A
REPORT
ON
GEOTECHNICAL INVESTIGATION
FOR

PROPOSED
G+VIII STORIED
BUILDING

AT

MOUZA- SHYAMNAGAR NOW KRISHNAPUR, C.S.DAG NO.- 960 - 966, C.S KHATIAN NO. - 28 IN RESPECT OF MUNICIPAL HOLDING NO.-72, GOURI NATH SHASTRI SARANI, J.L. NO.- 32/20, WARD NO. - 27, UNDER SOUTH DUM DUM MUNICIPALITY, P.S.- DUM DUM, DIST.-24 PARGANAS(N.)

CONDUCTED
BY

BOSE ENGINEERS

53, PURNA CHANDRA MITRA LANE
KOLKATA – 700033

An ISO 9001-2015 Certified Organization

AN APPROVED GEO-TECHNICAL INVESTIGATION CONSULTANT UNDER THE MINISTRY OF ROAD TRANSPORT AND HIGHWAYS, GOVERNMENT OF INDIA

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Project: Proposed Building at Mouza- Shyamnagar now Krishnapur, C.S.Dag No.- 960 - 966.

1. *Introduction*

Soil exploration, investigation and testing of soil samples in connection with the construction of proposed G+VIII storied building at Mouza- Shyamnagar now Krishnapur, C.S.Dag No.- 960 - 966, C.S Khatian No. - 28 in respect of Municipal Holding No.-72, Gouri Nath Shastri Sarani, J.L. No.- 32/20, Ward No. - 27, Under South Dum Dum Municipality, P.S.- Dum Dum, Dist.-24 Parganas(N.) was entrusted to M/s Bose Engineers, 53, Purna Chandra Mitra Lane, Kolkata-700033. The objective was to ascertain the subsoil characteristics and stratification and propose suitable load carrying capacity of the soil and facilitate design of the foundation for the proposed structure. The field work involved in the investigation including boring, recovery of samples and in-situ tests were carried on 6th to 8th June, 2018.

The scope of the work comprised of sinking two boreholes. It included advancing the boreholes by wash and auger equipment. The boreholes were of 150 mm in diameter. The scope also included conducting standard penetration tests (SPT), collecting disturbed samples at regular intervals for identification and logging purposes, collecting undisturbed tube samples at suitable intervals or at change of strata whichever is earlier and testing these in the laboratory.

Based on the above, this report presents the subsoil profile and laboratory and field test results. On the basis of field tests and laboratory test results and their analysis thereof, the most suitable type of foundation with it's safe bearing capacity is suggested. The field profile was sometimes modified in the light of laboratory test results.

2. *Field Exploration*

Geotechnical Investigation was envisaged in an attempt for optimization in the design of foundation for the proposed structures to be constructed at this site. The entire Investigation programme had been divided mainly into two parts, I) Field works & II) Laboratory tests.

I) Field works unfold the sub-surface deposit types and their characteristics

II) Laboratory tests part would help determining the relevant physical and geotechnical

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properties of the sub-surface deposits leading to finalisation of foundation depths of the structures and the bearing capacity with particular reference to the sub-surface types and their strength parameters and settlement potentials at the site.

A list of the boreholes with the terminating depth and standing water level are presented in a tabular form below:

Bore Hole No.	Terminating Depth (m)	Standing Water Table (m)	Date of Commencement	Date of Completion
01	25.10	-0.60	06.06.18	07.06.18
02	25.10	-1.00	07.06.18	08.06.18

The locations of boreholes are shown in Figure 1.

2.1 Boring

Boring was carried out by wash and auger method to sink nominal 150 mm diameter boreholes to desired depths and operated by a team of experienced technicians. Flush jointed seamless casings were used to stabilize the boreholes and prevent caving of the soil inside the boreholes. The casing pipes were advanced by turning in order to minimize the disturbance. Undisturbed soil samples were collected at suitable intervals or at change of strata whichever is met earlier by open drive sampling method since it was intended to ascertain the subsoil characteristics. The standing water table in each borehole was determined at least 24 hours after the termination of boring work.

2.2 Sampling

Nominal 100 mm diameter undisturbed samples were recovered. The sampling equipment used consists of a two-tier assembly of sample tubes 400 mm in length fitted at its lower end. The sampling assembly was driven by means of a jarring link to its full length or as far down as was found practicable. After withdrawal the ends of the tubes were sealed with wax at both ends and capped before transmission to the laboratory. At close intervals in depth, disturbed samples were collected both from split spoon sampler after the standard penetration test and from cutting edge for identification and logging purpose. These were tagged and

packed in polythene packets and transported to the laboratory. The depthwise locations of all the undisturbed and disturbed samples were used in the preparation of borehole log data and for general identification and classification purposes. The details of boring are presented in the Appendix in the form of bore log sheets.

2.3 Standard Penetration Test

Standard Penetration Tests were conducted in the boreholes at suitable intervals as per IS: 2131-1963 using a split spoon sampler. The split spoon sampler used is of a standard design having an outer diameter of 50.8 mm and inner diameter of 35 mm, driving with a monkey weighing 63.5 kgs, falling freely from a height of 75 cm. A record of the number of blows required to penetrate every 15 cm to a maximum depth of 45 cm was made. The first 15 cm of drive was considered to be seating drive and was neglected. The total blows required to effect each 15 cm of penetration was recorded. The "N" values were obtained by counting the number of blows required to drive the spoon from 15 cm to 45 cm. On completion of a test, the split spoon sampler was opened and soil specimens were preserved in polythene bags for logging purpose.

All the boreholes were sunk with winch. However, raising of hammer for SPT was done manually. Hence there will not be any inertia loss and the efficiency of hammer blows should be considered as 100%.

2.4 Measurement of Water Table

Level of water was noted when struck in. This is termed as observed water level. Standing water level after 24 hours of removal of casing was also noted and shown in the profile.

3. *Laboratory Testing*

For proper identification and classification of the sub-soil deposits and for deriving adequate information regarding its relevant physical and geotechnical properties at the site under investigation, the soil samples from the 10 cm diameter sampling tubes were extracted in the laboratory by pushing out the core by using the extractor frame. The core was jacked out in a direction that corresponded with the soil movement within the tube during sampling. In general, the following laboratory tests were conducted on the soil samples collected from the exploratory bore holes:

a) Grain size distribution (Sieve as well as Hydrometer).
b) Determination of Atterberg Limits.
c) Determination of Natural Moisture Content.
d) Determination of Specific Gravity.
e) Determination of Bulk & Dry Unit Weight.
f) Strength determination by Triaxial Unconsolidated Undrained Test (UU).
g) Strength Determination of Unconfined Compression Test on (UC)
h) One-dimensional Consolidation Test for determining settlement potentiality.

The triaxial tests/unconfined compression test 38 mm diameter x 76 mm long specimens were obtained by jacking out the soil core into thin-walled brass tubes. The inside of the tubs was coated with a thin layer of silicon oil. Self-explanatory test results are presented in the Appendix.

To obtain specimens for consolidation test the odeometer ring was placed on the trimmed horizontal face of the soil within the 10 cm sampling tube and the soil around the cutting edge was gradually removed with a spatula as the ring was gently pushed into the soil. The ring with the soil was then removed by cutting across the soil core with the help of a piano wire saw.

The laboratory tests were done to ascertain the engineering properties of the subsoil and to obtain the necessary data required to design the foundation. These are detailed below. Summary of all the test results are given in a tabular form in Table -1.

3.1 *Atterberg Limits and Natural Water Content*

Liquid limit, plastic limit and natural water content of the silty clay/clayey silt samples were determined (a) to classify the soil by the IS classification system and (b) to qualitatively assess their consistency and compressibility.

3.2 *Bulk density*

These were determined by measuring the weight and dimension of triaxial/unconfined compression test samples.

3.3 *Undrained Triaxial Test/ Unconfined Compression Test*

These were run on the clay/ clayey silt samples to determine their shear strength. The cell pressures employed in triaxial tests were 0.5, 1.0 and 2.0 kg/cm^2. The samples were tested under quick condition at the rate of 1.25 mm/min and were loaded upto a maximum of 20% of axial strain.

3.4 *Grain Size Analysis*

The grain-size distribution of a quantity of representative samples were determined from sieve analysis/combined sieve analysis and hydrometer analysis. The results are plotted in the Appendix.

3.5 *Consolidation Test*

Consolidation tests were run in floating ring type odeometers, in an eight unit consolidation frame under standard load increment ratio of one, starting from ¼ kg/cm^2 and going up to 8 kg/cm^2. The e vs. $\log_{10}$p curves are given in the Appendix.

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4. *Soil Profile and Properties*

Based on visual classification and results of field and laboratory tests on the samples recovered the proposed site may be divided into the following major soil strata as described below:

Layer Details				Average Field N-Value	Bulk Density (t/m3)	Liquid Limit (%)	Plasticity Index (%)	Shear strength Parameters
Stratum No.	Description	Depth below EGL (m)						
		From	To					
I	Filled up by soil roots etc.	0.00	1.00/1.10	-	-	-	-	-
II	Firm yellowish brown clayey silt / silty clay with mica, brown spot.	1.00/1.10	5.00/5.30	7 to 8	1.84	43.3	21.1	C= 4.3 t/m^2, ϕ =0 deg
III	Soft to firm greyish silty clay / clayey silt with traces of decomposed woods.	5.00/5.30	11.00/11.40	3 to 7	1.69	52.2	25.6	C= 2.5 t/m^2, ϕ =0 deg
IV	Firm to stiff yellowish / bluish grey silty clay / clayey silt with rusty spots.	11.00/11.40	17.60/17.80	7 to 10	1.86	42.4	20.8	C= 6.0 t/m^2, ϕ =0 deg
V	Stiff to very stiff yellowish brown sandy clayey silt with mica.	17.60/17.80	20.10/20.80	14 to 20	1.90*	31.1	14.9	C= 10.7* t/m^2, ϕ =0 deg
VI	Medium dense to dense yellowish brown silty fine sand with mica.	20.10/20.80	25.10	21 to 28	1.91*	- Non- Plastic		C= 0 t/m^2, ϕ =30-32* deg

* Suggested

A profile through the boreholes and the distribution of Field N-value with depth are shown in Figure 2 and Figure 3 respectively.

5. *Hydrogeology*

The ground water table at the site was found to exist at 0.60 m. to 1.00m below the ground level for the boreholes explored during the time of investigation work.

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6. *Calculations*

6.1 *Pile Foundation*

For bored pile, load bearing capacity is calculated according to IS:2911 (Part-I/Sec-2)-2010.

Skin Friction

$Q_{SF} = \sum A_S \alpha \bar{C}$ for cohesive soil

$= \sum A_S K P_{Di} \tan \delta$ for granular soil

where,

A_S = surface area of pile stem

$\bar{C}$ = average cohesion

α = reduction factor

K = co-efficient of earth pressure

P_{Di} = effective overburden pressure

δ = angle of wall friction between pile and soil

Q_{SF} = ultimate capacity due to skin friction

End Bearing

$Q_{EB} = A_P C_P N_c$ for cohesive soil

$= A_P P_D N_q$ for granular soil

where,

A_P = cross-sectional area of pile tip

N_q , N_C = bearing capacity factors

C_P = average cohesion at pile tip

Q_{EB} = ultimate capacity due to end bearing

Safe bearing capacity of pile

$= Q_{SAFE} = (Q_{SF} + Q_{EB})/FOS$

where,

FOS = Factor of safety

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7. *Discussions on Foundation*

The structure for which the subsoil exploration was conducted is proposed G+VIII storied building.

For anticipated load from superstructure, deep foundation in the form of R.C.C bored cast-in-situ piles is suggested. Piles of different termination level below EGL and different diameters are proposed with a cut-off level at -1.5m below E.G.L. The load carrying capacities of piles are presented below:

Pile diameter (mm)	Cut-off level	Pile termination level	Safe vertical capacity (t)	Safe uplift capacity (t)	Safe horizontal capacity (t)	Depth of fixity (m)
450	1.5m below E.G.L.	21.0m below EGL	50	34	4.5	4.05
500			58	38	5.1	4.50
600			76	46	6.8	5.40
450	1.5m below E.G.L.	24.0m below EGL	55	39	4.5	4.05
500			65	44	5.1	4.50
600			86	54	6.8	5.40

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8. ***Recommendations***

- The subsoil characteristic of site at Mouza- Shyamnagar now Krishnapur, C.S.Dag No.- 960 - 966, C.S Khatian No. - 28 in respect of Municipal Holding No.-72, Gouri Nath Shastri Sarani, J.L. No.- 32/20, Ward No. - 27, Under South Dum Dum Municipality, P.S.- Dum Dum, Dist.-24 Parganas(N.) in connection with the construction of proposed G+VIII storied building was determined from soil exploration with two boreholes.
- Deep foundation in the form of RCC bored cast-in-situ piles are suggested for anticipated loading from the superstructure. The cut-off level of pile shall be 1.5m below E.G.L with different termination level below EGL. Safe load carrying capacities for such pile of different diameter shall be governed by table given in **section 7.0**.
- The load carrying capacities of the piles shall be checked and confirmed by pile load test. The piles should be placed at a centre to centre spacing of three times the diameter of the pile.
- Suitable pile cap shall be provided for the piles in a group.
- The final decision regarding the foundation will depend on the judgment of the engineer concerned.

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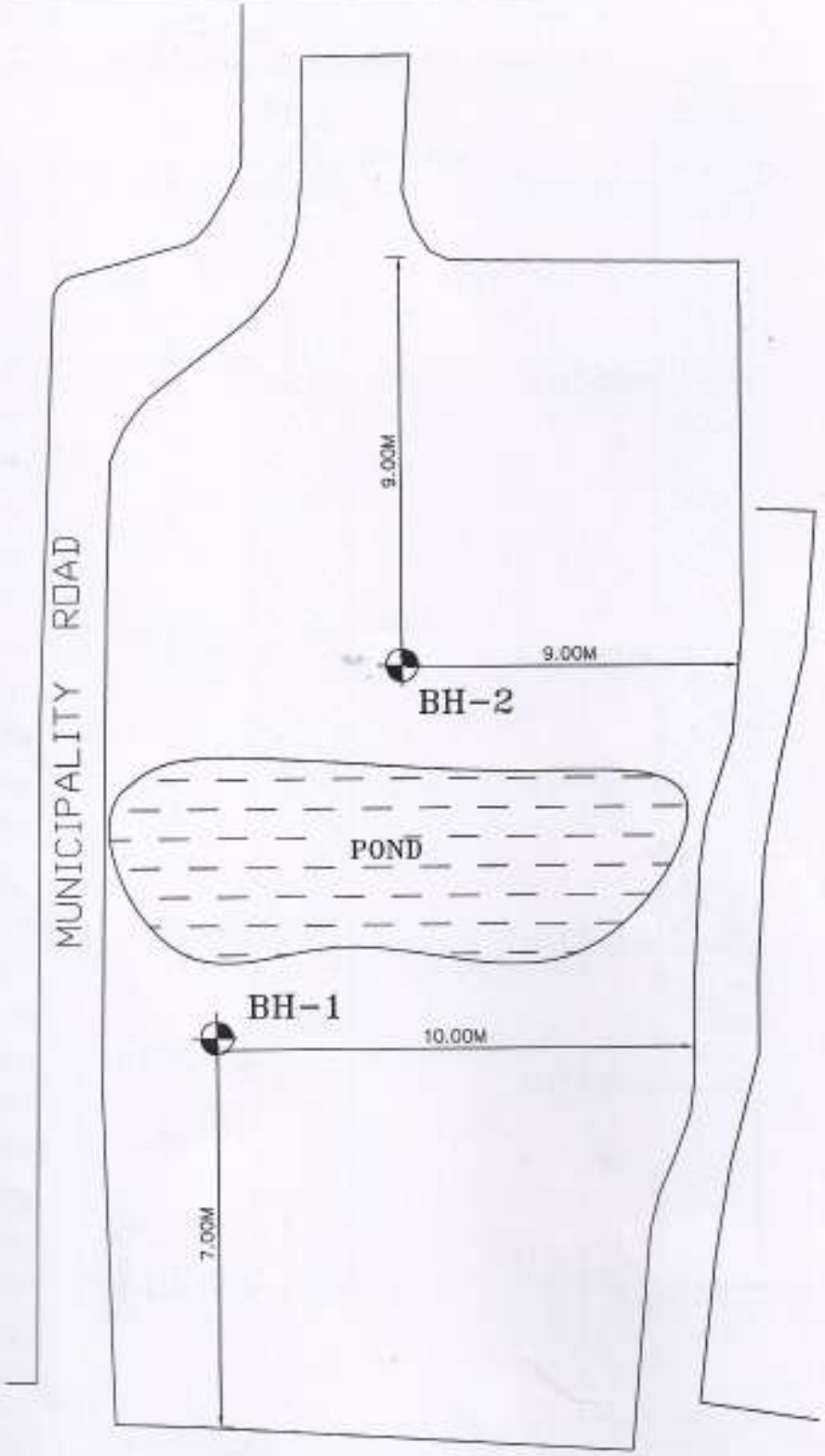
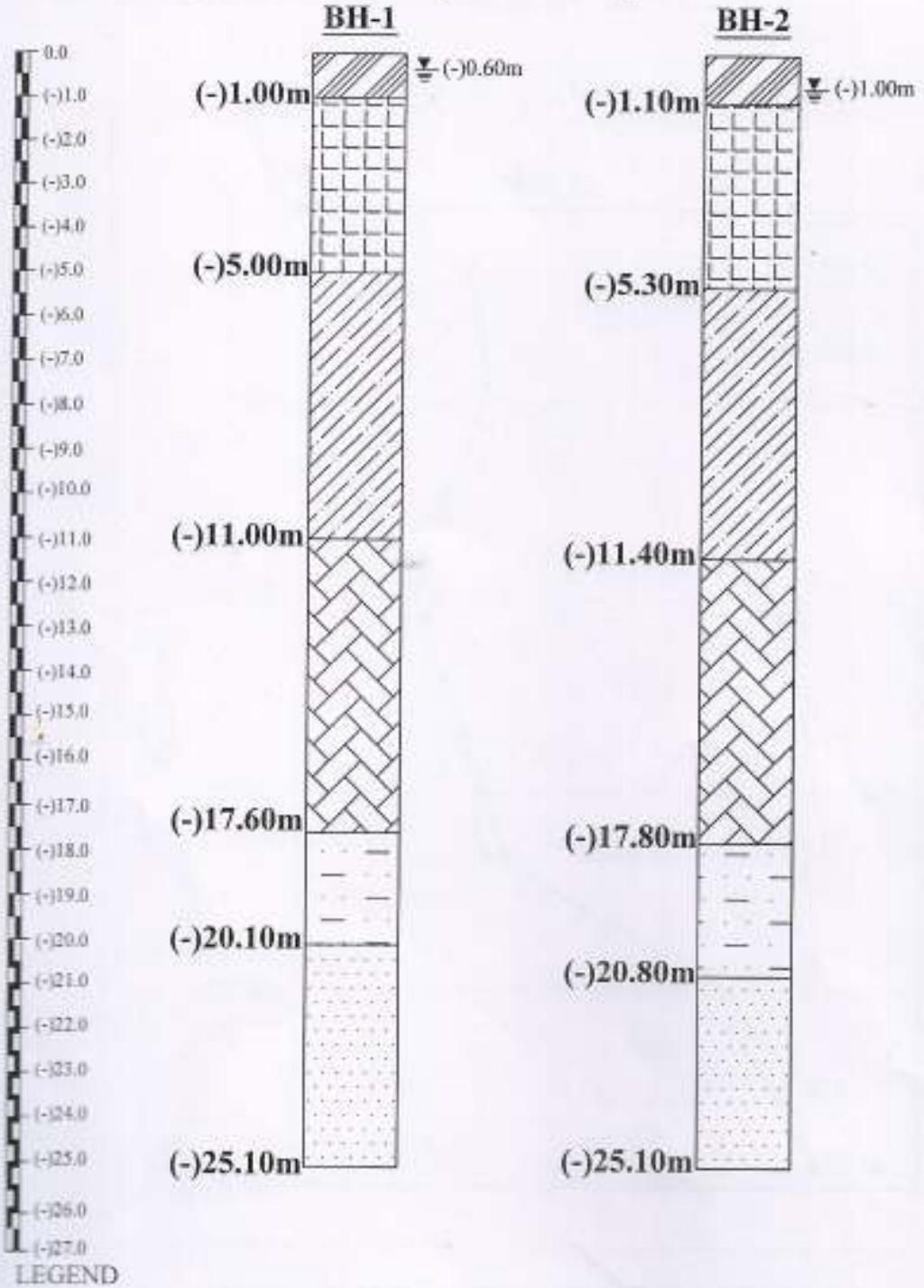


Figure 1 : Site Plan and Location of Boreholes
Not To Scale



LEGEND

	Layer-I	: Filled up by soil roots etc.
	Layer-II	: Firm yellowish brown clayey silt / silty clay with mica, brown spot.
	Layer-III	: Soft to firm greyish silty clay / clayey silt with traces of decomposed woods
	Layer-IV	: Firm to stiff yellowish / bluish grey silty clay / clayey silt with rusty spots.
	Layer-V	: Stiff to very stiff yellowish brown sandy clayey silt with mica
	Layer-VI	: Medium dense to dense yellowish brown silty fine sand with mica

Figure 2: Generalized soil profile

NOT TO SCALE

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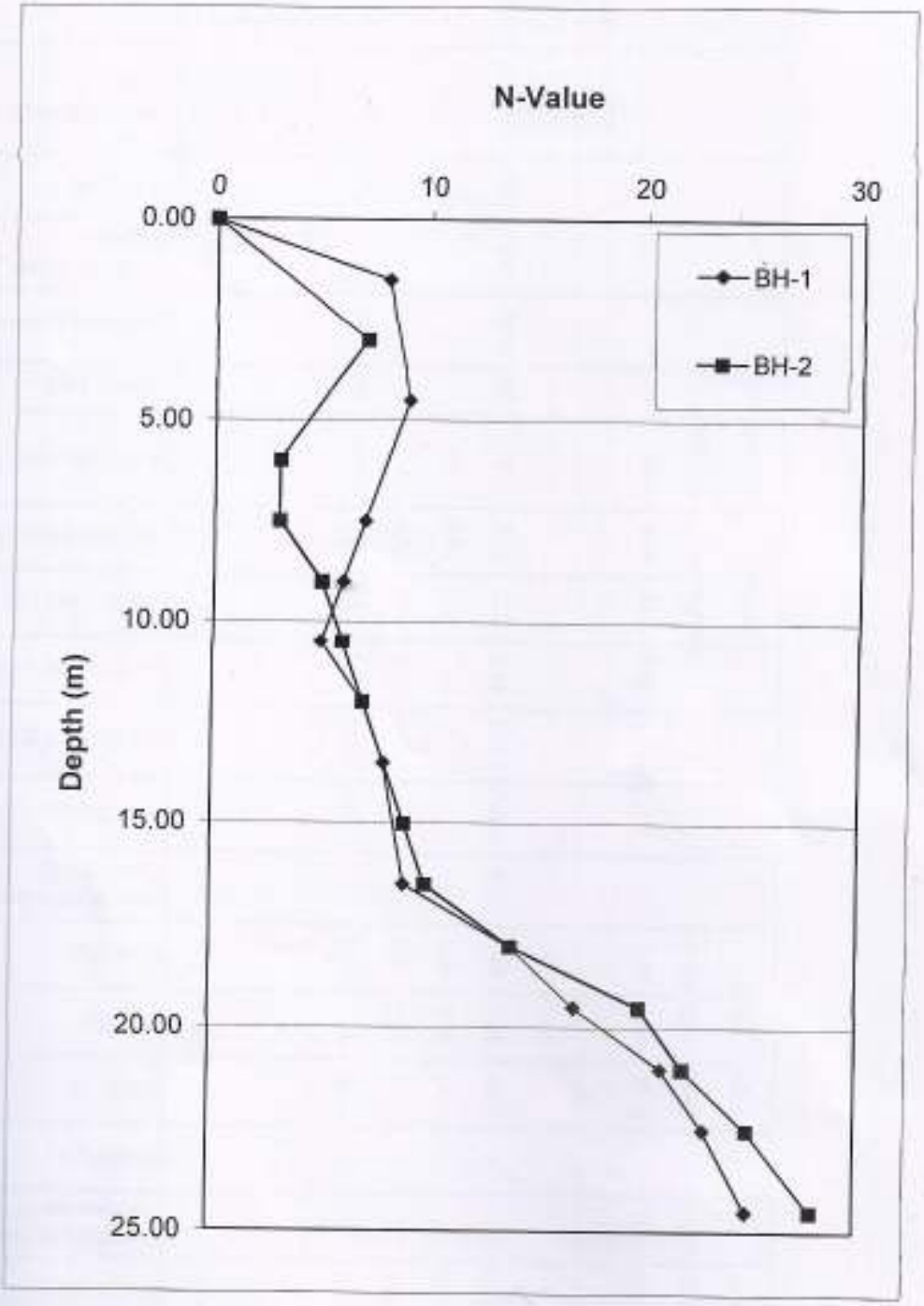

Figure 3: Distribution of N-Value with Depth

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TABLE 1: LABORATORY TEST RESULTS

Bore Hole No.	Type	Depth (m)	Standard Penetration Resistance 'N' value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density(gm/c.c.)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	IS Classification	Type of Test	Co-hesion (kg/cm^2)	Angle of Friction (degree)	Sp.Gravity	Pressure Range (kg/cm^2)	m_v (cm^2/kg)
BH-1	U	3.00	-	-	2.91	63.3	33.8	25.4	1.849	1.474	46.1	23.3	22.8	CI	UU	0.43	3.0	2.63	0.25-0.5 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	0.0266 0.0235 0.0181 0.0143 0.0113
	U	6.00	-	-	0.99	57.2	41.8	32.1	1.692	1.281	61.4	31.1	30.3	MH	UU	0.25	2.0	2.52		
	P	9.00	6	-	1.31	62.2	36.5				52.2	26.6	25.6	CH						
	P	12.00	7	-	1.11	58.8	40.1				58.1	29.3	28.8	CH						
	U	15.00	-	-	2.96	62.7	34.3	22.2	1.873	1.533	44.4	22.8	21.6	CI	UU	0.65	3.0	2.68	0.25-0.5 0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	0.0269 0.0214 0.0200 0.0195 0.0155
	P	18.00	14	-	24.25	54.4	21.4				32.2	16.6	15.6	CL						
	P	21.00	21	-	89.25	10.75*					Non-Plastic			SW-SM						
	P	24.50	25	-	90.05	9.95*					Non-Plastic			SW-SM						

* Silt & Clay

UC: Unconfined Compression Test
UU: Unconsolidation Undrained Test

TABLE 1: LABORATORY TEST RESULTS

Bore Hole No.	Type	Depth (m)	Standard Penetration Resistance 'N' value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density(gm/c.c.)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	IS Classification	Type of Test	Co-hesion (kg/cm^2)	Angle of Friction (degree)	Sp.Gravity	Pressure Range (kg/cm^2)	m$_v$ (cm^2/kg)
BH-2	U	1.50	-	-	3.18	64.2	32.6	23.9	1.863	1.504	43.3	22.2	21.1	CI	UU	0.45	2.0	2.65		
	U	4.50	-	-	3.00	65.5	31.5	24.7	1.853	1.486	45.1	23.3	21.8	CI	UU	0.43	2.0	2.64	0.25-0.5	0.0261
																			0.5-1.0	0.0241
																			1.0-2.0	0.0200
																			2.0-4.0	0.0144
																			4.0-8.0	0.0097
	P	7.50	3	-	1.42	61.4	37.2				56.2	28.8	27.4	CH						
	P	10.50	6	-	1.18	59.2	39.6				57.8	29.4	28.4	CH						
	U	13.50	-	-	2.71	64.1	33.2	24.1	1.866	1.504	47.3	24.1	23.2	CI	UU	0.60	3.0	2.67	0.25-0.5	0.0275
																			0.5-1.0	0.0225
																			1.0-2.0	0.0178
																			2.0-4.0	0.0132
																			4.0-8.0	0.0090
	P	16.50	10	-	2.78	65.5	31.7				42.4	21.6	20.8	CI						
	P	19.50	20	-	20.18	64.4	15.4				31.1	16.2	14.9	CL						
	P	22.50	25	-	87.75	12.25*					Non-Plastic			SW-SM						
	P	24.50	28	-	92.20	7.80*					Non-Plastic			SW-SM						

* Silt & Clay

UC: Unconfined Compression Test
UU: Unconsolidation Undrained Test

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Bore Hole No. : BH-1

Location : Krishnapur

Ground Elevation : 0.0m

Water Level (Static) :

Method of Boring / Drilling : Wash & Auger

Standing Water Level : 0.60m b.g.l

Dia of Boring / Drilling : 150 mm

Casing Lowered : 2.0m

Date : From 06.06.18 To 07.06.18

Date (dd / mm)	Depth (m) From	Depth (m) To	Length (m)	Nature of Sampling	SPT : No. of blows 0-15 cm	15-30 cm	30-45 cm	45-60 cm	N Value	Description
06.06.18	0.50			D						Filled up by soil roots etc.
	1.00			D						1.00m
	1.50	2.10	0.60	P	3	4	4	5	8	Firm yellowish brown clayey silt / silty clay with mica, brown spot.
	3.00	3.45	0.45	U						
	4.50	5.10	0.60	P	3	4	5	5	9	5.00m
	6.00	6.45	0.45	U						Firm greyish silty clay / clayey silt with traces of decomposed woods
	7.50	8.10	0.60	P	3	4	3	3	7	
	9.00	9.60	0.60	P	4	3	3	4	6	
	10.50	11.10	0.60	P	2	2	3	3	5	11.00m
	12.00	12.60	0.60	P	2	3	4	5	7	
	13.50	14.10	0.60	P	3	3	5	7	8	Firm to stiff yellowish / bluish grey silty clay / clayey silt with rusty spots.
	15.00	15.45	0.45	U						
	16.50	17.10	0.60	P	3	4	5	6	9	17.60m
	18.00	18.60	0.60	P	5	7	7	9	14	Stiff yellowish brown sandy clayey silt with mica.
	19.50	20.10	0.60	P	6	8	9	10	17	20.10m
	21.00	21.60	0.60	P	7	9	12	14	21	
	22.50	23.10	0.60	P	8	10	13	15	23	Medium dense to dense yellowish brown silty fine sand with mica.
07.06.18	24.50	25.10	0.60	P	8	11	14	17	25	
	25.10	(Termination Depth)								

Abbreviations: U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test

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Bore Hole No. : BH-2

Location : Krishnapur

Ground Elevation : 0.0m

Water Level (Static) :

Method of Boring / Drilling : Wash & Auger

Standing Water Level : 1.00m b.g.l

Dia.of Boring / Drilling : 150 mm

Casing Lowered : 2.0m

Date : From 07.06.18 To 08.06.18

Date (dd / mm)	Depth (m) From	Depth (m) To	Length (m)	Nature of Sampling	SPT No. of blows 0-15 cm	15-30 cm	30-45 cm	45-60 cm	N' Value	Description
07.06.18	0.50			D						Filled up by soil roots etc.
	1.00			D						1.10m
	1.50	1.95	0.45	U						Firm yellowish brown clayey silt / silty clay with mica, brown spot.
	3.00	3.60	0.60	P	2	3	4	5	7	
	4.50	4.95	0.45	U						5.30m
	6.00	6.60	0.60	P	1	1	2	2	3	
	7.50	8.10	0.60	P	1	1	2	3	3	Soft to firm greyish silty clay / clayey silt with traces of decomposed woods
	9.00	9.60	0.60	P	1	2	3	4	5	
	10.50	11.10	0.60	P	2	3	3	5	6	11.40m
	12.00	12.60	0.60	P	2	3	4	5	7	
	13.50	13.95	0.45	U						Firm to stiff yellowish / bluish grey silty clay / clayey silt.
	15.00	15.60	0.60	P	3	4	5	7	9	
	16.50	17.10	0.60	P	3	5	5	7	10	
	18.00	18.60	0.60	P	5	6	8	9	14	17.80m Stiff to very stiff yellowish brown sandy clayey silt with mica.
	19.50	20.10	0.60	P	6	9	11	13	20	20.80m
	21.00	21.60	0.60	P	8	10	12	13	22	
	22.50	23.10	0.60	P	9	12	13	15	25	Medium dense to dense yellowish brown silty fine sand with mica.
08.06.18	24.50	25.10	0.60	P	11	13	15	17	28	
	25.10	(Termination Depth)								

Abbreviations: U-Undisturbed Sample D-Disturbed Sample P-Standard Penetration Test

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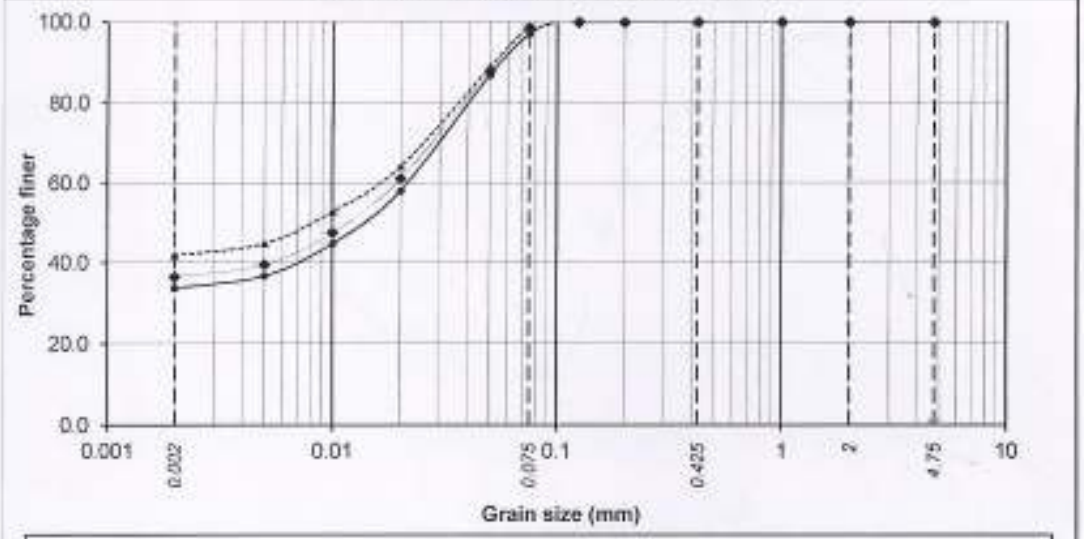
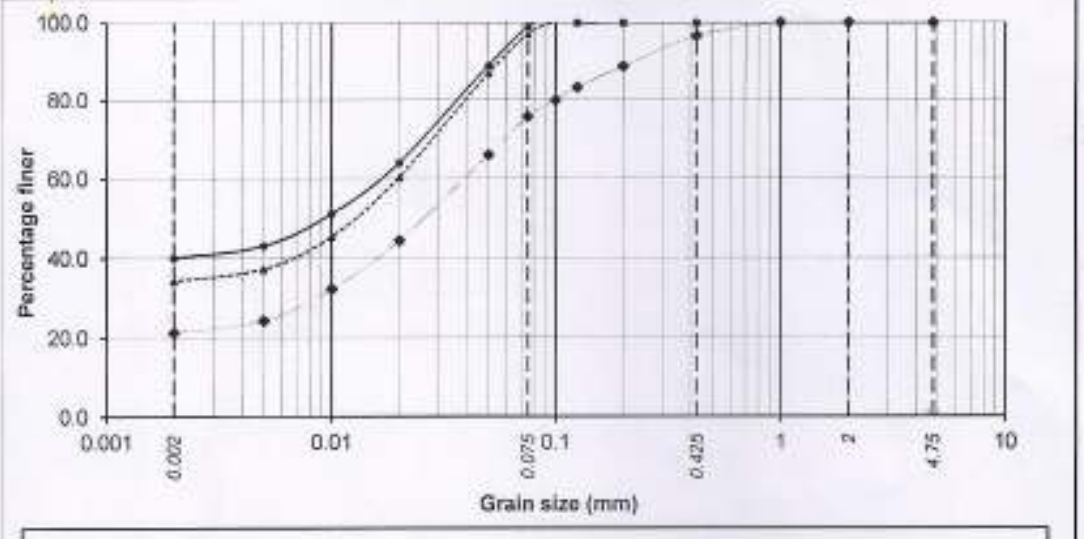
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-4.75	>4.75
Sample No.	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
BH-1, UDS(3.00-3.45m)	33.8	63.3	2.91	0.0
BH-1,UDS(6.00-6.45m)	41.8	57.2	0.99	0.0
BH-1, SPT(9.00-9.60m)	36.5	62.2	1.31	0.0

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-4.75	>4.75
Sample No.	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
BH-1,SPT(12.00-12.60m)	40.1	58.8	1.11	0.0
BH-1,UDS(15.00-15.45m)	34.3	62.7	2.96	0.0
BH-1,SPT(18.00-18.60m)	21.4	54.4	24.25	0.0

*Silt & Clay

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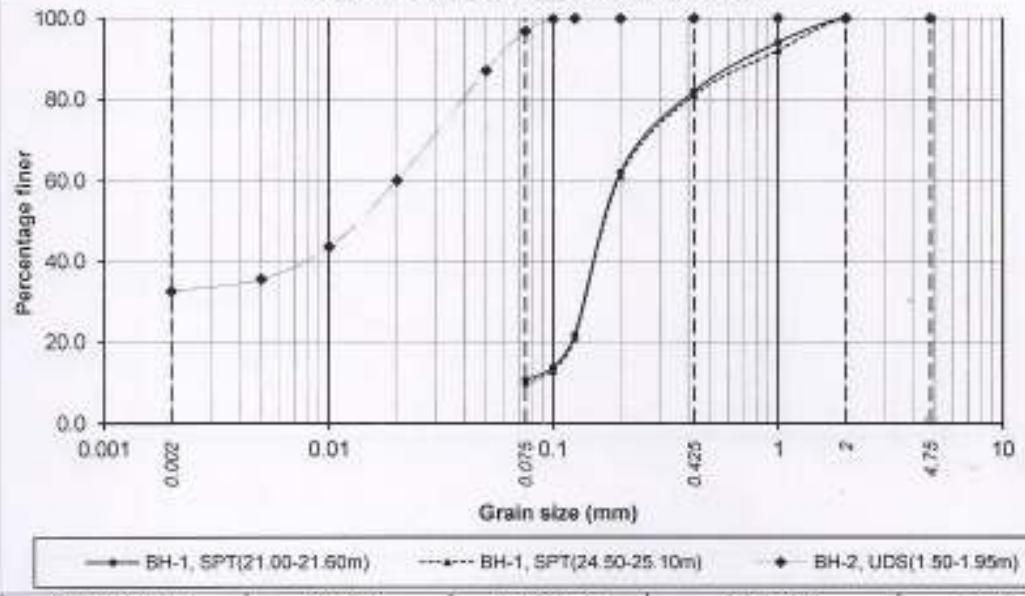
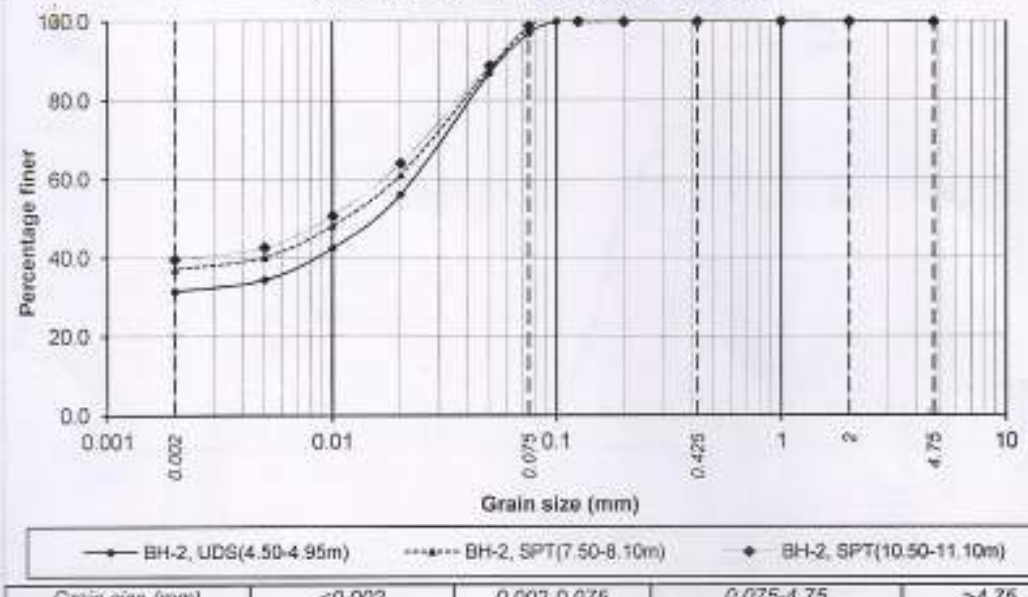
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-4.75	>4.75
Sample No.	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
BH-1, SPT(21.00-21.60m)	10.8		89.25	0.0
BH-1, SPT(24.50-25.10m)	10.0		90.05	0.0
BH-2, UDS(1.50-1.95m)	64.2	64.2	3.18	0.0

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-4.75	>4.75
Sample No.	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
BH-2, UDS(4.50-4.95m)	31.5	65.5	3.00	0.0
BH-2, SPT(7.50-8.10m)	37.2	61.4	1.42	0.0
BH-2, SPT(10.50-11.10m)	39.6	59.2	1.18	0.0

*Silt & Clay

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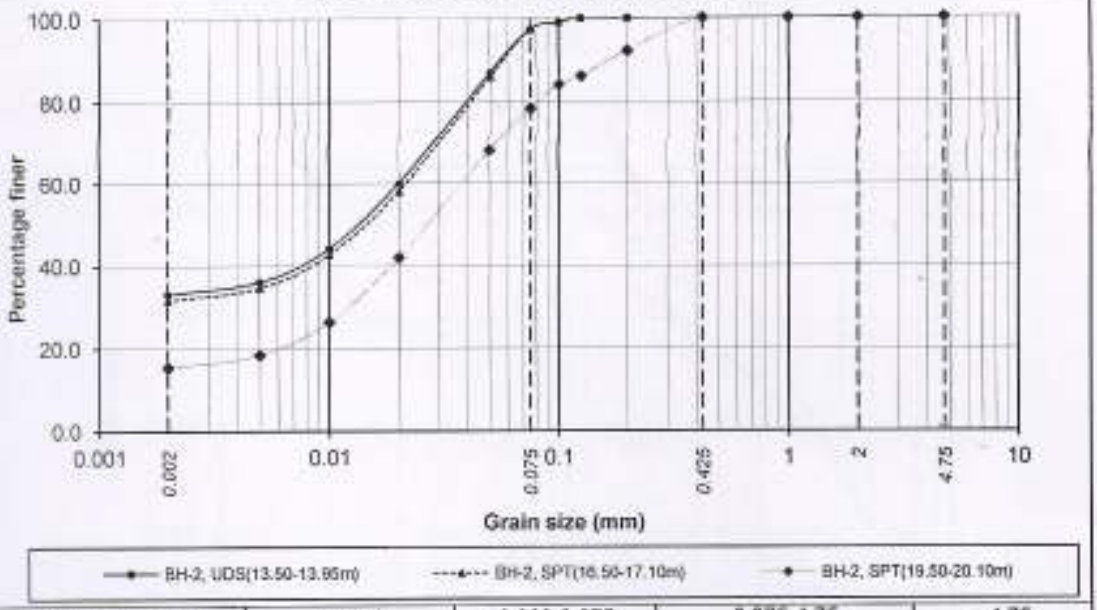
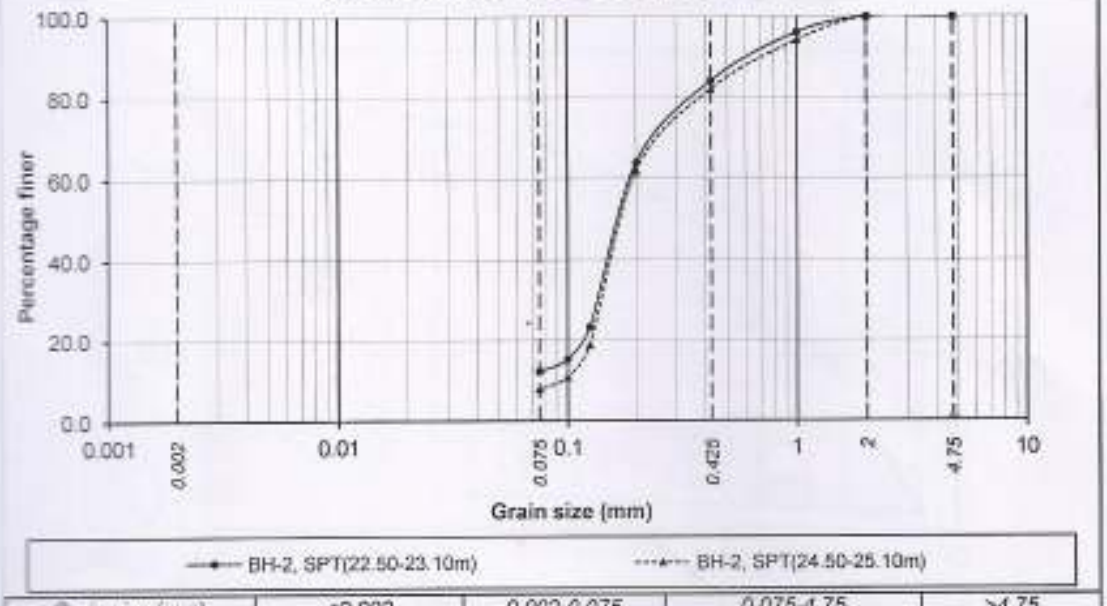
GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-4.75	>4.75
Sample No.	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
BH-2, UDS(13.50-13.95m)	33.2	64.1	2.71	0.0
BH-2, SPT(16.50-17.10m)	31.7	65.5	2.78	0.0
BH-2, SPT(19.50-20.10m)	15.4	64.4	20.18	0.0

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	<0.002	0.002-0.075	0.075-4.75	>4.75
Sample No.	Clay (%)	Silt (%)	Sand (%)	Gravel (%)
BH-2, SPT(22.50-23.10m)	12.3		87.75	0.0
BH-2, SPT(24.50-25.10m)	7.8		92.20	0.0

*Silt & Clay

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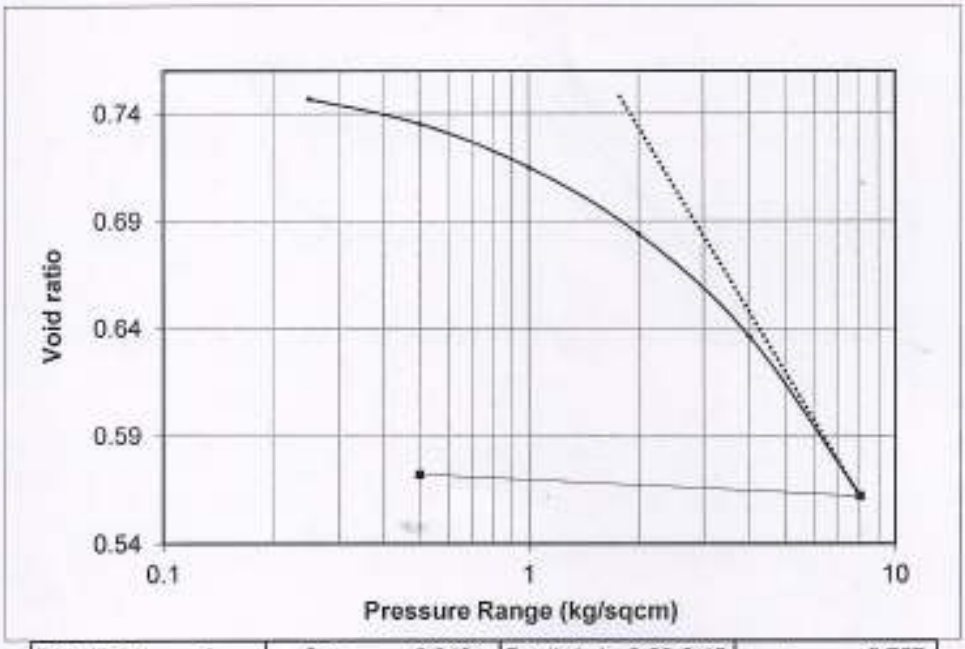
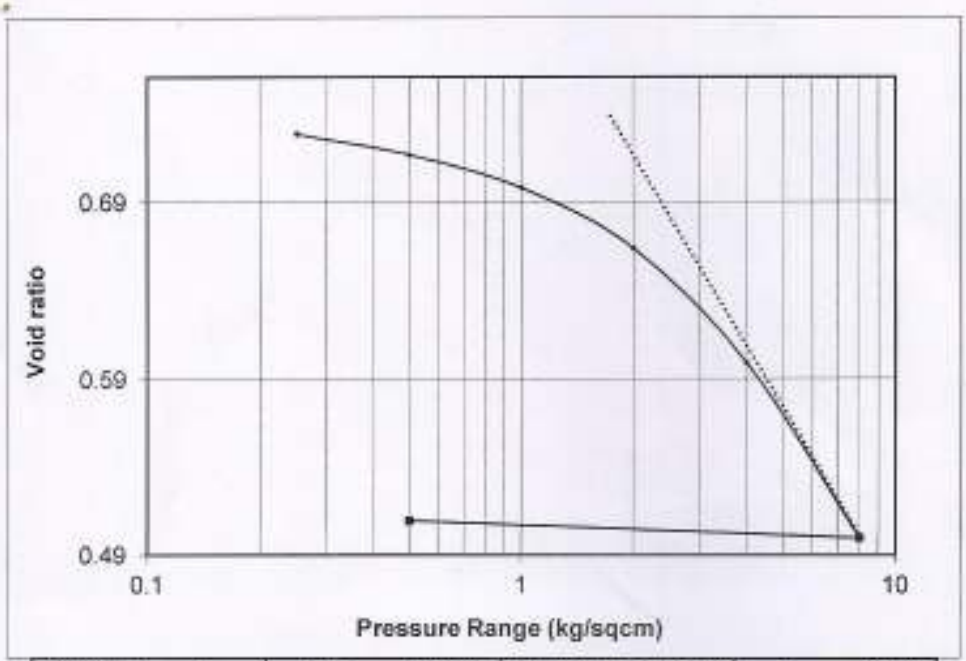
e-logp curve



Bore Hole: 1	Cc = 0.246	Depth (m): 3.00-3.45	e_{0} = 0.757



Bore Hole: 1	Cc = 0.329	Depth (m): 15.00-15.45	e_{0} = 0.738

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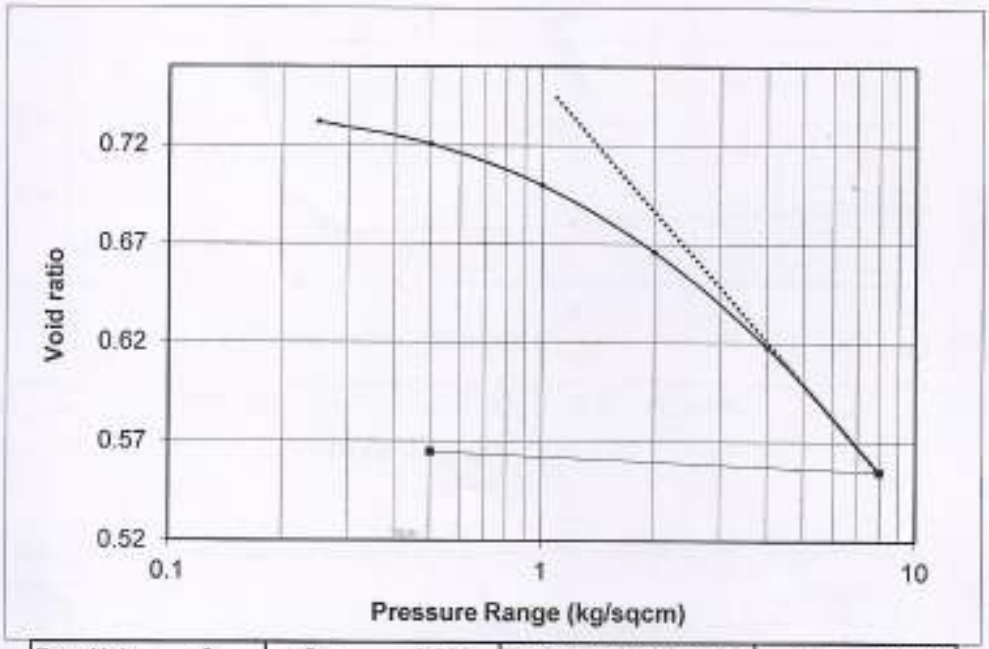
e-logp curve



Bore Hole: 2	Cc = 0.209	Depth (m): 4.50-4.95	e_0 = 0.742

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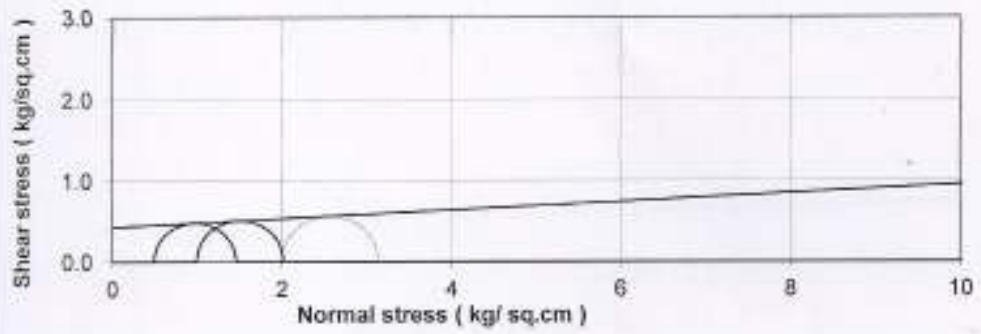
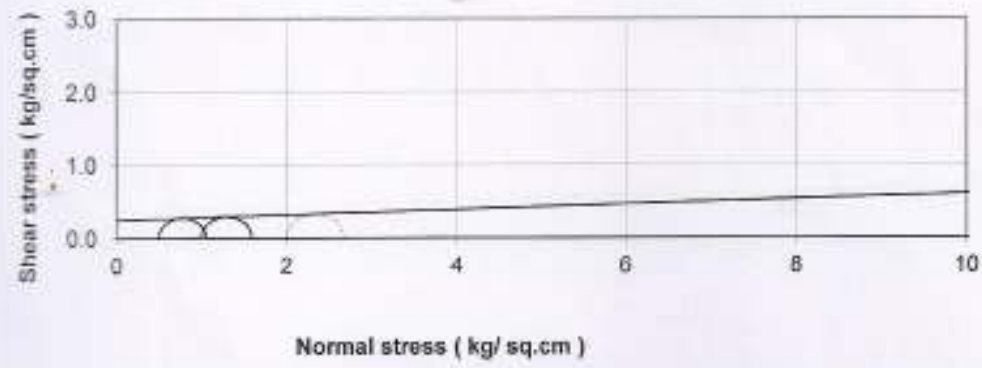
Mohr diagram



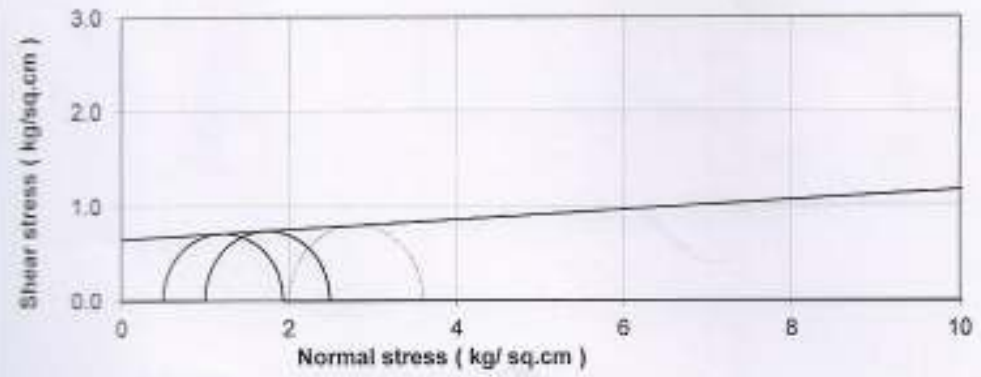
BH-	1	Depth (m)	3.00-3.45	C (kg/cm²)=	0.43	ϕ (degree) =	3

Mohr diagram



BH-	1	Depth (m)	6.00-6.45	C (kg/cm²)=	0.25	ϕ (degree) =	2

Mohr diagram



BH-	1	Depth (m)	15.00-15.45	C (kg/cm²)=	0.65	ϕ (degree) =	3

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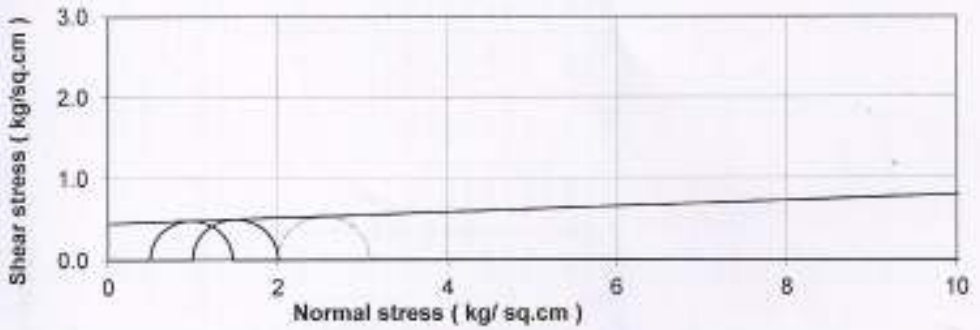
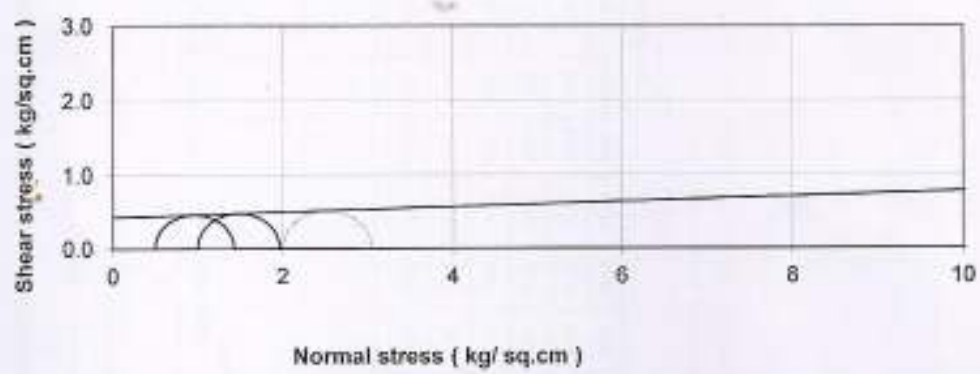
Project: Proposed Building at Mouza- Shyamnagar now Krishnapur

Mohr diagram



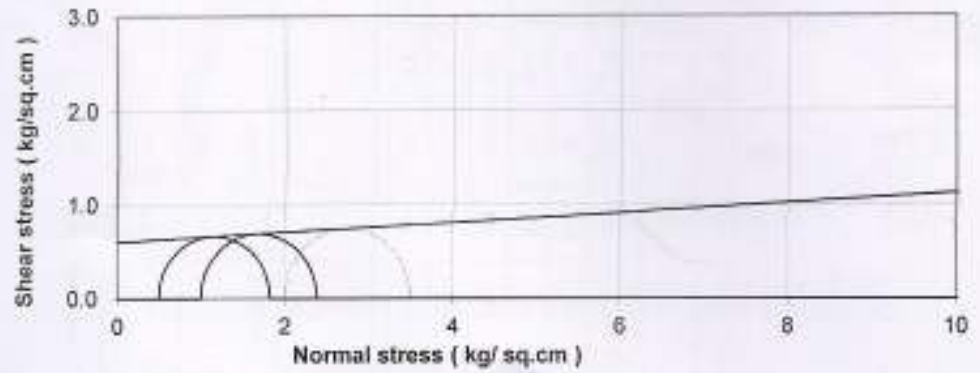
BH-	2	Depth (m)	1.50-1.95	C (kg/cm^2)=	0.45	ϕ (degree) =	2

Mohr diagram



BH-	2	Depth (m)	4.50-4.95	C (kg/cm^2)=	0.43	ϕ (degree) =	2

Mohr diagram



BH-	2	Depth (m)	13.50-13.95	C (kg/cm^2)=	0.60	ϕ (degree) =	3

BOSE ENGINEERS KOL-33

Determination of Vertical Load Bearing Capacity of "Bored Cast-in-situ Pile"

Pile Diameter	500 mm	Factor of Safety for Base Resistance	2.5	Based on Bore Hole	BH-1
Earth Pressure Coefficient, K_s	1.00	Factor of Safety for Shaft Friction	2.5	Cut Off Level (RL) :	-1.50 m
Critical Depth	-9.0 m			Pile Tip Level (m) :	-24.00

Ground Level RL(m)= 0.00

Pile Length(m)= 22.50

Starting Elevation (m)	Ending Elevation (m)	Thickness of Layer for pile (m)	Cohesion, C (t/m²)	Angle of Shearing Resistance, ϕ	Angle of Wall Friction, δ	Submerged Unit Weight of soil (γ') (t/m³)	Eff. Over-burden Pressure at Bottom of Layer 'P₀' (t/m²)	Based on Reissner's eqn. N_c	N_q	N_γ	Base Resistance, $P_{ult} = A_p * (C.N_c + q.N_q + 0.5 \gamma.D.N_\gamma)$ C.Nc	q.Nq	0.5γ'.D.Nγ	P_{ult} (Tonnes)	Shaft Friction $P_{ult} = (\Sigma(K_s.P_0.\tan\delta).A_{si} + a.c.A_b)$ Eff. Over-burden Pressure at c.g of the layer 'P₀' (t/m²)	A_{si} (m²)	$(K_s.P_0.\tan\delta)$	$(K_s.P_0.\tan\delta).A_{si}$	a	a.c.A_b	P_{ult}	Total Ult. Capacity, P_u (Tonnes)	Safe Load (Tonnes)
0.00	-1.00	0.0	2.0	0	0.0	0.600	0.00	9.00	0.00	0.00	18.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	1.000	0.00	0.00		
-1.00	-5.00	3.5	4.3	0	0.0	0.840	2.94	9.00	0.00	0.00	38.70	0.00	0.00	7.599	1.47	5.50	0.00	0.00	0.955	22.58	22.58	30.2	12.1
-5.00	-11.00	6.0	2.6	0	0.0	0.690	5.70	9.00	0.00	0.00	23.40	0.00	0.00	4.595	4.32	9.42	0.00	0.00	1.000	24.50	47.08	51.7	20.7
-11.00	-17.60	6.6	6.0	0	0.0	0.860	5.70	9.00	0.00	0.00	54.00	0.00	0.00	10.603	5.70	10.37	0.00	0.00	0.740	46.09	93.11	103.7	41.5
-17.60	-20.10	2.5	10.7	0	0.0	0.900	5.70	9.00	0.00	0.00	96.30	0.00	0.00	18.908	5.70	3.93	0.00	0.00	0.395	16.60	109.72	128.6	51.4
-20.10	-25.10	3.9	0.0	31	31.0	0.910	5.70	9.00	26.40	27.53	0.00	150.48	6.26	30.776	5.70	6.33	3.42	20.98	0.000	0.00	130.70	161.5	64.6

Safe Load Carrying Capacity of Pile = 65 T

Uplift Capacity = 44 T

Sample Calculation to Determine Horizontal Capacity

Code used: IS 2911 (Part1/sec-2) 2010

Diameter of pile =	500 mm	
Grade of concrete =	25 M	
Grade of reinforcement =	415 Fe	
Percentage of reinforcement =	1.0	
Nature of soil offering resistance =	Cohesive	
K_1 =	20000 kN/m^2	(Table-4 Annex C)
Effective cover of reinforcement, d1 =	80 mm	
K =	8000.0	
Modulus of Elasticity of concrete, E =	25000000 kN/m^2	
Moment of Inertia, I =	0.003068 m^4	

R = 2.09 cm

L_1 = 0 cm

L_1 / R = 0.00

From Fig. 2 L_f / R = 1.9 For Free Head Pile

= 2.15 For Fixed Head Pile

Hence, L_f = 3.98 m For Free Head Pile

∴ = 4.50 m For Fixed Head Pile

For Free Head Pile :

Deflection at the pile head = 0.0003 xQ cm

Maximum allowable deflection = 0.5 cm

Q= 1.83 t

For Fixed Head Pile :

Deflection at the pile head = 0.00010 xQ cm

Maximum allowable deflection = 0.5 cm

Q= 5.1 t

Therefore, consider horizontal capacity for fixed head pile = 5.1 t

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