REPORT ON

SOIL INVESTIGATION FOR CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA

Submitted to

CHIEF ENGINEER
BSEIDC, PATNA.

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PREFACE

The present report on sub-soil investigation was carried out as per Chief Engineer, BSEIDC, Patna letter no BSEIDC/TECH/1960/2018-4981 dated 03.09.2019.

The entire investigation process was broadly divided into two category –one field work and second was laboratory work.

Field work includes conducting SPT ,Dynamic cone test, collection of disturbed as well as undisturbed soil samples from different location and different depth of sub-soil strata.

It was tried to get information from local people to get an idea about variation of water table during different season of year and also to get first hand information about type of foundation usually provided in the locality.

We thanks Prof. M.P.Jakhanwal (Retired) ,M.Tech ,Ph.D. ,Muzaffarpur Institute of Technology, Muzaffarpur for his

valuable advice during laboratory test and during preparation of report.

Client's help is gratefully acknowledged in providing Bore hole locations, cooperation and guidance during finalization of report.

We belief that the present report will serve the purpose, for which sub-soil investigation has been carried out.

Subodh kumar Sinha

SUBODH KUMAR SINHA
Partner, Shamvwi Consultant

REPORT ON SUB-SOIL INVESTIGATION FOR THE CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA

1. INTRODUCTION

The objective of subsoil investigation reported here in, were taken up, to find out the nature of subsoil at the site of the proposed construction and to recommend the type or types of foundation suitable for it and the corresponding allowable bearing capacity.

The necessary field tests were carried out at the site. Soil samples from various depths in the different bore holes were collected, transported, carefully to the laboratory and tested to determine the engineering properties of the soil.

Based on the test results, certain recommendation were made and given in this report, regarding the type of foundation suitable for the proposed project and the allowable bearing capacity for certain sizes thereof.

2. TOPOGRAPHY

The land in question was even.

3. FIELD WORK

The field work consists of boring, soil sampling and conduct of Standard penetration tests and Dynamic cone penetration tests.

3.1 BORING

An appropriate number of boreholes of adequate depth were sunk at suitable spots as per direction of Engineer-in-charge. The details of the boreholes are given in table-1.

Table 1: Details of bore holes

DIAMETER OF BORE MM	DEPTH M	BORE HOLE
150	10.5	3 Bore Holes (BH-1 to BH-3)

The borings were kept dry while advancing through partially saturated soil. The position of water table in a borehole was recorded at least 48 hours after the stopping of the boring operation.

For boring below ground water level, the borehole was kept filled with water upto that level during boring.

3.2 SAMPLING

Undisturbed & disturbed samples were collected at different depth/where change of strata occurred. Identification slips were provided both inside and outside the tube.
On arrival in laboratory, the identification slips were checked against the boring and sampling records.
Samples were extracted from the tubes just before testing.

3.3 STANDARD PENETRATION TEST

This test was performed in the boreholes at interval of depth of 1.5m, or at the change of starta/ as per IS: 2131 of 1963.

3.4 DYNAMIC CONE PENETRATION TEST

This test was performed when a bore hole could not be advanced to desired depth due to caving- in of the soil, or when it was felt necessary to supplement the information gained from SPT. This test was performed, as per

relevant IS code till high value of penetration resistance was encountered or till desired depth of investigation was reached, at which stage the test was stopped.

4. LABORATORY TEST

Lab. Test was performed to determine the following properties of soil samples as per relevant I.S. code.
(a) Natural moisture content.
(b)Bulk density.
(c) Atterberg' s limits (on fine grained soil only)
(d) Grain size analysis.
(e) Specific gravity.
(f) Shear test.
(i) Unconfined/triaxial compression tests for fine-grained soils.
(ii) Direct shear test for coarse-grained soils.
(g)Consolidation tests for fine grained soils.
(h) Organic content, chemical test etc.
(i) pH of soil and water.
(j) Free swell Index
(k)Crushing strength test (uniaxial)

4.1 SAMPLE EXTRACTION & PREPARATION OF TEST SPECIMENS

Samples for different tests were prepared as per method described in relevant IS code/as per method described in standard book.

4.2 ROUTINE CLASSIFICATION TESTS.

Tests for the determination of natural moisture content, bulk density, Atterberg's limit, grain size distribution and specific gravity were performed as per IS code on representative disturbed soil samples, wherever felt necessary. The results were used in classifying the soils of different strata as per IS code 1498-1970.

5.0 PRESENTATION OF TEST RESULT

Results were presented in table form on the following pages.

6.0 METHOD FOR CALCLATION OF ALLOWABLE BEARING CAPACITY

6.1 COHESIVE SOIL

Net ultimate bearing capacity was calculated as per IS-6403-1981.
qd =cNcScDcIc

qd = net ultimate bearing capacity

Nc=5.14

Sc=1 for strip footing

Dc=1+0.2*D/B

Ic=1 for vertical loading

c= cohesion obtained through unconfined compression test for depth of 2B/3 below the foundation.

Settlement criteria

$S=H/(1+eo)*Cc*\log((po+p1)/po)$

S= settlement

H=thickness of compressible layer

eo=initial void ratio

po=initial effective pressure

p1=pressure increment

Cc=compression index

6.2 Soil with the value of c &θ

Net ultimate bearing capacity was calculated as per IS 6403-1981

$Qd=cNcScDcIc+q(Nq-1)SqDqIq+0.5R*BNr*Sr*Dr*Ir*w'$

For local shear failure

$\text{Tan } \underline{\theta}'=0.67*\text{Tan}\underline{\theta}$

$C'=2*c/3$

Sc=Sq=Sr=1 for strip footing

$Dc=1+0.2*(D/B)*\text{Tan}(45+\underline{\theta}/2)$

Ic=Iq=Ir=1 for vertical loading

$Dq=Dr=1+0.1*(D/B)\text{Tan}(45+\underline{\theta}/2)$

$q=(R-Rw)*D$

M= moisture content

R= bulk density of soil

Rw=unit weight of water

L.L.= liquid limit

P.L.=plastic limit

S.L.= shrinkage limit

D=depth below ground level

Settlement criteria

The net allowable bearing capacity for a permissible settlement of 25mm, was obtained by

teng's formula

Qna=3.5*(N-3)*{(B+0.3)/2*B}*{(B+0.3)/2*B}*w'*Fd

N= corrected N

Fd=1+D/B less than or equal to 2

7.0 METHOD FOR CALCLATION OF CAPACITY OF CAST-IN-SITU PLANE PILE AS PER BIS 2911 Part I/Sec 2-1979

7.1 COHESIVE SOIL

Net ultimate bearing capacity of pile is given by :

Q=Ap*Nc*Cp +a * C* As

Ap=cross sectional area of pile toe in cm2

Nc=Bearing capacity factor usually taken as 9

Cp=average cohesion at pile tip in Kg/cm

a=reduction factor

C= average cohesion throughout the length of pile in kg/cm2

As= surface area of pile shaft in cm2

8.0 METHOD FOR CALCLATION OF CAPACITY OF CAST-IN-SITU PLANE PILE AS PER BIS 2911 Part III-1980

8.1 COHESIVE SOIL

Net ultimate bearing capacity of pile is given by :

Q=Ap*Nc*Cp +Aa Nc* C'a + C'a*As'+α*Ca*As

Ap=cross sectional area of pile toe in cm2

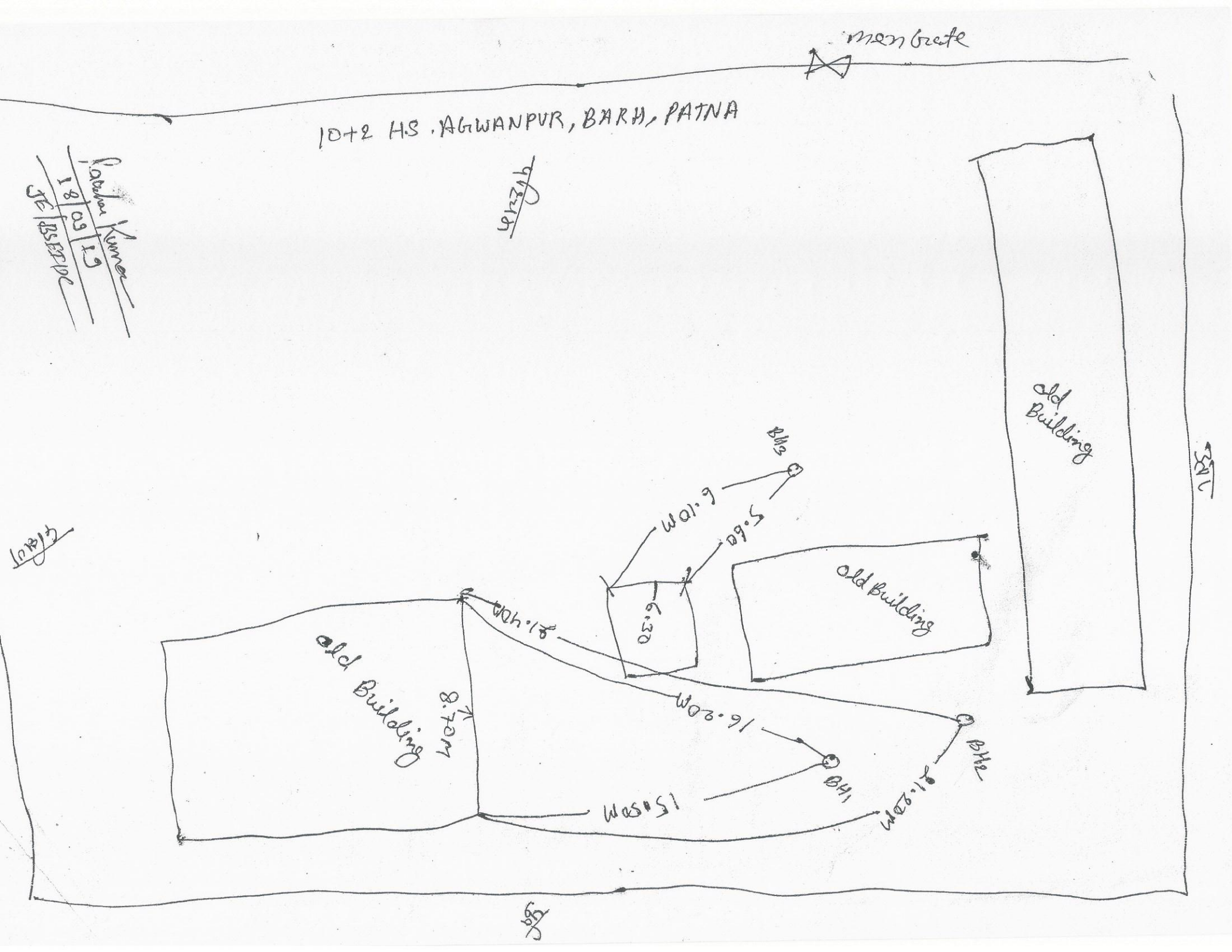
Nc=Bearing capacity factor usually taken as 9

Cp= cohesion of soil around toe.

α=reduction factor

Aa=π*(Du² - D²)/4

C'a= average cohesion around under ream
Du=dia of under-ream,D=dia of pile
As= surface area of pile shaft in cm2
As=surface area of stem
A's=surface area of the cylinder circumscribing the under ream.


main Gate
10+2 H.S. AGWANPUR, BARH, PATNA
Old Building
Old Building
Old Building
Old Building
BH3
BH2
BH1
6.10m
5.60
2.50
16.20m
15.15m
8.70m
21.40m
21.40m

SHAMVWI CONSULTANTS ,414J.T.C.,FRASER ROAD, PATNA	NAME OF PROJECT : SOIL INVESTIGATION FOR CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA	BORING DATES	TERMINATION DEPTH :10.5	TABLE NO :2
		START :18.09.2019	WATER TABLE DEPTH : 2.0M	BORE HOLE NO :BH1
		FINISH :18.09.2019		

SAMPLE NO	DEPTH OF SAMPLE	SPT BLOWS PER 30 CM		STANDARD PENETRATION RESISTANCE CURVE	VISUAL DESCRIPTION OF SOIL WITH B.I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS				ATTERBERG'S LIMITS			DENSITY		NATURAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR TEST			CONSISTENCY LIMITS		UNCONFINED COMPRESSION TEST ,q kg/cm2	COEFFICIENT OF VOLUME COMPRESSIBILITY Mv cm3/kg
		OBSERVED VALUE	CORRECTED VALUE	5 10 20			SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	BULK DENSITY (gm/cm3)	DRY DENSITY(gm/cm3)			TYPE OF TEST	COHESION c (kg/cm2)	ANGLE OF FRICTION IN DEGREE	VOID RATIO eo	COMPRESSION INDEX Cc		
DS	G.L.																						
UDS 1					Blackish clay (Broken Brick bat) CI																		
SPT1	1.5	16				7.4	1.70	90.9		35	18	17	1.99	1.66	19.7	2.62	UUT	0.3	18.0				
UDS 2					Brownish clay CI																		
SPT2	3	30				0.70	1.80	97.5		38	18	20	1.99	1.66	19.9	2.62	UUT	0.50	18.00	0.84	0.13		
UDS 3					Brownish clay CI																		
SPT3	4.5	28				0.50	2.40	97.1		38	19	19	1.99	1.65	20.7	2.62							
UDS 4					Brownish clay CI																		
SPT4	6	28				0.90	1.30	97.8		42	21	21	1.99	1.63	22.4	2.62	UUT	0.60	16.00				

UUT : UNCONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST	UCT : UNCONFINED COMPRESSION SHEAR TEST	DST : DIRECT SHEAR TEST
! SAMPLE SLIPED ~ TEST ON REMOULDED SAMPLE	UDS : UNDISTURBED SAMPLE	SPT : STANDARD PENETRATION TEST VALUE

NOTES : CONSOLIDATION TEST RESULTS ARE FOR THE LOADING RANGE OF 5.0-10.0 t/m2

SHAMVWI CONSULTANTS ,414J.T.C.,FRASER ROAD, PATNA	NAME OF PROJECT : SOIL INVESTIGATION FOR CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA	BORING DATES	TERMINATION DEPTH :10.5	TABLE NO :3
		START :18.09.2019	WATER TABLE DEPTH : 2.0M	BORE HOLE NO :BH1
		FINISH :18.09.2019		

SAMPLE NO	DEPTH OF SAMPLE	SPT BLOWS PER 30 CM		STANDARD PENETRATION RESISTANCE CURVE	VISUAL DESCRIPTION OF SOIL WITH B.I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS				ATTERBERG'S LIMITS			DENSITY		NATURAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR TEST			CONSISTENCY LIMITS		UNCONFINED COMPRESSION TEST ,q kg/cm2	COEFFICIENT OF VOLUME COMPRESSIBILITY Mv cm3/kg
		OBSERVED VALUE	CORRECTED VALUE	5 10 20		GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	BULK DENSITY (gm/cm3)	DRY DENSITY(gm/cm3)			TYPE OF TEST	COHESION c (kg/cm2)	ANGLE OF FRICTION IN DEGREE	VOID RATIO eo	COMPRESSION INDEX Cc		
UDS 5					Brownish clay CL																		
SPT5	7.5	22				0.0	2.8	97.2		35	17	18	1.99	1.62	22.8	2.62							
UDS 6					Brownish clay CL																		
SPT6	9.0	16				0.00	2.20	97.8		35	17	18	1.99	1.61	23.30	2.62	UUT	0.60	16.00				
UDS 7					Brownish clay CL																		
SPT7	10.5	19				0.20	2.50	97.3		35	17	18	1.99	1.61	23.60	2.62	UUT	0.70	16.00				

UUT : UNCONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST

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		START :18.09.2019	WATER TABLE DEPTH : 2.0M	BORE HOLE NO :BH2
		FINISH :18.09.2019		

SAMPLE NO	DEPTH OF SAMPLE	SPT BLOWS PER 30 CM		STANDARD PENETRATION RESISTANCE CURVE	VISUAL DESCRIPTION OF SOIL WITH B.I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS				ATTERBERG'S LIMITS			DENSITY		NATURAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR TEST			CONSISTENCY LIMITS		UNCONFINED COMPRESSION TEST ,q kg/cm2	COEFFICIENT OF VOLUME COMPRESSIBILITY Mv cm3/kg
		OBSERVED VALUE	CORRECTED VALUE	5 10 20			SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	BULK DENSITY (gm/cm3)	DRY DENSITY(gm/cm3)			TYPE OF TEST	COHESION c (kg/cm2)	ANGLE OF FRICTION IN DEGREE	VOID RATIO eo	COMPRESSION INDEX Cc		
DS	G.L.																						
UDS 1					Blackish clay CL																		
SPT1	1.5	16				0.3	1.80	97.9		35	18	17	1.99	1.67	18.9	2.62	UUT	0.4	18.0				
UDS 2					Blackish clay CI																		
SPT2	3	28				0.50	1.90	97.6		38	18	20	1.99	1.65	20.3	2.62							
UDS 3					Blackish clay CI																		
SPT3	4.5	27				0.60	2.30	97.1		38	20	18	1.99	1.65	20.3	2.62	UUT	0.50	16.00				
UDS 4					Silty clay CI																		
SPT4	6	29				0.60	1.20	98.2		42	21	21	1.99	1.64	21.6	2.62							

UUT : UNCONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST	UCT : UNCONFINED COMPRESSION SHEAR TEST	DST : DIRECT SHEAR TEST
! SAMPLE SLIPED ~ TEST ON REMOULDED SAMPLE	UDS : UNDISTURBED SAMPLE	SPT : STANDARD PENETRATION TEST VALUE

NOTES : CONSOLIDATION TEST RESULTS ARE FOR THE LOADING RANGE OF 5.0-10.0 t/m2

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		START :18.09.2019	WATER TABLE DEPTH : 2.0M	BORE HOLE NO :BH2
		FINISH :18.09.2019		

SAMPLE NO	DEPTH OF SAMPLE	SPT BLOWS PER 30 CM		STANDARD PENETRATION RESISTANCE CURVE	VISUAL DESCRIPTION OF SOIL WITH B.I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS				ATTERBERG'S LIMITS			DENSITY		NATURAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR TEST			CONSISTENCY LIMITS		UNCONFINED COMPRESSION TEST ,q kg/cm2	COEFFICIENT OF VOLUME COMPRESSIBILITY Mv cm3/kg
		OBSERVED VALUE	CORRECTED VALUE	5 10 20		GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	BULK DENSITY (gm/cm3)	DRY DENSITY(gm/cm3)			TYPE OF TEST	COHESION c (kg/cm2)	ANGLE OF FRICTION IN DEGREE	VOID RATIO eo	COMPRESSION INDEX Cc		
UDS 5					Brownish clay CL																		
SPT5	7.5	22				0.1	2.8	97.1		35	17	18	1.99	1.62	22.8	2.62	UUT	0.6	16.0				
UDS 6					Brownish clay CL																		
SPT6	9.0	18				0.10	2.60	97.3		35	17	18	1.99	1.62	23.20	2.62							
UDS 7					Brownish clay CL																		
SPT7	10.5	18				0.10	2.60	97.3		35	17	18	1.99	1.61	23.50	2.62	UUT	0.70	13.00				

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		START :18.09.2019	WATER TABLE DEPTH : 2.0M	BORE HOLE NO :BH3
		FINISH :18.09.2019		

SAMPLE NO	DEPTH OF SAMPLE	SPT BLOWS PER 30 CM		STANDARD PENETRATION RESISTANCE CURVE	VISUAL DESCRIPTION OF SOIL WITH B.I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS				ATTERBERG'S LIMITS			DENSITY		NATURAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR TEST			CONSISTENCY LIMITS		UNCONFINED COMPRESSION TEST ,q kg/cm2	COEFFICIENT OF VOLUME COMPRESSIBILITY Mv cm3/kg
		OBSERVED VALUE	CORRECTED VALUE	5 10 20			SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	BULK DENSITY (gm/cm3)	DRY DENSITY(gm/cm3)			TYPE OF TEST	COHESION c (kg/cm2)	ANGLE OF FRICTION IN DEGREE	VOID RATIO eo	COMPRESSION INDEX Cc		
DS	G.L.																						
UDS 1					Blackish clay (Broken Brick bat) CI																		
SPT1	1.5	15				7.2	1.60	91.2		35	18	17	1.99	1.67	18.9	2.62	UUT	0.4	16.0				
UDS 2					Blackish clay CI																		
SPT2	3	27				0.90	1.60	97.5		38	17	21	1.99	1.65	20.3	2.63							
UDS 3					Blackish clay CI																		
SPT3	4.5	28				0.70	2.40	96.9		42	20	22	1.99	1.64	21.4	2.63	UUT	0.50	15.00				
UDS 4					Silty clay CI																		
SPT4	6	27				0.70	1.30	98.0		42	20	22	1.99	1.64	21.5	2.62							

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		START :18.09.2019	WATER TABLE DEPTH : 2.0M	BORE HOLE NO :BH3
		FINISH :18.09.2019		

SAMPLE NO	DEPTH OF SAMPLE	SPT BLOWS PER 30 CM		STANDARD PENETRATION RESISTANCE CURVE	VISUAL DESCRIPTION OF SOIL WITH B.I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS				ATTERBERG'S LIMITS			DENSITY		NATURAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR TEST			CONSISTENCY LIMITS		UNCONFINED COMPRESSION TEST ,q kg/cm2	COEFFICIENT OF VOLUME COMPRESSIBILITY Mv cm3/kg
		OBSERVED VALUE	CORRECTED VALUE	5 10 20		GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	BULK DENSITY (gm/cm3)	DRY DENSITY(gm/cm3)			TYPE OF TEST	COHESION c (kg/cm2)	ANGLE OF FRICTION IN DEGREE	VOID RATIO eo	COMPRESSION INDEX Cc		
UDS 5					Brownish clay CL																		
SPT5	7.5	24				0.1	2.8	97.1		35	16	19	1.99	1.63	22.2	2.62	UUT	0.6	14.0				
UDS 6					Brownish clay CL																		
SPT6	9.0	16				0.40	2.70	96.9		35	16	19	1.99	1.62	22.50	2.62							
UDS 7					Brownish clay CL																		
SPT7	10.5	17				0.80	2.80	96.4		35	16	19	1.99	1.62	23.20	2.62	UUT	0.70	13.00				

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UCT : UNCONFINED COMPRESSION SHEAR TEST

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~ TEST ON REMOULDED SAMPLE

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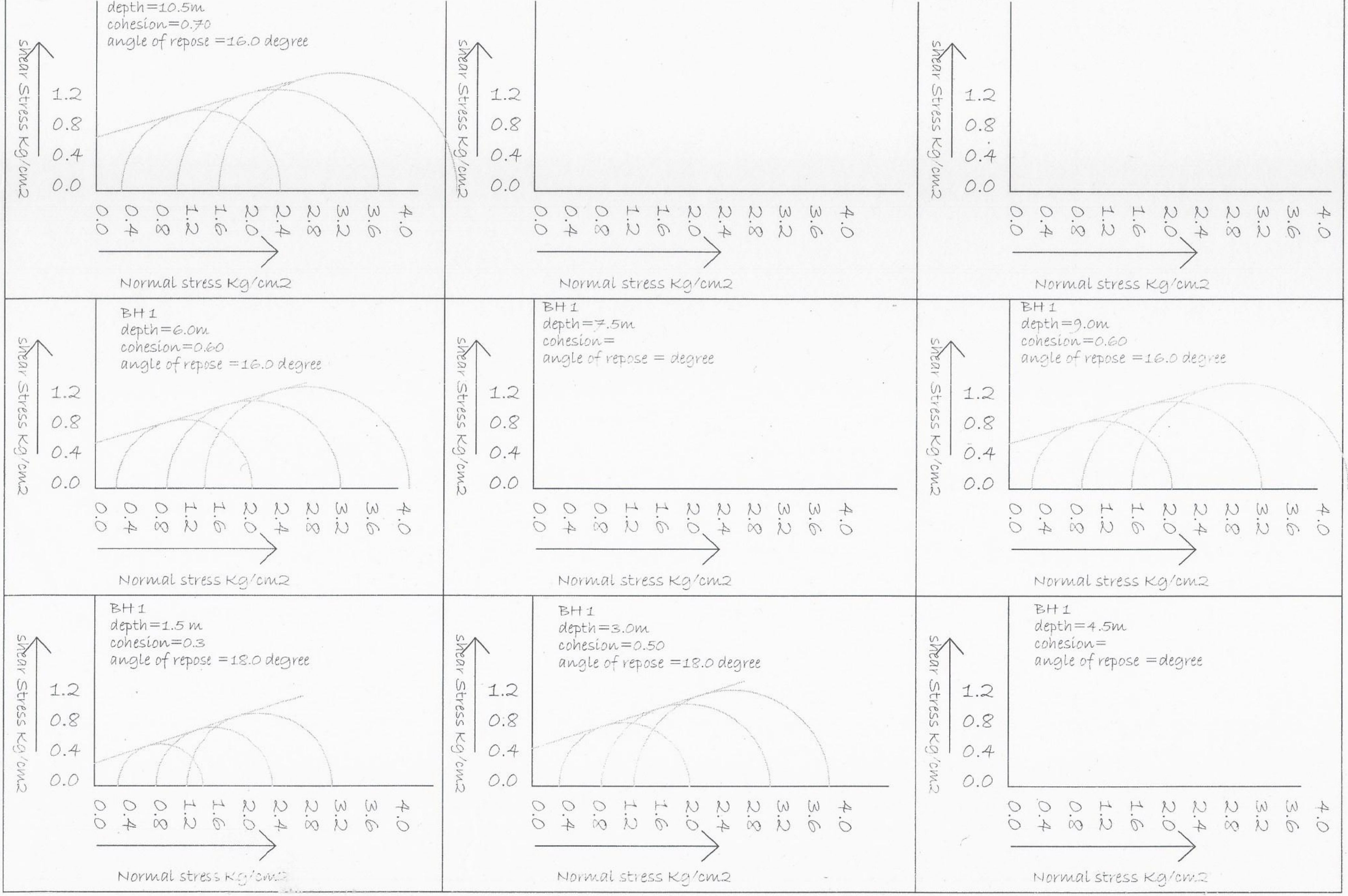
SPT : STANDARD PENETRATION TEST VALUE

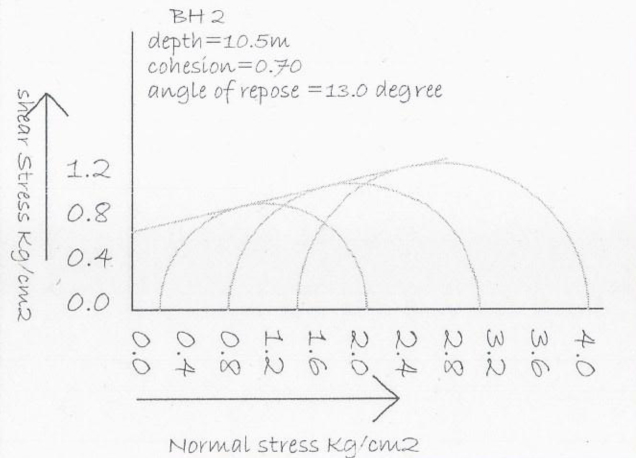
NOTES : CONSOLIDATION TEST RESULTS ARE FOR THE LOADING RANGE OF 5.0-10.0 t/m2

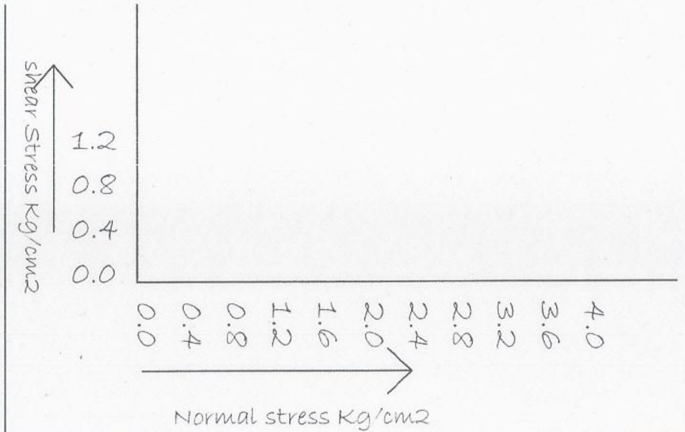
TRIAXIAL/DIRECT TEST RESULT

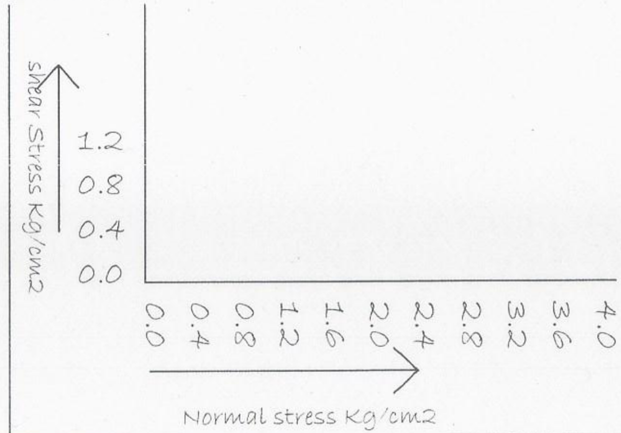


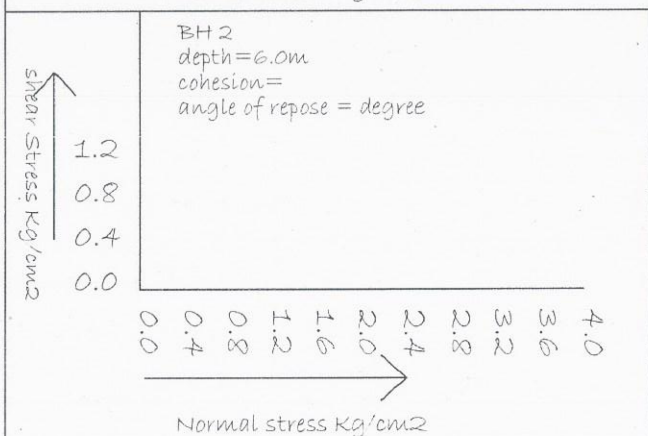
OIL INVESTIGATION FOR CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL, AGWANPUR, BARH, PATNA

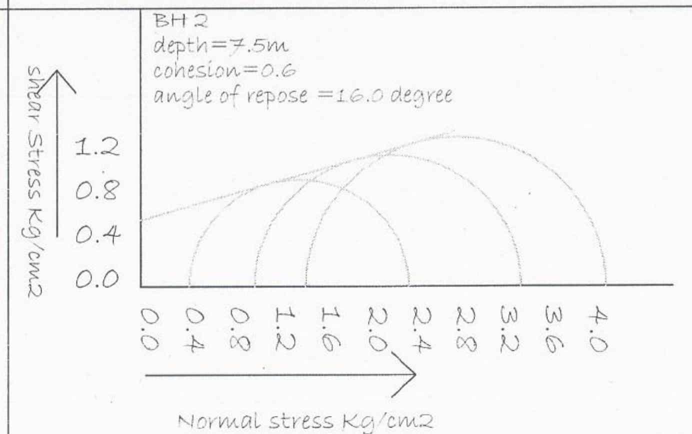
TRIAXIAL/DIRECT TEST RESULT

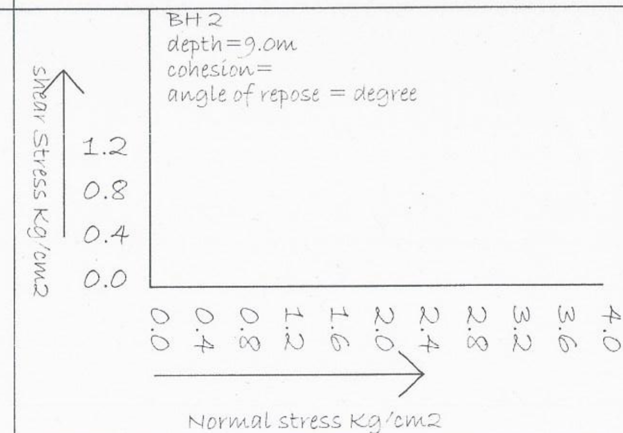


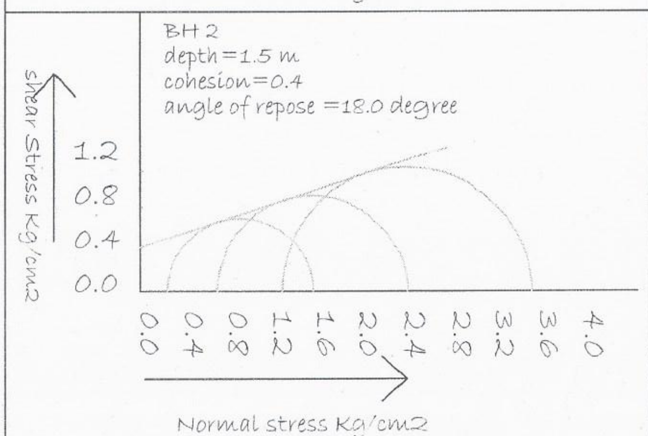


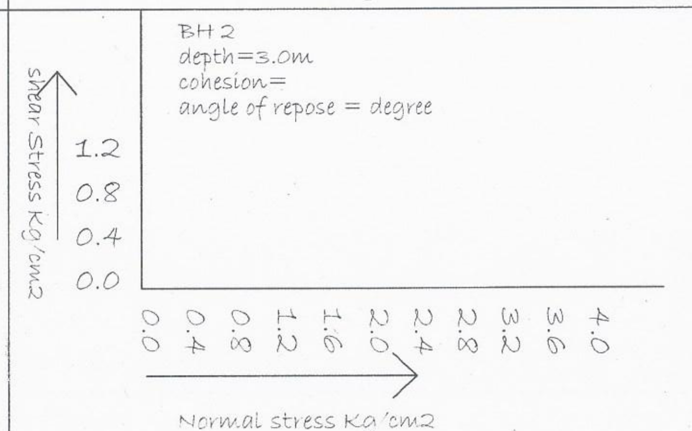


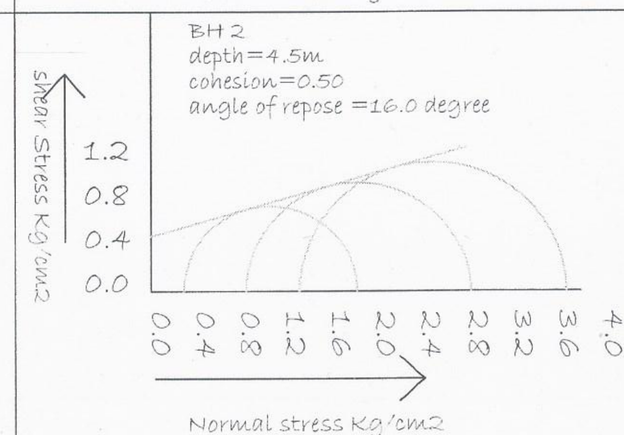




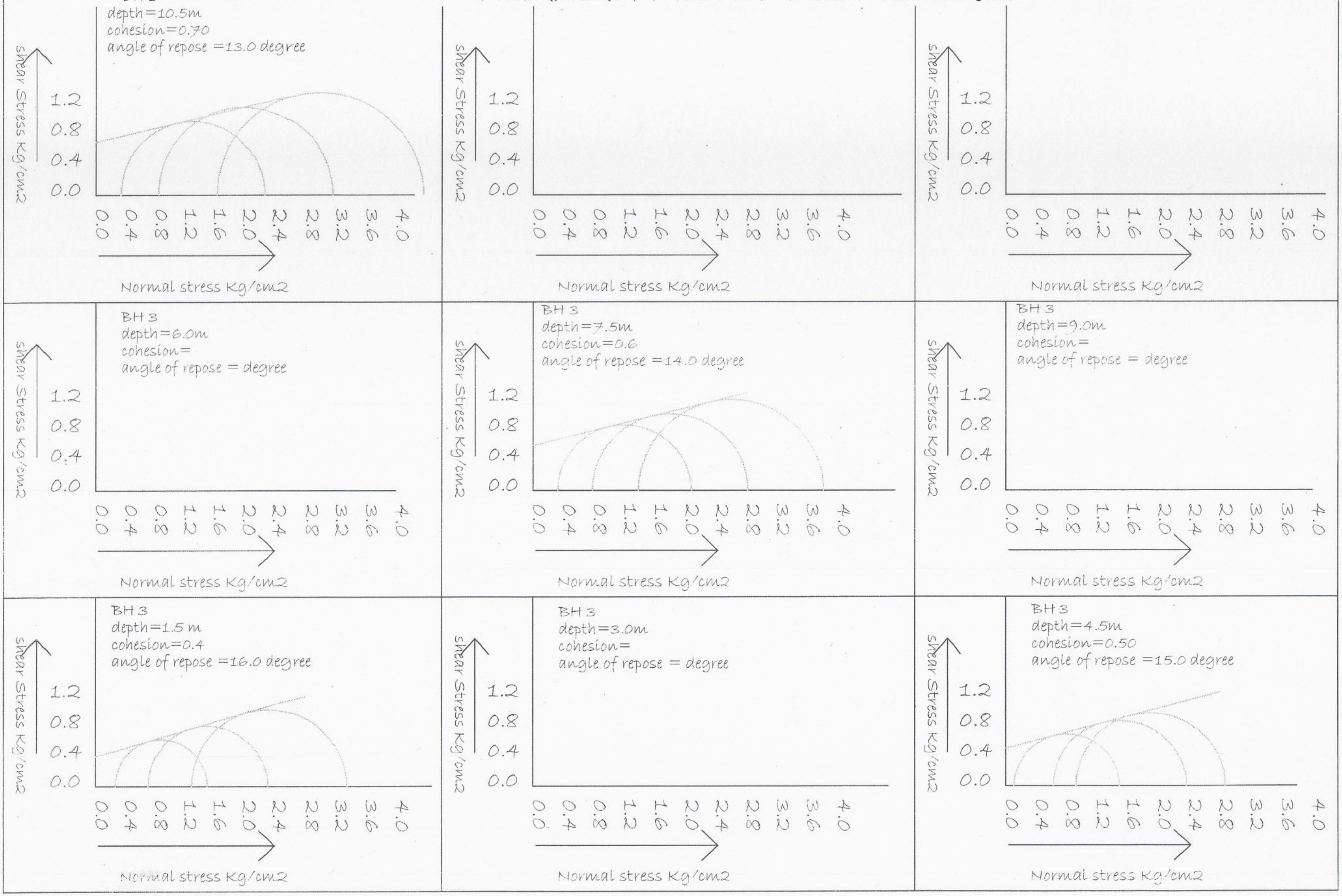




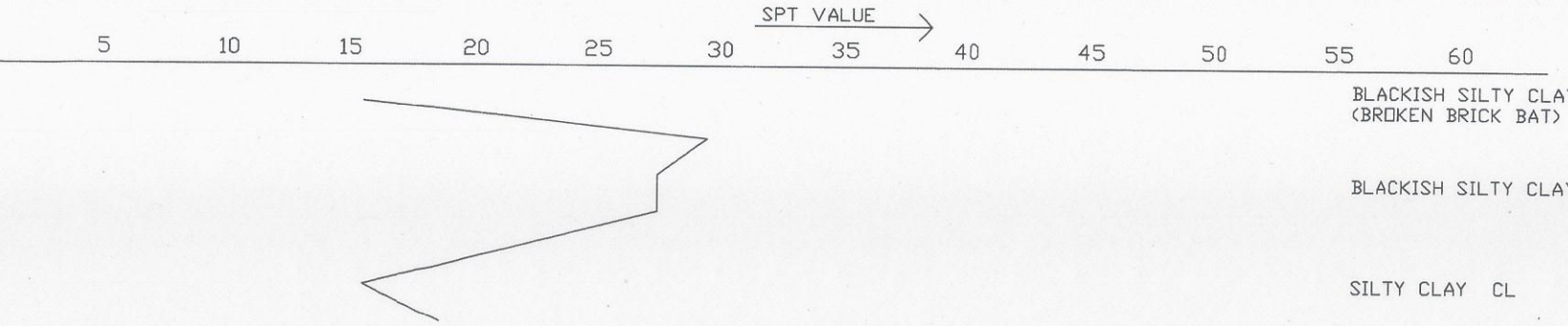




TRIAXIAL/DIRECT TEST RESULT



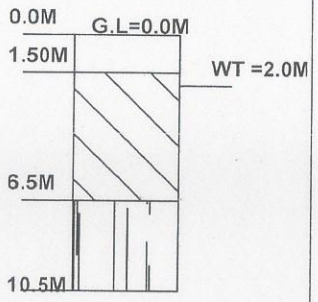
E LOG AND DEPTH ~ SPT GRAPH (CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA)



BLACKISH SILTY CLAY CL
(BROKEN BRICK BAT)

BLACKISH SILTY CLAY CI

SILTY CLAY CL



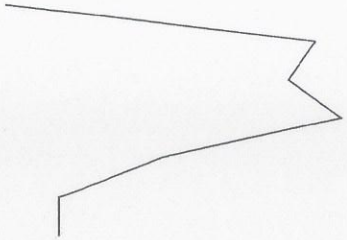
BORE LOG

BH1

E LOG AND DEPTH ~ SPT GRAPH (CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA)

SPT VALUE →

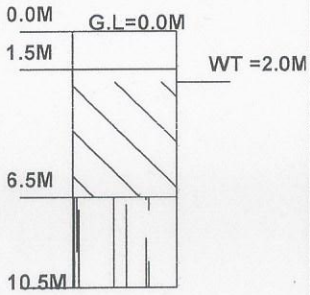
5 10 15 20 25 30 35 40 45 50 55 60



BLACKISH SILTY CLAY CL

BLACKISH SILTY CLAY CI

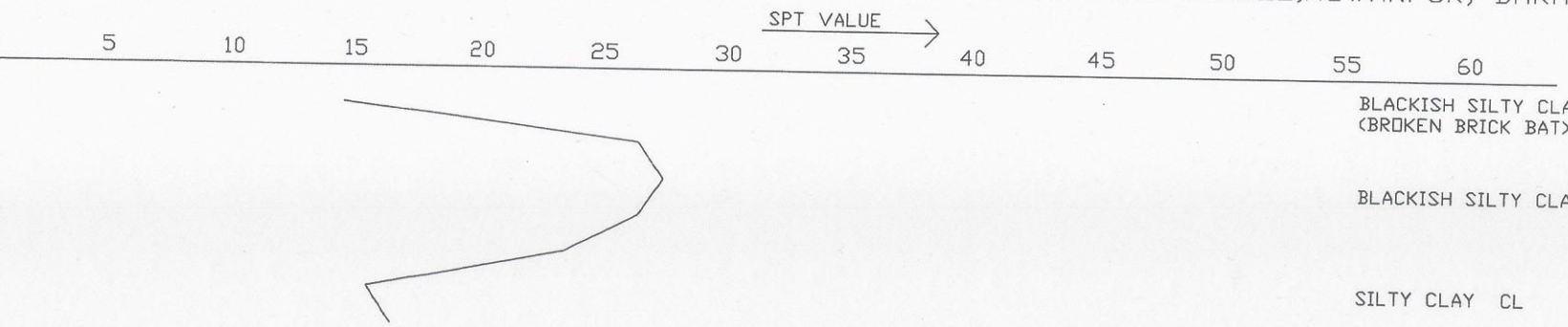
SILTY CLAY CL



BORE LOG

BH2

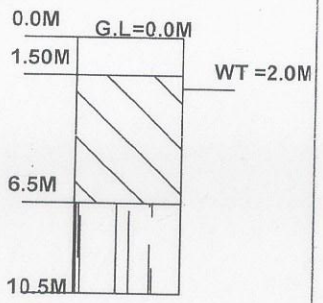
RE LOG AND DEPTH ~ SPT GRAPH (CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA)



BLACKISH SILTY CLAY CL
(BROKEN BRICK BAT)

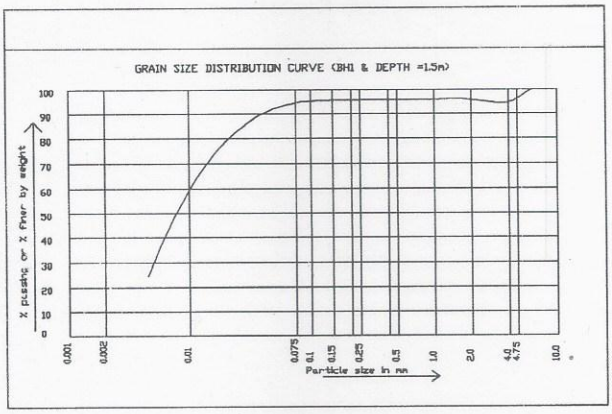
BLACKISH SILTY CLAY CI

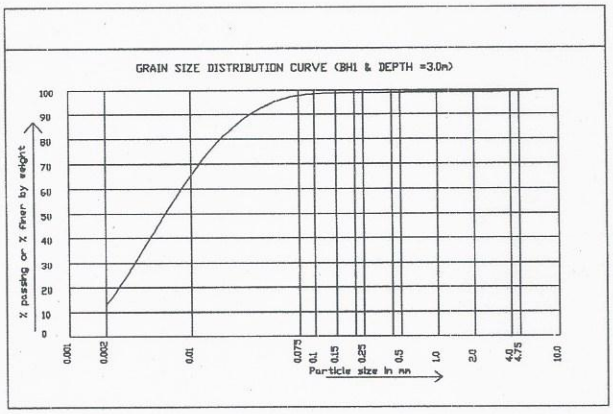
SILTY CLAY CL

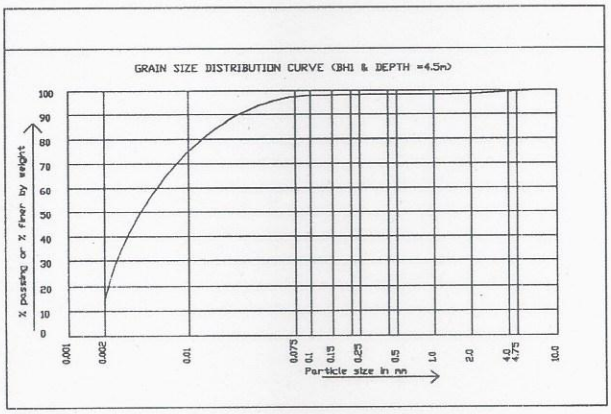


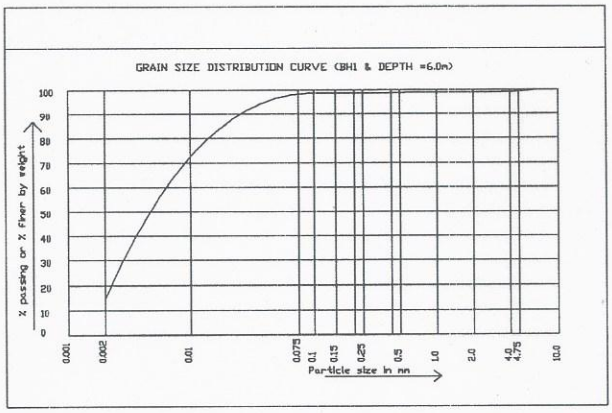
BORE LOG

BH3

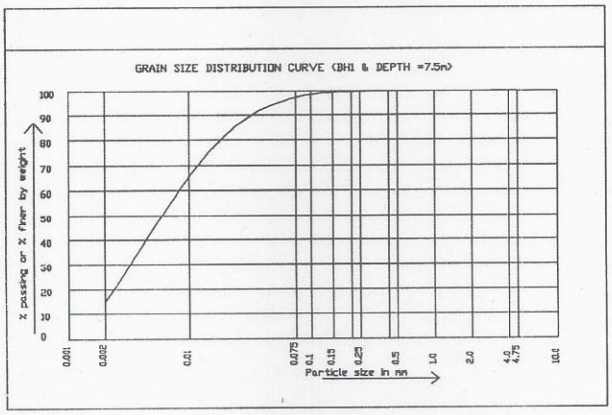

GRAIN SIZE DISTRIBUTION CURVE (BH1 & DEPTH =1.5m)
% passing or % finer by weight
Particle size in mm

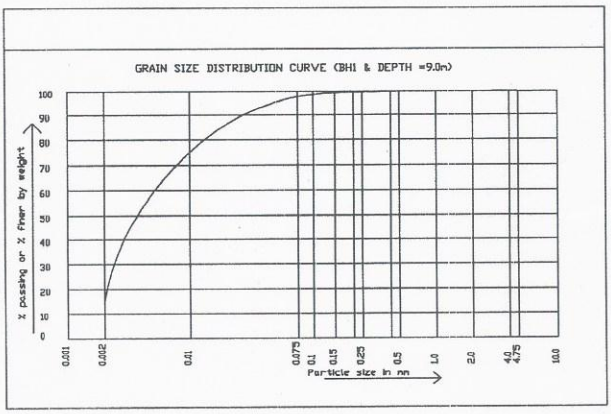

GRAIN SIZE DISTRIBUTION CURVE (BH1 & DEPTH =3.0m)
% passing or % finer by weight
Particle size in mm

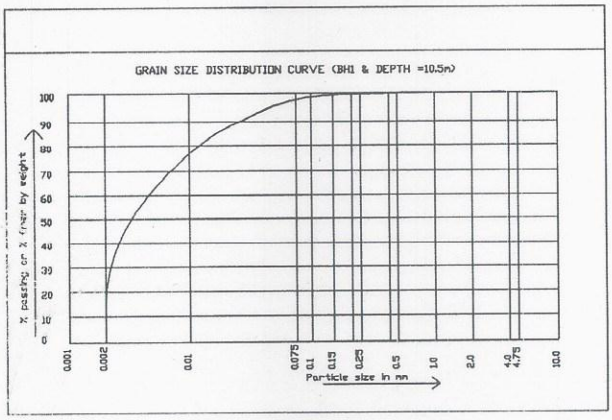

GRAIN SIZE DISTRIBUTION CURVE (BH1 & DEPTH =4.5m)
% passing or % finer by weight
Particle size in mm

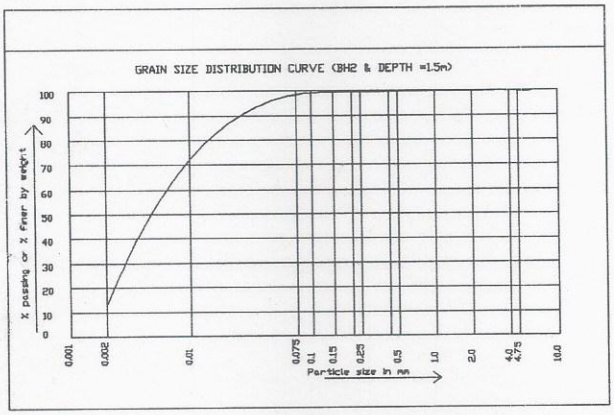

GRAIN SIZE DISTRIBUTION CURVE (BH1 & DEPTH =6.0m)
% passing or % finer by weight
Particle size in mm

18


GRAIN SIZE DISTRIBUTION CURVE (BH1 & DEPTH =7.5m)
% passing or % finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH1 & DEPTH =9.0m)
% passing or % finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH1 & DEPTH =10.5m)
% passing or % finer by weight
Particle size in mm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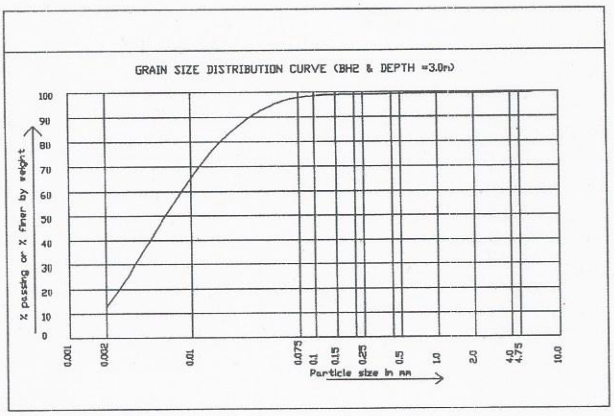
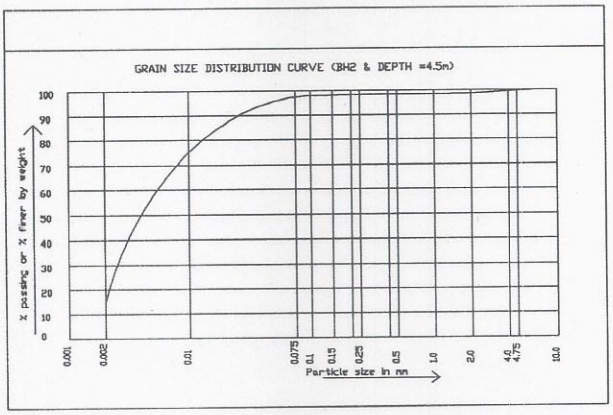
% passing or % finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH2 & DEPTH =3.0m)
% passing or % finer by weight
Particle size in mm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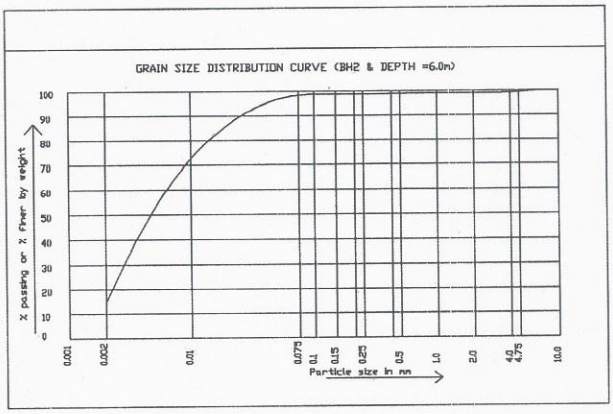
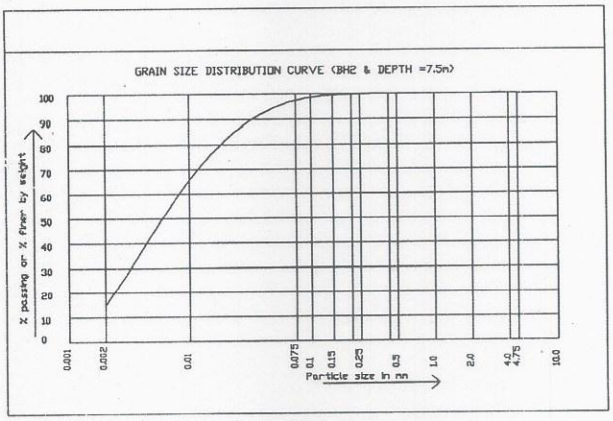
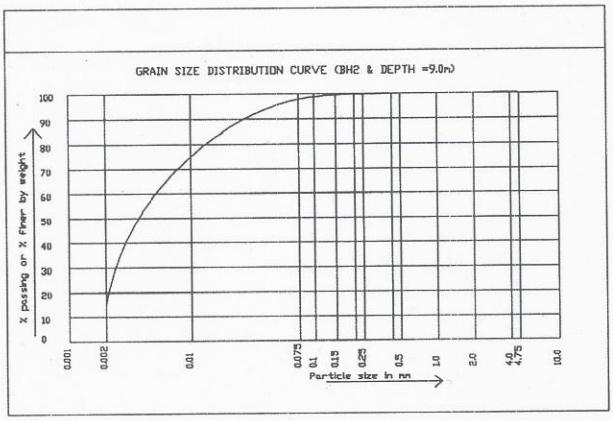
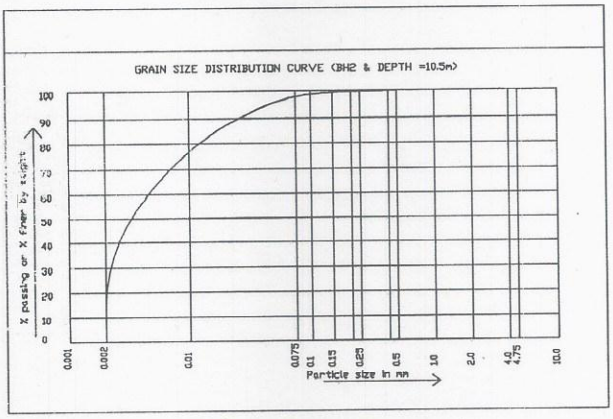
% passing or % finer by weight
Particle size in mm

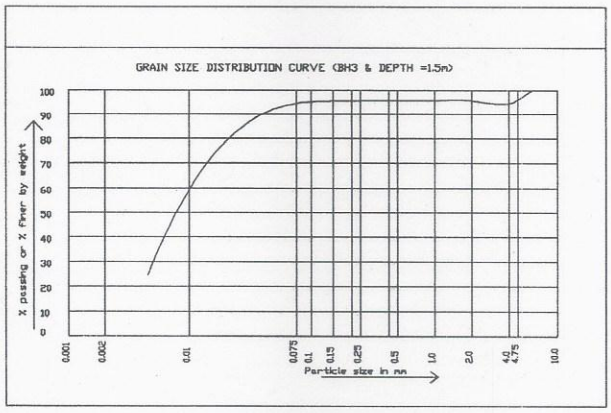

GRAIN SIZE DISTRIBUTION CURVE (BH2 & DEPTH =6.0m)
% passing or % finer by weight
Particle size in mm

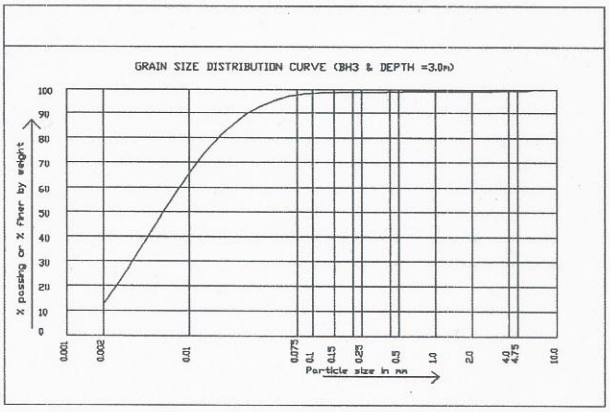
18


GRAIN SIZE DISTRIBUTION CURVE (BH2 & DEPTH =7.5m)
% passing or % finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH2 & DEPTH =9.0m)
% passing or % finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH2 & DEPTH =10.5m)
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH3 & DEPTH =1.5m)
X passing or X finer by weight
Particle size in mm
0.001
0.002
0.01
0.075
0.1
0.15
0.25
0.5
1.0
2.0
4.0
4.75
10.0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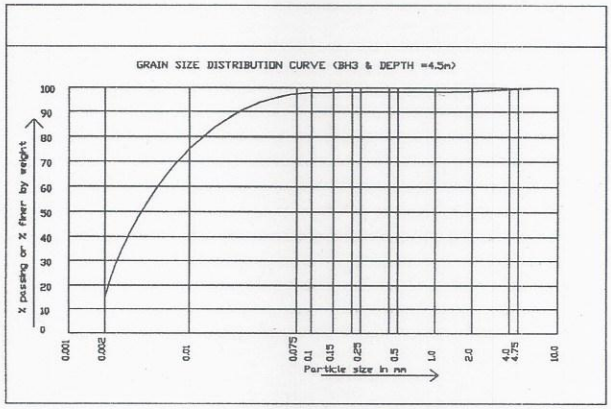
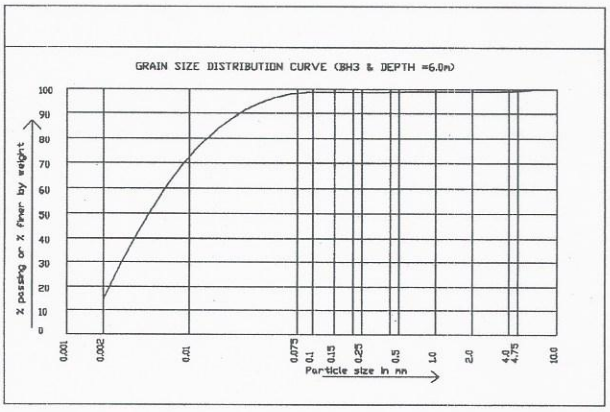
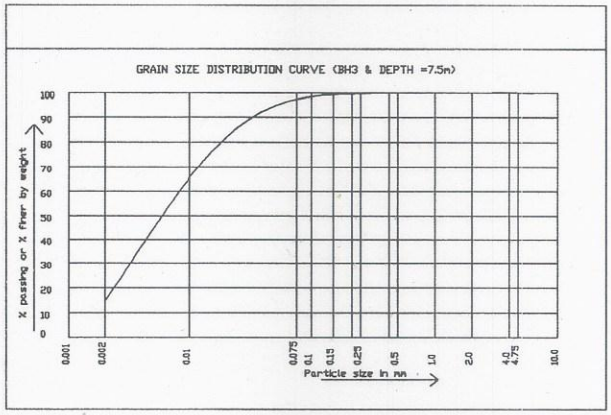
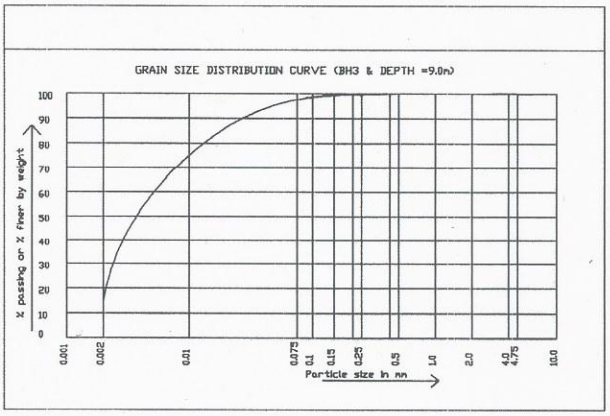
X passing or X finer by weight
Particle size in mm

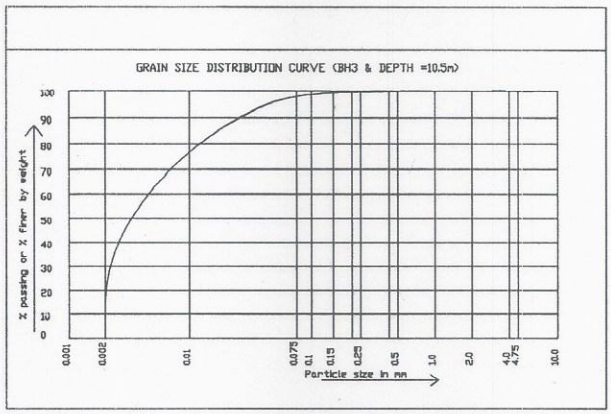

GRAIN SIZE DISTRIBUTION CURVE (BH3 & DEPTH =4.5m)
X passing or X finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH3 & DEPTH =6.0m)
X passing or X finer by weight
Particle size in mm

18


GRAIN SIZE DISTRIBUTION CURVE (BH3 & DEPTH =7.5m)
X passing or X finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH3 & DEPTH =9.0m)
X passing or X finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (BH3 & DEPTH =10.5m)
X passing or X finer by weight
Particle size in mm

SAMPLE CALCULATION OF CAPACITY OF UNDER REAM PILE for		NAME OF PROJECT : SOIL INVESTIGATION FOR CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA

The load carrying capacity of the pile has been calculated using IS : 2911 (Part III) 1980,Clause 5.2.3.1

These calculations are based on

(a) in fine- grained soils, only on cohesion (c). In t/m², taking angle of internal friction = 0

This is likely to give the minimum capacity of the pile

Pile diameter, D (m) =	0.3	Hence, area of pile base. Ap (m²) =		0.071	& circumference (in m) of pile base j =				0.942		
Under ream, diameter, Du (m) =	0.75	Hence, Aa (m²) =	0.37	Spacing between under ream in m =		1.13	Hence, A's (m²) =		2.66		
The following values are taken in view of the codal provisions :						Surface area of pile's contact with soil, As (m²) = j x t					
Reduction factor, α, depending on N.	0.5					where t = thickness of soil layer in contact with pile.					
Skin friction in clay, Qs = α *Ca*As.		Total Ultimate capacity of pile, Qu = Ap*Nc*Cp + Aa*Nc*C'a +C'a*A's									
Total Ultimate capacity of pile, Qu = Ap*Nc*Cp + Aa*Nc*C'a +C'a*A's + Qs					Nc=	9					
Safe capacity of pile, Qsf = Qs / fs1 + Qb / fs1											
takeing factor of safety =	2.5										

Depth of soil layer (m)	Soil type	Average cohesion Ca	cohesion cp t/m²	Thickness of layer, t [m]	Average cohesion C'a	As = m²	Ap*Nc*Cp I	Aa*Nc*C'a II	C'a*A's III	Qs = α *Ca*As IV	Ultimate capacity (TON)	Safe capacity (TON)	
6	clay	5	6	6	5	4.59	3.83	16.65	13.30	11.48	45.26	18	

NAME OF PROJECT : SOIL INVESTIGATION FOR CONSTRUCTION OF +2 SCHOOL AT HIGH SCHOOL,AGWANPUR, BARH, PATNA									
Calculation of settelement in clay for Strip Footing as per IS : 8009 (Part I)-1976 (Reaffirmed 1993)									
Width of FOOTING in meter	2.50								
bearing capacity of soil in ton /m2 =	8.5								
Unit weight of soil in ton/m2 =	1.99								
Height of compressible soil in meter =H	3.75	Assuming 2:1 pressure distribution							
initial void ratio e0=	0.84								
Compression index Cc=	0.13								
Depth of Foundation in meter=	2								
Length of Footing=	1								
Determination of Bearing pressure at different depth below footing level factor for Strip footing									
Initial Effective stress at the top of clay layer=po					3.98	t/m2			
It is assumed that water table does not goes above footing level.									
Initial Effective stress at the bottom of clay layer=po					7.693	t/m2			
Average Effective stress on the clay stratum before construction=						5.836	t/m2	p0	
Additional Stress at the top of stratum due to construction=						8.5	t/m2		
Additional Stress at the bottom of stratum due to construction=						3.40	t/m2		
Additional Stress at the center of stratum due to construction=						4.857	t/m2		
Hence Average effective stress on the clay stratum after construction=							10.7	(p0+p1)	
Settelement s in mm =s=H/(1+e0)*Cc*Log10((po+p1)/p0)						69.68			
D/sqrt(L*B)	1.26								
Final D/sqrt(L*B)=	0.79								
L/B=	2.50								
Depth Factor=	1								
Correction for normally consolidated soil=	0.9								
Correction for rigidity=	1								
Corrected Settelement s in mm=	63								

Table 8

Soil stratification

DEPTH	SOIL TYPE	CONSISTANCY	CLASSIFICATION
0.0-1.5	BLACKISH BROWNISH SILTY CLAY (BROKEN BRICK BAT etc)	MEDIUM	CL
2.0-6.5	BLACKISH BROWNISH SILT CLAY	MEDIUM TO STIFF	CI
6.5-10.5	SILTY CLAY	MEDIUM TO STIFF	CL

WATER TABLE was found at 2.0m as reported in September'2019.

RECOMMENDATION

The present report is prepared on the basis of lab. Test result & field test conducted in the field. The lab. Test result is obtained by conducting different test on representative sample obtained through 3 no. of bore holes whose location and depth were decided by Engineer-in-charge of the department and shown in the bore hole location plan. These Boreholes are marked as BH1, BH2 and BH3.

The laboratory test of soil samples obtained in all bore holes are given in Tables 2-.Study of these tables reveals :

(a) Strata up to 10.5m consist of fine grained soil Broken brick bat has been found in top 1.5m strata..Therefore, it is more desirable to provide foundation at or beyond 2.0m depth below NGL.

Both Shallow as well as pile foundation is feasible for the site. Bentonite or casing may be suggested to prevent the collapse of pile bore. Since, Permissible differential settlement depends on the structural parameters such as structural system, span etc., these can be obtained from the IS 1904, 1986.

By way of example the calculated value of safe capacity of certain type and size of Shallow foundation are being tabulated below: -

Shallow foundation

Depth below GL (m)	Width of foundation (m)	Allowable bearing capacity(t/m2)	Maximum expected settlement(mm)
2.0	2.5	8.5	60

By way of example the calculated value of safe capacity of certain diameter of piles using IS : 2911 (Part III) 1980: -

Double Under-reamed Pile Capacity

Depth of Pile below GL(m)	Dia of Pile (m)	Dia of Under-reamed (m)	Allowable Capacity (Ton)
6.0	0.3	0.75	18
6.0	0.4	1.0	26
8.0	0.3	0.75	21

Limitation

If the sub-soil condition is found much different from those reported here during trenching, suitable steps should be taken. Back filling over footing shall be done with proper compaction.

Pile capacity shall be confirmed by Initial and Routine pile load test as per relevant Indian codes.

Subodh kumar Sinha

SUBODH KUMAR SINHA
Partner Shamvwi consultant