

C & C

REPORT ON

**SOIL INVESTIGATION FOR PROPOSED NATIONAL
TRAINING CENTRE AT RAJARHAT (NEAR
RAMMANDIR) KOLKATA, WEST BENGAL.**

CLIENT:

**COLLAGE DESIGN PVT. LTD.
200 SAI SAMPANNA STATION RD.
VIKHROLI EAST, MUMBAI – 400 083.**

OWNER :

**ALL INDIA FOOTBALL FEDERATION
FOOTBALL HOUSE, SECTOR – 19, PHASE – 1,
DWARKA, NEW DELHI – 110 075.**

PREPARED BY:

**C & C CONSULTING FIRM
(AN ISO 9001:2008 COMPANY)
64A, HINDUSTHAN PARK,
KOLKATA-700 029**



SPECIALISATIONS INCLUDE CONSULTANCY ON SURVEY
(LAND, QUANTITY, VALUATION & HYDROGRAPHIC)
SOIL INVESTIGATION

C & C CONSULTING FIRM

64A, HINDUSTHAN PARK (GROUND FLOOR), KOLKATA-700 029
PHONE : 91+82740 02411, (033) 2419 8402
FAX : 91 33 2419 8403
e-mail : info@ccconsultingfirm.co.in / cccf@cal3.vsnl.net.in
Website : www.ccconsultingfirm.co.in

CCCF/CD/SR/18/241
April 05, 2018

Collage Design Pvt. Ltd.
300 Sai Sampanna Station Rd.
Vikhroli East,
Mumbai – 400 083.

Sub: Report on Soil Investigation for proposed National Training Center at
Rajarhat, Kolkata.

Ref.: Work Order No.: 2018/FIFA/RAJARGHAT/PO/01 dtd. 27.01.2018.

Dear Sirs,

Please find the Report on Soil Investigation for proposed National Training
Center at Rajarhat, Kolkata.

Thanking you and assuring you of our best services at all times.

Yours faithfully,
For C & C CONSULTING FIRM

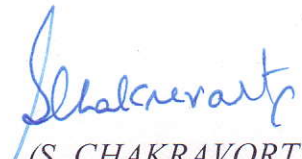

(S. CHAKRAVORTY)

Table of Contents

1.0 INTRODUCTION	1
2.0 FIELD EXPLORATION	1 to 2
3.0 LABORATORY TESTS	3 to 5
4.0 SOIL PROFILE	5 to 6
5.0 SOIL PROPERTIES	6 to 8
6.0 FOUNDATION CONSIDERATION	8 to 10
7.0 RECOMMENDATION	11

ANNEXURE

Layout of bore hole location
Subsoil profile
Bore log data sheets
Laboratory Test Results
e-Log P Curves
Grain Size Distribution Curves

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

1. INTRODUCTION

It has been proposed to construct a structure for a G+3 storied building for National Training Centre at Rajarhat (Near Rammandir), Kolkata, West Bengal. The job of subsoil exploration for the proposed building was entrusted to M/S C&C Consulting Firm 64A, Hindusthan Park Kolkata -700029. They approached the Department of Civil Engineering, Jadavpur University, for recommendation for foundation design of the proposed building structure. Soil exploration was carried out at the site to determine the subsoil condition and to ascertain the foundation types suitable for the proposed structure. Total Five nos. of borehole, with maximum depth of exploration of 35.00m were sunk, at different locations (shown in Fig.1 in Annexure). The fieldwork for the soil exploration, including all field tests and undisturbed sampling, was done by M/S C&C Consulting Firm 64A, Hindusthan Park Kolkata -700029, West Bengal India, in the month of February, 2018. The undisturbed samples and disturbed samples were tested in the Soil Mechanics laboratory of Civil Engineering Department, Jadavpur University. This report deals with the findings of field and laboratory tests and makes recommendations for the foundations of the proposed shed structure.

2. FIELD EXPLORATION

2.1 BORING

The boring was done at the site using 150mm diameter auger and shell equipment by a manually operated winch. To prevent possible caving in of the sides of the boreholes,

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

flush jointed casing pipes were used as boring progressed. Circulation of bentonite slurry was resorted to whenever necessary to stabilize the sides of the boreholes.

2.2 SAMPLING

Undisturbed samples were collected at suitable intervals of depth from the bore holes by driving two - tier thin walled open drive samplers of 100mm diameter. The area ratio of the tubes was kept about 15%, after withdrawal, the lower tube was retained, covered with an impervious disc and sealed with wax at both ends before transportation to the laboratory. In addition, disturbed samples were taken at suitable intervals of depth and at changes of strata in order to physical examination of the nature of all the representative strata. These were collected from the auger and the barrel of the split spoon sampler after the standard penetration tests. The depth wise locations of the entire undisturbed, disturbed and standard penetration test samples have been given in the bore log data sheets, enclosed with this report.

2.3 IN-SITU TEST

a) Standard Penetration Test :-

Standard penetration tests were conducted within the bore holes at suitable intervals of depth at levels as shown in the bore log data sheets. The tests were done with the standard split spoon sampler as per IS: 2131 latest edition. The N – values were obtained by counting the number of blows required to drive the split spoon sampler from 15 cm to 45 cm.

3. LABORATORY TESTS

The soil samples from the 10cm diameter sampling tubes were extracted in the laboratory by pushing out the soil core with the help of a jack and a frame. The core was jacked out in a direction that corresponded to the soil movement within the tube during sampling. The following tests were done on representative samples of the cohesive strata.

- a) Natural Water Content
- b) Atterberg Limits
- c) Bulk Density
- d) Specific Gravity
- e) Grain Size Distribution
- f) Undrained Triaxial Test
- g) Consolidation Test

The laboratory tests were run to ascertain the average engineering properties of the sub-soil strata and to obtain the necessary data required for determination of particulars of the foundation. These are detailed below. A summary of all test results has been given in the enclosed laboratory sheet.

3.1 Natural moisture content & Atterberg limits

Natural moisture content of clayey silt / silty sand / sand samples have been determined by oven drying method and also liquid limit and plastic limit of clayey silt samples were

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

determined (a) to classify the soil by the IS classification system and (b) to qualitatively assess their consistency and compressibility.

3.2 Bulk density & Dry density

These were determined by measuring the weights and dimensions of tri-axial shear and unconfined compressive strength test samples before testing and after oven drying. The bulk density & dry density values of the samples have been given in the enclosed laboratory sheet.

3.3 Grain size analysis

The grain size distributions of some representative samples were determined from hydrometer and /or sieve analysis. The results are Plotted and shown in this report.

3.4 Tri-axial shear test (UU)

For triaxial shear and unconfined compressive strength tests, three no. 38 mm diameter 76 mm long specimens were obtained by jacking out the soil core, each into a thin-walled brass tube, having the wall thickness of 1/32". The inside of the tubes was coated with a thin layer of silicon oil.

These were run on the clayey silt samples to determine their shear strengths. The cell pressures employed were 0.5, 1.0 and 1.5 kg/sq.cm. The samples were tested under quick condition at a rate of 1.25 mm/min and were loaded up to maximum 20% axial strain.

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

3.5 Consolidation test

To obtain specimens for consolidation test, the odometer ring was placed on the trimmed horizontal faces of the soil within the 10 cm diameter 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.

Consolidation tests were run in floating ring type odometers, in single & four unit consolidation frames under standard load increment ratio starting from 0.25 kg/sq.cm and going up to 16 kg/sq.cm in general. The pressure vs void ratio curves are given in this report.

3.6 Specific Gravity

The Specific Gravity of the soil samples was determined by adopting standard procedure. The soil sample was oven dried for 24 hours and pulverized. The sample was then poured into a specific gravity bottle and topped up with distilled water. The specific gravity bottle was stirred and heated to eliminate air bubbles. The weight of the specific gravity bottle was recorded along with the temperature of the sample.

4. SOIL PROFILE

The soil profile as revealed by borings is shown in Fig 2 in Annexure. The depth wise variation of N values along the boreholes is shown alongside the soil profile. The average subsoil stratification has been considered for the design. The soil stratification may, in general, has been summarized as shown in Table 1.

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

Table 1: Average Subsoil Profile:

Stratum	Description	Thickness (m) in worse condition	N-Value
Top Soil	Brownish grey silty clay / grey silty clay with kankars and organic materials	1.50	-
I	Very soft to soft dark grey silty clay with organic materials and decomposed wood	11.00	1-3
II	Stiff light bluish grey silty clay with kankars	4.00	9-16
III	Stiff to very stiff light yellowish grey clayey silt	4.00	15-23
IV	Medium to very dense brownish grey silty fine sand with mica	7.50	23-63
V	Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots	>7.00	23-40

The ground water table was observed at 1.60m EGL. However, the water table may fluctuate due to seasonal variation and it has been considered to exist at EGL for design purpose.

5.0 SOIL PROPERTIES

5.1 FIELD TEST DATA (STANDARD PENETRATION RESISTANCE)

A summary of the stratum wise variation of N-values throughout the site is given in Annexure.

REPORT SHEET

C & C

C & C CONSULTING FIRM

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

5.2 Laboratory Test Data

A summary of all laboratory test results is given in Annexure. From a study of these test results, the engineering properties of different strata can be summarized as follows.

Top Soil : Brownish grey silty clay /grey silty clay with kankars and organic materials(0.00-1.50m below G.L)

Stratum I:

Very soft to soft dark grey silty clay with organic materials and decomposed wood.(1.50-12.50m below G.L)

Bulk density : 1.67 t/m^3

Natural moisture Content : 42 %

LL : 60 %

PL : 27%

C_u : 1.20 t/m^2

m_v : $0.0067 \text{ m}^2/\text{ton}$ (at pressure range $0.50\text{-}1.0\text{kg/cm}^2$)

Stratum II:

Stiff light bluish grey silty clay with kankars(12.50-16.50m below GL).

Bulk density : 1.90 t/m^3

Natural moisture Content : 31 %

LL : 58 %

PL : 23%

C_u : 6.00 t/m^2

m_v : $0.0025 \text{ m}^2/\text{ton}$ (at pressure range $0.50\text{-}1.0\text{kg/cm}^2$)

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

Stratum III :

Stiff to very stiff light yellowish grey clayey silt (16.50-20.50m below GL).

Bulk density : 1.95 t/m^3

Natural moisture Content : 30 %

LL : 45 %

PL : 24%

C_u : 8.50 t/m^2

m_v : $0.0021 \text{ m}^2/\text{ton}$ (at pressure range $0.50\text{-}1.0\text{kg/cm}^2$)

Stratum IV: Medium to very dense brownish grey silty fine sand with mica

(20.50- 28.00m below GL)

Bulk density : 1.95 t/m^3

ϕ : 34°

Stratum V:

Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots. (28.00-35.00m below G.L)

Bulk density : 1.92 t/m^3

Natural moisture Content : 28 %

LL : 46 %

PL : 24%

C_u : 12.00 t/m^2

m_v : $0.0012 \text{ m}^2/\text{ton}$ (at pressure range $0.50\text{-}1.0\text{kg/cm}^2$)

6. FOUNDATION STUDY

6.1 General Considerations

Foundation of a structure is to be designed from considerations of superstructure loading as well as subsoil condition at the site. Suitable foundations for a structure should satisfy the following basic design criteria:

- a) There must be adequate factor of safety of the foundations against any possible bearing capacity failure and
- b) The settlement of the foundations must be within permissible limits.

6.2. Deep Foundation:

From the considerations of superstructure loading and subsoil condition, deep foundation in the form of RCC bored cast-in-situ piles has been studied. Pile toe may be kept at 22.00 below the EGL. Cut-off level may be considered at 2.00m below the EGL.

The ultimate load carrying capacity (Q_u) of a pile foundation has been estimated using the expression as given below (as per IS :2911) :

$$Q_u = A_p (0.5 \times D \times \gamma \times N_\gamma + P_d \times N_q) + \sum a C A_s + K P_{di} \tan \delta A_{si}$$

where ,

A_p = Cross-sectional area of pile toe, D = Pile stem diameter,

γ = Effective unit weight of soil at pile toe,

P_d = Effective overburden pressure at pile toe,

N_γ & N_q = Bearing capacity factors depending upon the angle of internal friction (Φ) of soil at pile toe,

\sum = Summation for n layers in which pile is installed,

a = Reduction factor, C = Average cohesion of soil,

A_s = Surface area of pile stem, K = Coefficient of earth pressure = 1.5,

P_{di} = Effective overburden pressure for the i th layer;

δ = Angle of wall friction between pile and soil in degrees (may be taken equal to Φ) and

A_{si} = Surface area of pile stem in the i th layer.

Values of safe bearing capacity of RCC Bored Cast in situ pile with tip resting at 22.0 m from EGL and 2.00 cut-off from EGL (shaft length 20m) for different diameters have been estimated and are given in the table -2.

TABLE-2

For pile shaft length 20.00m from cut off level at 2.00m below EGL
(Grade of Concrete = M25)

Pile Dia., mm	500	600	750
Suggested Safe load carrying capacity In Compression, MT (FS = 2.5)	46	60	90
Suggested Safe load carrying capacity In Tension, MT (FS = 3)	28	36	46
Suggested Capacity against Lateral Load, MT	0.95	1.58	2.91
Depth of fixity (m)	7.84	8.99	10.63

DMC method should be adopted for construction of piles. During construction boreholes should be cleaned after lowering the reinforcement caging, otherwise there is a chance of reduction of capacity of the pile. The above tabulated pile capacities should be checked at the site by conducting initial and routine load tests on piles according to IS: 2911 (Part-IV). Minimum pile spacing should be kept equal to 3 times the diameter of pile.

REPORT SHEET

C & C CONSULTING FIRM

C & C

Subsoil Investigation for a G+3 storied building for National Training Centre
at Rajarhat (Near Rammandir) Kolkata, West Bengal

7.0 RECOMMENDATIONS:

It has been proposed to construct a (G+3) storied building for National Training Centre at the site at Rajarhat, Kolkata. A detailed soil investigation programme was undertaken to assess the subsoil stratification / properties and to suggest suitable foundation systems for the proposed structure. Based on field and laboratory tests and analysis of the results the following recommendations have been made.

- 1.0 R.C.C. Cast- in- situ bored piles of shaft length 20.00m with tip resting at 22.0m below G.L. and cut off at 1.50m below EGL has been suggested.
- 2.0 The capacity of such piles of different diameter has been given in table-2. There should be adequate provision for Load test of piles according to IS 2911 – Part IV (latest edition). The minimum spacing of piles should be kept equal to 3 times the pile diameter.

For C & C Consulting Firm

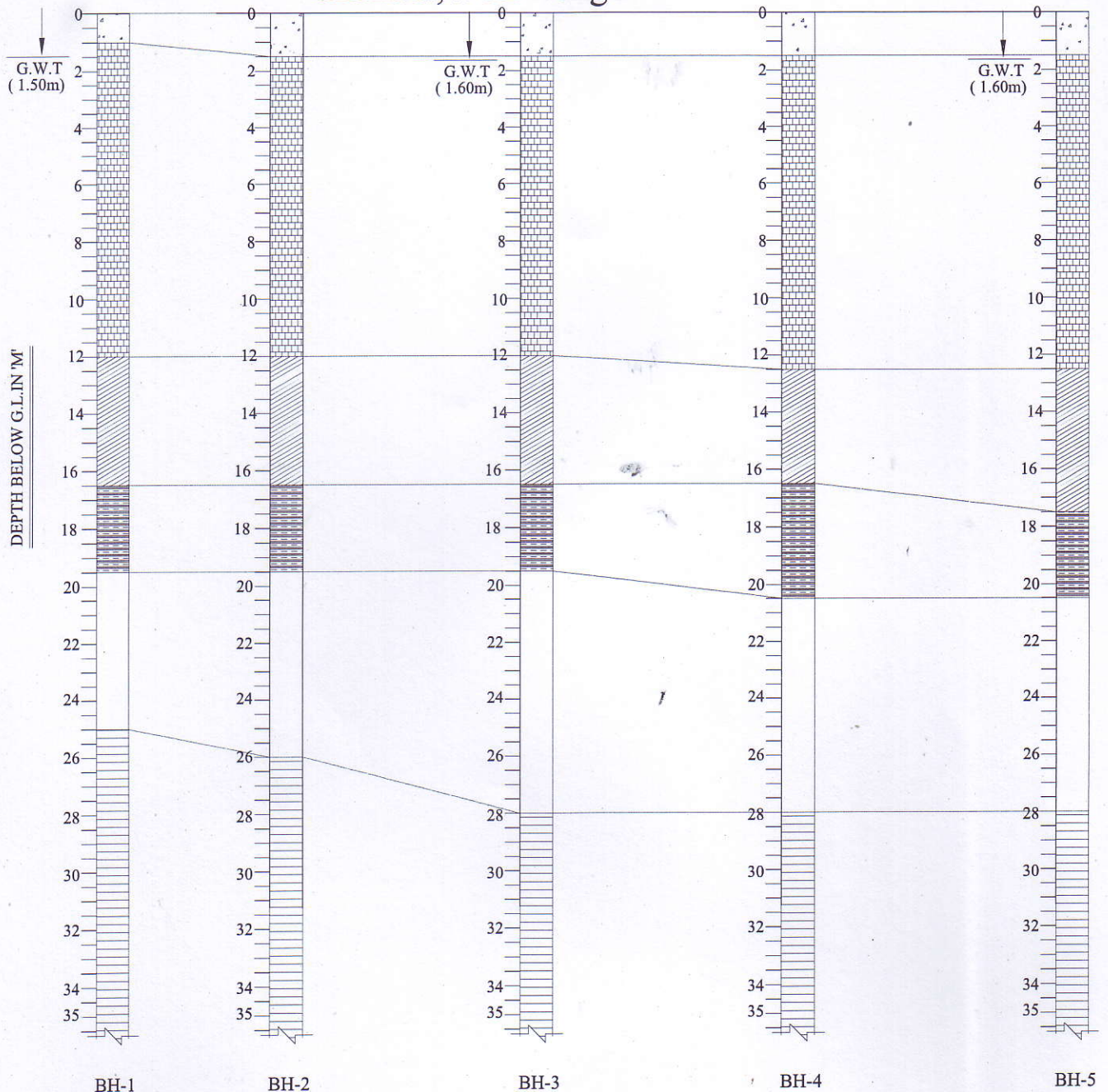
(Dr. R. B. Sahu)
Professor of Civil Engineering
DEPARTMENT OF CIVIL ENGINEERING,
JADAVPUR UNIVERSITY
KOLKATA-700032







Dr. R. B. Sahu
Professor of Civil Engineering
Jadavpur University
Kolkata-700032

ANNEXURE

SOIL PROFILE THROUGH SELECTED BORE HOLES

SITE : National Training Centre Rajarhat (Near Rammandir)
Kolkata, West Bengal



-  Top Soil : Brownish grey silty clay /grey silty clay with kankars and organic materials
-  Very soft to soft dark grey silty clay with organic materials and decomposed wood
-  Stiff light bluish grey silty clay with kankars
-  Stiff to very stiff light yellowish grey clayey silt
-  Medium to very dense brownish grey silty fine sand with mica
-  Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots

BORELOG DATA SHEET

BORE HOLE NO. : 1(ONE)
 LOCATION : National Training Centre Rajarhat (Near Rammandir)
 Kolkata, West Bengal

DIA. OF BORE HOLE : 150 MM.
 DEPTH OF BORE HOLE : 35.00 M.

FIELD TEST

(a) COMMENCED ON : 08.02.2018
 (b) COMPLETED ON : 10.02.2018
 TYPE OF BORING : WASH & AUGUR BORING
 LOCATION OF G.W.L. : 1.50m

DESCRIPTION		Depth (m)		Thickness (M)	N-Value	Type & marked	Samples Depth (M)
		From	To				
Top Soil : Brownish grey silty clay /grey silty clay with kankars and organic materials		0.00	1.00	1.00	-	DS	0.50
					-	DS	1.00
Very soft to soft dark grey silty clay with organic materials and decomposed wood		1.00	12.00	11.00	1	SPT	1.50
					1	SPT	3.00
					-	UDS	4.50
					1	SPT	6.00
					1	SPT	7.50
					-	UDS	9.00
					2	SPT	10.50
					10	SPT	12.00
Stiff light bluish grey silty clay with kankars		12.00	16.50	4.50	13	SPT	13.50
					-	UDS	15.00
					18	SPT	16.50
Stiff to very stiff light yellowish grey clayey silt		16.50	19.50	3.00	23	SPT	18.00
					35	SPT	19.50
Medium to very dense brownish grey silty fine sand with mica		19.50	25.00	5.50	47	SPT	22.50
					58	SPT	24.00
					28	SPT	25.50
Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots		25.00	35.00	10.00	36	SPT	27.00
					-	UDS	28.50
					26	SPT	30.00
					32	SPT	31.50
					29	SPT	33.00
					32	SPT	35.00

UDS-Undisturbed sample, SPT-Standard penetration test DS-Disturbed sample.

BORELOG DATA SHEET

BORE HOLE NO. : 2(ONE)

LOCATION : National Training Centre Rajarhat (Near Rammandir)
Kolkata, West Bengal

DIA. OF BORE HOLE : 150 MM.

DEPTH OF BORE HOLE : 35.00 M.


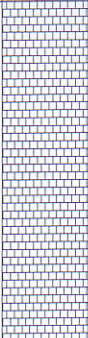



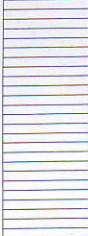
FIELD TEST

(a) COMMENCED ON : 10.02.2018

(b) COMPLETED ON : 12.02.2018

TYPE OF BORRING : WASH & AUGUR BORING

LOCATION OF G.W.L. : 1.50m

DESCRIPTION		Depth (m)		Thickness (M)	N-Value	Type & marked	Samples Depth (M)
		From	To				
Top Soil : Brownish grey silty clay /grey silty clay with kankars and organic materials		0.00	1.50	1.50	-	DS	0.50
					-	DS	1.00
Very soft to soft dark grey silty clay with organic materials and decomposed wood		1.50		10.50	1	SPT	1.50
					2	SPT	3.00
					1	SPT	4.50
					-	UDS	6.00
					2	SPT	7.50
					2	SPT	9.00
			12.00		2	SPT	10.50
					11	SPT	12.00
Stiff light bluish grey silty clay with kankars		12.00		4.50	-	UDS	13.50
			16.50		12	SPT	15.00
					-	UDS	16.50
Stiff to very stiff light yellowish grey clayey silt		16.50		3.00	18	SPT	18.00
			19.50		28	SPT	19.50
Medium to very dense brownish grey silty fine sand with mica		19.50		6.50	42	SPT	22.50
					38	SPT	24.00
			26.00		49	SPT	25.50
Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots		26.00		9.00	32	SPT	27.00
					35	SPT	28.50
					28	SPT	30.00
					-	UDS	31.50
					30	SPT	33.00
			35.00		36	SPT	35.00

BORELOG DATA SHEET

BORE HOLE NO. : 3(THREE)

LOCATION : National Training Centre Rajarhat (Near Rammandir)
Kolkata, West Bengal

DIA. OF BORE HOLE : 150 MM.

DEPTH OF BORE HOLE : 35.00 M.

FIELD TEST

(a) COMMENCED ON : 12.02.2018

(b) COMPLETED ON : 13.02.2018

TYPE OF BORING : WASH & AUGUR BORING

LOCATION OF G.W.L. : 1.60m

DESCRIPTION		Depth (m)		Thickness (M)	N-Value	Type & marked	Samples Depth (M)
		From	To				
Top Soil : Brownish grey silty clay /grey silty clay with kankars and organic materials		0.00	1.50	1.50	-	DS	0.50
					-	DS	1.00
Very soft to soft dark grey silty clay with organic materials and decomposed wood		1.50	12.00	10.50	2	SPT	1.50
					-	UDS	3.00
					1	SPT	4.50
					-	UDS	6.00
					1	SPT	7.50
					2	SPT	9.00
					2	SPT	10.50
					10	SPT	12.00
Stiff light bluish grey silty clay with kankars		12.00	16.50	4.50	-	UDS	13.50
					11	SPT	15.00
					17	SPT	16.50
Stiff to very stiff light yellowish grey clayey silt		16.50	19.50	3.00	-	UDS	18.00
					29	SPT	19.50
					38	SPT	21.00
Medium to very dense brownish grey silty fine sand with mica		19.50	28.00	8.50	46	SPT	22.50
					53	SPT	24.00
					59	SPT	25.50
					63	SPT	27.00
Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots		28.00	35.00	7.00	28	SPT	28.50
					24	SPT	30.00
					32	SPT	31.50
					-	UDS	33.00
					35	SPT	35.00

BORELOG DATA SHEET

BORE HOLE NO. : 4(FOUR)
 LOCATION : National Training Centre Rajarhat (Near Rammandir)
 Kolkata, West Bengal

DIA. OF BORE HOLE : 150 MM.

DEPTH OF BORE HOLE : 35.00 M.

FIELD TEST

(a) COMMENCED ON : 14.02.2018

(b) COMPLETED ON : 15.02.2018

TYPE OF BORRING : WASH & AUGUR BORING

LOCATION OF G.W.L. : Not found

DESCRIPTION		Depth (m)		Thickness (M)	N-Value	Type & marked	Samples Depth (M)
		From	To				
Top Soil : Brownish grey silty clay /grey silty clay with kankars and organic materials		0.00	1.50	1.50	-	DS	0.50
					2	SPT	1.00
Very soft to soft dark grey silty clay with organic materials and decomposed wood		1.50		11.00	-	UDS	2.50
					1	SPT	4.00
					2	SPT	5.50
					-	UDS	7.00
					3	SPT	8.50
					-	UDS	10.00
			12.50		3	SPT	11.50
Stiff light bluish grey silty clay with kankars		12.50		4.00	11	SPT	13.50
					12	SPT	14.50
					16	SPT	16.00
Stiff to very stiff light yellowish grey clayey silt		16.50		4.00	-	UDS	17.50
					18	SPT	19.00
			20.50		23	SPT	20.50
Medium to very dense brownish grey silty fine sand with mica		20.50		7.50	36	SPT	22.00
					42	SPT	23.50
					48	SPT	25.00
					61	SPT	26.50
			28.00		24	SPT	28.00
Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots		28.00		7.00	23	SPT	29.50
					28	SPT	31.00
					32	SPT	32.50
			35.00		27	SPT	34.60

BORELOG DATA SHEET

BORE HOLE NO. : 5(FIVE)

LOCATION : National Training Centre Rajarhat (Near Rammandir)
Kolkata, West Bengal

DIA. OF BORE HOLE : 150 MM.

DEPTH OF BORE HOLE : 35.00 M.

FIELD TEST

(a) COMMENCED ON : 15.02.2018

(b) COMPLETED ON : 17.02.2018

TYPE OF BORING : WASH & AUGUR BORING

LOCATION OF G.W.L. : 1.60m

DESCRIPTION		Depth (m)		Thickness (M)	N-Value	Type & marked	Samples Depth (M)
		From	To				
Top Soil : Brownish grey silty clay / grey silty clay with kankars and organic materials		0.00	1.50	1.50	-	DS	0.50
Very soft to soft dark grey silty clay with organic materials and decomposed wood		1.50	12.50	11.00	2	SPT	1.00
					-	UDS	2.00
					2	SPT	3.50
					-	UDS	5.00
					1	SPT	6.50
					-	UDS	8.00
					1	SPT	9.50
					-	UDS	11.00
Stiff light bluish grey silty clay with kankars		12.50	16.50	4.00	9	SPT	12.50
Stiff to very stiff light yellowish grey clayey silt		16.50	20.50	4.00	-	UDS	14.00
					13	SPT	15.50
					15	SPT	17.00
Medium to very dense brownish grey silty fine sand with mica		20.50	28.00	7.50	-	UDS	18.50
					32	SPT	20.00
					41	SPT	21.50
					46	SPT	23.00
					50	SPT	24.50
Hard light brownish grey clayey silt / silty clay with traces of sand and occasional presence of kankars and brown spots		28.00	35.00	7.00	43	SPT	26.00
					50	SPT	27.50
					40	SPT	29.00
					35	SPT	30.50
					30	SPT	32.00
					32	SPT	33.50
					28	SPT	35.00

LABORATORY TEST RESULTS (BH-1,BH-2,BH-3)

SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal

Borehole No.	Depth (m)	Sample Type	Bulk density (t/m ³)	NMC (%)	Sp. Gr.	Atterberg Limit		Shear Strength				Consolidation m _v (cm ² /kg)	Grain Size		
						LL (%)	PL (%)	TEST	UCS (kg/cm ²)	C (kg/cm ²)	φ ^o		Sand (%)	Silt (%)	Clay (%)
1	4.50	UDS	1.65	41.63	2.61	58	27	UCS/UU	0.14	0.15	3	0.065	4	56	40
	9.00	UDS	1.67	40.25	2.58	62	28	UCS/UU	0.11	0.12	0	0.069	3	54	43
	15.00	UDS	1.91	30.86	2.67	58	23	UU	-	0.54	10	0.024	9	55	36
	28.50	UDS	1.91	28.63	2.68	48	24	UCS	1.15	-	-	0.014	9	61	30
2	6.00	UDS	1.66	43.54	2.57	61	29	UCS/UU	0.11	0.12	0	-	3	53	44
	13.50	UDS	1.90	31.18	2.66	57	22	UCS	0.60	-	-	0.025	8	58	34
	16.50	UDS	1.94	30.72	2.67	47	23	UU	-	0.75	12	0.021	8	64	28
	31.50	UDS	1.92	28.15	-	45	25	UCS	1.20	-	-	0.012	12	60	28
3	3.00	UDS	1.65	42.90	2.58	57	27	UCS/UU	0.13	0.15	4	0.068	4	55	41
	6.00	UDS	1.66	43.12	2.58	61	28	UCS	0.12	-	-	0.065	3	54	43
	13.50	UDS	1.90	31.24	2.66	57	23	UCS	0.58	-	-	0.026	7	58	35
	18.00	UDS	1.96	29.84	-	44	23	UCS	0.86	-	-	-	11	63	26
	33.00	UDS	1.94	27.86	2.68	44	25	UCS	1.24	-	-	0.010	10	59	31

LABORATORY TEST RESULTS (BH-4, BH-5)

SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal

Borehole No.	Depth (m)	Sample Type	Bulk density (t/m ³)	NMC (%)	Sp. Gr.	Atterberg Limit		Shear Strength				Consolidation	Grain Size		
						LL (%)	PL (%)	TYPE OF TEST	UCS (kg/cm ²)	C _u (kg/cm ²)	ϕ		Sand (%)	Silt (%)	Clay (%)
4	2.50	UDS	1.65	40.46	2.60	58	25	UCS/UU	0.14	0.14	4	0.066	4	55	41
	7.00	UDS	1.67	41.83	2.58	61	28	UCS	0.12	-	-	0.067	3	55	42
	10.00	UDS	1.69	40.75	-	60	27	UCS	0.12	-	-	-	3	56	41
	17.50	UDS	1.94	29.68	2.68	45	24	UCS	0.84	-	-	0.020	10	63	27
	2.00	UDS	1.66	41.36	2.58	56	26	UCS	0.15	-	-	0.065	5	56	39
5	5.00	UDS	1.67	42.10	-	61	27	UCS/UU	0.11	0.12	0	0.068	3	55	42
	8.00	UDS	1.68	41.78	2.58	62	28	UCS	0.10	-	-	0.067	2	55	43
	11.00	UDS	1.67	42.16	2.57	61	27	UCS	0.12	-	-	0.068	3	56	41
	14.00	UDS	1.90	30.86	2.67	58	23	UCS	0.62	-	-	-	7	58	35
	18.50	UDS	1.95	30.14	2.68	46	24	UCS	0.87	-	-	0.021	9	63	28

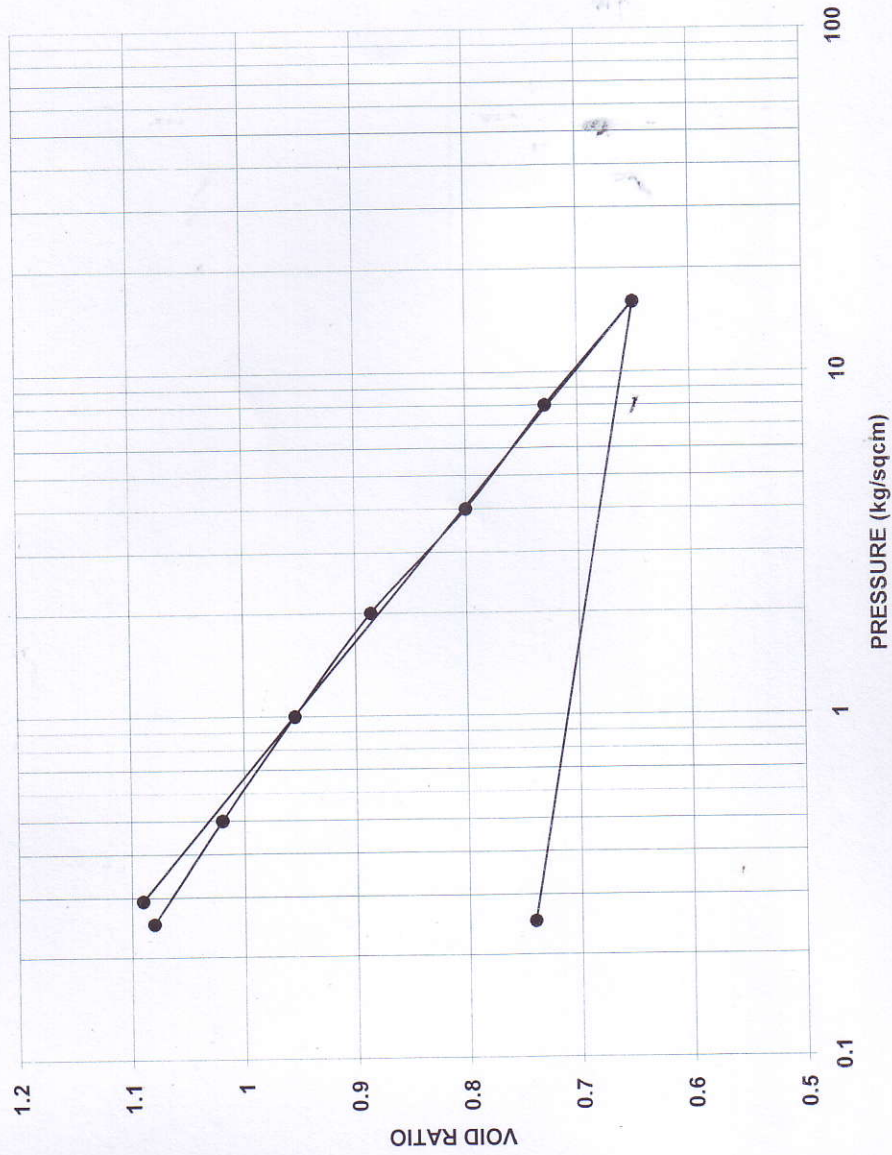
LABORATORY TEST RESULTS

SITE : SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal

Borehole No.	Depth (m)	Sample Type	Bulk density (t/m ³)	saturation water content(%)	Shear Strength			Grain Size		
					TYPE OF TEST	C (kg/ cm ²)	ϕ	Sand (%)	Silt (%)	Clay (%)
1	19.50	SPT	1.92	20.00	DS	0	33	62	38	0
2	22.50	SPT	-	-	-	-	-	70	30	0
3	24.00	SPT	1.94	20.00	DS	0	34	73	27	0
4	25.00	SPT	-	-	-	-	-	63	37	0
5	27.50	SPT	1.96	20.00	DS	0	35	76	24	0

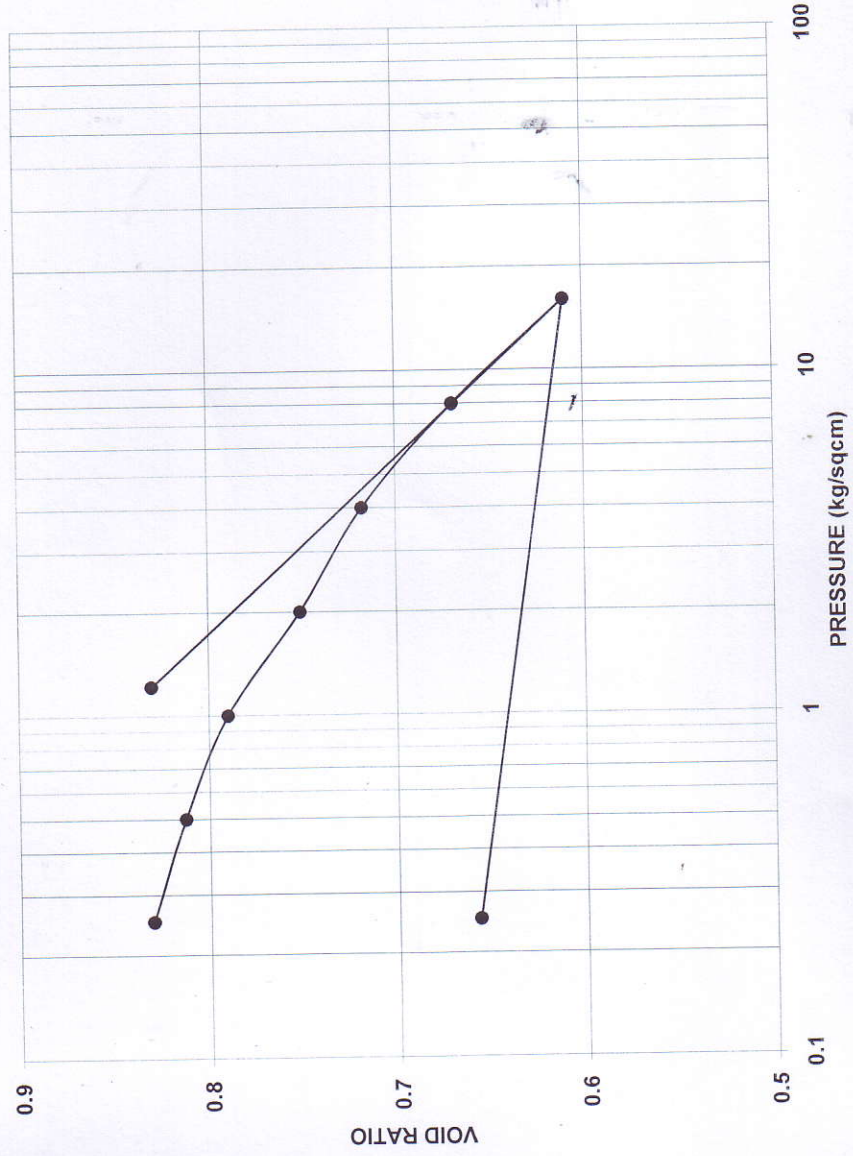
DS test from remoulded spt sample at that density and saturation water content

BH No. -1
Depth - 4.50m
 $e_0 = 1.09$
 $mv = 0.065 \text{ sqcm/kg}$



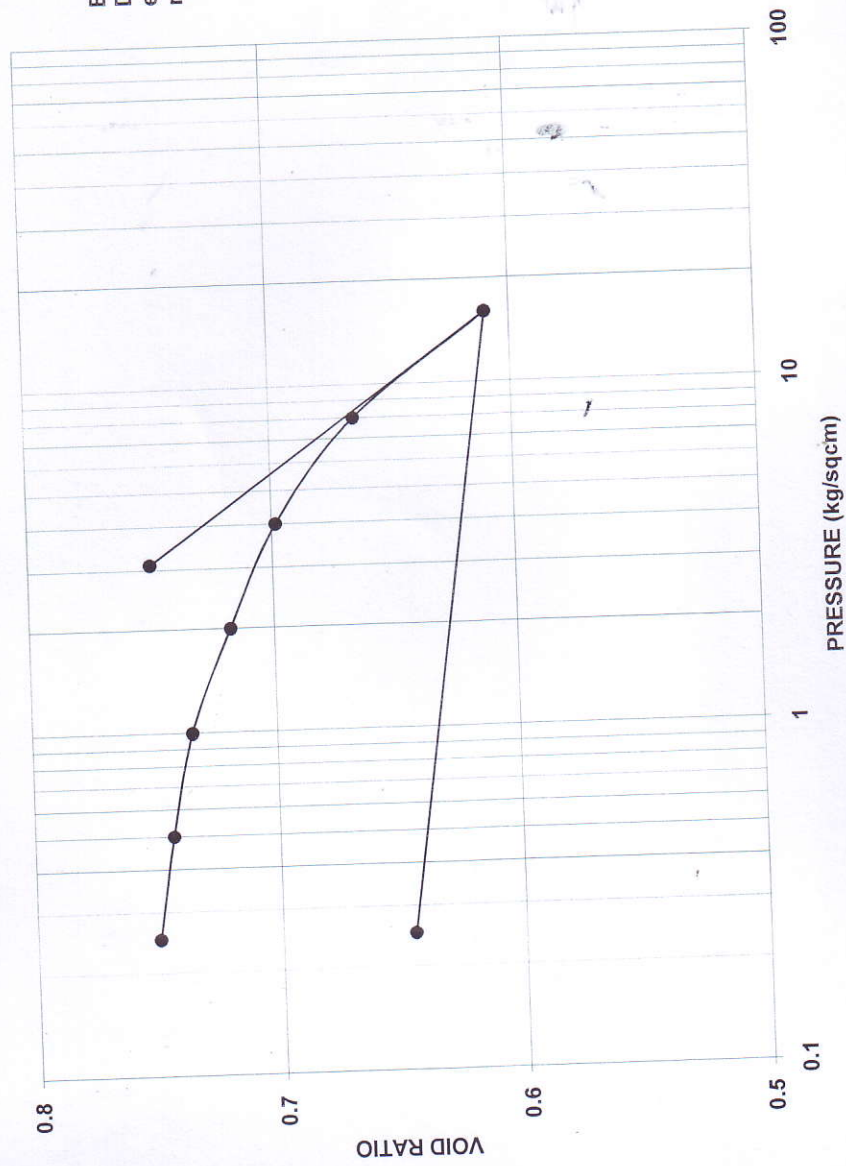
VOID RATIO VS LOGARITHM OF PRESSURE CURVE, SITE : National Training Centre Rajarhat (Near Rammandir)
Kolkata, West Bengal

BH No. -2
Depth - 13.50m
 $e_0 = 0.83$
 $mv = 0.025 \text{ sqcm/kg}$



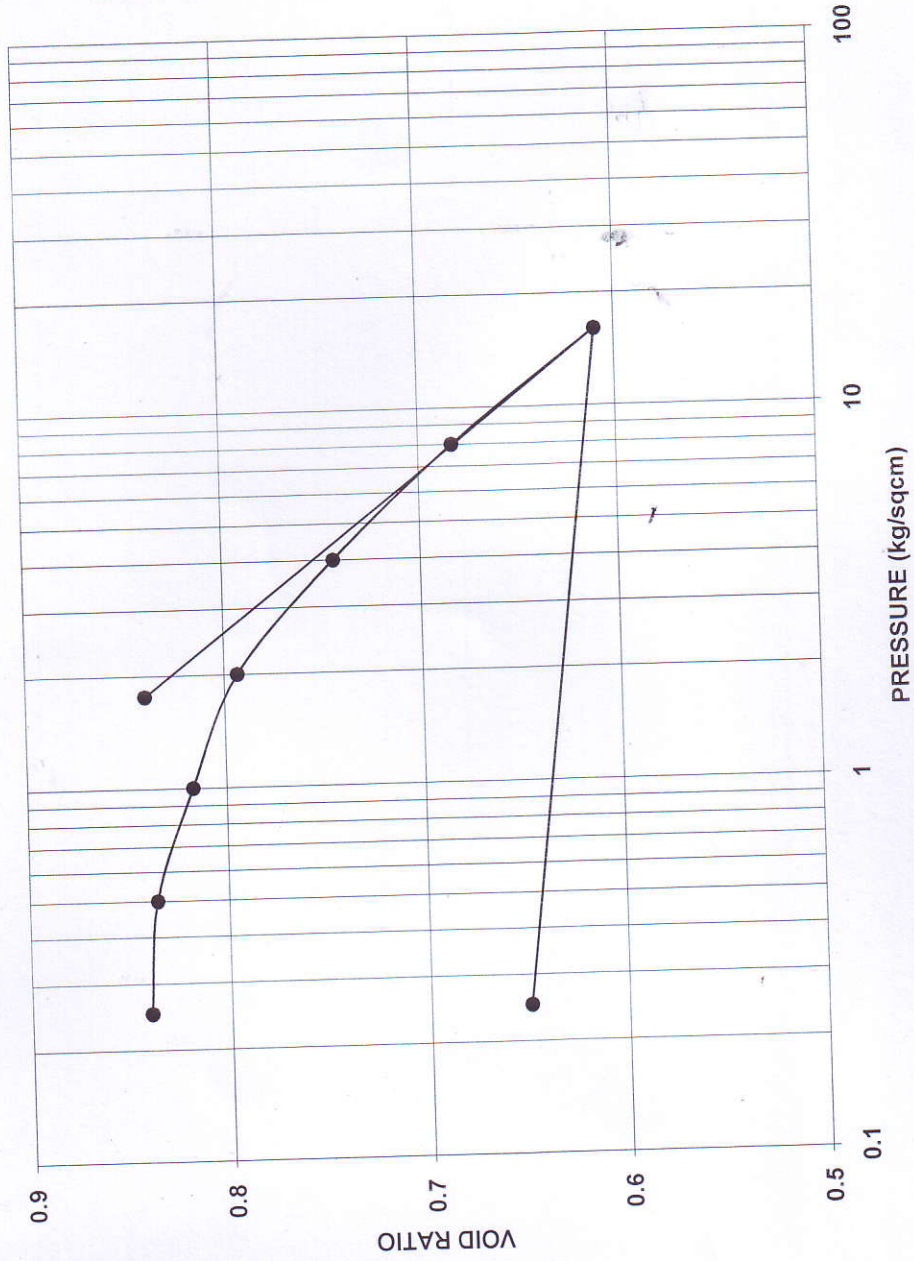
VOID RATIO VS LOGARITHM OF PRESSURE CURVE, SITE : National Training Centre Rajarhat (Near Rammandir)
Kolkata, West Bengal

BH No. -3
 Depth - 33.00m
 $e_0 = 0.75$
 $mv = 0.010 \text{ sqcm/kg}$

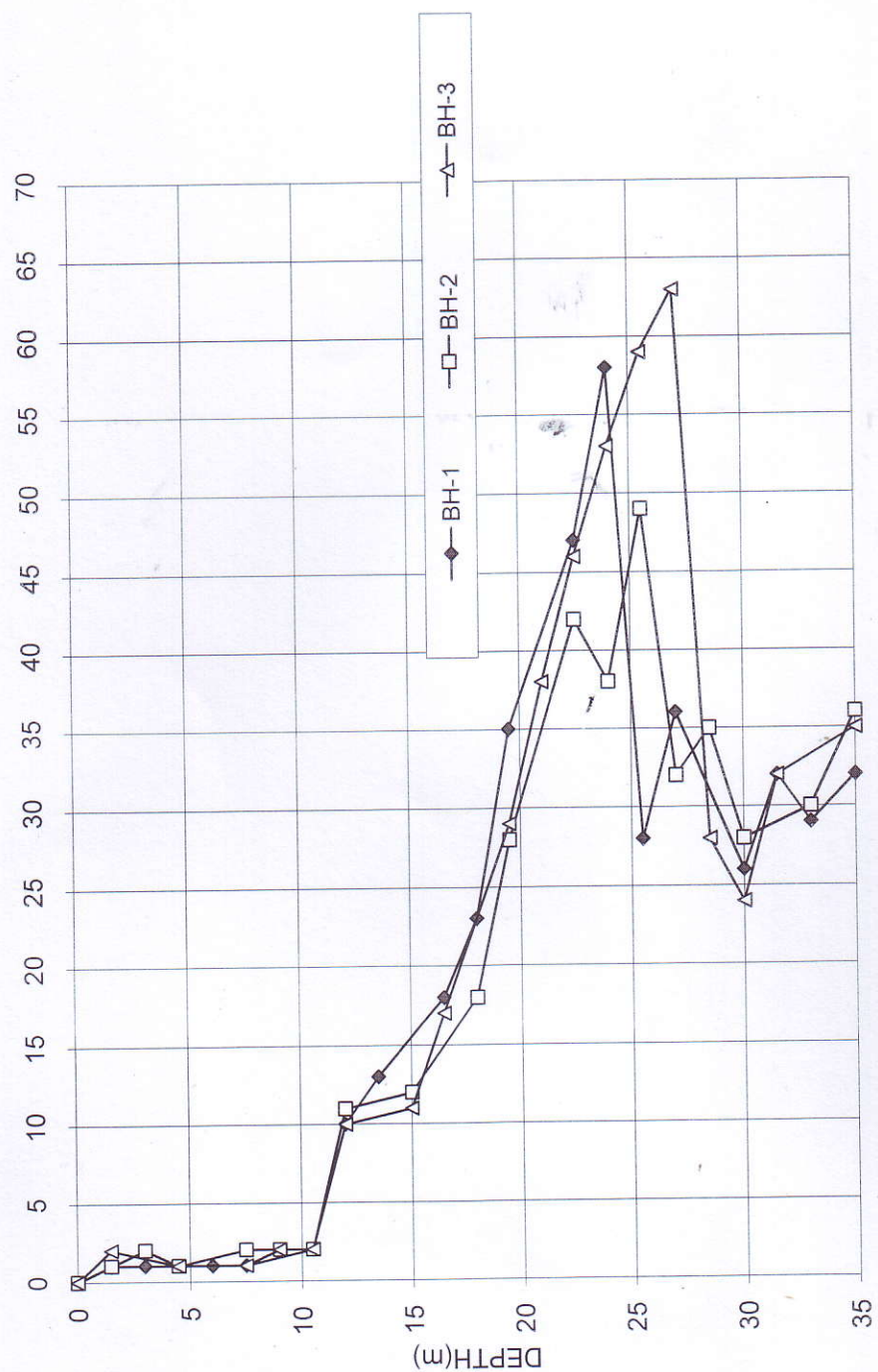


VOID RATIO VS LOGARITHM OF PRESSURE CURVE, SITE : SNational Training Centre Rajarhat (Near Rammandir)
 Kolkata, West Bengal

BH No. -5
 Depth - 18.50m
 $e_0 = 0.84$
 $mv = 0.021 \text{ sqcm/kg}$

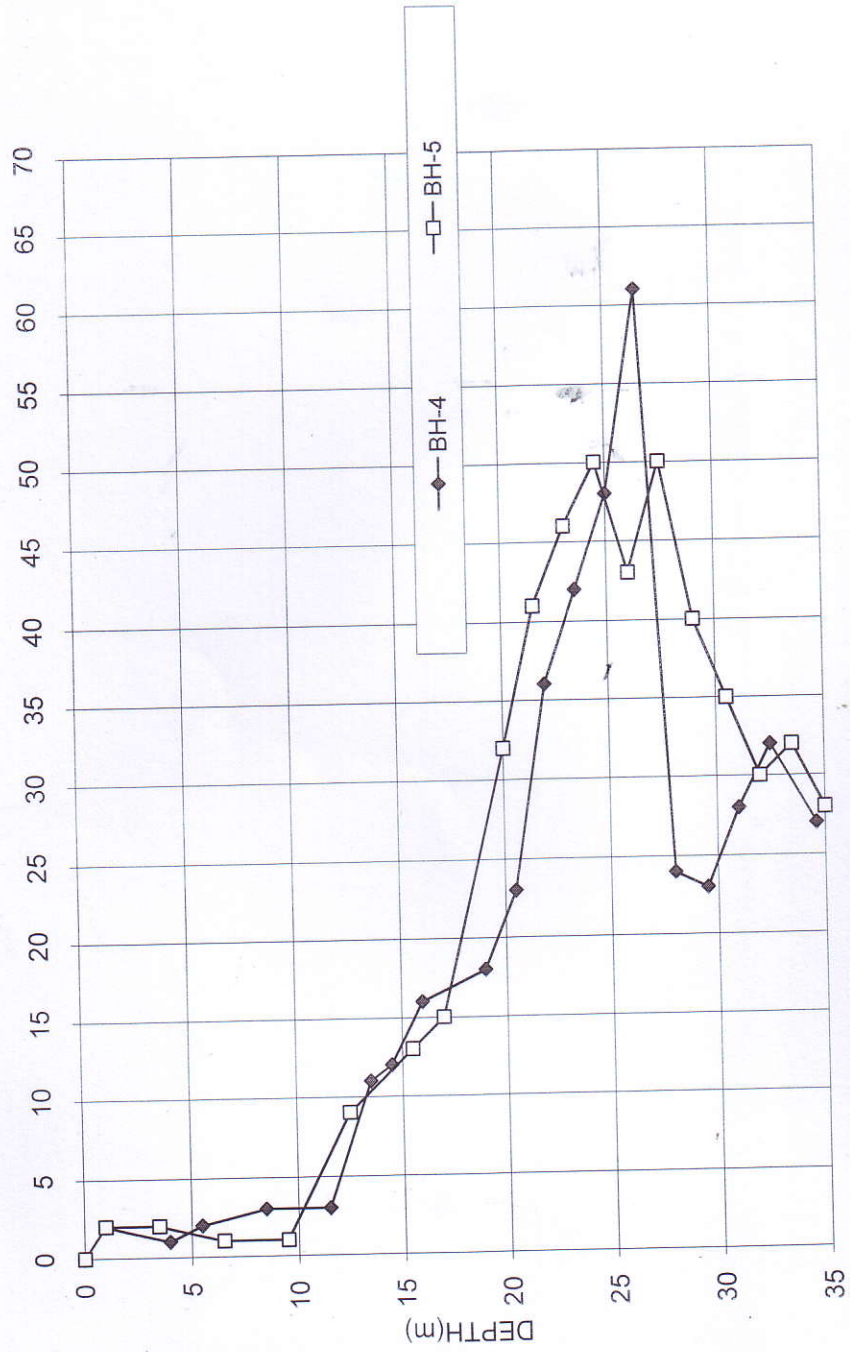


VOID RATIO VS LOGARITHM OF PRESSURE CURVE , SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal

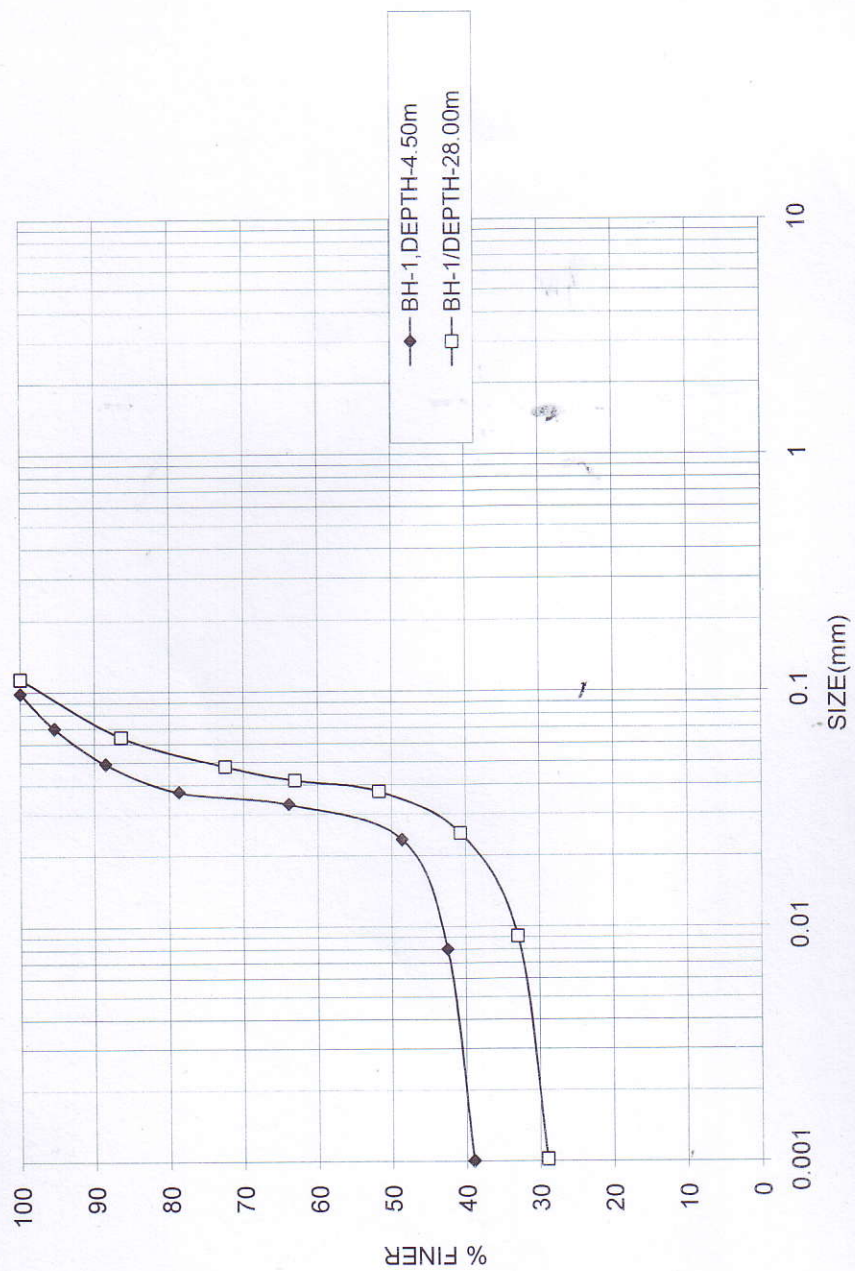


'N'VALUE

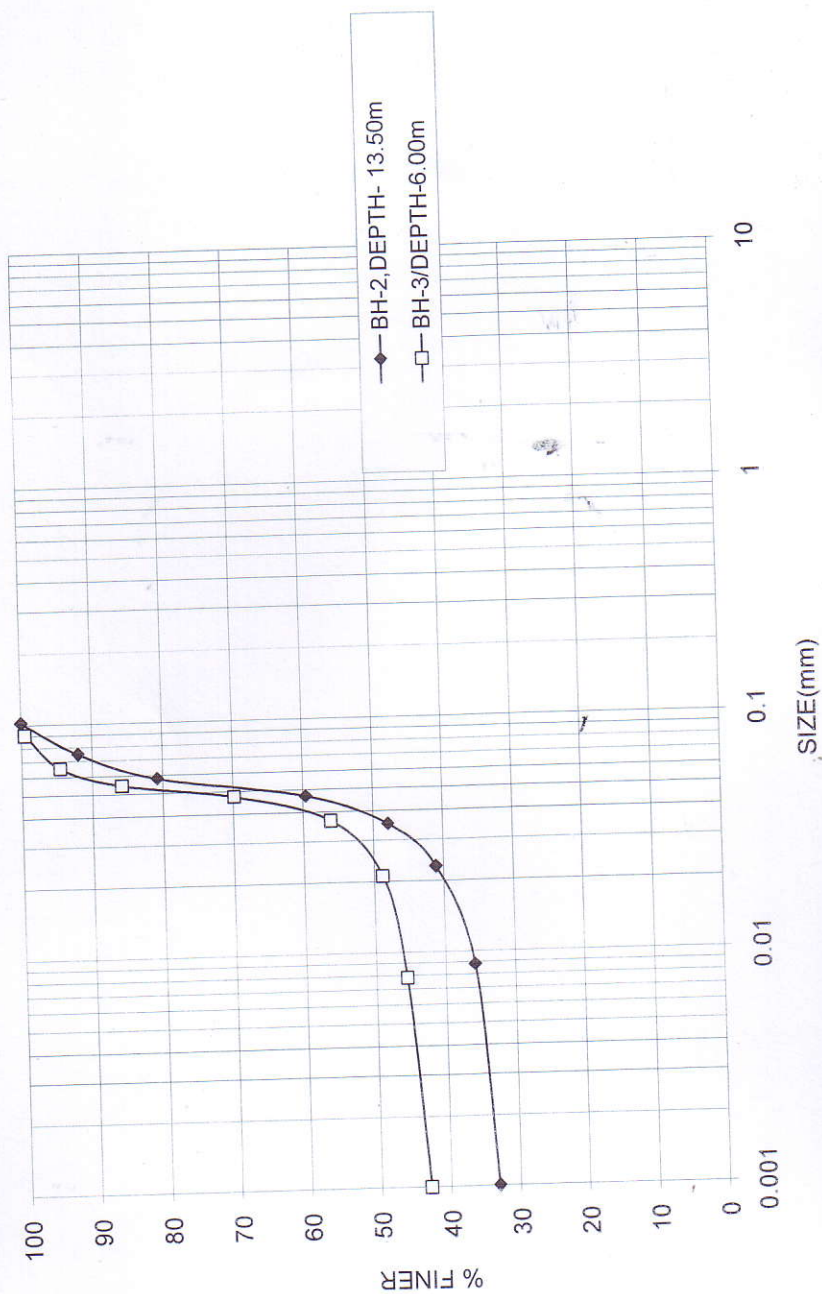
N-BLOWS/30CM, SITE : Nional Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal



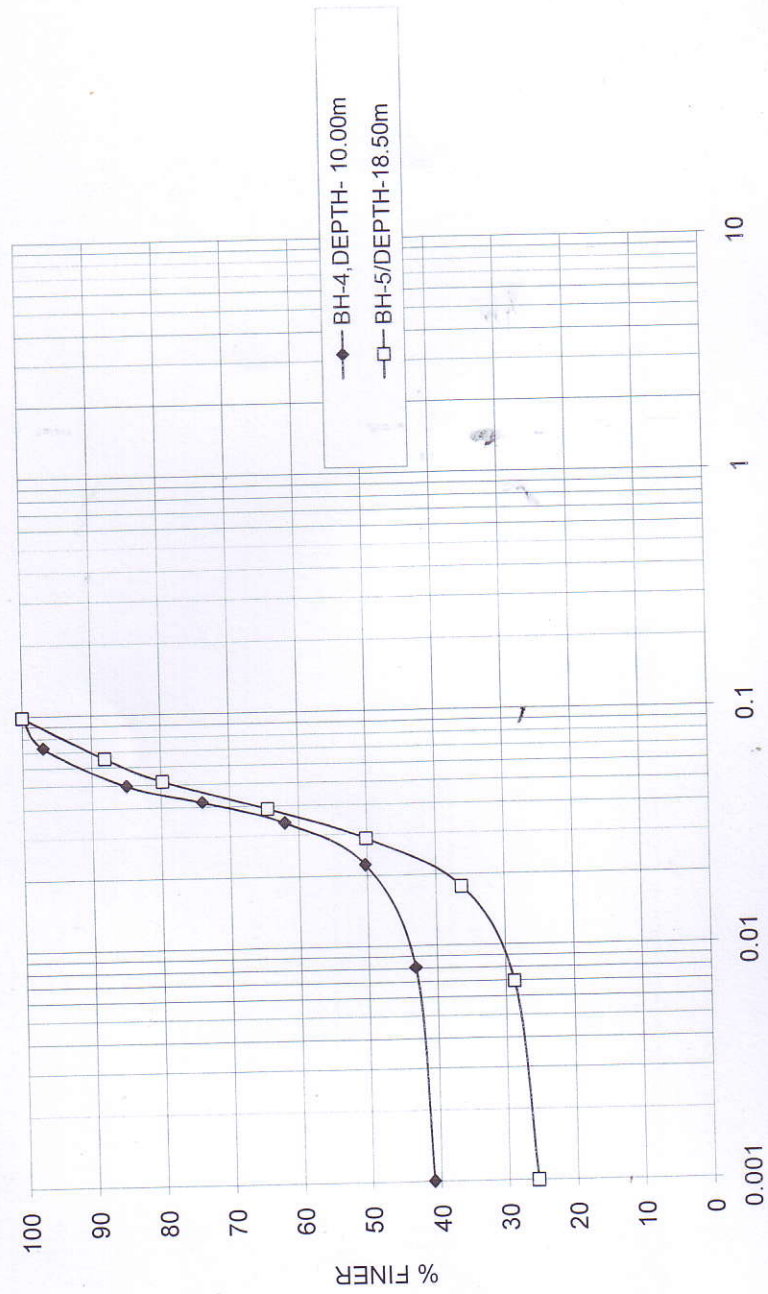
N-BLOWS/30CM, SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal



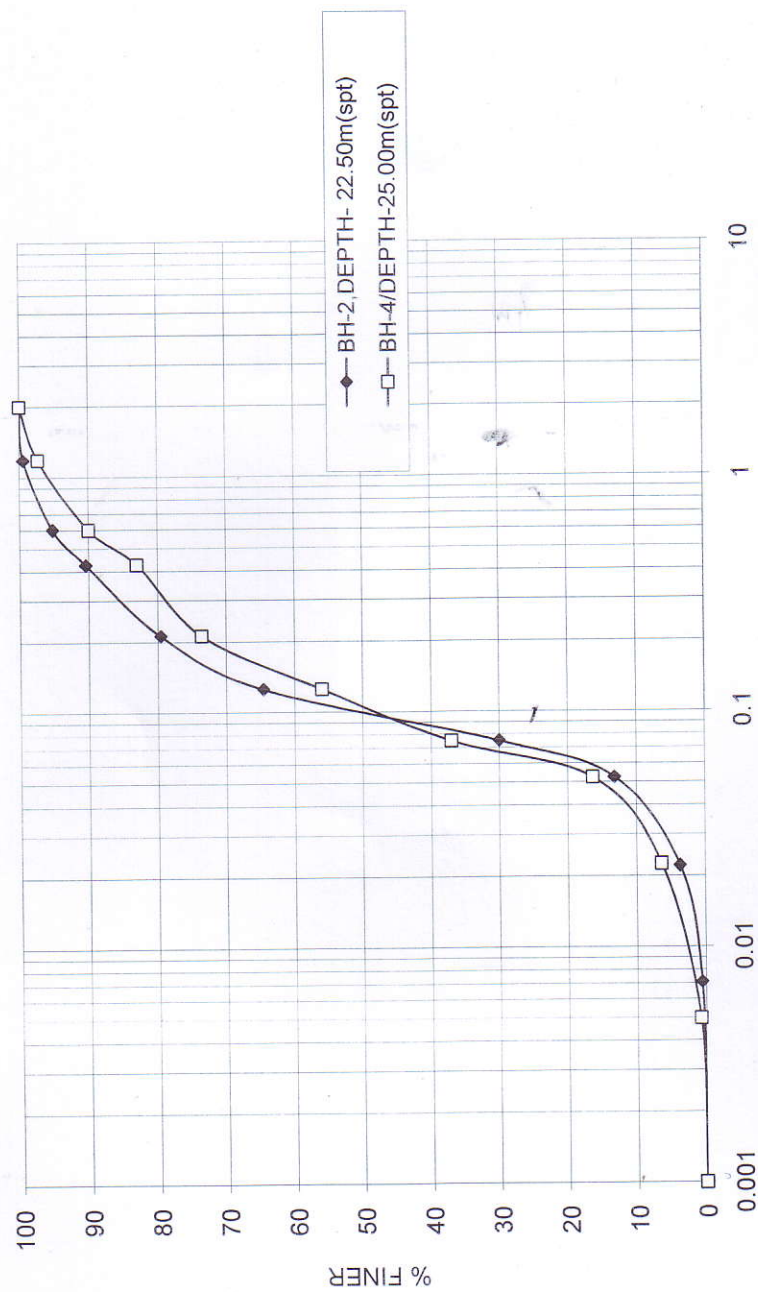
PARTICLE SIZE DISTRIBUTION CURVE, SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal



PARTICLE SIZE DISTRIBUTION CURVE . SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal



PARTICLE SIZE DISTRIBUTION CURVE . SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal



PARTICLE SIZE DISTRIBUTION CURVE . SITE : National Training Centre Rajarhat (Near Rammandir) Kolkata, West Bengal

SAMPLE CALCULATION OF PILE CAPACITY

SITE : Rajat hat NTC

CUT OFF LEVEL AT 2.00 (m)	AVG. THICK.	A_p	D in (m)	γ	N_γ	P_D	N_q	K	P_{Di}	Φ	$\tan \delta$	A_{Si}	A_p	C_p	N_c	α	C	A_s
CUT OFF	2.00			1.75							-0.05	D						D
STRATUM I	10.50			1.67	0.00	0.00	0.00	0.00	5.02	0	-0.05	D				1.00	1.20	32.98 D
STRATUM II	4.00			1.90	0.00	0.00	0.00	0.00	10.34	0	-0.05	D				0.74	6.00	12.56 D
STRATUM III	4.00			1.95	0.00	0.00	0.00	0.00	14.04	0	-0.05	D				0.52	8.50	12.56 D
STRATUM IV	1.50			1.95	27.53	15.50	24.00	1.20	16.65	34	0.60	D				0.00	0.00	4.71 D
END PROP	1.50	0.785		1.95	27.53	15.50	24.00	1.20	16.65	34	0.60	D	0.785	0.00	9.00	0.00	0.00	32.98 D

SAND

CLAY

Here, $A_p = \frac{\pi D^2}{4}$, $N_\gamma = (N_q - 1) \times \tan(1.5 \times \text{deg})$, $K = 1 \text{ OR } 2$, $\tan \delta = \tan(\Phi - 3^\circ)$, $A_{Si} = \pi D h$

Ultimate Skin Resistance

$$Q_{ult} = (\alpha \times C \times A_s) + \sum K \times P_{Di} \times \tan \delta \times \pi \times D \times h$$

For Cohesive Soil

$$(\alpha \times C \times A_s) = (\alpha \times C \times \pi \times D \times h)$$

Depth 2.00 m to 12.50 m - $Q_{ui} = 1.00 \times 1.20 \times 3.141 \times D \times 10.50 = 39.577 D$
 Depth 12.50m to 16.50m - $Q_{uII} = 0.74 \times 6.00 \times 3.141 \times D \times 4.00 = 55.407 D$
 Depth 16.50m to 20.50 m - $Q_{uIII} = 0.52 \times 8.50 \times 3.141 \times D \times 4.00 = 55.533 D$

For Non - Cohesive Soil

$$\sum K \times P_{Di} \times \tan \delta \times \pi \times D \times h$$

Depth 20.50 m to 22.50 m - $Q_{uiv} = 1.20 \times 16.65 \times 0.601 \times 3.141 \times D \times 1.50 = 56.554 D$

Total Ultimate Skin Resistance = 207.07

P_{Di} Calculation

$$P_{Di(iv)} = (0.750 \times 2.000) + (0.670 \times 10.50) + (0.900 \times 4.000) + (0.950 \times 4.000) + (0.950 \times 0.750) = 16.65$$

END BEARING

For Non Cohesive Soil

$$Q_{ult} = A_p (0.5 D \gamma N_\gamma + P_D N_q)$$

$$= \frac{\pi D^2}{4} \{ (0.500 \times D \times 0.95 \times 27.530) + (15.500 \times D \times 0.800 \times 24.000) \}$$

$$= (10.2652 D^3 + 233.616 D^3)$$

Ultimate load carrying capacity in Compression = $243.881 D^3 + 0.000 D^2 + 207.07 D$

Ultimate load carrying capacity in Tension = $207.071 D$

For uniform diameter straight shaft RCC bored Pile when toe at 22.00m below EGL
and cut off at 2.00 m below EGL

	500	600	750
Safe load carrying capacity in Compression (MT) (Using Factor of Safety = 2.50)	54	71	103
Safe load carrying capacity in Tension (MT) (Using Factor of Safety = 3)	35	41	52