_o$

k_o = Lateral Earth Pressure Coefficient at rest

$\bar{q}$ = $\bar{P}_o = \bar{\gamma}\ D_f$ = Effective over burden Pressure at the depth under considerations.

δ = Effective friction angle in between the Pile and the soil materials.

q_{pu} = Ultimate End bearing capacity of the Pile.

η_q = 1.00 for all except the Vesic values.

Nc′, N_q‘ = Bearing capacity factors for the Deep foundation.

Based on the above formulae, the skin friction as well as the end bearing capacities of the Pile have been determined and are provided in the Table No-3.4.

b. Non-Cohesive Soil

The values of the skin friction as well as the end bearing capacities of the Pile for the Non-cohesive soil may be evaluated on the basis of the corrected values of the field SPT as suggested by Meyerhof according to the following formulae:

$f_{su} = q_c/200 = 4N/200$ TON/ft^2 … … … (iii)

$q_{pu} = q_c = 4N$ TON/ft^2 … … … (iv)

Where,

q_{pu} = Ultimate Pile End Bearing capacity

f_{su} = Ultimate Pile Skin friction

q_c = Static Cone Penetration Result

N = SPT value at the depth under considerations.

But in our case, the investigated soils are not sand, rather there exhibit some silt materials, we may modify the above relations of Meyerhof according to Schmertmaun's (1970) observations in the following way.

$q_{pu} = q_c = 3N$ TON/ft^2 … … … … (v)

$f_{su} = q_c/200 = 3N/200$ TON/ft^2 … … … … (vi)

Based on the above formulae, the skin friction as well as the end bearing capacities of the Pile have been determined and are provided in the Table No-3.4.

Table No. 3.4: The allowable values of the skin friction & the end bearing capacities for the driven pile in TSF (F.S. = 2.50).

Depth (ft.)	BH-1						BH-2					
	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}
5′-0″	2	4	0.10	0.13	0.05	-	2	4	0.10	0.13	0.05	-
10′-0″	6	12	0.24	0.38	0.12	-	8	16	0.25	0.50	0.15	-
15′-0″	14	21	0.41	0.88	0.25	12.40	11	16	0.41	0.69	0.22	8.70
20′-0″	7	9	0.55	0.11	0.08	4.10	8	10	0.57	0.13	0.09	4.50
25′-0″	8	9	0.71	0.13	0.10	5.20	7	8	0.71	0.11	0.09	4.10
30′-0″	16	16	0.88	0.25	0.14	13.30	14	14	0.88	0.22	0.12	12.60
35′-0″	20	19	1.05	0.31	0.17	16.20	17	16	1.05	0.27	0.16	15.30
40′-0″	21	19	1.19	0.33	0.18	17.90	22	20	1.19	-	0.12	24.00
45′-0″	14	12	1.36	0.22	0.17	13.60	19	17	1.36	-	0.10	20.40
50′-0″	24	20	1.53	-	0.12	24.00	20	17	1.50	-	0.10	20.40
55′-0″	30	24	1.70	-	0.14	28.80	26	21	1.66	-	0.13	25.20
60′-0″	36	28	1.88	-	0.17	33.60	29	23	1.80	-	0.14	27.60
65′-0″	34	26	2.05	-	0.16	31.20	28	22	1.96	-	0.13	26.40
70′-0″	23	17	2.19	-	0.10	20.40	28	21	2.12	-	0.13	25.20
75′-0″	24	17	2.33	-	0.10	20.40	24	18	2.26	-	0.11	21.60
80′-0″	28	20	2.49	-	0.12	24.00	27	19	2.42	-	0.11	22.80
85'-0"							30	21	2.58	-	0.13	25.20
90'-0"							34	23	2.75	-	0.14	27.60
95'-0"							37	24	2.93	-	0.14	28.80
100'-0"							41	26	3.13	-	0.16	31.20

Note:

a. ***N_f = Field SPT, N' = Corrected value of the field SPT due to the effect of the Overburden Pressure.***

b. ***$\bar{P}o$ = Effective Overburden pressure at the depth under consideration (in Tsf), C = Cohesion.***

c. ***f_{sa} = Allowable value of the skin friction over the shaft of the driven pile (F.S. = 2.5)***

   q_{pa} = Allowable value of the end bearing capacity at the tip of the driven pile (F.S = 2.5).

d. ***For the Bored type R.C.C. Piles, the above values of f_{sa} and q_{pa} may be reduced to 50% in making the Preliminary estimate about the Carrying capacity of the same.***

Table No. 3.4: (Continued).

Depth (ft.)	BH-3						BH-4					
	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}
5′-0″	3	6	0.12	0.19	0.07	-	3	6	0.12	0.19	0.06	-
10′-0″	5	10	0.27	0.31	0.10	-	12	24	0.28	0.75	0.23	-
15′-0″	17	25	0.43	1.06	0.32	14.80	19	28	0.45	0.30	0.12	11.80
20′-0″	8	9	0.59	0.13	0.08	4.60	13	15	0.62	0.20	0.10	9.90
25′-0″	7	7	0.73	0.11	0.09	4.20	8	8	0.77	0.13	0.10	5.50
30′-0″	10	10	0.89	0.16	0.12	7.40	13	12	0.90	0.20	0.13	12.40
35′-0″	16	15	1.06	0.25	0.15	14.90	17	16	1.07	0.27	0.16	15.50
40′-0″	20	18	1.20	-	0.11	21.60	19	17	1.24	0.30	0.18	19.40
45′-0″	26	23	1.36	-	0.14	27.60	23	20	1.38	-	0.12	24.00
50′-0″	30	25	1.53	-	0.15	30.00	29	24	1.54	-	0.14	28.80
55′-0″	32	26	1.70	-	0.16	31.20	34	28	1.71	-	0.17	33.60
60′-0″	29	23	1.85	-	0.14	27.60	33	26	1.88	-	0.16	31.20
65′-0″	25	19	2.01	-	0.11	22.80						
70′-0″	20	14	2.15	-	0.08	16.80						
75′-0″	22	15	2.30	-	0.09	18.00						
80′-0″	27	18	2.45	-	0.11	21.60						

Table No. 3.4: (Continued).

Depth (ft.)	BH-5						BH-6					
	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}
5′-0″	11	22	0.16	0.69	0.20	-	1	2	0.10	-	-	-
10′-0″	14	25	0.33	0.88	0.27	-	7	14	0.24	0.44	0.14	-
15′-0″	17	23	0.50	1.06	0.33	14.90	14	21	0.41	0.88	0.27	12.40
20′-0″	14	15	0.67	0.88	0.29	13.20	5	6	0.55	0.08	0.07	3.10
25′-0″	10	10	0.82	0.16	0.11	7.00	9	10	0.71	0.14	0.10	6.10
30′-0″	8	8	0.98	0.13	0.12	7.30	14	14	0.88	0.22	0.13	12.70
35′-0″	9	8	1.13	0.14	0.13	8.30	17	16	1.05	0.27	0.16	15.30
40′-0″	17	15	1.27	-	0.09	18.00	25	23	1.20	-	0.14	27.60
45′-0″	19	17	1.40	-	0.10	20.40	27	23	1.36	-	0.14	27.60
50′-0″	20	17	1.54	-	0.10	20.40	32	27	1.53	-	0.16	32.40
55′-0″	24	19	1.68	-	0.11	22.80	30	24	1.70	-	0.14	28.80
60′-0″	27	21	1.83	-	0.13	25.20	28	22	1.85	-	0.13	26.40

Note:

a. ***N_f = Field SPT, N' = Corrected value of the field SPT due to the effect of the Overburden Pressure.***
b. ***$\bar{P}o$ = Effective Overburden pressure at the depth under consideration (in Tsf), C = Cohesion.***
c. ***f_{sa} = Allowable value of the skin friction over the shaft of the driven pile (F.S. = 2.5)***
   q_{pa} = Allowable value of the end bearing capacity at the tip of the driven pile (F.S = 2.5).
d. ***For the Bored type R.C.C. Piles, the above values of f_{sa} and q_{pa} may be reduced to 50% in making the Preliminary estimate about the Carrying capacity of the same.***

Table No. 3.4: (Continued).

Depth (ft.)	BH-7						BH-8					
	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}
5′-0″	1	2	0.10	0.69	-	-	12	24	0.17	0.75	0.22	-
10′-0″	4	8	0.23	0.25	0.08	-	13	23	0.34	0.81	0.25	-
15′-0″	8	12	0.38	0.50	0.16	6.60	16	21	0.51	1.00	0.31	14.20
20′-0″	6	8	0.53	0.09	0.07	3.20	19	21	0.68	1.19	0.38	19.20
25′-0″	8	9	0.68	0.13	0.09	4.30	14	14	0.85	0.88	0.30	13.70
30′-0″	13	13	0.85	0.20	0.12	11.90	7	7	0.99	0.11	0.11	5.10
35′-0″	15	14	1.02	0.23	0.15	14.10	8	7	1.15	0.13	0.13	8.20
40′-0″	22	20	1.17	-	0.12	24.00	18	16	1.30	-	0.10	19.20
45′-0″	25	22	1.30	-	0.13	26.40	23	20	1.45	-	0.12	24.00
50′-0″	28	24	1.45	-	0.14	28.80	30	25	1.62	-	0.15	30.00
55′-0″	27	22	1.61	-	0.13	26.40	27	21	1.76	-	0.13	25.20
60′-0″	33	26	1.78	-	0.16	31.20	29	22	1.92	-	0.13	26.40

Table No. 3.4: (Continued).

Depth (ft.)	BH-9					
	N_f	N'	$\bar{P}_o$	C	f_{sa}	q_{pa}
5′-0″	18	36	0.17	1.12	0.32	-
10′-0″	17	31	0.34	1.06	0.32	-
15′-0″	20	26	0.51	1.25	0.38	19.40
20′-0″	15	16	0.68	0.94	0.31	13.90
25′-0″	10	10	0.83	0.16	0.11	7.10
30′-0″	9	9	0.99	0.14	0.12	7.60
35′-0″	10	9	1.15	0.16	0.14	8.70
40′-0″	21	18	1.29	-	0.11	21.60
45′-0″	26	22	1.45	-	0.13	26.40
50′-0″	34	28	1.62	-	0.17	33.60
55′-0″	37	29	1.80	-	0.17	34.80
60′-0″	32	25	1.97	-	0.15	30.00

Note:

a. ***N_f = Field SPT, N' = Corrected value of the field SPT due to the effect of the Overburden Pressure.***

b. ***$\bar{P}o$ = Effective Overburden pressure at the depth under consideration (in Tsf), C = Cohesion.***

c. ***f_{sa} = Allowable value of the skin friction over the shaft of the driven pile (F.S. = 2.5)***

   q_{pa} = Allowable value of the end bearing capacity at the tip of the driven pile (F.S = 2.5).

d. ***For the Bored type R.C.C. Piles, the above values of f_{sa} and q_{pa} may be reduced to 50% in making the Preliminary estimate about the Carrying capacity of the same.***

3.5. ESTIMATING THE PILE CARRYING CAPACITY

The Carrying capacities particularly of the Bored R.C.C. Piles have also been evaluated considering the different diameters and the different embedment lengths, in the case of each borehole. The evaluated values are being provided in the following Table.

Table No-3.5: The estimated carrying capacities of the Bored R.C.C. pile in Ton (F.S. = 2.5).

PILE LENGTH (FT)	PILE DIAMETER : 18"								
	BH-1	BH-2	BH-3	BH-4	BH-5	BH-6	BH-7	BH-8	BH-9
40.0	27.7	32.6	30.4	29.4	32.7	36.3	30.3	36.5	37.9
45.0	26.0	30.7	37.2	35.3	36.0	37.9	33.9	42.0	43.5
50.0	36.9	31.9	41.0	41.0	37.2	43.9	37.6	48.9	51.6
55.0	42.6	37.5	43.9	47.1	40.5	42.5	37.0	46.3	54.7
60.0	48.7	41.2	42.5	46.9	44.0	42.0	43.0	48.9	52.4
65.0	48.5	41.7	39.7						
70.0	40.5	42.2	35.6						
75.0	41.7	40.4	37.6						
80.0	46.2	42.8	42.0						
85.0		46.3							
90.0		50.0							
95.0		52.7							
100.0		56.6							

Note:

a. ***EGL = Existing Ground level, 1 Ton = 2,000 lbs.***

b. ***The length of the Pile has been measured from the EGL.***

c. ***The above values are the Net allowable Carrying capacities (F.S = 2.50).***

d. ***The carrying capacities of the Bored R.C.C. pile, as given in the table No-3.3 must the confirmed from the load tests.***

CHAPTER-4: CONCLUSIONS & RECOMMENDATIONS

4.1. CONCLUSIONS

The following conclusions may be drawn regarding the subsoil formation of the project area.

a. The layers of soil, up to the depth of the investigation, have been observed regular in between the boreholes.

b. The top layer of the soil, as investigated existing roughly to the depth of 17'-0"/ 18'-0" (BH-1, BH-2, BH-3, BH- 6 & BH-7) 23'-0" (BH-4, BH-5 & BH-9) to 28'-0" (BH-8) is plastic by nature consisting of silty clay.

c. The underlying layers of soil existing roughly to the depth of 37'-0"/38'-0" (BH-2, BH-3, BH-5, BH-6, BH-7, BH-8 & BH-9), 43'-0" (BH-1 & BH-4) are slightly plastic by nature consisting of clayey silt.

d. Further below, a layer of sandy silt exists roughly up to the depth of 43'-0" (BH-3 & BH-5), 47'-0"/48'-0" (BH-7 & BH-8) to 52'-0" (BH-1) measured from the EGL.

e. The subsequent layers of soil existing to the depth of the investigation are non-plastic by nature consisting of very fine sand with little/trace silt (Ref: Bore-logs).

f. The consistency of the top layer of silty clay existing roughly to the depth of 6'-6" to 8'-0", particularly at and around BH-1, BH-2, BH-3, BH-4, BH-6 & BH-7) is usually very soft.

g. Further below, the consistency of the layer of silty clay existing roughly to the depth of 17'-0"/18'-0" (BH-1, BH-2, BH-3, BH-6 & BH-7), 23'-0" (BH-4) gradually increases to medium & stiff.

h. The consistency of the top layer of silty clay existing roughly to the depth of 23'-0" (BH-5, BH-8 & BH-9) is usually stiff & very stiff.

i. Further below, the consistency of the layer of clayey silt existing roughly to the depth of 37'-0"/38'-0" (BH-2, BH-5, BH-6, BH-7 & BH-8), 43'-0" (BH-3) to 47'-0" (BH-1) usually varies from medium to stiff and occasionally vary stiff.

j. The subsequent deep layers of non-plastic soil is sandy silt and fine sand existing roughly to the depth of the investigation generally have been observed in a medium to dense state.

k. The top layer of silty clay has been observed naturally in a well compacted state having satisfactory consistency roughly at and around the depth of 10'-0", measured from the EGL, particularly at and around the area marked by BH-2, BH-4, BH-5, BH-6, BH-8 & BH-9.

l. The bearing capacities of the shallow foundation are also satisfactory in the case of above boreholes.

m. Therefore, the shallow foundations of both of the combined as well as the isolated type footing foundations may be provided in the case of BH-2, BH-4, BH-5, Bh-6, BH-8 & BH-9.

n. In the case of other borers (BH-1, BH-3 & BH-7), the foundation base needs improvement.

o. Improvement of the foundation base may be done by providing a layer of compacted sand (F.M. = 1.5 to 2.0) of the required thickness below the base of the foundation.

p. After proper compaction of the layer of sand, the shallow foundation of both of the combined as well as the isolated type footing foundation may be provided over the improve base particularly in the case of BH-1, BH-3 & BH-7.

q. Alternatively, the mat foundation may be provided. The bearing capacities of the mat are provided in the table No- 3.3.

r. Alternatively, the deep foundation particularly of the piles may also be considered.

s. Regarding the deep foundation, the required values of the skin friction as well as the end bearing capacities of the pile are provided in the table No-3.4.

t. Moreover, the carrying capacities of the bored R.C.C. for the different sizes/ diameters with different embedment lengths have also been estimated and are provided respectively in the Table No-3.5.

4.2. RECOMMENDATIONS

The following recommendations are suggested for the construction of the proposed six storied social science faculty building with one basement of **Jahangirnagar University** situated at Jahangirnagar University, Savar, Dhaka.

A. COMBINED & ISOLATED FOOTING

a. The bearing capacity of the combined footing foundation particularly at and around BH-2, BH-4, BH-5, BH-6, BH-8 & BH-9, preferably at a depth of 9'-0" to 10'-0" (measured from the EGL) shall be considered in the following way.

- To be 2000 to 2500 PSF (F.S. = 3.0) particularly at and around BH-2 & BH-6.
- To be 4000 PSF (F.S. = 3.0) at and around BH-4, BH-5, BH-7 & BH-8.

b. Alternatively, the isolated column footing foundation may also be provided in the case of BH-2, BH-4, BH-5, BH-6, BH-8 & BH-9, preferably at a depth of 9'-0" to 10'-0" (measured from the EGL). The bearing capacity of the same shall be considered in the following way.

- To be 2500 PSF (F.S. = 3.0) in the case of BH-2 & BH-6.
- To be 4000 to 5000 PSF (F.S. = 3.0) particularly at and around BH-4, BH-5, BH-8 & BH-9.

B. COMBINED & ISOLATED FOOTING AFTER IMPROVEMENT OF SOIL

a. The shallow foundation both of the combined as well as the isolated type footing foundation shall be provided after improvement of the foundation base particularly at and around BH-1, BH-3 & BH-7.

b. Improvement of the foundation base may be done in the following way.

- The soils should be excavated and removed roughly up to the depth of 12'-0" to 13'-0", measured from the EGL.

- The excavated base should then be backfilled with sand (F.M. 1.5 to 2.0) though compaction preferably of 0'-6" thickness at a time and up to a height of 4'-0" to 5'-0", measured from the base of excavation.
- Use of brick particles [3/4" downgraded jhama bricks] during the process of compaction is expected to increase the degree of compaction in a more satisfactory way.
- The foundation base must be kept dry during the process of compaction.

c. After ensuring proper compaction of the sand bricks mix, the shallow foundations may be provided over the improved base.

d. The bearing capacity of the shallow foundation over the improved base shall be considered in the following way particularly in the case of BH-1, BH-3 & BH-7.

- To be 2000 PSF (F.S = 3.0) for the combined footing foundation.
- To be 2000 to 2500 PSF (F.S = 3.0) for the isolated column footing foundation.

C. RAFT FOUNDATION

a. Alternatively, the Raft foundation may be provided.

b. The required depth as well as the bearing capacity of the raft foundation may be obtained from the table values (Ref: Table No- 3.3).

c. The foundation base must be kept dry during the construction of the Raft foundation.

D. DEEP FOUNDATION

a. Alternatively, the Deep foundations particularly of the piles may also be provided.

b. The Bored type R.C.C. Piles are the appropriate type of Deep foundation for the existing subsoil and may be provided from the EGL.

c. Regarding the deep foundation, the required values of the skin friction as well as the end bearing capacities of the pile (Driven type) are provided in the Table no-3.4.

d. Moreover, the Carrying capacities of the pile particularly of the Bored R.C.C. Piles have also been estimated in the case of each Borehole and are being provided in the Table No-3.5.

e. The Carrying capacities of the Bored R.C.C. Pile to calculated/obtained from the table values (Ref: Table No-3.4) or estimated from the table values (Ref: Table No-3.5) must be confirmed from carrying out the load tests, covering the entire building area.

Note:

a. 1 Ton = 2,000 Lbs., EGL = Existing Ground Level.

b. The designer may select any other alternative type, depth as well as the bearing capacity of the foundation or the method of improving the topsoil according to his requirements, in the light of information provided in this report.

06.09.2022
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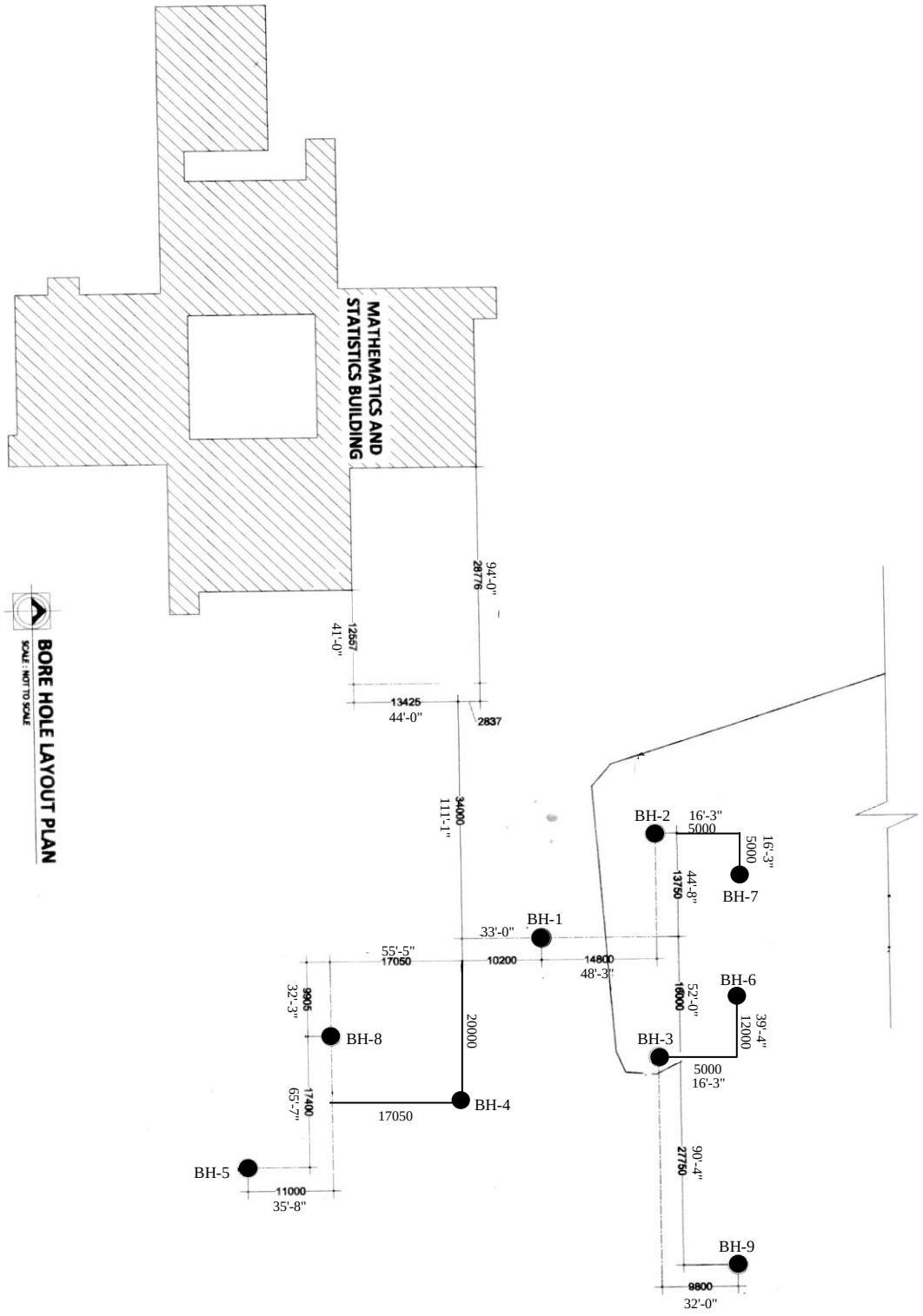
Proprietor

CREATIVE SOIL INVESTIGATION



LOCATION SKETCH OF THE BOREHOLE POINT

PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
CLIENT : JAHANGIRNAGAR UNIVERSITY
LOCATION : JAHANGIRNAGAR UNIVERSITY, SAVAR, DHAKA.

CREATIVE SOIL INVESTIGATION

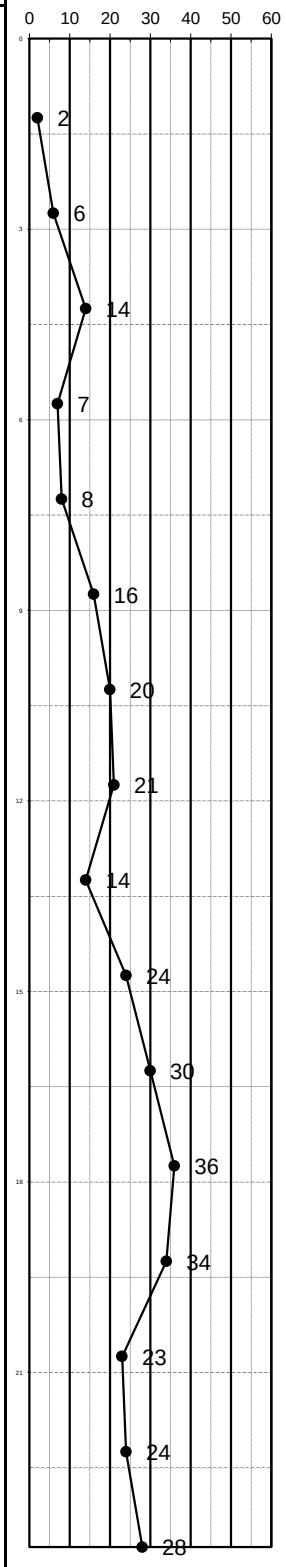
Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	:	1 (One)
Boring Depth	:	80'-0"
G.W.L	:	3'-6" down
E.G.L	:	15'-1" down from road level
Date	:	2/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Depth (ft)	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
5.0	D-1	(8.00)	Red ash spotted medium plastic very soft Silty CLAY, CL.		5.0	1	1	1	**2**	
		8.00								
10.0	D-2		Yellow ash spotted medium plastic medium to stiff Silty CLAY, CL.		10.0	2	2	4	**6**	
15.0	D-3	(10.00)			15.0	3	6	8	**14**	
		18.00								
20.0	D-4		Pale yellow ash spotted low plastic stiff to very stiff Clayey SILT, ML.		20.0	2	3	4	**7**	
25.0	D-5				25.0	3	3	5	**8**	
30.0	D-6	(29.00)			30.0	4	6	10	**16**	
35.0	D-7				35.0	6	8	12	**20**	
40.0	D-8				40.0	4	7	14	**21**	
45.0	D-9				45.0	3	6	8	**14**	
		47.00								
50.0	D-10	(5.00)	Pale yellow medium dense Sandy SILT, ML.		50.0	6	10	14	**24**	
		52.00								
55.0	D-11		Pale yellow dense fine SAND, little/trace silt, SM.		55.0	8	13	17	**30**	
60.0	D-12	(15.50)			60.0	8	15	21	**36**	
65.0	D-13				65.0	8	14	20	**34**	
		67.60								
70.0	D-14		Pale yellow medium dense fine SAND, with clay laminations, SM.		70.0	6	9	14	**23**	
75.0	D-15	(13.50)			75.0	6	9	15	**24**	
80.0	D-16				80.0	8	11	17	**28**	
		81.00								



CREATIVE SOIL INVESTIGATION

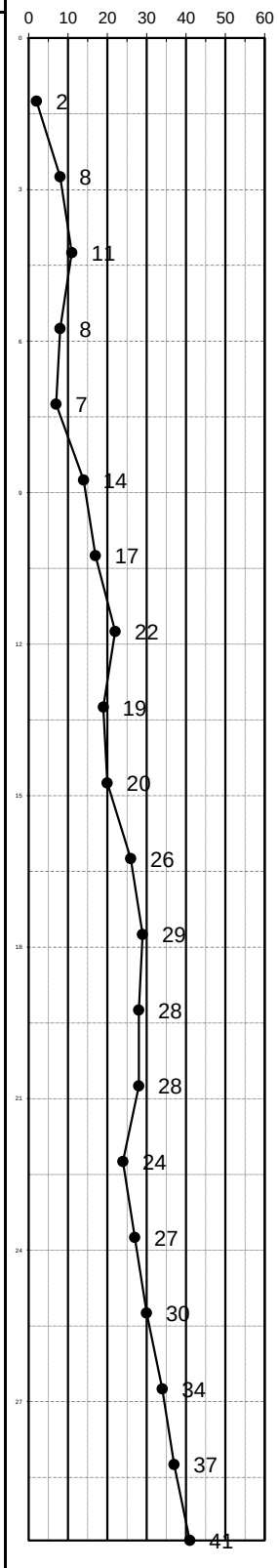
Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	:	2 (Two)
Boring Depth	:	100'-0"
G.W.L	:	3'-0" down
E.G.L	:	16'-5" down from road level
Date	:	3/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Depth (ft)	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
5.0	D-1	(7.00)	Reddish Yellow medium plastic very soft Silty CLAY, CL.		5.0	1	1	1	**2**	
		7.00								
10.0	D-2		Red ash spotted medium plastic stiff Silty CLAY, CL.		10.0	2	3	5	**8**	
15.0	D-3	(11.00)			15.0	3	4	7	**11**	
		18.00								
20.0	D-4		Pale yellow ash spotted low plastic stiff Clayey SILT, ML.		20.0	2	4	4	**8**	
25.0	D-5	(20.00)			25.0	2	3	4	**7**	
30.0	D-6				30.0	3	6	8	**14**	
35.0	D-7				35.0	5	7	10	**17**	
		38.00								
40.0	D-8		Dark Reddish yellow medium dense Sandy SILT, ML.		40.0	6	8	14	**22**	
45.0	D-9	(10.00)			45.0	4	7	12	**19**	
		48.00								
50.0	D-10		Pale reddish Yellow to pale yellowish Brown medium dense to dense very fine SAND, little/trace silt, SM.		50.0	6	8	12	**20**	
55.0	D-11				55.0	7	12	14	**26**	
60.0	D-12				60.0	6	13	16	**29**	
65.0	D-13				65.0	8	12	16	**28**	
70.0	D-14				70.0	8	12	16	**28**	
75.0	D-15	(53.00)			75.0	7	10	14	**24**	
80.0	D-16				80.0	7	11	16	**27**	
85.0	D-17				85.0	9	13	17	**30**	
90.0	D-18				90.0	8	15	19	**34**	
95.0	D-19				95.0	8	16	21	**37**	
100.0	D-20				100.0	10	18	23	**41**	
		101.00								



CREATIVE SOIL INVESTIGATION

Client : Jahangirnagar University

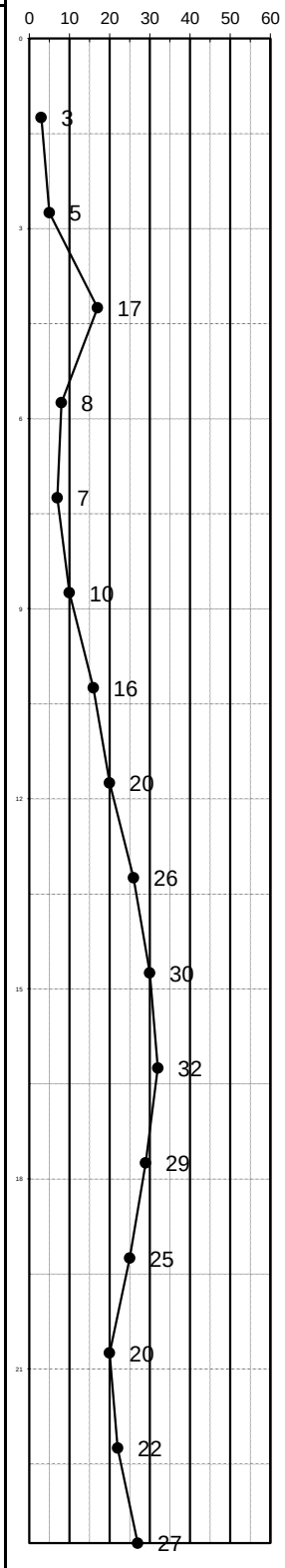
Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	:	3 (Three)
Boring Depth	:	80'-0"
G.W.L	:	4'-0" down
E.G.L	:	15'-4" down from road level
Date	:	4/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Depth (ft)	Standard Penetration Test Values 6"	6"	6"	12"
5.0	D-1	(6.50) 6.60	Pale Brownish yellow medium plastic very soft Silty CLAY, CL.	5.0	1	1	2	**3**
10.0	D-2	(11.00)	Pale red to reddish yellow ash spotted medium plastic medium to stiff & very stiff Silty CLAY, CL.	10.0	1	2	3	**5**
15.0	D-3	17.60		15.0	5	7	10	**17**
20.0	D-4			20.0	2	3	5	**8**
25.0	D-5	(20.50)	Pale reddish yellow ash spotted low plastic medium to stiff & very stiff Clayey SILT, ML.	25.0	2	3	4	**7**
30.0	D-6			30.0	4	4	6	**10**
35.0	D-7	38.00		35.0	4	7	9	**16**
40.0	D-8	(5.00) 43.00	Pale reddish Yellow medium dense Sandy SILT, ML.	40.0	6	9	11	**20**
45.0	D-9			45.0	6	12	14	**26**
50.0	D-10	(20.00)	Pale reddish Yellow medium dense & dense very fine SAND, little/trace silt, SM.	50.0	7	11	19	**30**
55.0	D-11			55.0	9	14	18	**32**
60.0	D-12	63.00		60.0	7	12	17	**29**
65.0	D-13			65.0	6	10	15	**25**
70.0	D-14	(18.00)	Pale reddish Yellow medium dense very fine SAND, with little/trace silt with clay laminations, SM.	70.0	5	8	12	**20**
75.0	D-15			75.0	6	9	13	**22**
80.0	D-16	81.00		80.0	8	12	15	**27**

S.P.T



CREATIVE SOIL INVESTIGATION

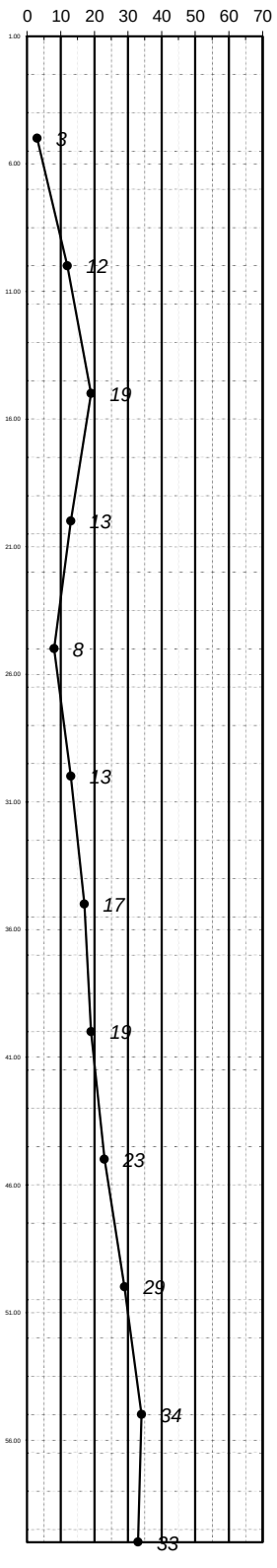
Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	: 4 (Four)
Boring Depth	: 60'-0"
G.W.L	: 5'-0" down
E.G.L	: 13'-1" down from road level
Date	: 5/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
5.0	D-1	(8.00)	Reddish Yellow medium plastic very soft Silty CLAY, CL.		1	1	2	**3**	
		8.00							
10.0	D-2				3	5	7	**12**	
15.0	D-3	(15.00)	Pale red ash spotted medium plastic stiff Silty CLAY, CL.		4	8	11	**19**	
20.0	D-4				3	5	8	**13**	
		23.00							
25.0	D-5				3	3	5	**8**	
30.0	D-6				4	5	8	**13**	
		(20.00)	Pale red to reddish yellow low plastic stiff to very stiff Clayey SILT, ML.						
35.0	D-7				5	7	10	**17**	
40.0	D-8				4	7	12	**19**	
		43.00							
45.0	D-9				6	9	14	**23**	
50.0	D-10	(18.00)	Pale reddish Yellow to yellowish Brown medium dense to dense very fine SAND, little/trace silt, SM.		6	12	17	**29**	
55.0	D-11				8	15	19	**34**	
60.0	D-12				7	15	18	**33**	
		61.00							



CREATIVE SOIL INVESTIGATION

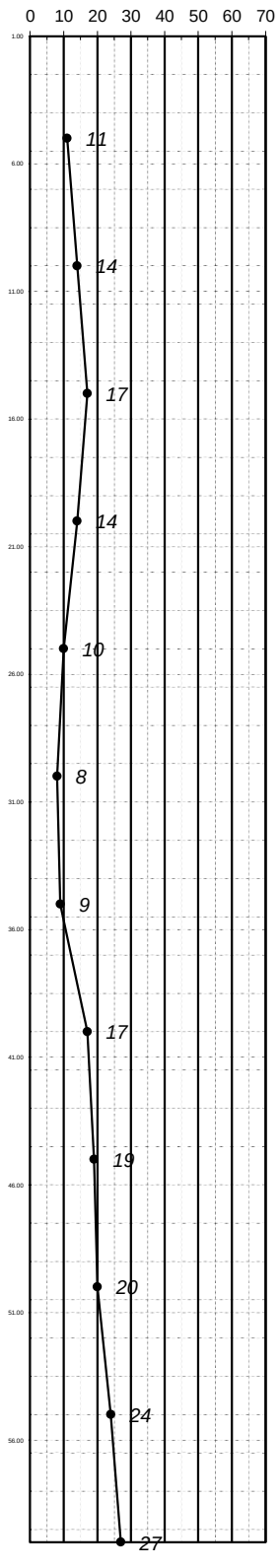
Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	: 5 (Five)
Boring Depth	: 60'-0"
G.W.L	: 6'-0" down
E.G.L	: 11'-0" down from road level
Date	: 5/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
		(23.00)							
5.0	D-1				3	5	6	**11**	
10.0	D-2		Pale red to reddish Yellow ash spotted medium plastic stiff Silty CLAY, CL.		4	6	8	**14**	
15.0	D-3				5	7	10	**17**	
20.0	D-4				4	5	9	**14**	
		23.00							
25.0	D-5				3	4	6	**10**	
30.0	D-6	(14.00)	Pale red ash spotted medium to low plastic stiff Clayey SILT, ML.		2	3	5	**8**	
35.0	D-7				3	3	6	**9**	
		37.00							
40.0	D-8	(5.00)	Reddish Yellow medium dense Sandy SILT, ML.		4	6	11	**17**	
		42.00							
45.0	D-9				5	7	12	**19**	
50.0	D-10	(19.00)	Pale reddish Yellow medium dense fine SAND, little/trace silt, SM.		6	8	12	**20**	
55.0	D-11				7	10	14	**24**	
60.0	D-12				7	12	15	**27**	
		61.00							



CREATIVE SOIL INVESTIGATION

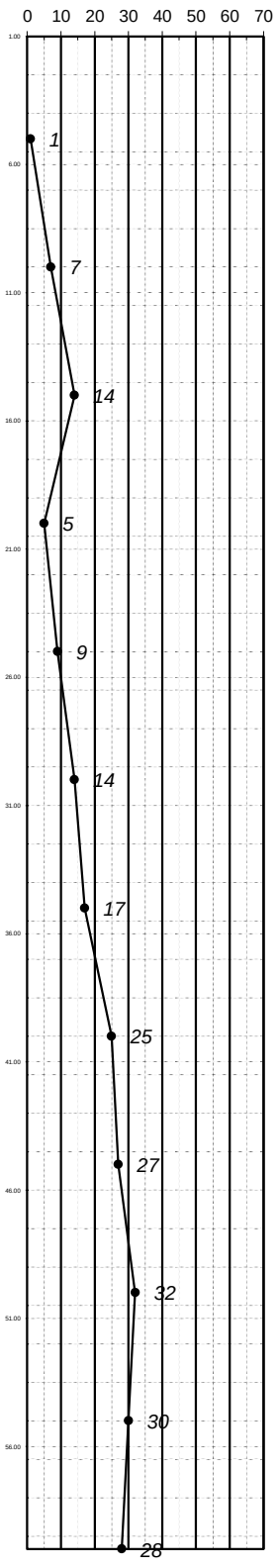
Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	: 6 (Six)
Boring Depth	: 60'-0"
G.W.L	: 4'-0" down
E.G.L	: 16'-5" down from road level
Date	: 6/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
5.0	D-1	(9.00)	Pale yellow medium plastic very soft Silty CLAY, CL.		1	0	1	**1**	
		9.00							
10.0	D-2		Pale red ash spotted medium plastic medium to stiff Silty CLAY, CL.		2	3	4	**7**	
15.0	D-3	(9.00)			4	6	8	**14**	
		18.00							
20.0	D-4		Pale reddish yellow low plastic stiff to very stiff Clayey SILT, ML.		1	2	3	**5**	
25.0	D-5				2	3	6	**9**	
30.0	D-6	(20.00)			3	5	9	**14**	
35.0	D-7				3	7	10	**17**	
		38.00							
40.0	D-8		Pale reddish yellow medium dense & dense very fine SAND, little/trace silt, SM.		6	10	15	**25**	
45.0	D-9				7	12	15	**27**	
50.0	D-10	(23.00)			8	14	18	**32**	
55.0	D-11				8	13	17	**30**	
60.0	D-12				7	12	16	**28**	
		61.00							



CREATIVE SOIL INVESTIGATION

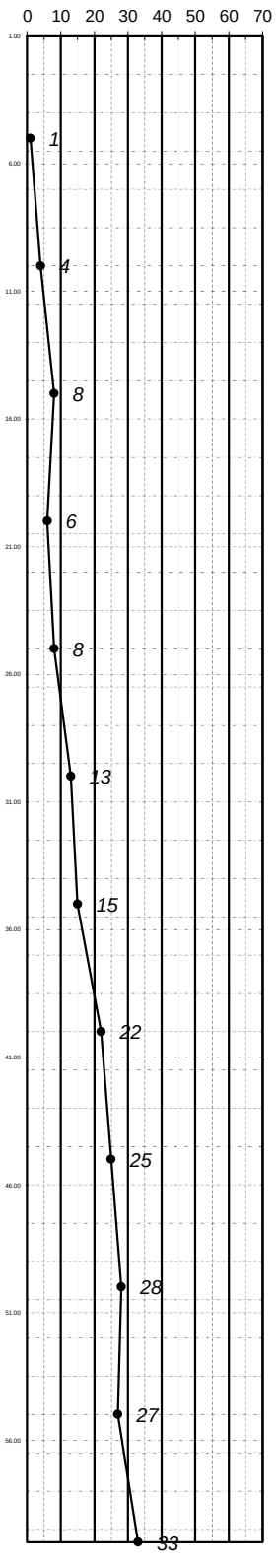
Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	: 7 (Seven)
Boring Depth	: 60'-0"
G.W.L	: 4'-0" down
E.G.L	: 16'-5" down from road level
Date	: 6/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
5.0	D-1	(9.00)	Pale yellow ash spotted medium plastic very soft Silty CLAY, CL.		1	0	1	**1**	
		9.00							
10.0	D-2		Pale yellow ash spotted medium plastic medium to stiff Silty CLAY, CL.		1	2	2	**4**	
15.0	D-3	(8.00)			2	3	5	**8**	
		17.00							
20.0	D-4		Pale red to reddish yellow low plastic medium to stiff Clayey SILT, ML.		2	2	4	**6**	
25.0	D-5				2	3	5	**8**	
		(20.00)							
30.0	D-6				3	5	8	**13**	
35.0	D-7				5	6	9	**15**	
		37.00							
40.0	D-8		Pale red to reddish yellow medium dense Sandy SILT, ML.		6	9	13	**22**	
		(10.00)							
45.0	D-9				6	11	14	**25**	
		47.00							
50.0	D-10		Pale reddish yellow medium dense to dense very fine SAND, little/ trace silt, SM.		8	12	16	**28**	
		(14.00)							
55.0	D-11				7	12	15	**27**	
60.0	D-12				6	15	18	**33**	
		61.00							



CREATIVE SOIL INVESTIGATION

Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	: 8 (Eight)
Boring Depth	: 60'-0"
G.W.L	: 6'-0" down
E.G.L	: 10'-0" down from road level
Date	: 7/8/2022

Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
									0 10 20 30 40 50 60 70
		(28.00)							
5.0	D-1				3	5	7	**12**	12
10.0	D-2				3	5	8	**13**	13
			Pale red ash spotted medium plastic stiff to very stiff Silty CLAY, CL.						
15.0	D-3				4	7	9	**16**	16
20.0	D-4				4	7	12	**19**	19
25.0	D-5				3	5	9	**14**	14
		28.00							
30.0	D-6				2	3	4	**7**	7
		(10.00)	Pale reddish yellow low plastic medium to stiff Clayey SILT, ML.						
35.0	D-7				3	3	5	**8**	8
		38.00							
40.0	D-8				5	8	10	**18**	18
		(10.00)	Pale reddish yellow medium dense Sandy SILT, ML.						
45.0	D-9				7	10	13	**23**	23
		48.00							
50.0	D-10				5	13	17	**30**	30
		(13.00)	Reddish yellow medium dense very fine SAND, little/trace silt, SM.						
55.0	D-11				6	12	15	**27**	27
60.0	D-12				7	13	16	**29**	29
		61.00							

CREATIVE SOIL INVESTIGATION

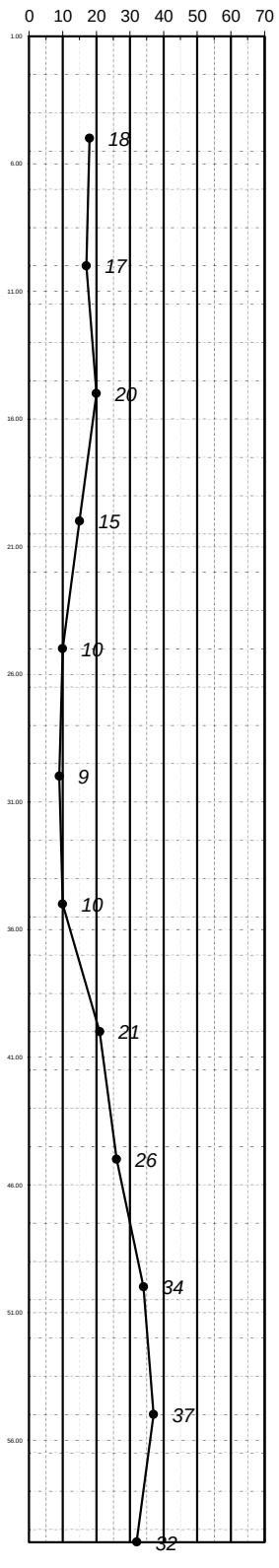
Client : Jahangirnagar University

Project : six storied social science faculty building with one basement

Location : Jahangirnagar, University, Savar, Dhaka.

Borehole No.	: 9 (Nine)
Boring Depth	: 60'-0"
G.W.L	: 6'-0" down
E.G.L	: 11'-8" down from road level
Date	: 7/8/2022

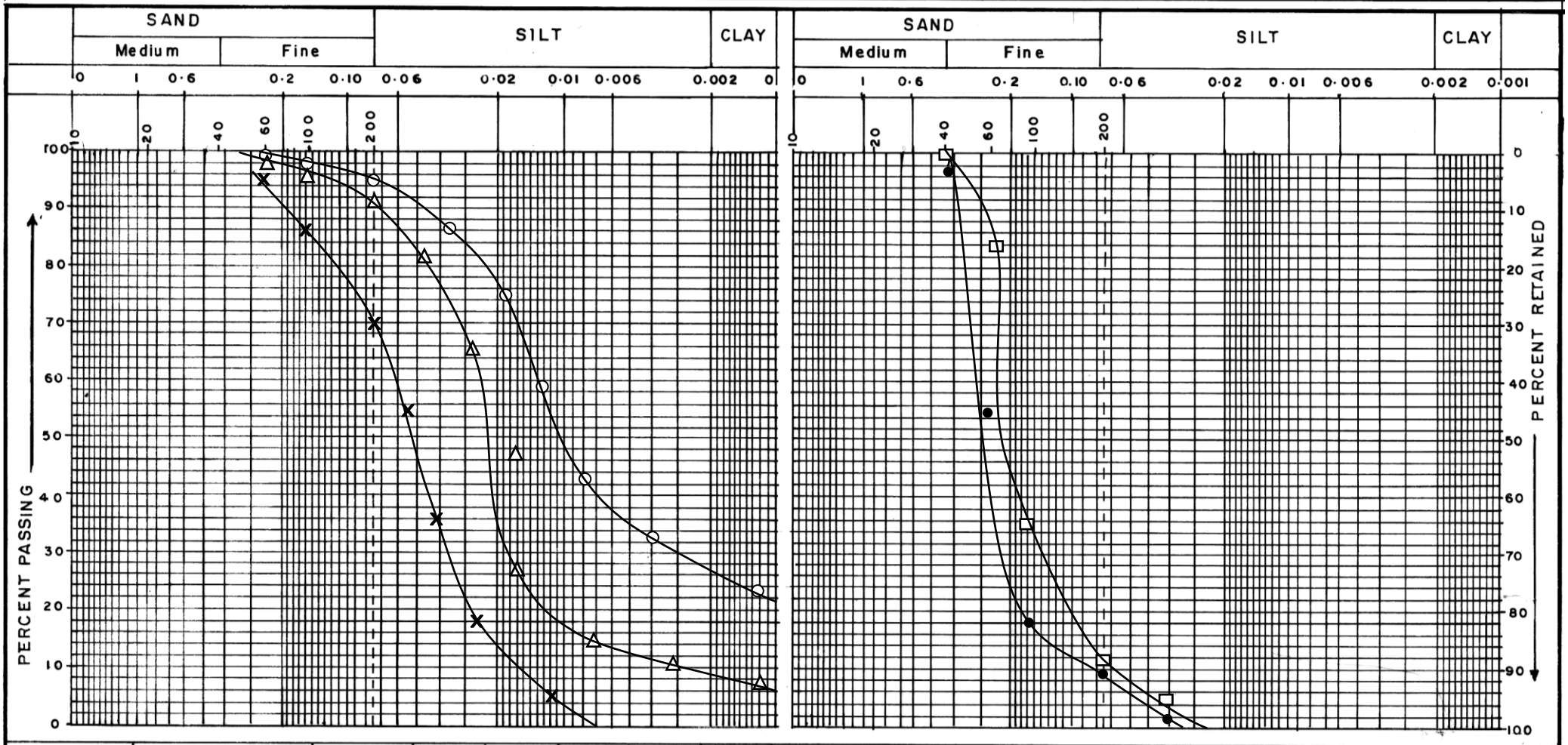
Depth (ft)	Sample Type & No.	Sample Depth (Thick)	Description of materials	Bore Log	Standard Penetration Test Values 6"	6"	6"	12"	S.P.T
5.0	D-1	(23.00)	Pale red ash spotted medium plastic very stiff Silty CLAY, CL.		5	8	10	**18**	
10.0	D-2				3	7	10	**17**	
15.0	D-3				5	8	12	**20**	
20.0	D-4				4	6	9	**15**	
25.0	D-5	23.00	Pale reddish yellow low plastic stiff Clayey SILT, ML.		3	4	6	**10**	
30.0	D-6	(15.00)			3	3	6	**9**	
35.0	D-7				4	4	6	**10**	
40.0	D-8	38.00	Pale reddish yellow to yellow medium dense very fine SAND, little/trace silt, SM.		5	9	12	**21**	
45.0	D-9				5	10	16	**26**	
50.0	D-10	(23.00)			7	15	19	**34**	
55.0	D-11				8	16	21	**37**	
60.0	D-12	61.00			7	14	18	**32**	



CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

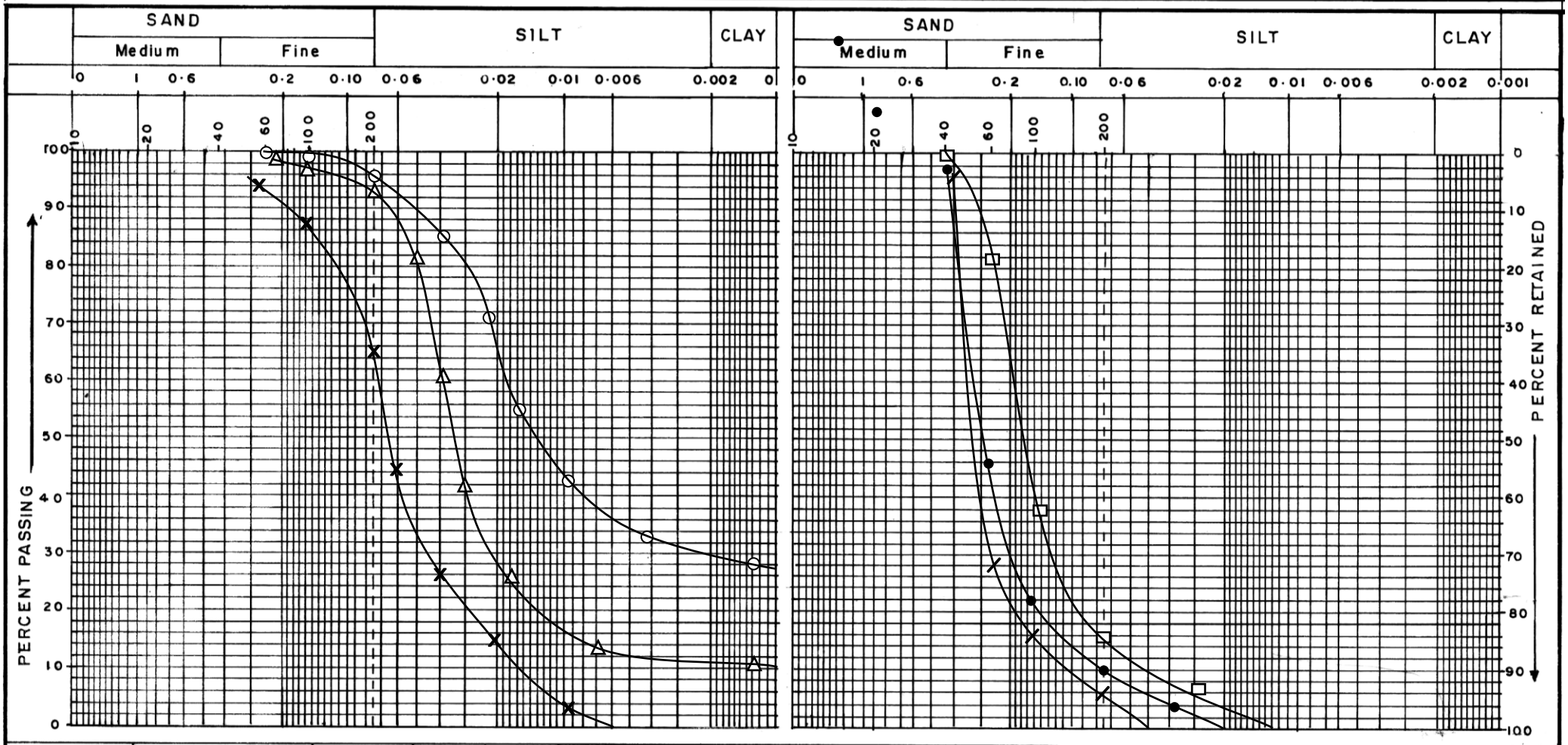


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-1	9'-6"-11'-0"	○—○							5.00	68.00	27.00
BH-1	24'-6"-26'-0"	△—△							9.00	82.00	9.00
BH-1	49'-6"-51'-0"	×—×							30.00	70.00	0.00
BH-1	64'-6"-66'-0"	□—□							88.00	12.00	0.00
BH-1	79'-6"-81'-0"	●—●							91.00	9.00	0.00

CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

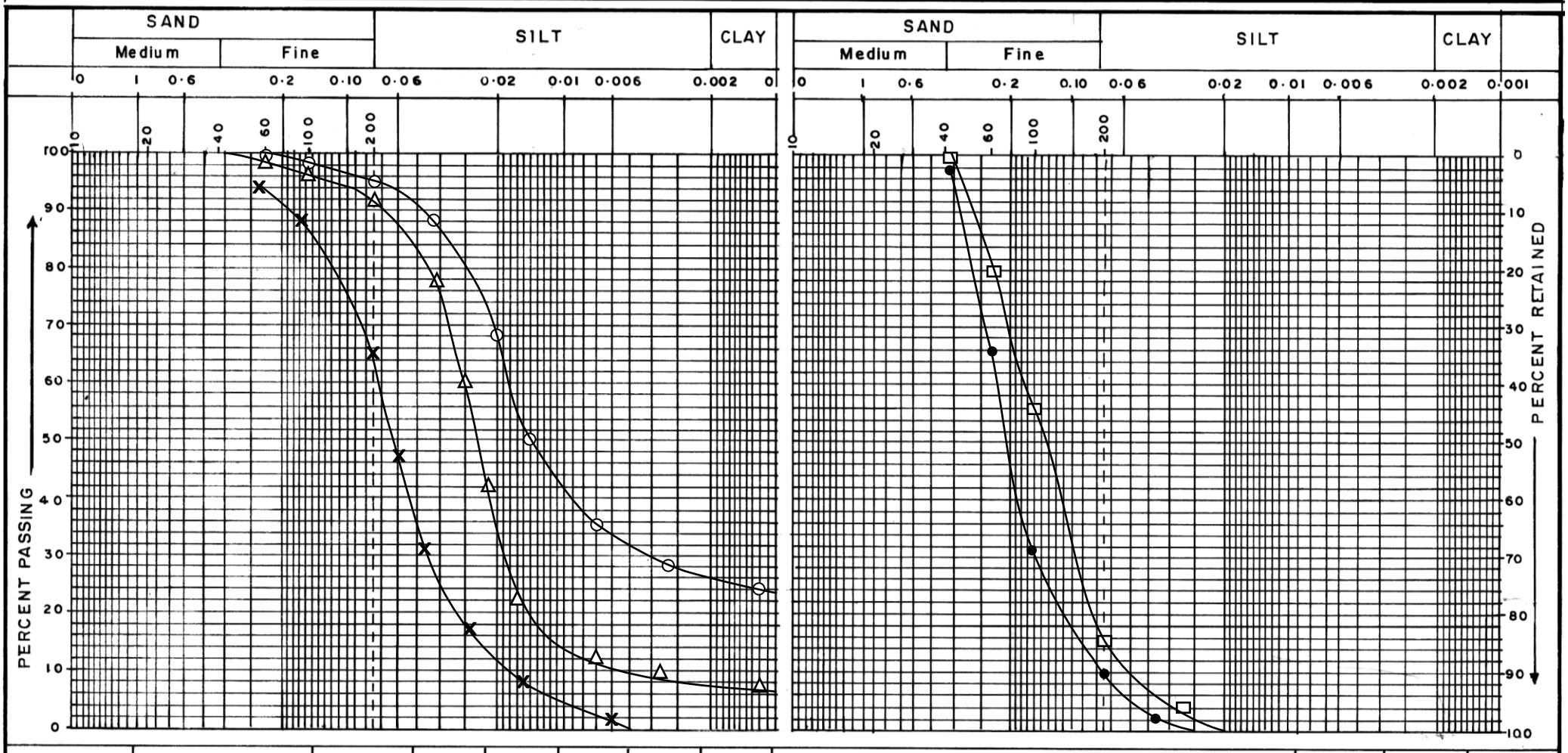


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-2	9'-6"-11'-0"	○—○							4.00	66.00	30.00
BH-2	24'-6"-26'-0"	△—△							7.00	81.00	12.00
BH-2	44'-6"-46'-0"	×—×							33.00	67.00	0.00
BH-2	59'-6"-61'-0"	□—□							85.00	15.00	0.00
BH-2	79'-6"-81'-0"	●—●							90.00	10.00	0.00
BH-2	99'-6"-101'-0"	⊢—⊣							94.00	6.00	0.00

CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

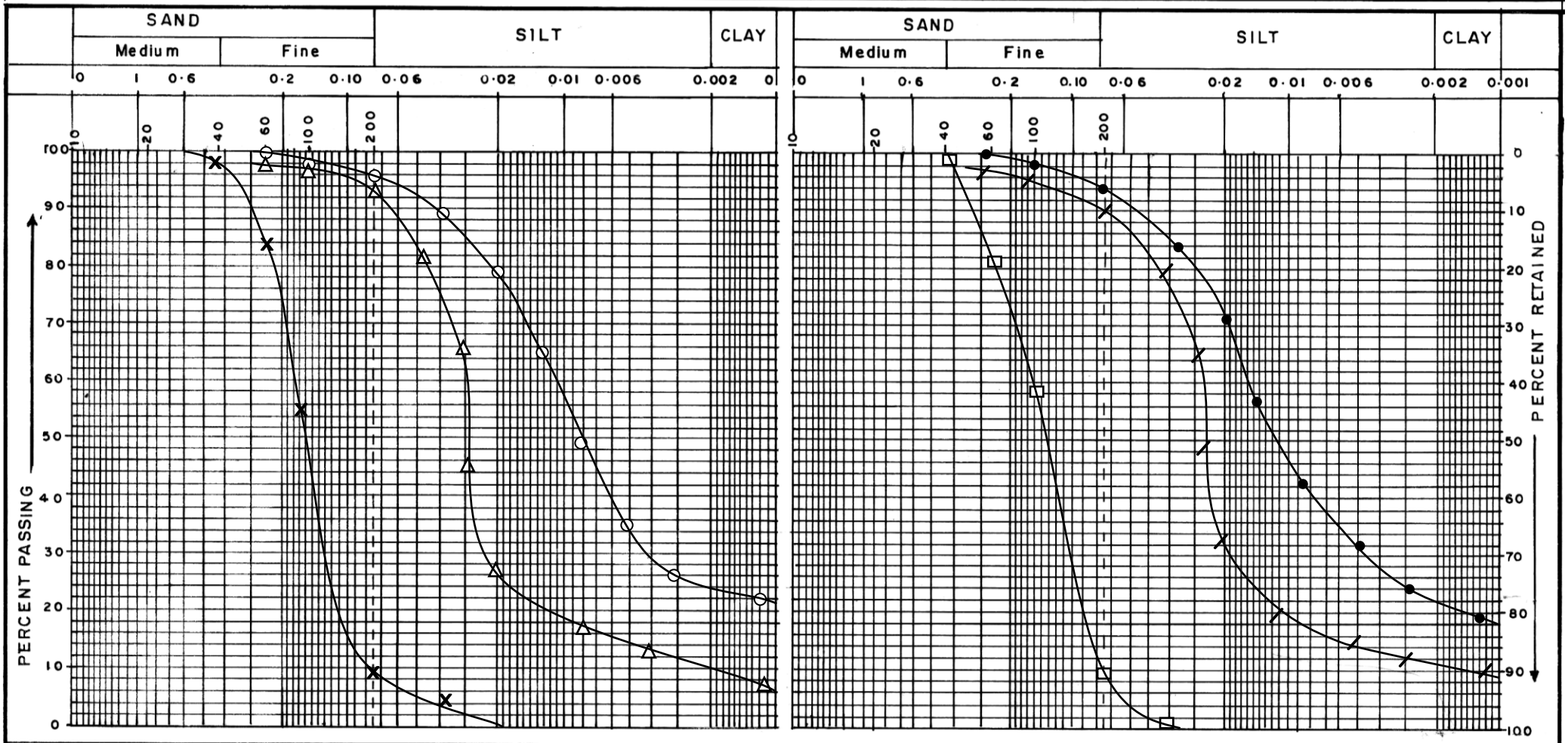


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-3	14'-6"-16'-0"	○—○							5.00	69.00	26.00
BH-3	29'-6"-31'-0"	△—△							9.00	83.00	8.00
BH-3	39'-6"-41'-0"	×—×							35.00	65.00	0.00
BH-3	59'-6"-61'-0"	□—□							86.00	14.00	0.00
BH-3	79'-6"-81'-0"	●—●							90.00	10.00	0.00

CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

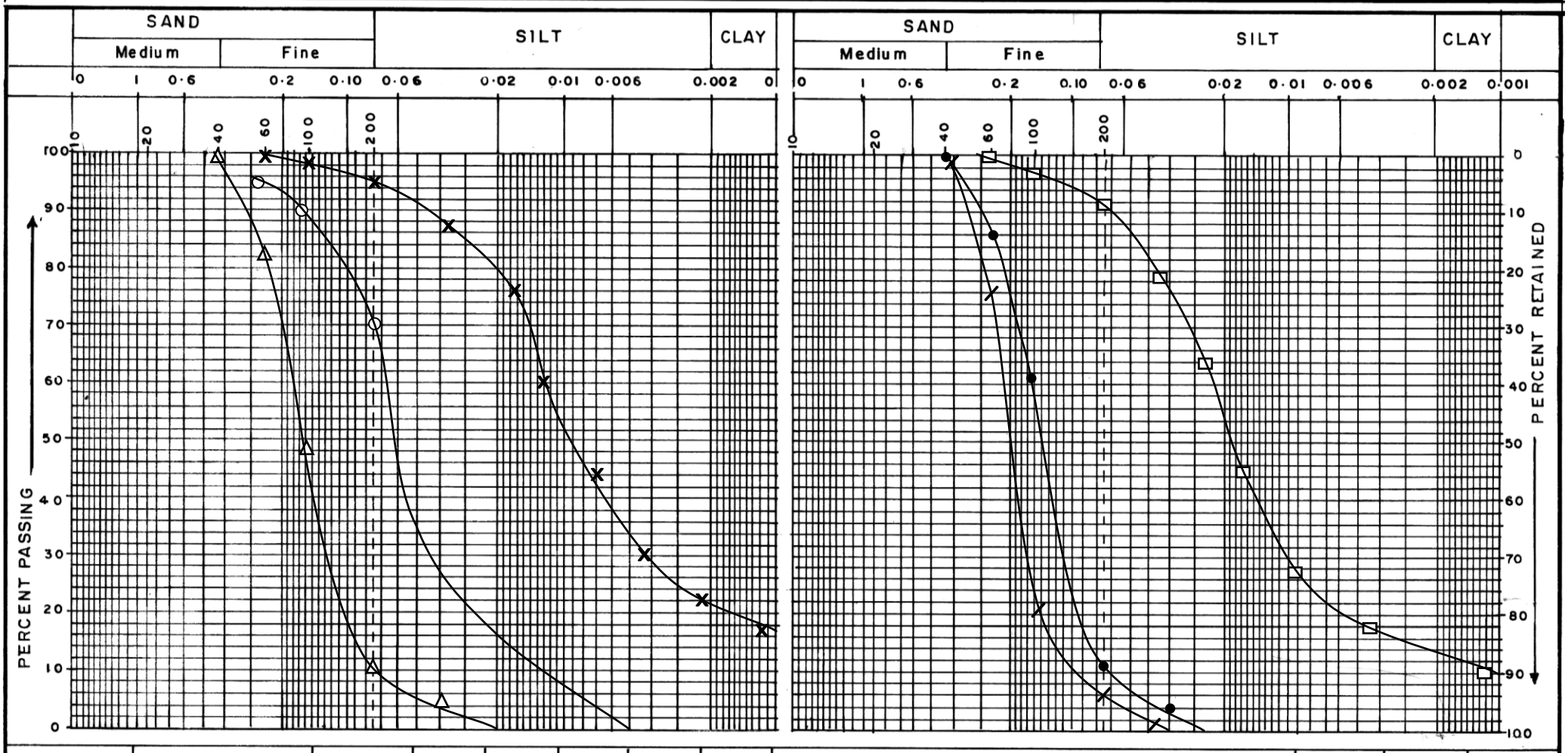


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-4	9'-6"-11'-0"	○—○							4.00	72.00	24.00
BH-4	24'-6"-26'-0"	△—△							7.00	84.00	9.00
BH-4	39'-6"-41'-0"	×—×							90.00	10.00	0.00
BH-4	59'-6"-61'-0"	□—□							89.00	11.00	0.00
BH-5	9'-6"-11'-0"	●—●							6.00	72.00	22.00
BH-5	24'-6"-26'-0"	⊢—⊣							10.00	79.00	11.00

CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

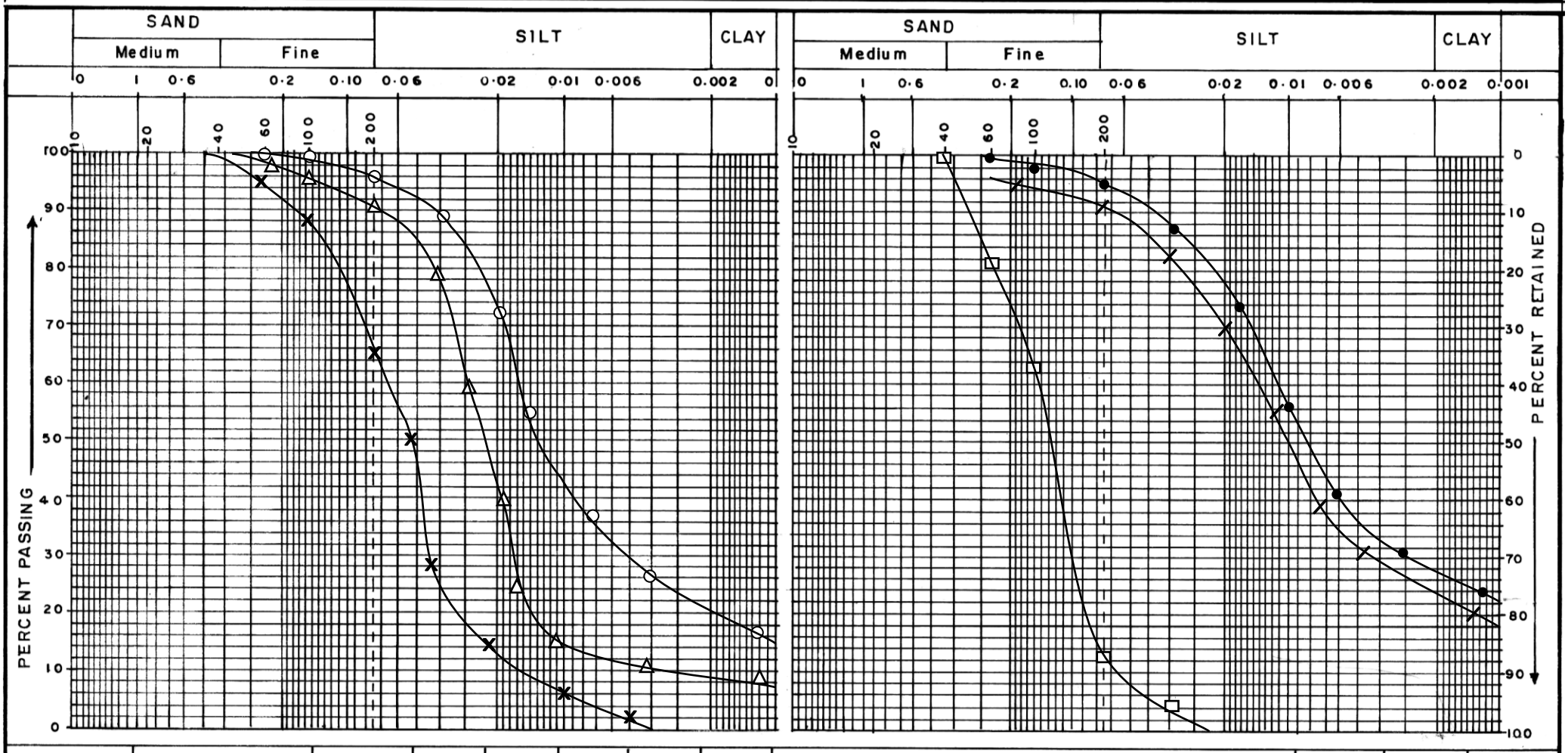


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-5	39'-6"-41'-0"	○—○							30.00	70.00	0.00
BH-5	59'-6"-61'-0"	△—△							90.00	10.00	0.00
BH-6	9'-6"-11'-0"	×—×							5.00	74.00	21.00
BH-6	24'-6"-26'-0"	□—□							9.00	79.00	12.00
BH-6	39'-6"-41'-0"	●—●							89.00	11.00	0.00
BH-6	59'-6"-61'-0"	⊢—⊣							94.00	6.00	0.00

CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

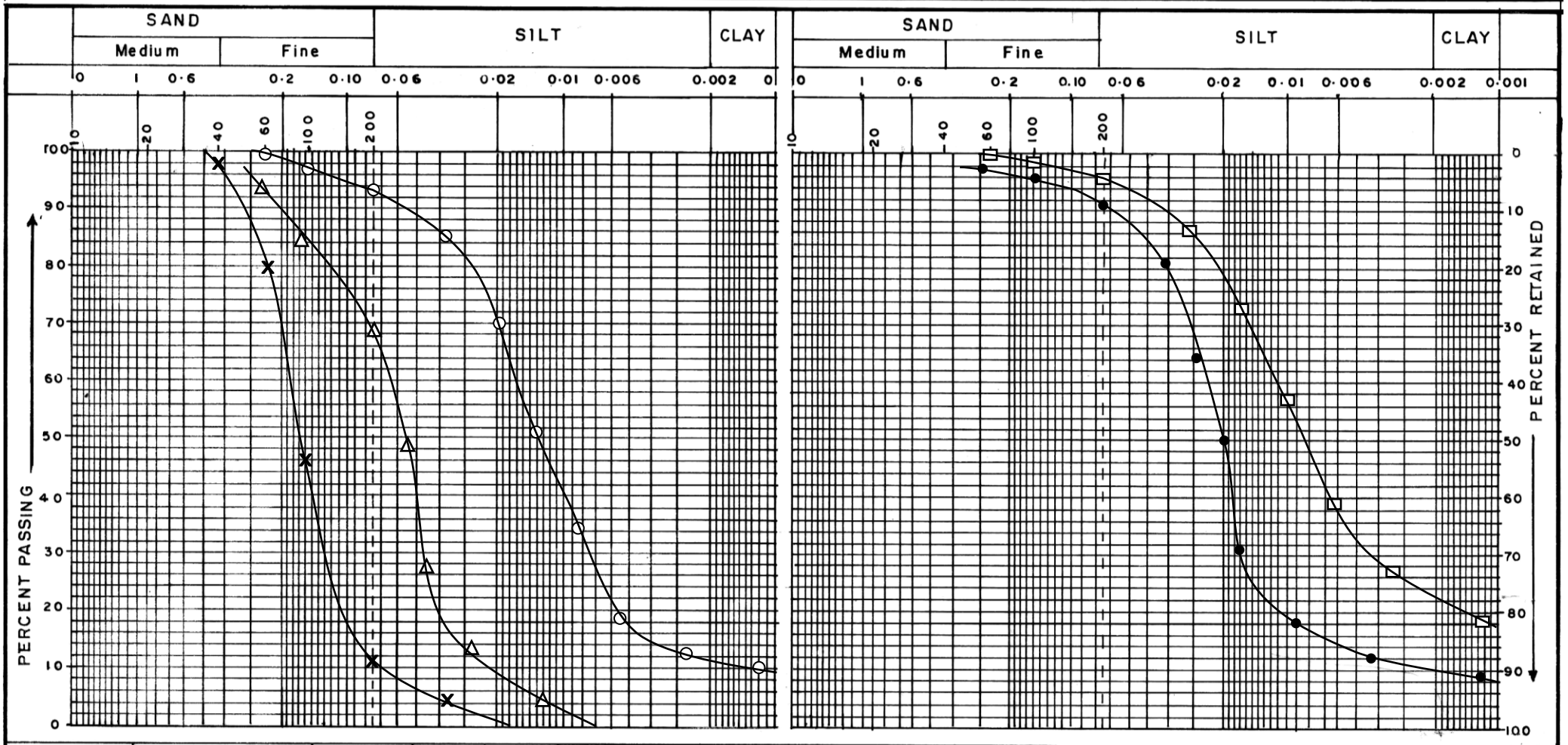


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-7	14'-6"-16'-0"	○—○							4.00	75.00	21.00
BH-7	29'-6"-31'-0"	△—△							9.00	83.00	8.00
BH-7	44'-6"-46'-0"	×—×							35.00	65.00	0.00
BH-7	59'-6"-61'-0"	□—□							87.00	13.00	0.00
BH-8	9'-6"-11'-0"	●—●							6.00	68.00	26.00
BH-8	24'-6"-26'-0"	⊢—⊣							9.00	67.00	24.00

CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

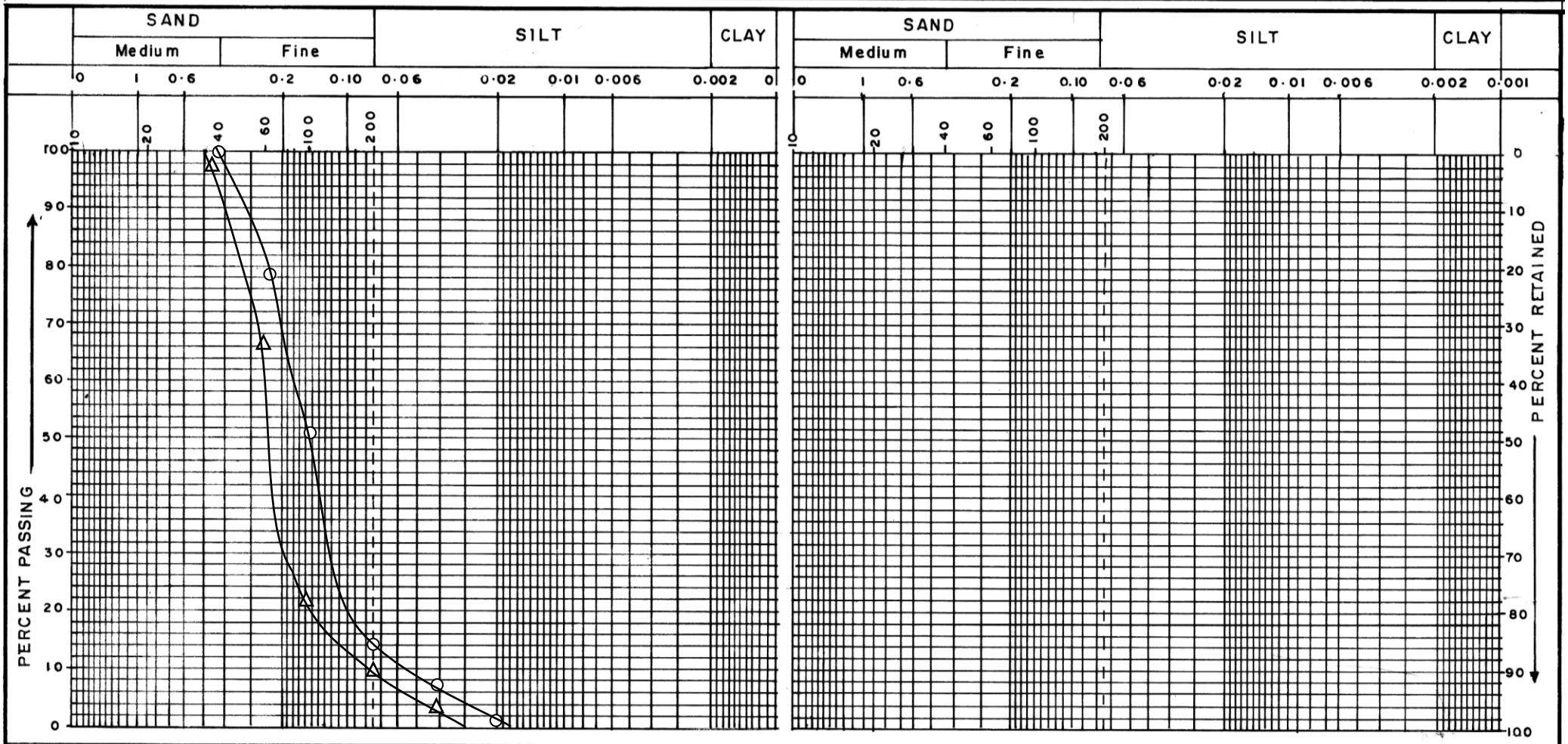


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-8	34'-6"-36'-0"	○—○							6.00	82.00	12.00
BH-8	44'-6"-46'-0"	△—△							31.00	69.00	0.00
BH-8	59'-6"-61'-0"	×—×							91.00	9.00	0.00
BH-9	9'-6"-11'-0"	□—□							4.00	74.00	22.00
BH-9	24'-6"-26'-0"	●—●							8.00	82.00	10.00

CREATIVE SOIL INVESTIGATION

GRAIN SIZE DISTRIBUTION

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

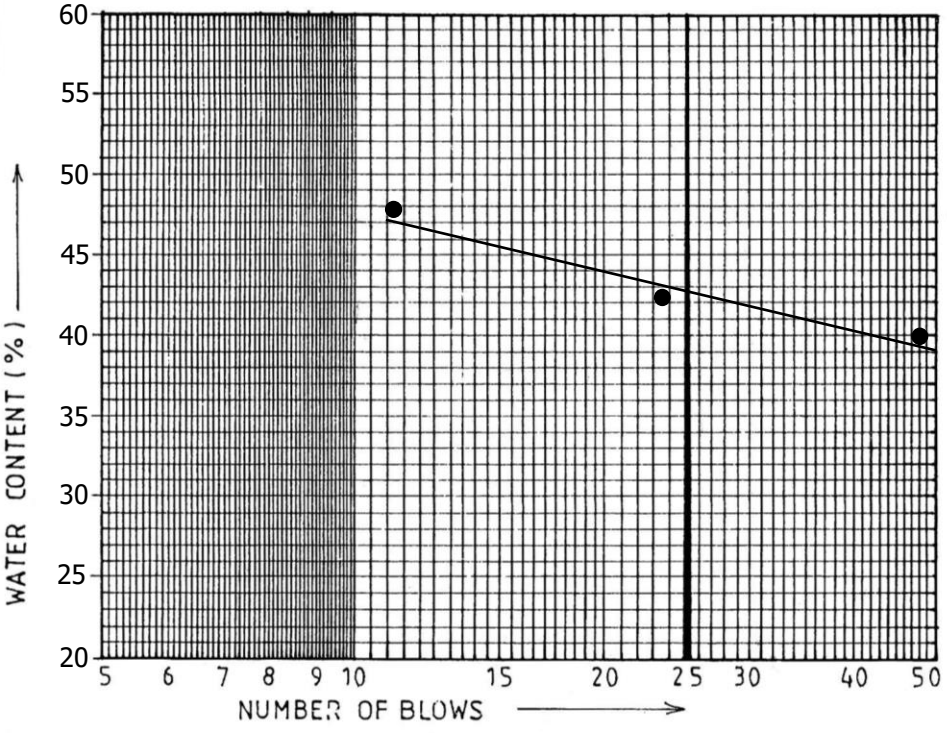


HOLE NO.	DEPTH IN FT./M	SYMBOL	D_{60}	D_{30}	D_{10}	C_U	C_Z	SOIL CLASSIFICATION	SAND(%)	SILT(%)	CLAY(%)
BH-9	39'-6"-41'-0"	○—○							86.00	14.00	0.00
BH-9	59'-6"-61'-0"	△—△							90.00	10.00	0.00

CREATIVE SOIL INVESTIGATION

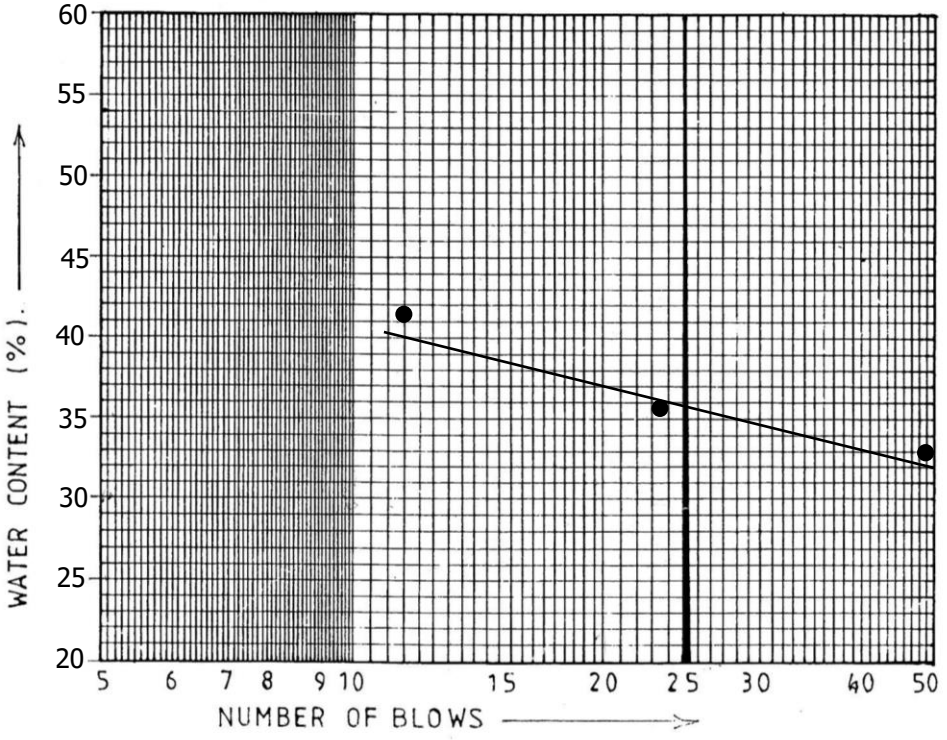
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



BORING HOLE NO.	BH-1
SAMPLE NO.	D-3
DEPTH	14'-6"-16'-0"
LIQUID LIMIT.	42.60
PLASTIC LIMIT.	25.50
PLASTICITY INDEX.	17.10

ATTERBERG LIMIT
FLOW CURVE

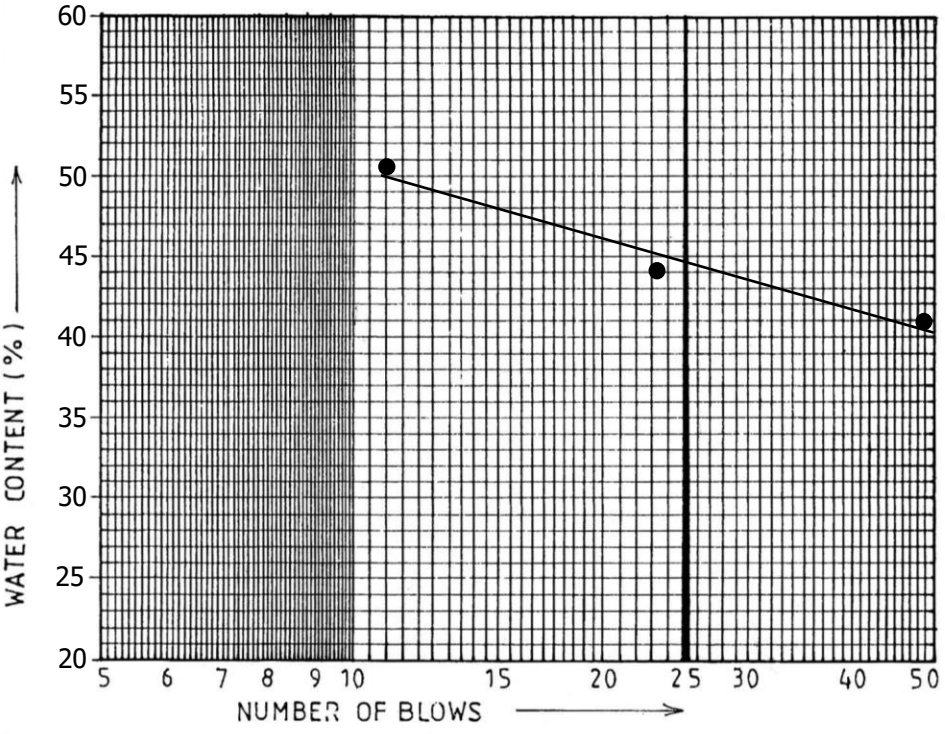


BORING HOLE NO.	BH-1
SAMPLE NO.	D-6
DEPTH	29'-6"-31'-0"
LIQUID LIMIT.	35.80
PLASTIC LIMIT.	26.50
PLASTICITY INDEX.	9.30

CREATIVE SOIL INVESTIGATION

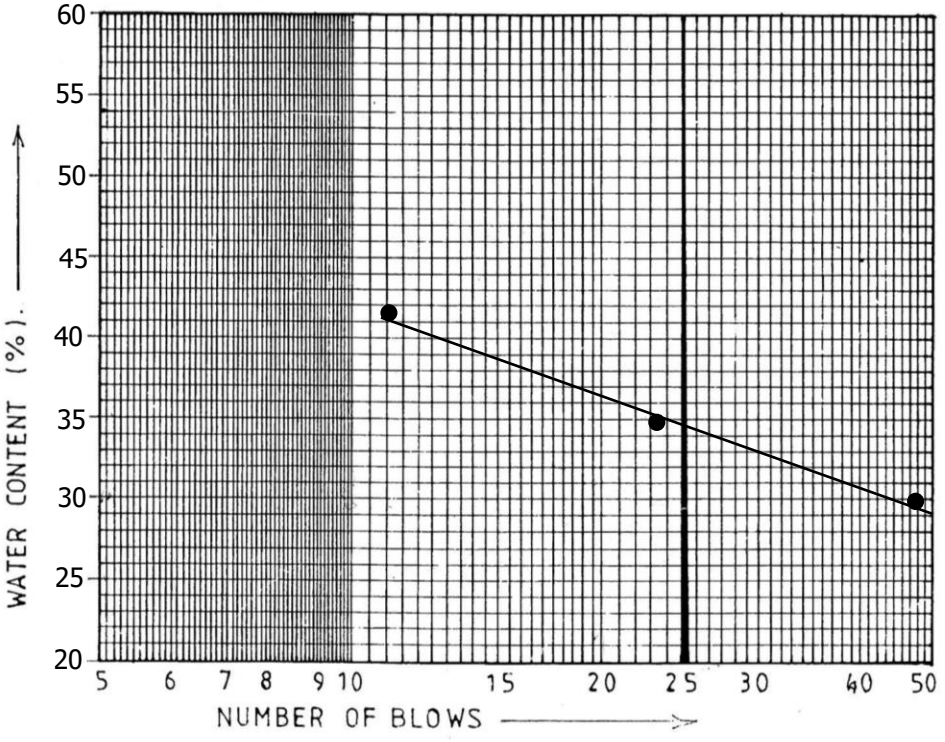
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



BORING HOLE NO.	BH-2
SAMPLE NO.	D-3
DEPTH	14'-6"-16'-0"
LIQUID LIMIT.	44.80
PLASTIC LIMIT.	25.50
PLASTICITY INDEX.	19.30

ATTERBERG LIMIT
FLOW CURVE

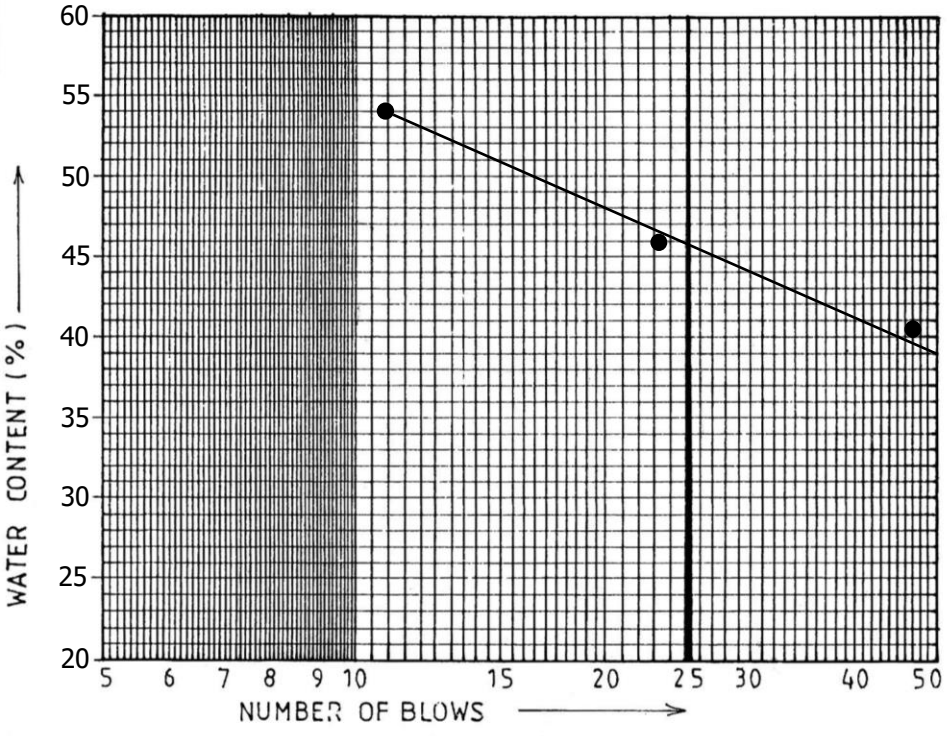


BORING HOLE NO.	BH-2
SAMPLE NO.	D-6
DEPTH	29'-6"-31'-0"
LIQUID LIMIT.	34.80
PLASTIC LIMIT.	26.50
PLASTICITY INDEX.	8.30

CREATIVE SOIL INVESTIGATION

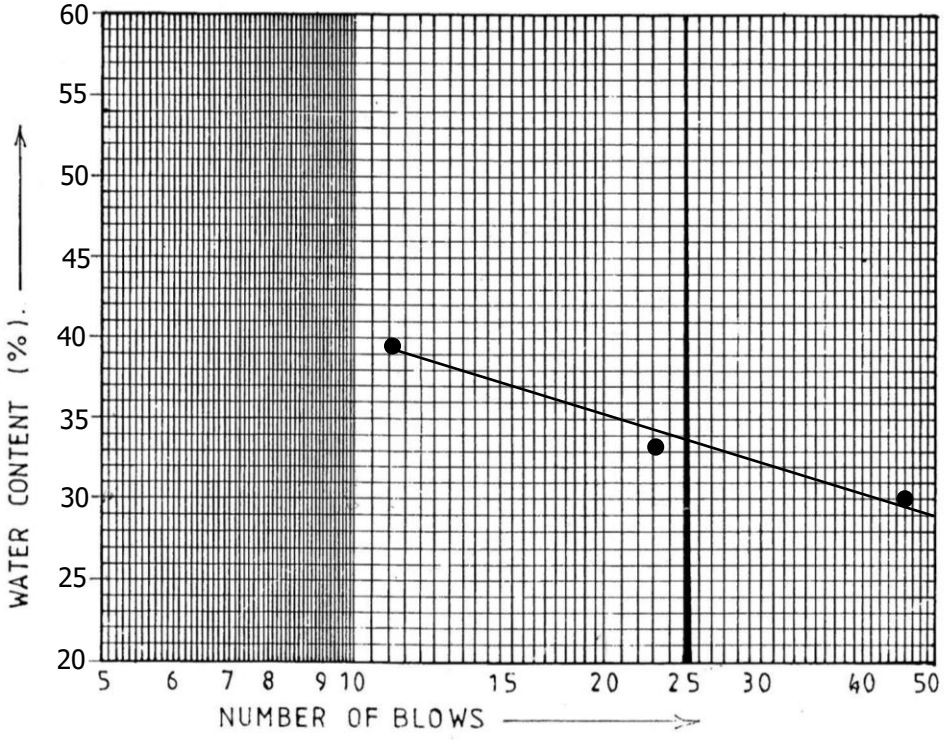
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



BORING HOLE NO.	BH-3
SAMPLE NO.	D-2
DEPTH	9'-6"-11'-0"
LIQUID LIMIT.	45.80
PLASTIC LIMIT.	25.50
PLASTICITY INDEX.	19.70

ATTERBERG LIMIT
FLOW CURVE

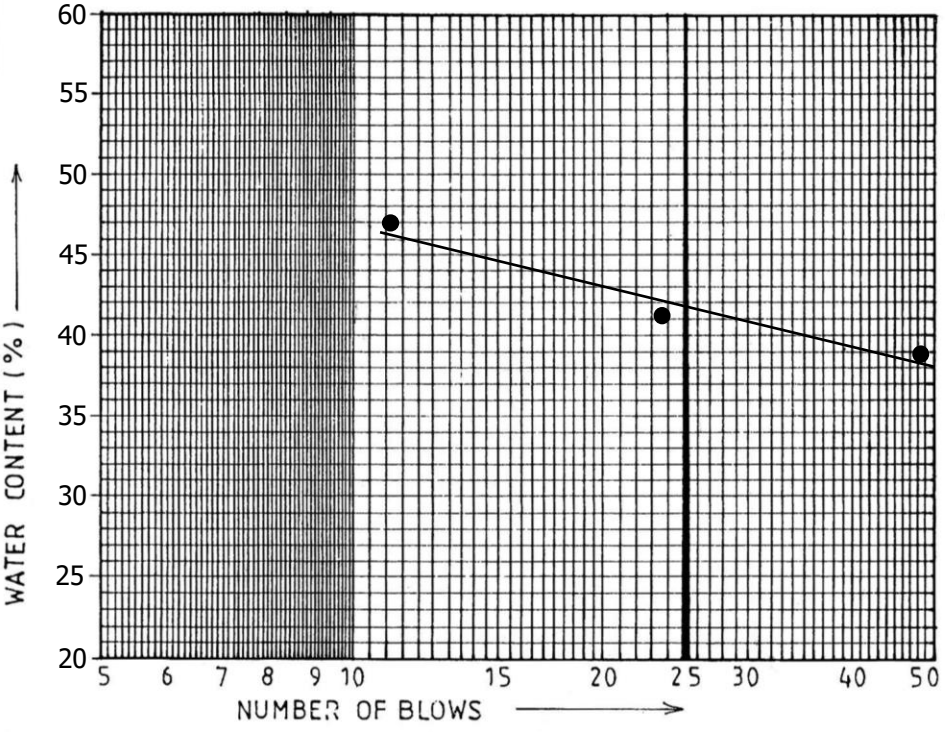


BORING HOLE NO.	BH-3
SAMPLE NO.	D-7
DEPTH	34'-6"-36'-0"
LIQUID LIMIT.	33.60
PLASTIC LIMIT.	26.50
PLASTICITY INDEX.	7.10

CREATIVE SOIL INVESTIGATION

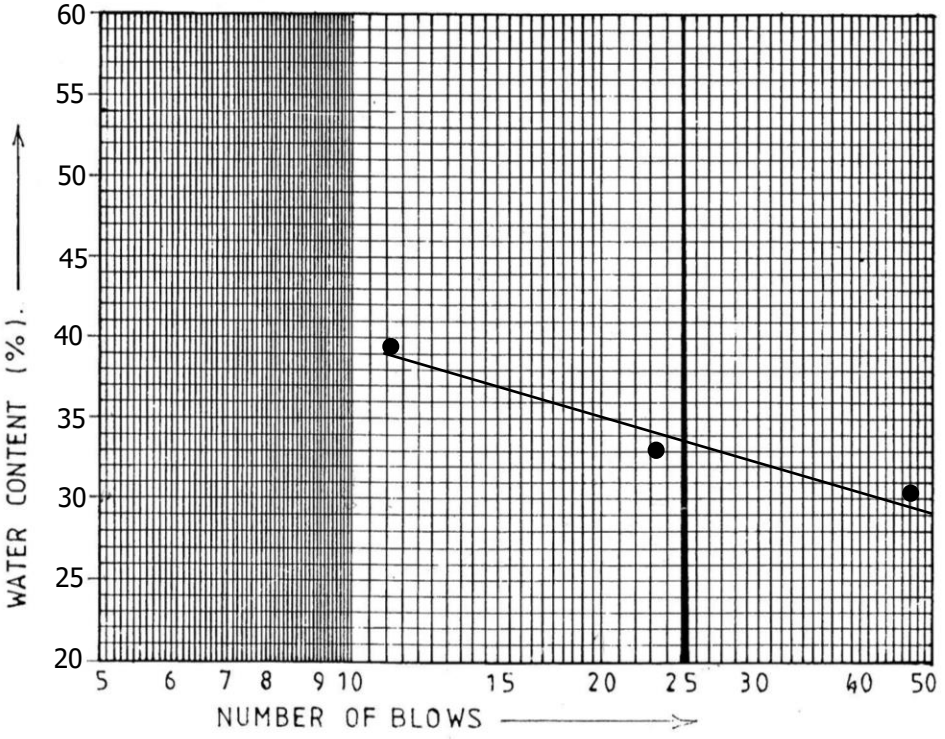
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



BORING HOLE NO.	BH-4
SAMPLE NO.	D-3
DEPTH	14'-6"-16'-0"
LIQUID LIMIT.	41.90
PLASTIC LIMIT.	24.50
PLASTICITY INDEX.	17.40

ATTERBERG LIMIT
FLOW CURVE

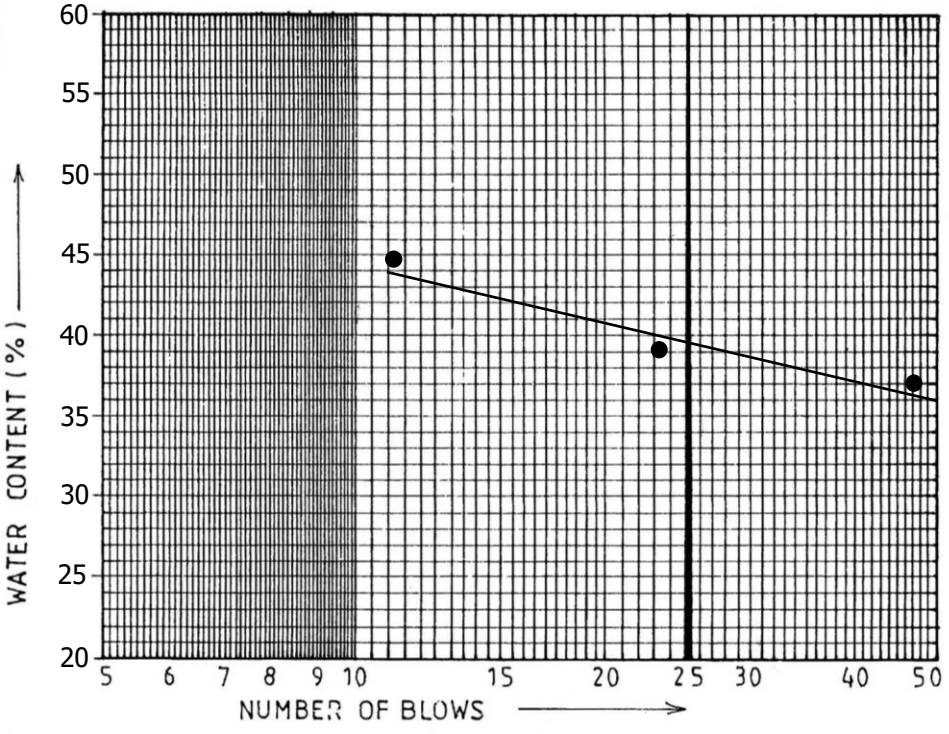


BORING HOLE NO.	BH-4
SAMPLE NO.	D-7
DEPTH	34'-6"-36'-0"
LIQUID LIMIT.	33.60
PLASTIC LIMIT.	26.50
PLASTICITY INDEX .	7.10

CREATIVE SOIL INVESTIGATION

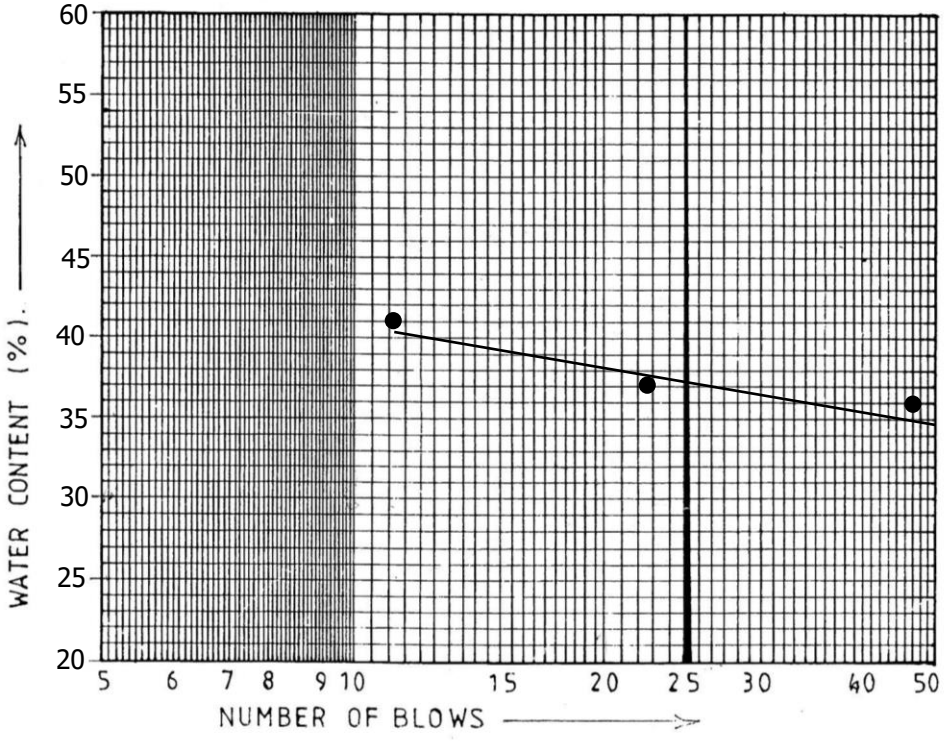
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT FLOW CURVE



BORING HOLE NO.	BH-5
SAMPLE NO.	D-3
DEPTH	14'-6"-16'-0"
LIQUID LIMIT.	39.70
PLASTIC LIMIT.	24.50
PLASTICITY INDEX.	15.30

ATTERBERG LIMIT FLOW CURVE

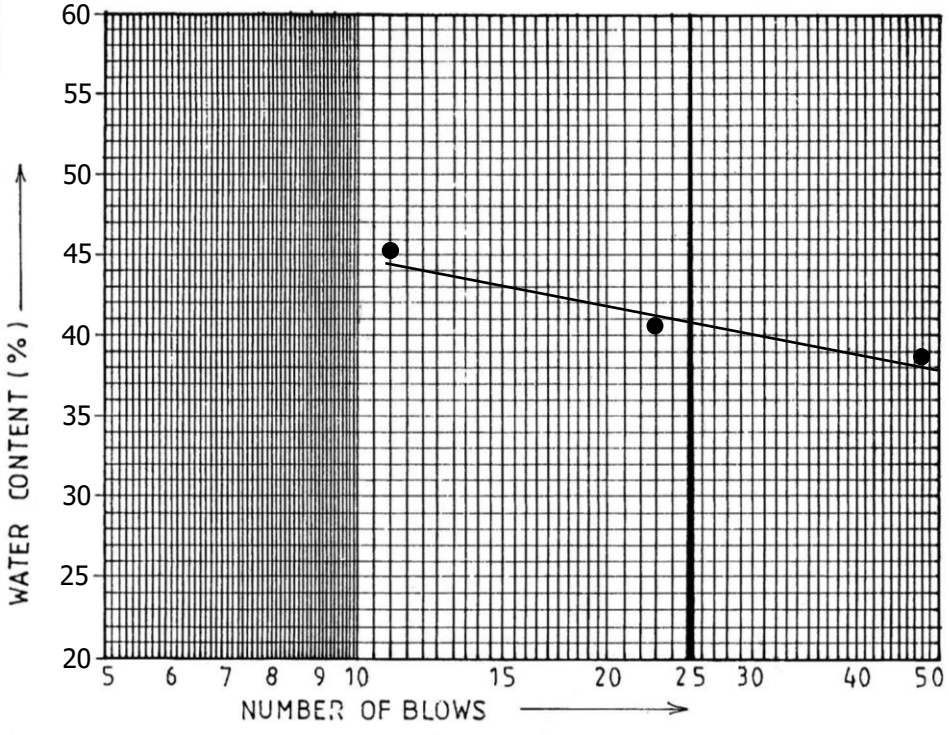


BORING HOLE NO.	BH-5
SAMPLE NO.	D-6
DEPTH	29'-6"-31'-0"
LIQUID LIMIT.	37.30
PLASTIC LIMIT.	26.50
PLASTICITY INDEX	10.80

CREATIVE SOIL INVESTIGATION

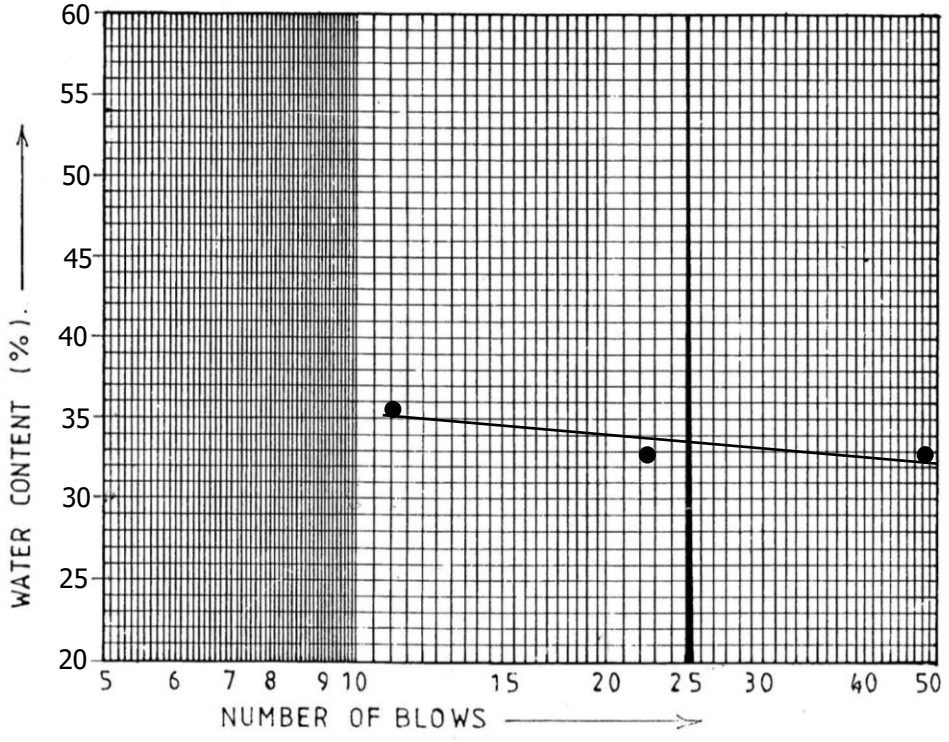
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



BORING HOLE NO.	BH-6
SAMPLE NO.	D-3
DEPTH	14'-6"-16'-0"
LIQUID LIMIT.	40.80
PLASTIC LIMIT.	24.50
PLASTICITY INDEX.	16.30

ATTERBERG LIMIT
FLOW CURVE

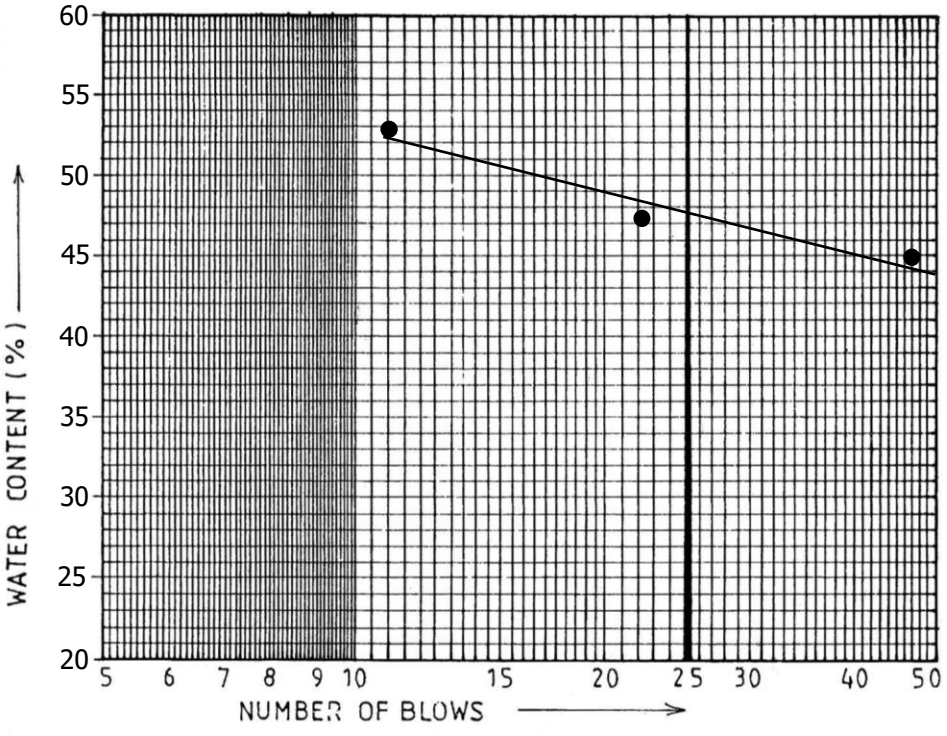


BORING HOLE NO.	BH-6
SAMPLE NO.	D-6
DEPTH	29'-6"-31'-0"
LIQUID LIMIT.	33.80
PLASTIC LIMIT.	25.50
PLASTICITY INDEX .	8.30

CREATIVE SOIL INVESTIGATION

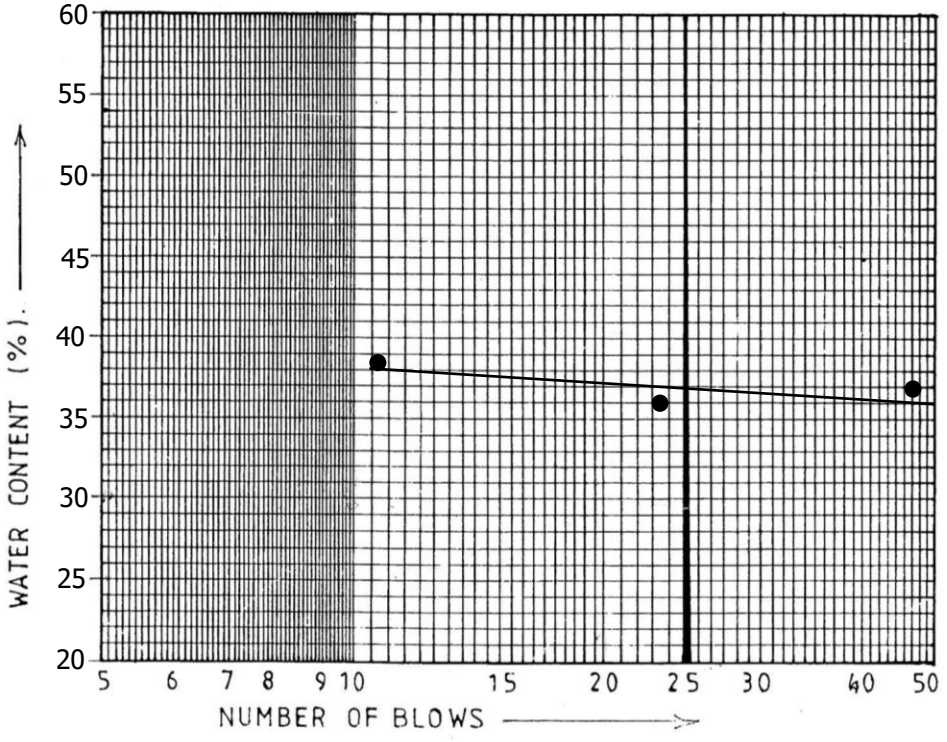
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



BORING HOLE NO.	BH-7
SAMPLE NO.	D-2
DEPTH	9'-6"-11'-0"
LIQUID LIMIT.	47.90
PLASTIC LIMIT.	26.50
PLASTICITY INDEX.	21.40

ATTERBERG LIMIT
FLOW CURVE

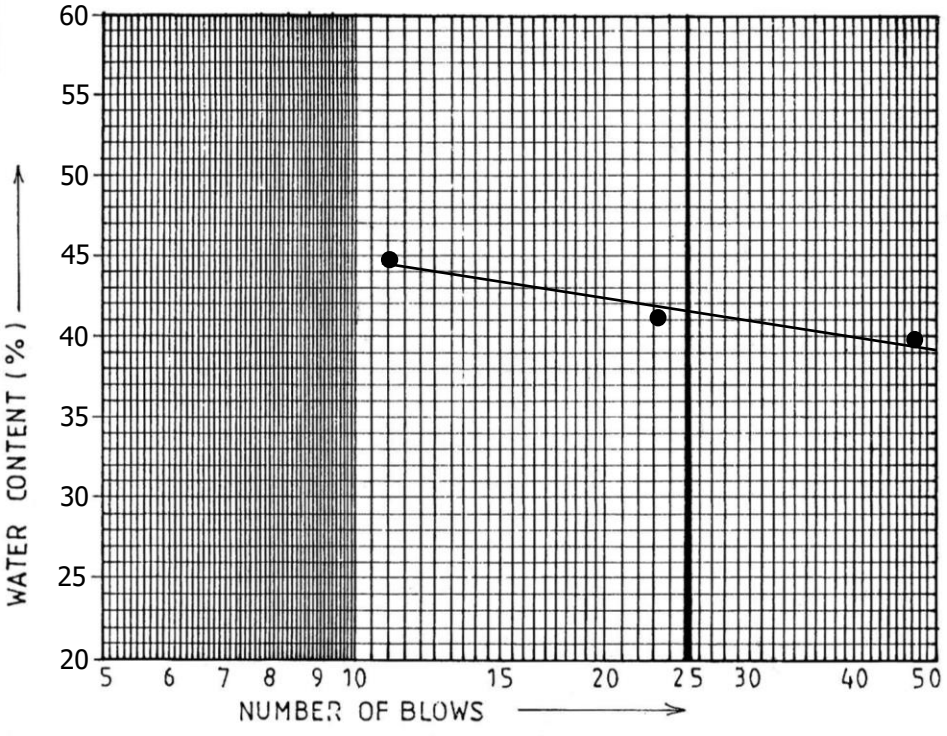


BORING HOLE NO.	BH-7
SAMPLE NO.	D-7
DEPTH	34'-6"-36'-0"
LIQUID LIMIT.	36.80
PLASTIC LIMIT.	26.50
PLASTICITY INDEX	10.30

CREATIVE SOIL INVESTIGATION

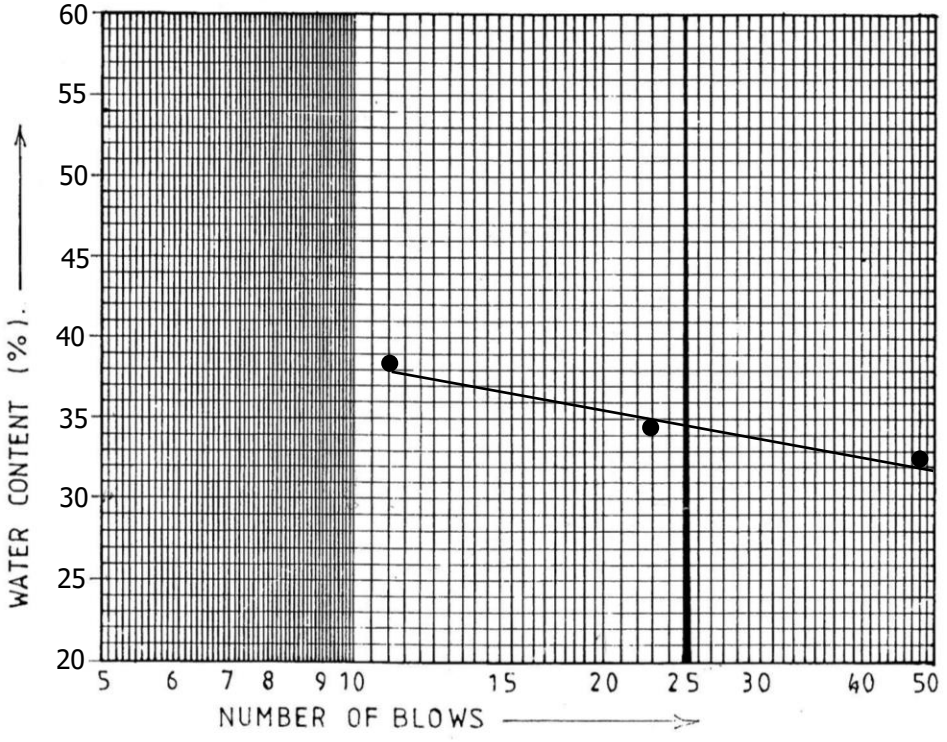
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



BORING HOLE NO.	BH-8
SAMPLE NO.	D-3
DEPTH	14'-6"-16'-0"
LIQUID LIMIT.	41.60
PLASTIC LIMIT.	25.50
PLASTICITY INDEX.	16.10

ATTERBERG LIMIT
FLOW CURVE

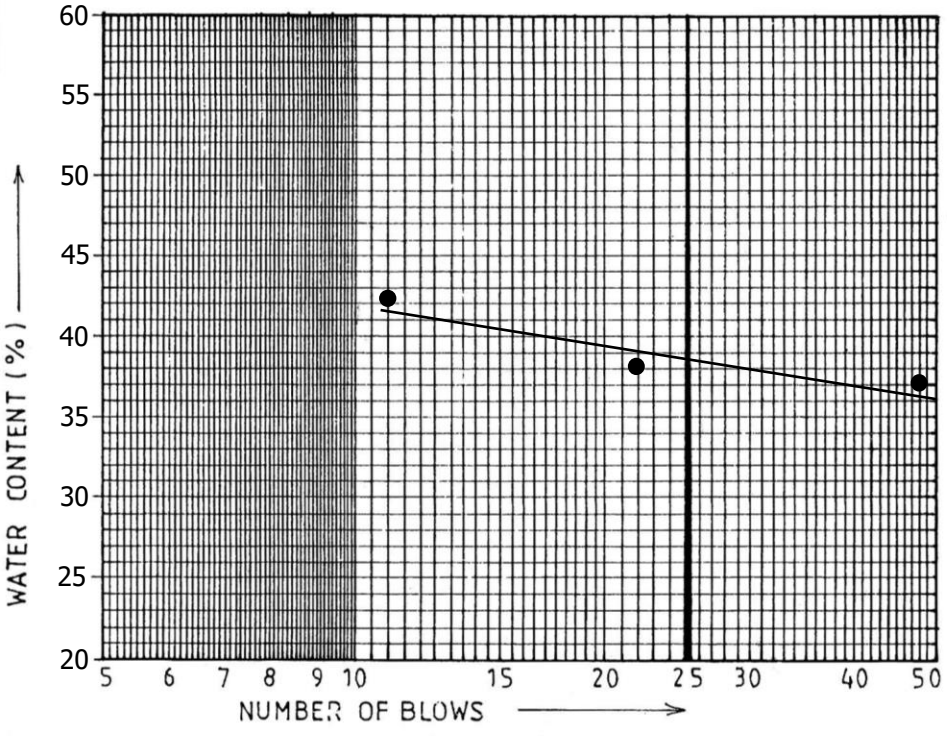


BORING HOLE NO.	BH-8
SAMPLE NO.	D-6
DEPTH	29'-6"-31'-0"
LIQUID LIMIT.	34.70
PLASTIC LIMIT.	26.50
PLASTICITY INDEX .	8.20

CREATIVE SOIL INVESTIGATION

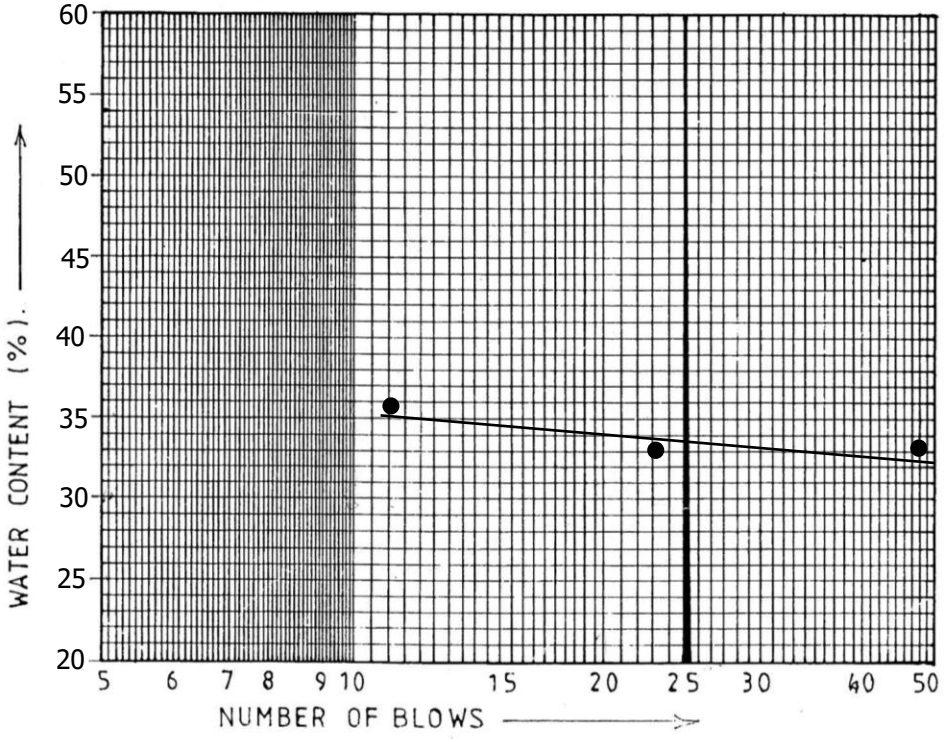
CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

ATTERBERG LIMIT
FLOW CURVE



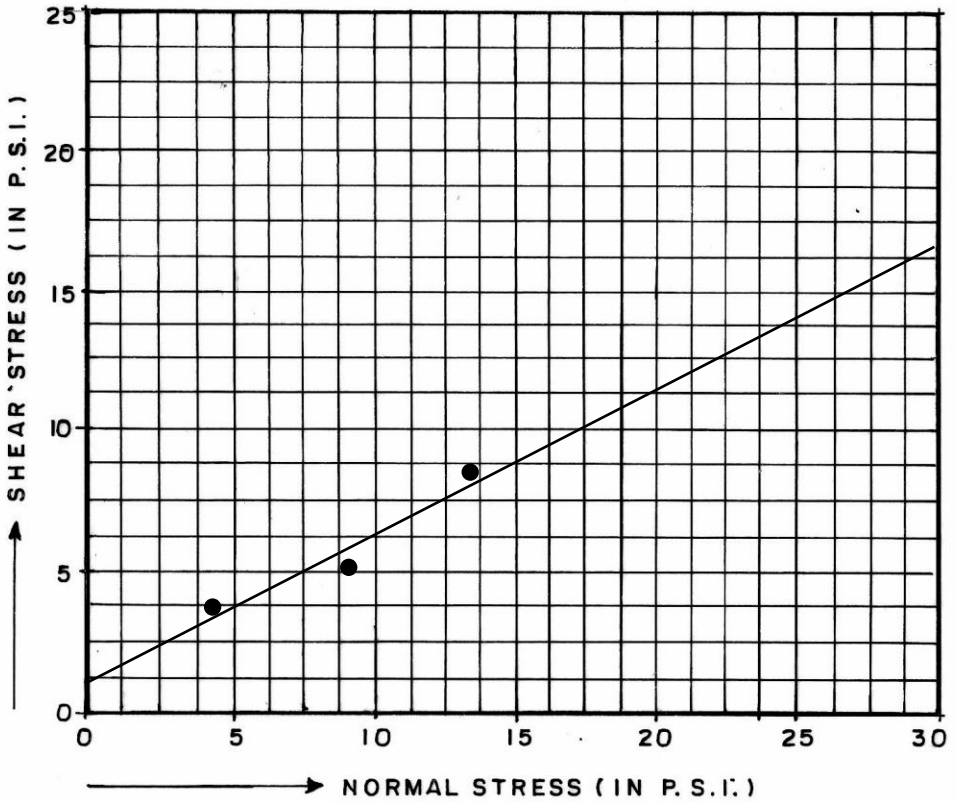
BORING HOLE NO.	BH-9
SAMPLE NO.	D-3
DEPTH	14'-6"-16'-0"
LIQUID LIMIT.	38.80
PLASTIC LIMIT.	23.50
PLASTICITY INDEX.	15.30

ATTERBERG LIMIT
FLOW CURVE

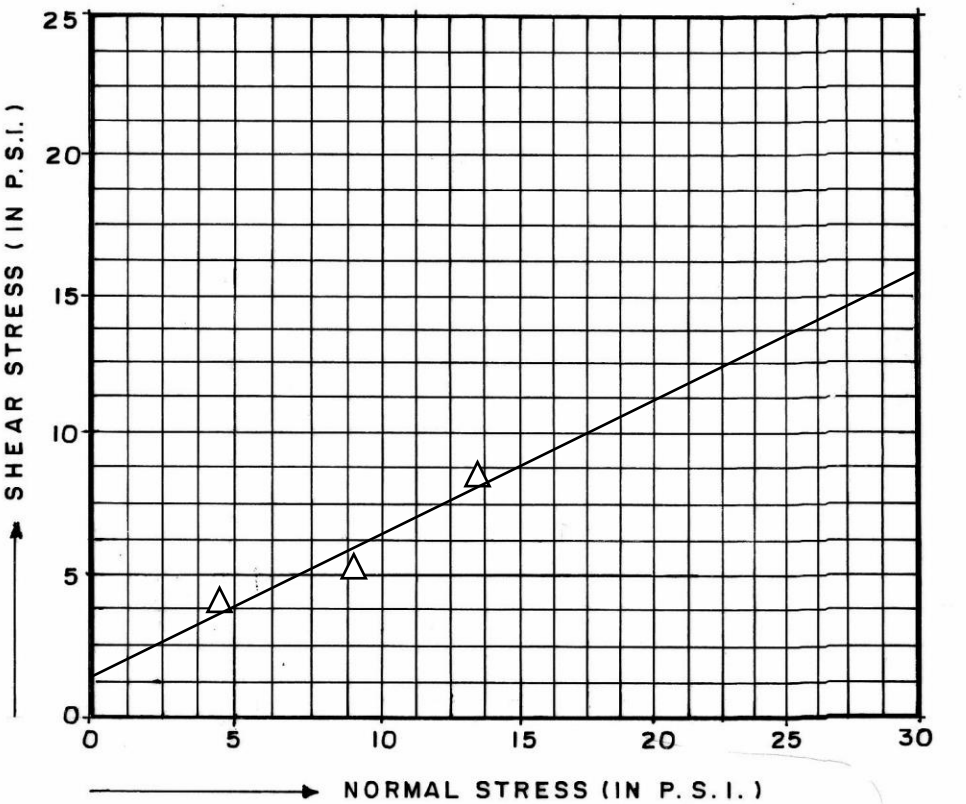


BORING HOLE NO.	BH-9
SAMPLE NO.	D-6
DEPTH	29'-6"-31'-0"
LIQUID LIMIT.	33.60
PLASTIC LIMIT.	26.50
PLASTICITY INDEX.	7.10

CREATIVE SOIL INVESTIGATION	DIRECT SHEAR TEST	CLIENT : JAHANGIRNAGAR UNIVERSITY PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT LOCATION : SAVAR, DHAKA.



BORE HOLE NO	BH-1	SAMPLE	D-11
DEPTH (FT/MT)	54'-6"-56'-0"	SYMBOL	●—●
COHESION (IN P.S.I)	1.25	ANGLE OF INTERNAL FRICTION	27.6°

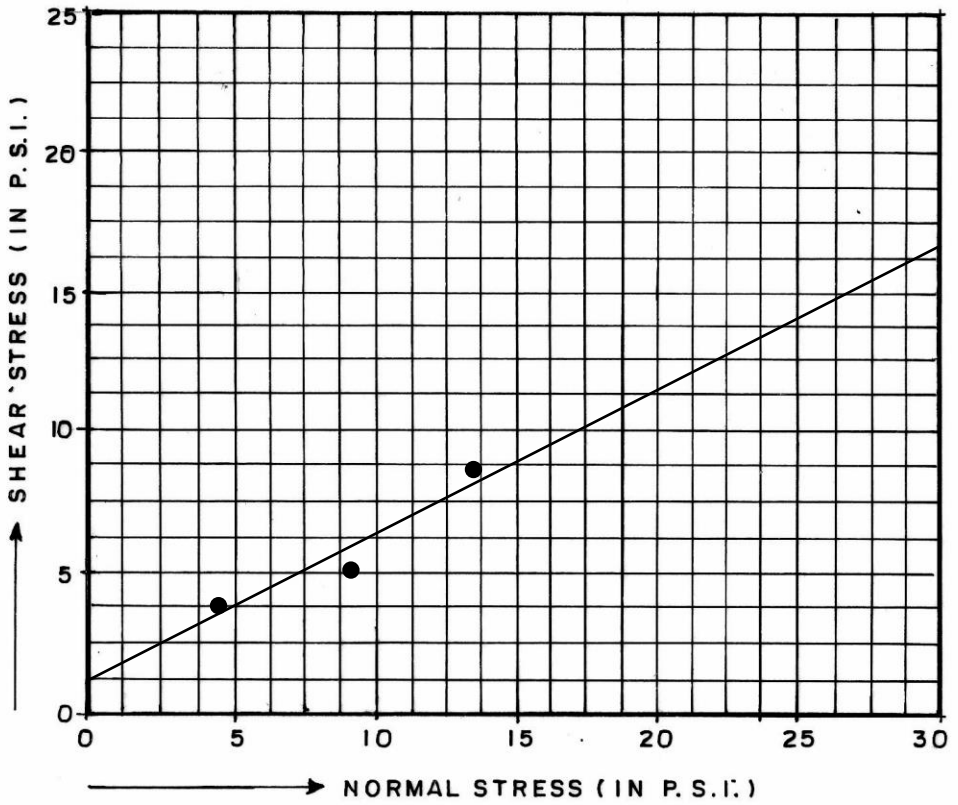


BORE HOLE NO	BH-1	SAMPLE	D-14
DEPTH (FT/MT)	69'-6"-71'-0"	SYMBOL	△—△
COHESION (IN P.S.I)	1.60	ANGLE OF INTERNAL FRICTION	25.5°

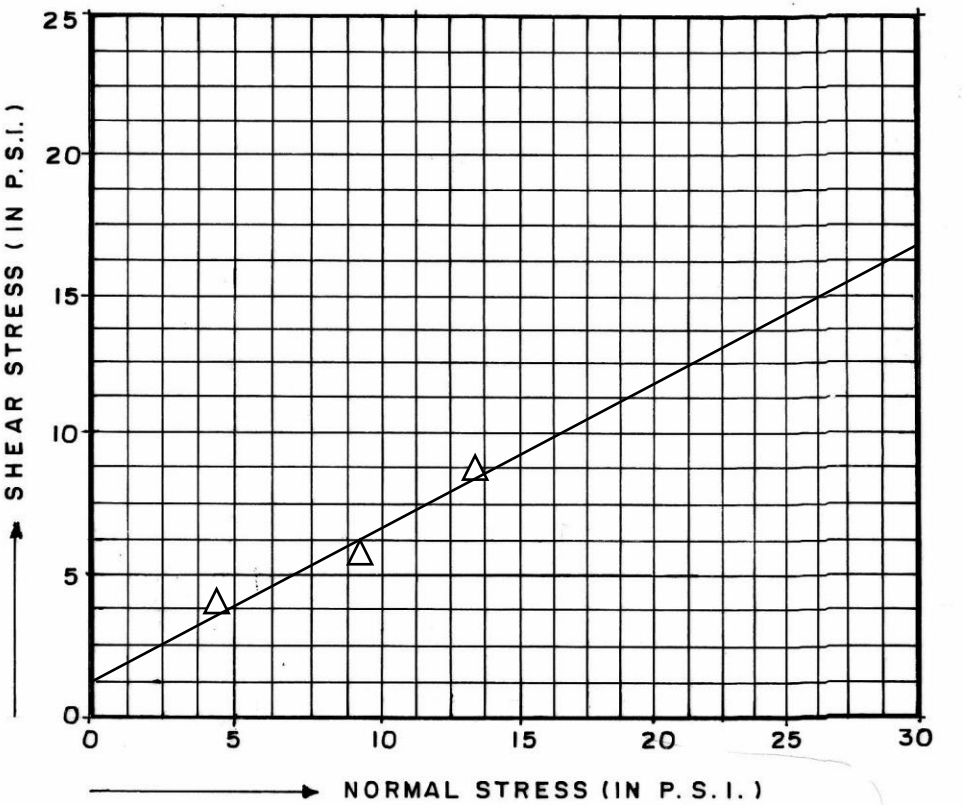
CREATIVE SOIL INVESTIGATION

DIRECT SHEAR TEST

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.

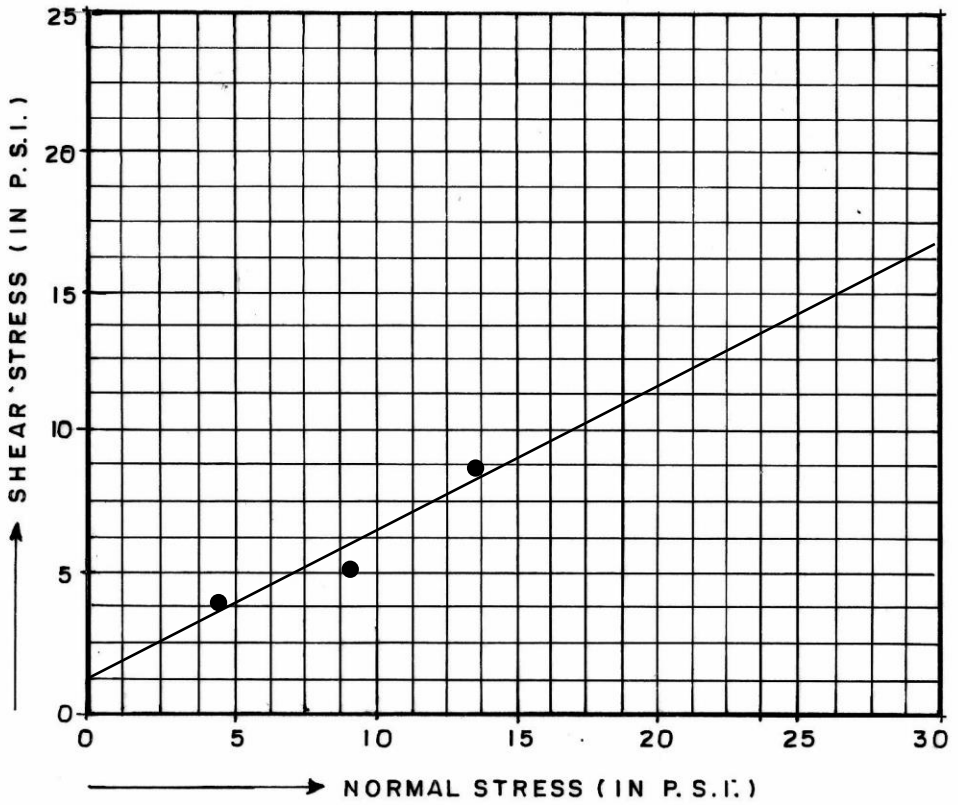


BORE HOLE NO	BH-2	SAMPLE	D-13
DEPTH (FT/MT)	64'-6"-66'-0"	SYMBOL	●—●
COHESION (IN P.S.I)	1.25	ANGLE OF INTERNAL FRICTION	27.0°

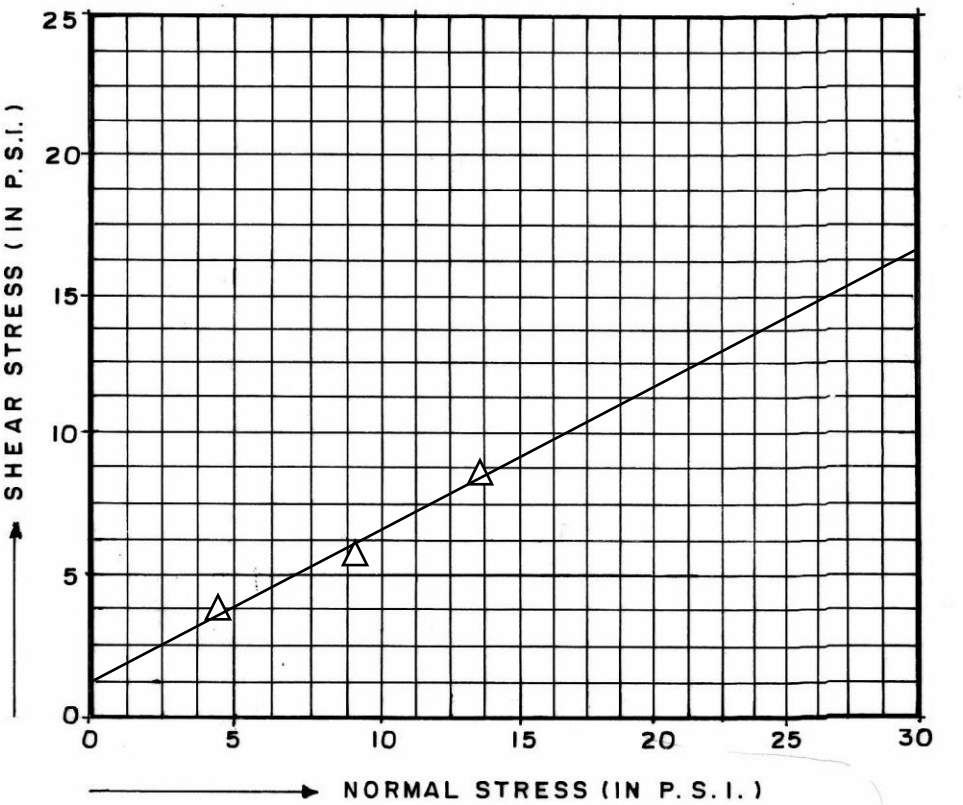


BORE HOLE NO	BH-2	SAMPLE	D-17
DEPTH (FT/MT)	84'-6"-86'-0"	SYMBOL	△—△
COHESION (IN P.S.I)	1.25	ANGLE OF INTERNAL FRICTION	27.5°

CREATIVE SOIL INVESTIGATION	DIRECT SHEAR TEST	CLIENT : JAHANGIRNAGAR UNIVERSITY PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT LOCATION : SAVAR, DHAKA.



BORE HOLE NO	BH-6	SAMPLE	D-10
DEPTH (FT/MT)	49'-6"-51'-0"	SYMBOL	●–●
COHESION (IN P.S.I)	1.20	ANGLE OF INTERNAL FRICTION	28.0°

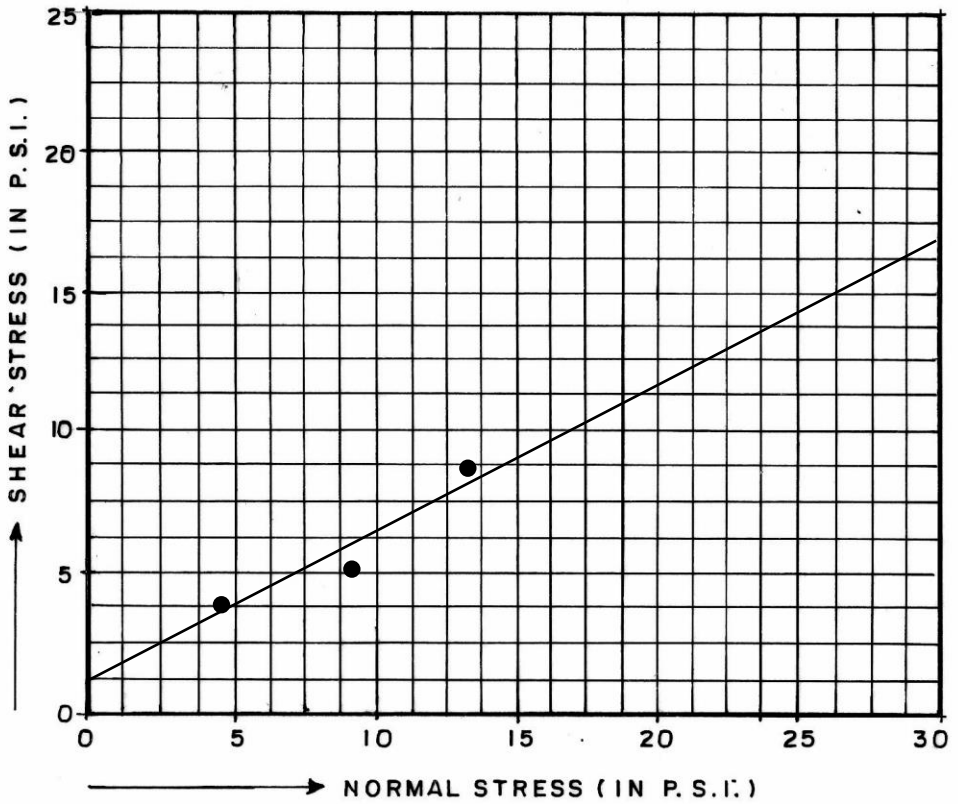


BORE HOLE NO	BH-7	SAMPLE	D-10
DEPTH (FT/MT)	49'-6"-51'-0"	SYMBOL	△–△
COHESION (IN P.S.I)	1.25	ANGLE OF INTERNAL FRICTION	27.0°

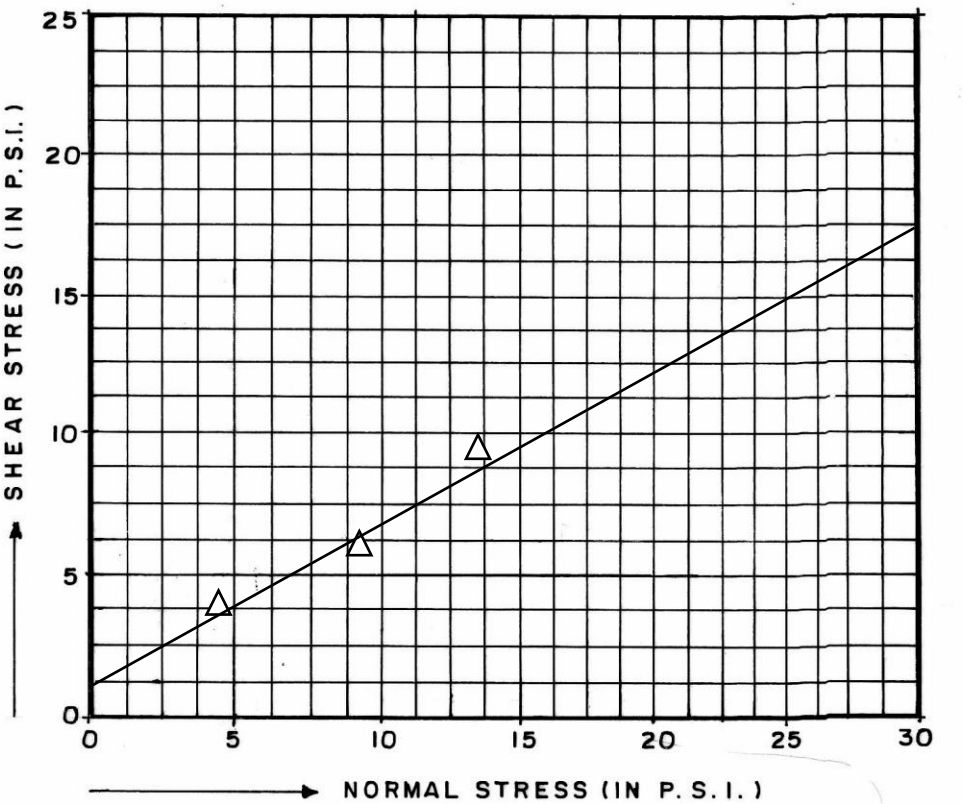
CREATIVE SOIL INVESTIGATION

DIRECT SHEAR TEST

CLIENT : JAHANGIRNAGAR UNIVERSITY
PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
LOCATION : SAVAR, DHAKA.



BORE HOLE NO	BH-8	SAMPLE	D-10
DEPTH (FT/MT)	49'-6"-51'-0"	SYMBOL	●–●
COHESION (IN P.S.I)	1.25	ANGLE OF INTERNAL FRICTION	27.8°



BORE HOLE NO	BH-9	SAMPLE	D-10
DEPTH (FT/MT)	49'-6"-51'-0"	SYMBOL	△–△
COHESION (IN P.S.I)	1.10	ANGLE OF INTERNAL FRICTION	28.6°

CREATIVE SOIL INVESTIGATION

SUMMARY SHEET FOR TEST RESULTS

PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT

CLIENT : JAHANGIRNAGAR UNIVERSITY

LOCATION : SAVAR, DHAKA.

BORING NO.	SAMPLE	Depth (ft./m)	ATTERBERG LIMIT			GRAIN SIZE ANALYSIS			SPECIFIC GRAVITY (Gs)	NATURAL UNIT WET, DRY DENSITY & MOISTURE CONTENT			UNCONFINED COMPRESSION STRENGTH		DIRECT SHEAR		CONSOLIDATION TEST	
			LL (W_L)	PL (W_P)	PI	SAND (%)	SILT (%)	CLAY (%)		γ WET (lbs/cft)	γ_{DRY} (lbs/cft)	W_I (%)	q_u (psi)	Strength at failure (%)	COHESION (PSI)	ANGLE OF FRICTION (φ)	NATURAL VOID RATIO (e_o)	COMPRESSION INDEX (Cc)
BH-1	D-2	10.0				5.00	68.00	27.00	2.67									
	D-3	15.0	42.60	25.50	17.10													
	D-5	25.0				9.00	82.00	9.00	2.68									
	D-6	30.0	35.80	26.50	9.30													
	D-10	50.0				30.00	70.00	0.00	2.66									
	D-11	55.0													1.25	27.6		
	D-13	65.0				88.00	12.00	0.00	2.61									
	D-14	70.0													1.60	25.5		
	D-16	80.0				91.00	9.00	0.00	2.60									
BH-2	D-2	10.0				4.00	66.00	30.00	2.68									
	D-3	15.0	44.80	25.50	19.30													
	D-5	25.0				7.00	81.00	12.00	2.67									
	D-6	30.0	34.80	26.50	8.30													
	D-9	45.0				33.00	67.00	0.00	2.66									
	D-12	60.0				85.00	15.00	0.00	2.61									
	D-13	65.0													1.25	27.0		
	D-16	80.0				90.00	10.00	0.00	2.60									
	D-17	85.0													1.25	27.5		
	D-20	100.0				94.00	6.00	0.00	2.60									
BH-3	D-2	10.0	45.80	25.50	19.70													
	D-3	15.0				5.00	69.00	26.00	2.73									
	D-6	30.0				9.00	83.00	8.00	2.68									
	D-7	35.0	33.60	26.50	7.10													
	D-8	40.0				35.00	65.00	0.00	2.65									
	D-12	60.0				86.00	14.00	0.00	2.61									
	D-16	80.0				90.00	10.00	0.00	2.60									

CREATIVE SOIL INVESTIGATION	SUMMARY SHEET FOR TEST RESULTS	PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT
		CLIENT : JAHANGIRNAGAR UNIVERSITY
		LOCATION : SAVAR, DHAKA.

BORING NO.	SAMPLE	Depth (ft./m)	ATTERBERG LIMIT			GRAIN SIZE ANALYSIS			SPECIFIC GRAVITY (Gs)	NATURAL UNIT WET, DRY DENSITY & MOISTURE CONTENT			UNCONFINED COMPRESSION STRENGTH		DIRECT SHEAR		CONSOLIDATION TEST	
			LL (W_L)	PL (W_P)	PI	SAND (%)	SILT (%)	CLAY (%)		γ WET (lbs/cft)	γ_{DRY} (lbs/cft)	W_I (%)	q_u (psi)	Strength at failure (%)	COHESION (PSI)	ANGLE OF FRICTION (φ)	NATURAL VOID RATIO (e_o)	COMPRESSION INDEX (Cc)
BH-4	D-2	10.0				4.00	72.00	24.00	2.70									
	D-3	15.0	41.90	24.50	17.40													
	D-5	25.0				7.00	84.00	9.00	2.67									
	D-7	35.0	33.60	26.50	7.10													
	D-8	40.0				90.00	10.00	0.00	2.60									
	D-12	60.0				89.00	11.00	0.00	2.60									
BH-5	D-2	10.0				6.00	72.00	22.00	2.70									
	D-3	15.0	39.70	24.50	15.30													
	D-5	25.0				10.00	79.00	11.00	2.68									
	D-6	30.0	37.30	26.50	10.80													
	D-8	40.0				30.00	70.00	0.00	2.66									
	D-12	60.0				90.00	10.00	0.00	2.60									
BH-6	D-2	10.0				5.00	74.00	21.00	2.68									
	D-3	15.0	40.80	24.50	16.30													
	D-5	25.0				9.00	79.00	12.00	2.67									
	D-6	30.0	33.80	25.50	8.30													
	D-8	40.0				89.00	11.00	0.00	2.61									
	D-10	50.0													1.20	28.0		
	D-12	60.0				94.00	6.00	0.00	2.60									

CREATIVE SOIL INVESTIGATION

SUMMARY SHEET FOR TEST RESULTS

PROJECT : SIX STORIED SOCIAL SCIENCE FACULTY BUILDING WITH ONE BASEMENT

CLIENT : JAHANGIRNAGAR UNIVERSITY

LOCATION : SAVAR, DHAKA.

BORING NO.	SAMPLE	Depth (ft./m)	ATTERBERG LIMIT			GRAIN SIZE ANALYSIS			SPECIFIC GRAVITY (Gs)	NATURAL UNIT WET, DRY DENSITY & MOISTURE CONTENT			UNCONFINED COMPRESSION STRENGTH		DIRECT SHEAR		CONSOLIDATION TEST	
			LL (W_L)	PL (W_P)	PI	SAND (%)	SILT (%)	CLAY (%)		γ WET (lbs/cft)	γ_{DRY} (lbs/cft)	W_I (%)	q_u (psi)	Strength at failure (%)	COHESION (PSI)	ANGLE OF FRICTION (φ)	NATURAL VOID RATIO (e_o)	COMPRESSION INDEX (Cc)
BH-7	D-2	10.0	47.90	26.50	21.40													
	D-3	15.0				4.00	75.00	21.00	2.68									
	D-6	30.0				9.00	83.00	8.00	2.70									
	D-7	35.0	36.80	26.50	10.30													
	D-9	45.0				35.00	65.00	0.00	2.65									
	D-10	50.0													1.25	27.0		
	D-12	60.0				87.00	13.00	0.00	2.61									
BH-8	D-2	10.0				6.00	68.00	26.00	2.70									
	D-3	15.0	41.60	25.50	16.10													
	D-5	25.0				9.00	67.00	24.00	2.70									
	D-6	30.0	34.70	26.50	8.20													
	D-7	35.0				6.00	82.00	12.00	2.67									
	D-9	45.0				31.00	69.00	0.00	2.65									
	D-10	50.0													1.25	27.8		
	D-12	60.0				91.00	9.00	0.00	2.60									
BH-9	D-2	10.0				4.00	74.00	22.00	2.73									
	D-3	15.0	38.80	23.50	15.30													
	D-5	25.0				8.00	82.00	10.00	2.68									
	D-6	30.0	33.60	26.50	7.10													
	D-8	40.0				86.00	14.00	0.00	2.61									
	D-10	50.0													1.10	28.6		
	D-12	60.0				90.00	10.00	0.00	2.60									