REPORT ON

SOIL INVESTIGATION FOR CONSTRUCTION OF GIRL,BOY HOSTEL EDUCATIONAL BHAWAN, PRINCIPAL-CUM-STAFF QUARTER BUILDING(G+4) AT DIET, RAMBAGH, MUZAFFARPUR,BIHAR

Submitted to

CHIEF ENGINEER
BSEIDC, PATNA.

SHAMVWI CONSULTANT

414, Jagat Trade Centre,
Fraser Road, Patna – 800 001
Tel.: 0612 – 2950329, 2366308

Mobile: +919835218184,8986215718.

PREFACE

The present report on sub-soil investigation was carried out as per Chief Engineer, BSEIDC, Patna letter no BSEIDC/TECH/1960/2018-7139 dated 02.09.2023 .

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 ,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

CONTENTS

CONTENTS

LIST OF FIGURE / GRAPHS

REPORT ON SUB-SOIL INVESTIGATION FOR THE CONSTRUCTION OF GIRL, BOY HOSTEL EDUCATIONAL BHAWAN, PRINCIPAL-CUM-STAFF QUARTER BUILDING(G+4) AT DIET DIET,RAMBAGH, MUZAFFARPUR,BIHAR.

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

Tan θ'=0.67*Tanθ

C'=2*c/3

Sc=Sq=Sr=1 for strip footing

Dc=1+0.2*(D/B)*Tan(45+θ/2)

Ic=Iq=Ir=1 for vertical loading

Dq=Dr=1+0.1*(D/B)Tan(45+θ/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, may be 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

$Aa=\pi*(Du^2 - D^2)/4$

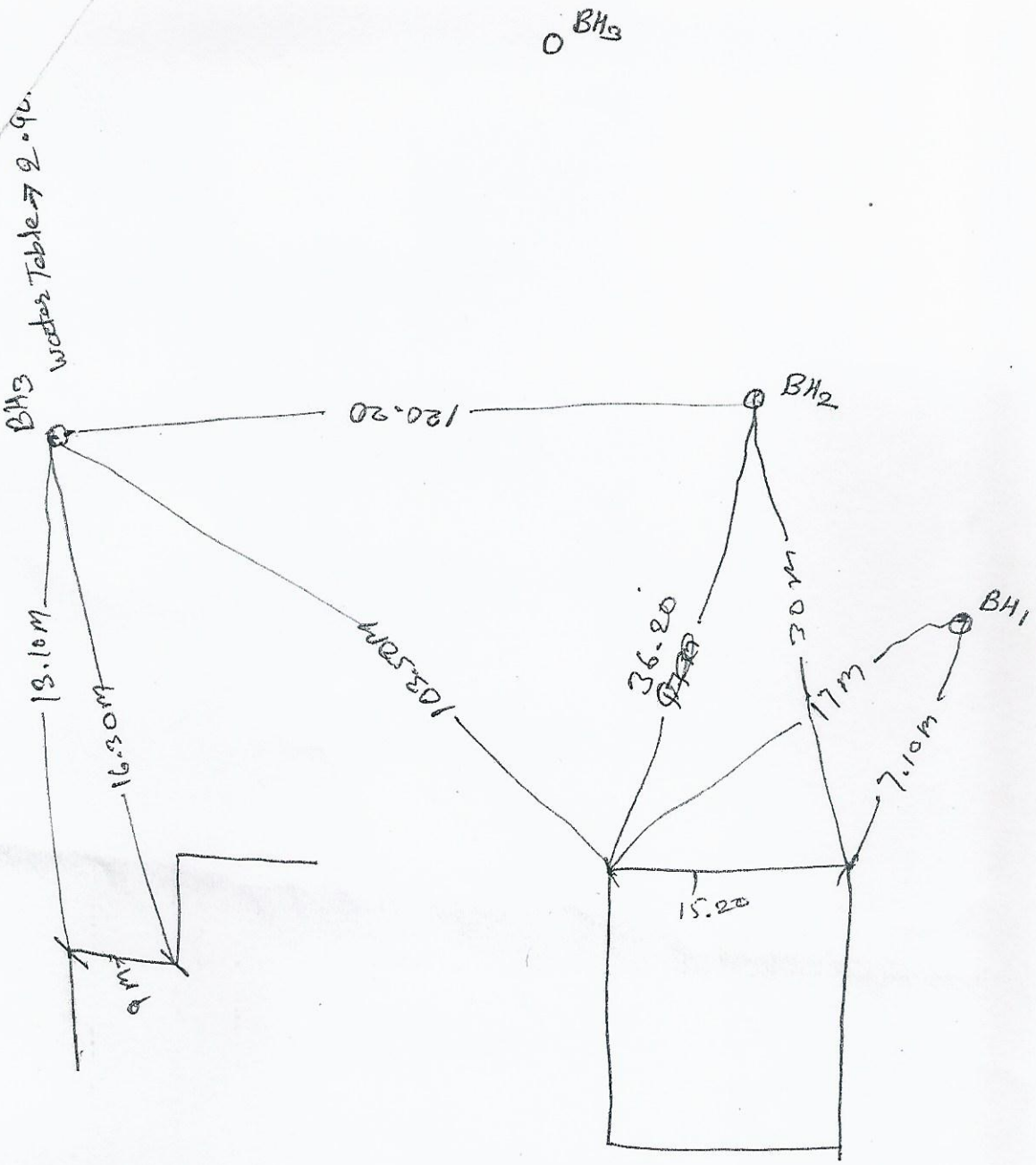
C'a= average cohesion around under ream

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.



Bijay Kumar
Stat Shamrui consultant

C/S

06/09/2023
NEBSEIDC
Tirhut East

LEAD CHART OF DISTANCE COVEREDED

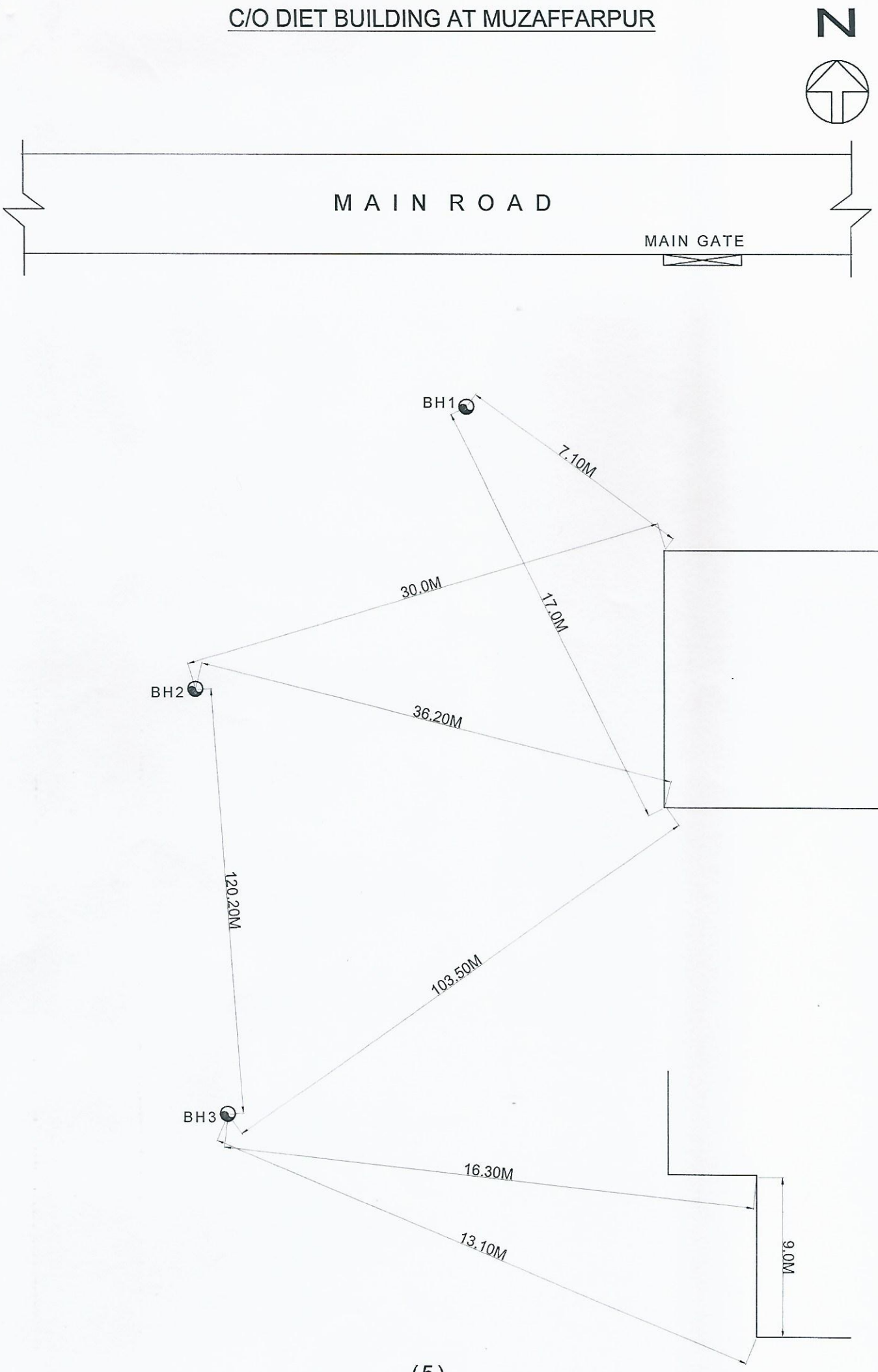
SL-NO	NAME OF SCHOOL	DISTANCE COVEREDED	LEAD CHART
(1)	DAIT Building Muzaffarpur	75 KM	Patna Lab to DAIT Building at Muzaffarpur
	Bijay Kumar Lab Shamvmi Consultant		

CS

6/09/2023
SE BSEIDC
Tirhut East

MUZAFARPUR

C/O DIET BUILDING AT MUZAFFARPUR



SHAMVWI CONSULTANT ,414,J.T.C.,FRASER ROAD, PATNA	NAME OF PROJECT : SOIL INVESTIGATION FOR CONSTRUCTION OF GIRL,BOY HOSTEL EDUCATIONAL BHAWAN, PRINCIPAL-CUM-STAFF QUARTER BUILDING(G+4) AT DIET,RAMBAGH, MUZAFFARPUR,BIHAR	BORING DATES	TERMINATION DEPTH :10.5M	TABLE NO :2
		START :05.09.2023	WATER TABLE DEPTH : 3.2m	BORE HOLE NO :BH1
		FINISH :05.09.2023		

SAMPLE NO	DEPTH OF SAMPLE	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		
DS	G.L.																						
UDS 1					Sandy Silt ML																		
SPT1	1.5	20				0.0	5.30	94.7		34	24	10	1.97	1.67	17.7	2.70	UUT	0.13	22.00				
UDS 2					Sandy Silt ML																		
SPT2	3.0	18				3.2	13.40	83.4		35	24	11	1.97	1.67	18.1	2.70	UUT	0.15	22.00				
UDS 3					Sandy Silt ML																		
SPT3	4.5	18				3.4	13.30	83.3		35	24	11	1.97	1.66	18.4	2.72	UUT	0.23	23.00				
DS4					Silty Sand SM/SP																		
SPT4	6	19				2.4	58.40	39.2		NON-PLASTIC			1.95	1.64	18.6	2.70	DST	0.00	29.00				

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

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		START :05.09.2023	WATER TABLE DEPTH : 3.2m	BORE HOLE NO :BH1
		FINISH :05.09.2023		

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		
DS5					Silty Sand SM/SP																		
SPT5	7.5	17				2.4	58.50	39.1		NON-PLASTIC			1.95	1.64	18.6	2.70	DST	0.00	30.00				
DS6					Silty Sand SP																		
SPT6	9.0	16				0.6	86.5	12.9		NON-PLASTIC			1.92	1.66	15.4	2.70	DST	0.00	30.00				
DS7					Silty Sand SP																		
SPT7	10.5	17				0.5	82.3	17.2		NON-PLASTIC			1.92	1.67	15.3	2.70	DST	0.00	30.00				

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DST : DIRECT SHEAR TEST

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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

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		START :05.09.2023	WATER TABLE DEPTH : 3.2m	BORE HOLE NO :BH2
		FINISH :05.09.2023		

SAMPLE NO	DEPTH OF SAMPLE	OBSERVED VALUE	CORRECTED VALUE	STANDARD PENETRATION RESISTANCE CURVE (5 — 10 — 20)	VISUAL DESCRIPTION OF SOIL WITH B.I.S. CLASSIFICATION	GRAIN SIZE ANALYSIS: GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	ATTERBERG'S LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	DENSITY: BULK DENSITY (gm/cm3)	DRY DENSITY(gm/cm3)	NATURAL MOISTURE CONTENT (%)	SPECIFIC GRAVITY	SHEAR TEST: TYPE OF TEST	COHESION c (kg/cm2)	ANGLE OF FRICTION IN DEGREE	CONSISTENCY LIMITS: VOID RATIO eo	COMPRESSION INDEX Cc	UNCONFINED COMPRESSION TEST ,q kg/cm2	COEFFICIENT OF VOLUME COMPRESSIBILITY Mv cm3/kg
DS	G.L.																						
UDS 1					Sandy Silt ML																		
SPT1	1.5	20				0.0	5.40	94.6		34	24	10	1.97	1.68	17.5	2.70	UUT	0.13	22.00				
UDS 2					Sandy Silt ML																		
SPT2	3.0	16				3.0	32.20	64.8		33	26	7	1.97	1.66	18.4	2.70	UUT	0.15	22.00				
UDS 3					Sandy Silt ML																		
SPT3	4.5	19				2.9	34.00	63.1		33	26	7	1.97	1.65	19.5	2.72	UUT	0.23	23.00				
DS4					Silty Sand SM/SP																		
SPT4	6	17				2.4	57.90	39.7		NON-PLASTIC			1.94	1.60	21.5	2.70	DST	0.00	29.00				

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		START :05.09.2023	WATER TABLE DEPTH : 3.2m	BORE HOLE NO :BH2
		FINISH :05.09.2023		

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		
DS5					Silty Sand SM/SP																		
SPT5	7.5	17				2.4	58.40	39.2		NON-PLASTIC			1.94	1.59	21.8	2.70	DST	0.00	30.00				
DS6					Silty Sand SP																		
SPT6	9.0	18				0.6	86.5	12.9		NON-PLASTIC			1.92	1.66	15.4	2.70	DST	0.00	30.00				
DS7					Silty Sand SP																		
SPT7	10.5	15				0.5	82.3	17.2		NON-PLASTIC			1.92	1.67	15.3	2.70	DST	0.00	30.00				

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		START :06.09.2023	WATER TABLE DEPTH : 3.2m	BORE HOLE NO :BH3
		FINISH :06.09.2023		

SAMPLE NO	DEPTH OF SAMPLE	OBSERVED VALUE	CORRECTED VALUE	STANDARD PENETRATION RESISTANCE CURVE (5 10 20)	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
						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		
DS	G.L.																						
UDS 1					Sandy Silt ML																		
SPT1	1.5	17				0.1	5.50	94.4		34	24	10	1.97	1.69	16.8	2.70	UUT	0.13	22.00				
UDS 2					Sandy Silt ML																		
SPT2	3.0	15				2.9	13.50	83.6		35	24	11	1.97	1.66	18.5	2.70	UUT	0.15	22.00				
UDS 3					Sandy Silt ML																		
SPT3	4.5	17				3.2	13.40	83.4		35	24	11	1.97	1.66	18.6	2.72	UUT	0.23	23.00				
DS4					Silty Sand SM/SP																		
SPT4	6	15				2.3	58.50	39.2		NON-PLASTIC			1.95	1.63	19.8	2.70	DST	0.00	29.00				

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DST : DIRECT SHEAR TEST

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

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		START :06.09.2023	WATER TABLE DEPTH : 3.2m	BORE HOLE NO :BH3
		FINISH :06.09.2023		

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		
DS5					Silty Sand SM/SP																		
SPT5	7.5	14				2.3	58.60	39.1		NON-PLASTIC			1.95	1.64	18.6	2.70	DST	0.00	30.00				
DS6					Silty Sand SP																		
SPT6	9.0	11				0.6	86.3	13.1		NON-PLASTIC			1.92	1.65	16.2	2.70	DST	0.00	30.00				
DS7					Silty Sand SP																		
SPT7	10.5	16				0.5	82.6	16.9		NON-PLASTIC			1.92	1.65	16.2	2.70	DST	0.00	30.00				

UUT : UNCONSOLIDATED UNDRAINED TRIAXIAL SHEAR TEST

UCT : UNCONFINED COMPRESSION SHEAR TEST

DST : DIRECT SHEAR TEST

! SAMPLE SLIPED

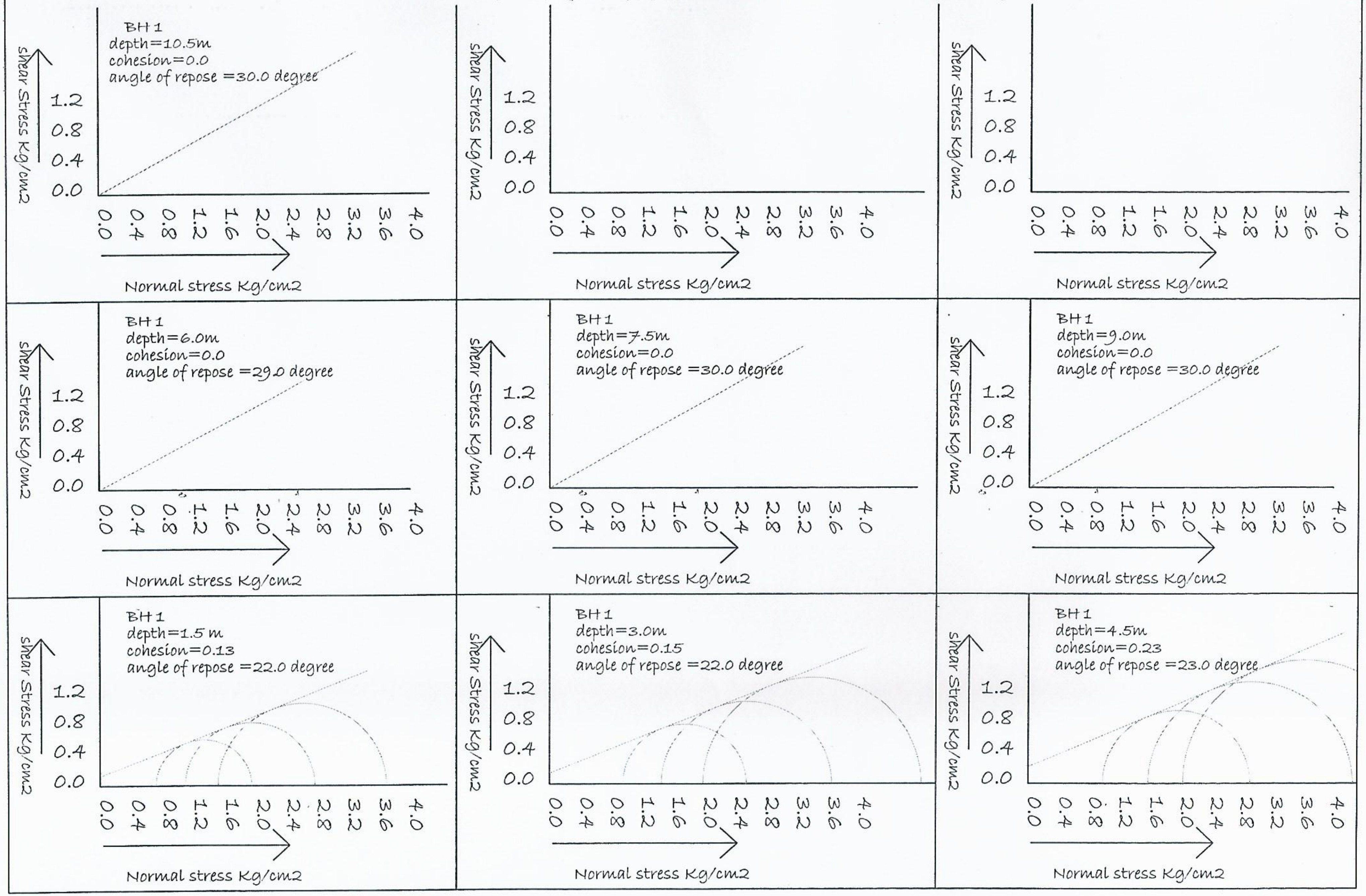
~ TEST ON REMOULDED SAMPLE

UDS : UNDISTURBED SAMPLE

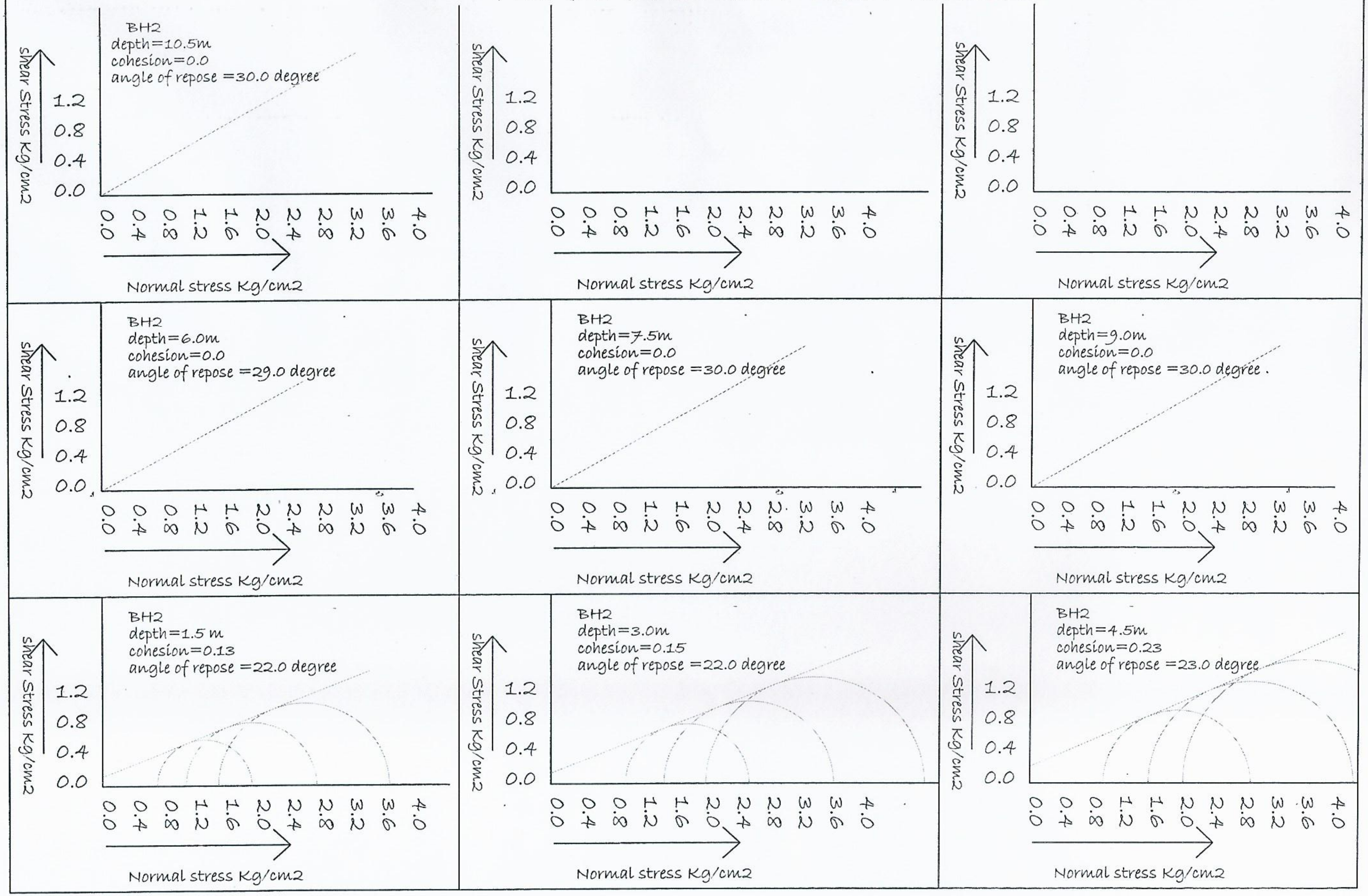
SPT : STANDARD PENETRATION TEST VALUE

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

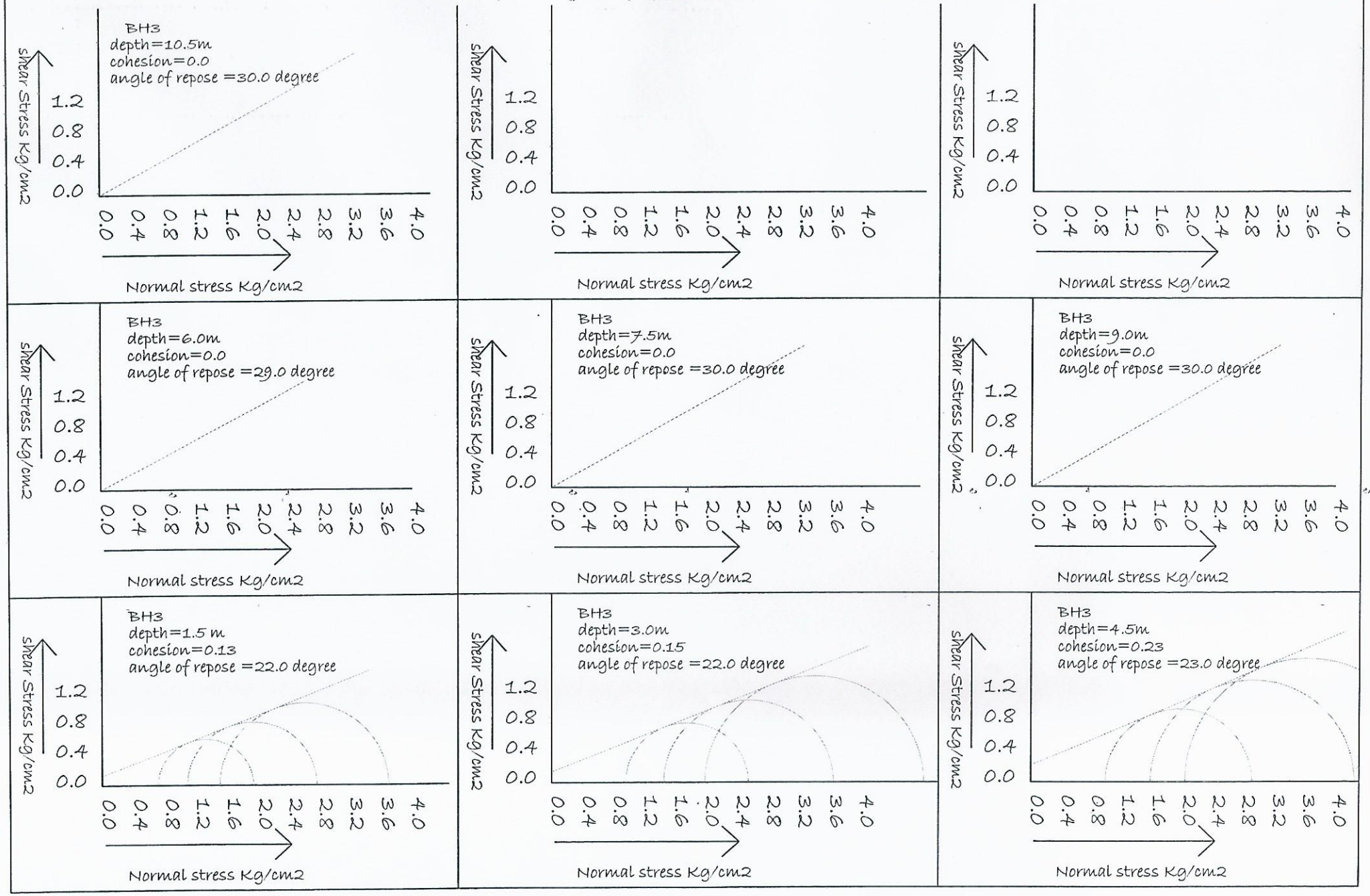
TRIAXIAL/DIRECT TEST RESULT



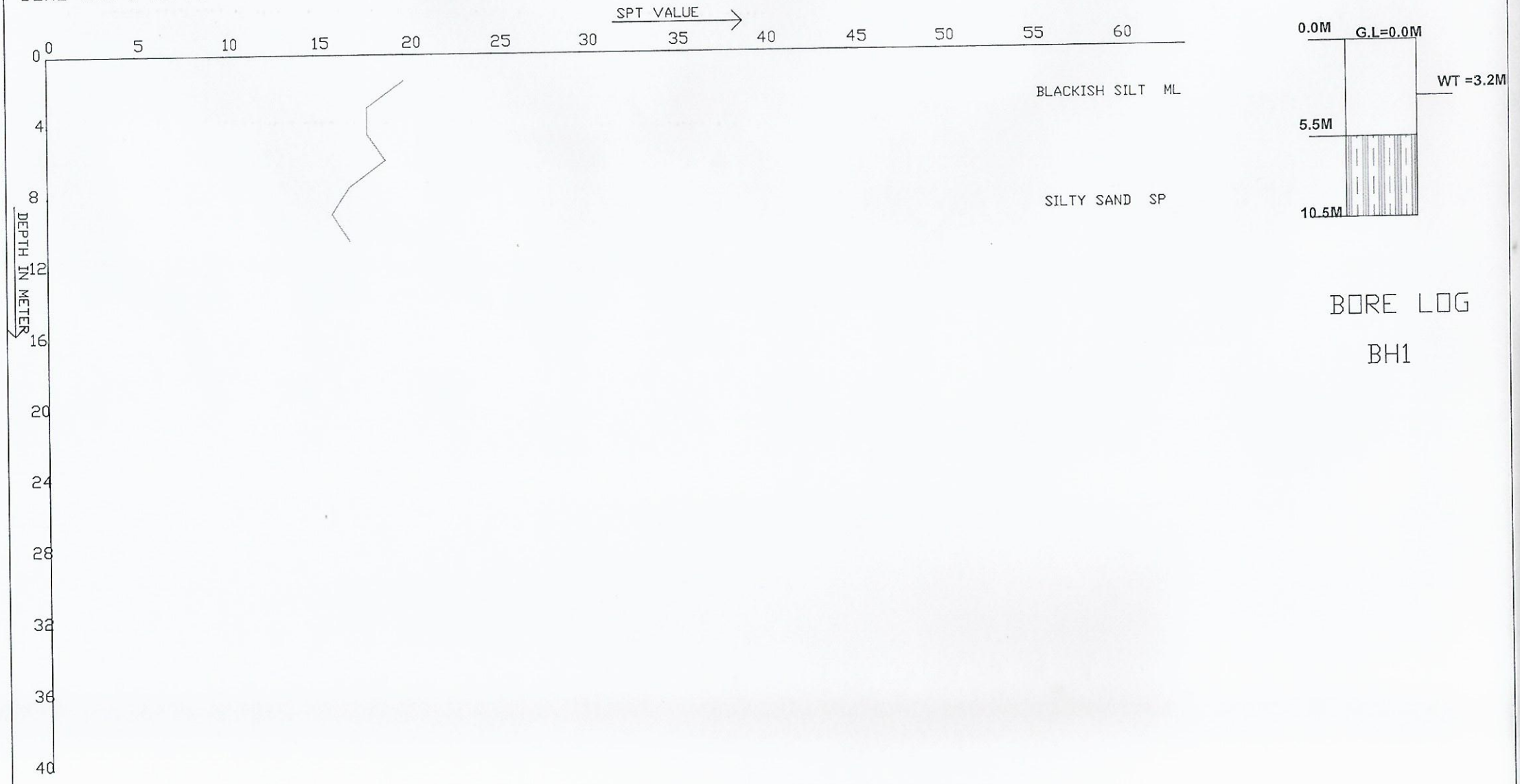
TRIAXIAL/DIRECT TEST RESULT



TRIAXIAL/DIRECT TEST RESULT



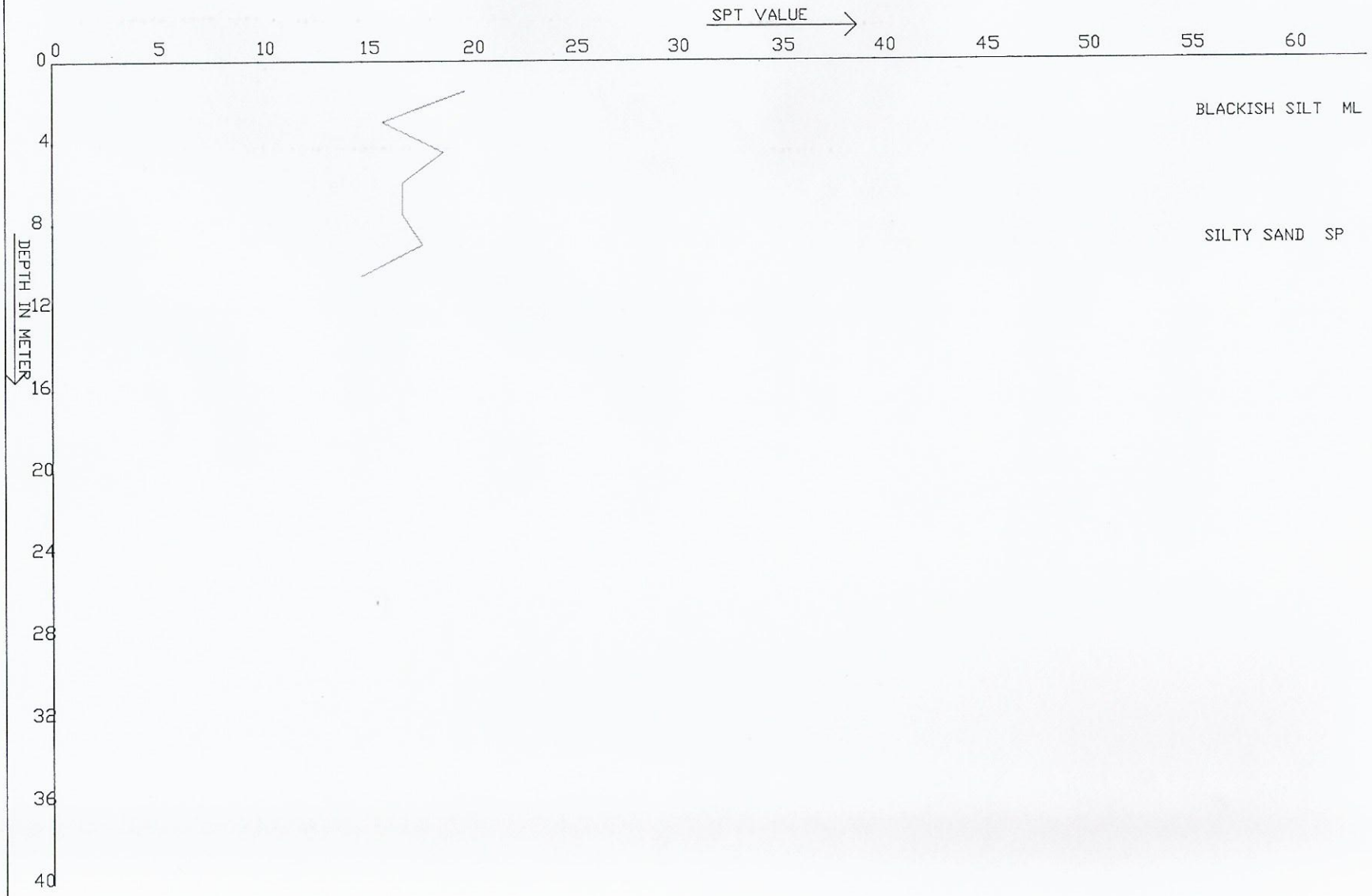
BORE LOG & DEPTH ~ SPT GRAPH (C/O GIRL,BOY HOSTEL EDUCATIONAL BHAWAN, PRINCIPAL-CUM-STAFF QUARTER BUILDING(G+4) AT DIET, MUZAFFARPUR

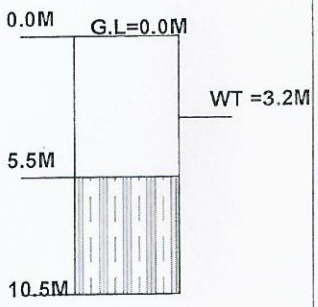


BORE LOG

BH1

BORE LOG & DEPTH ~ SPT GRAPH (C/O GIRL,BOY HOSTEL EDUCATIONAL BHAWAN, PRINCIPAL-CUM-STAFF QUARTER BUILDING(G+4) AT DIET, MUZAFFARPUR

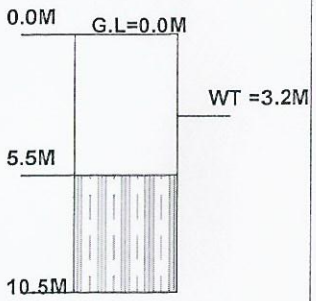




BORE LOG

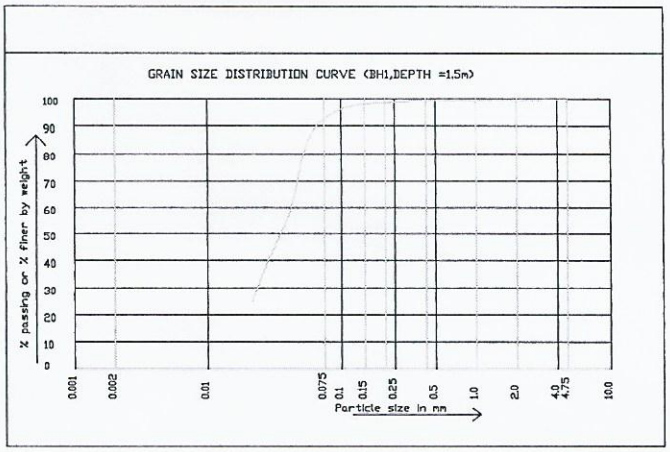
BH2

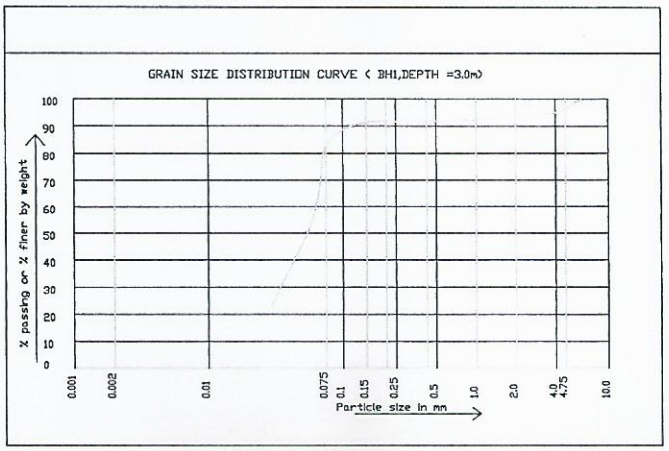
BORE LOG & DEPTH ~ SPT GRAPH (C/O GIRL,BOY HOSTEL EDUCATIONAL BHAWAN, PRINCIPAL-CUM-STAFF QUARTER BUILDING(G+4) AT DIET, MUZAFFARPUR



BORE LOG

BH3


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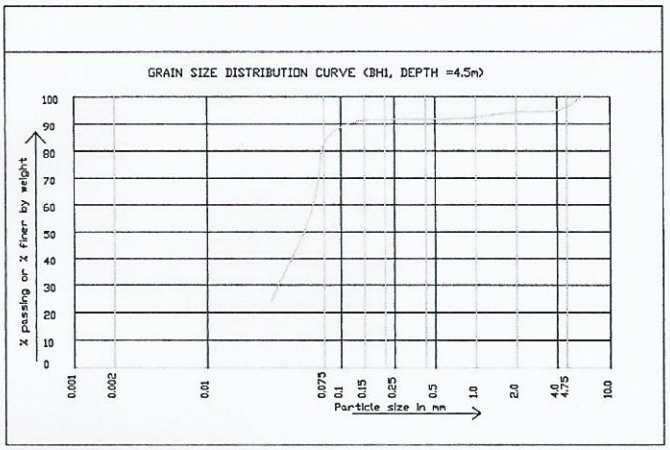
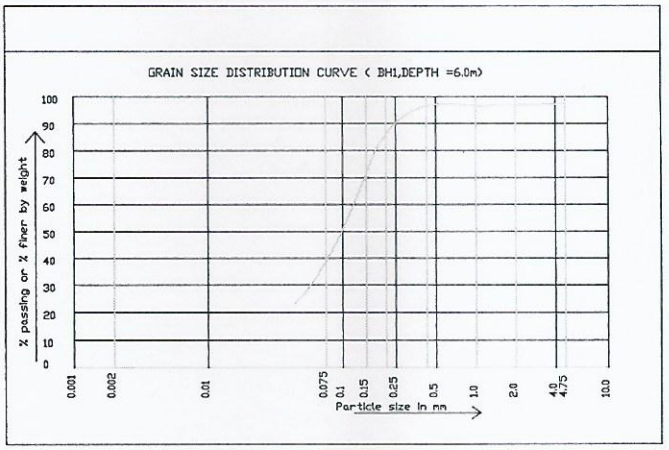
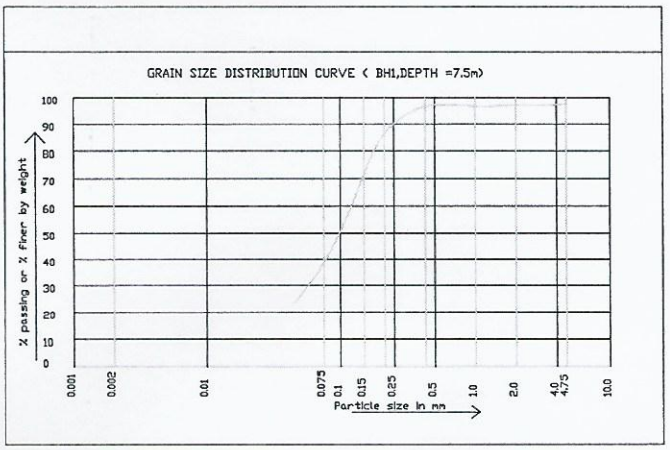
% passing or % finer by weight
Particle size in mm


GRAIN SIZE DISTRIBUTION CURVE (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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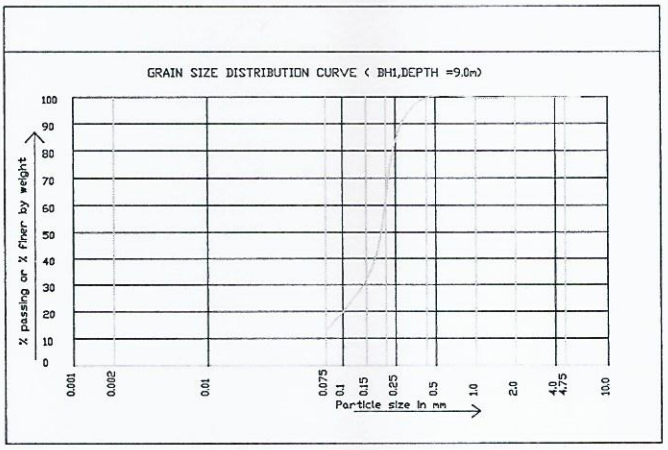
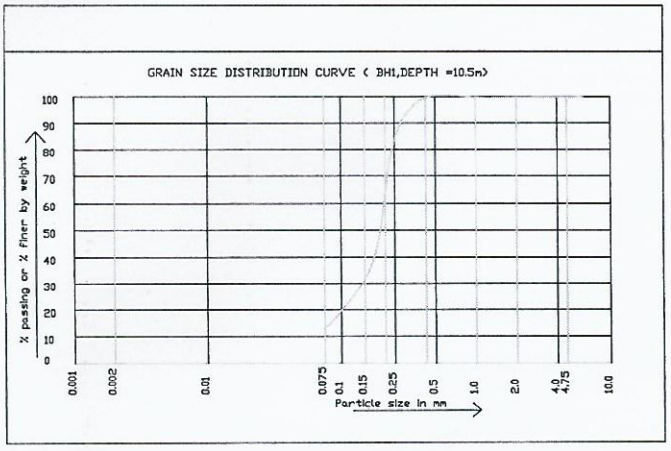
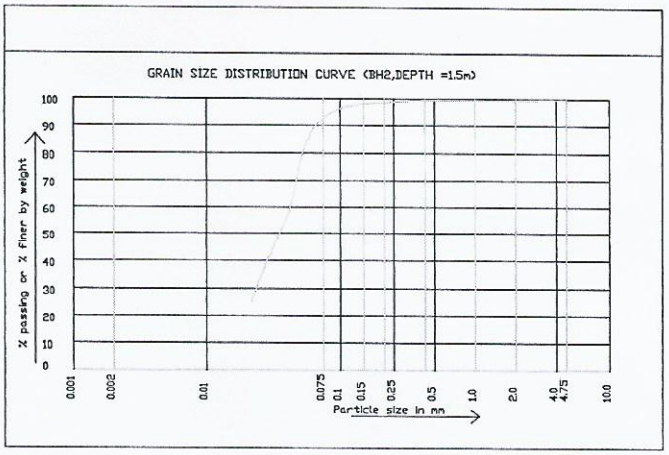
% passing or % finer by weight
Particle size in mm


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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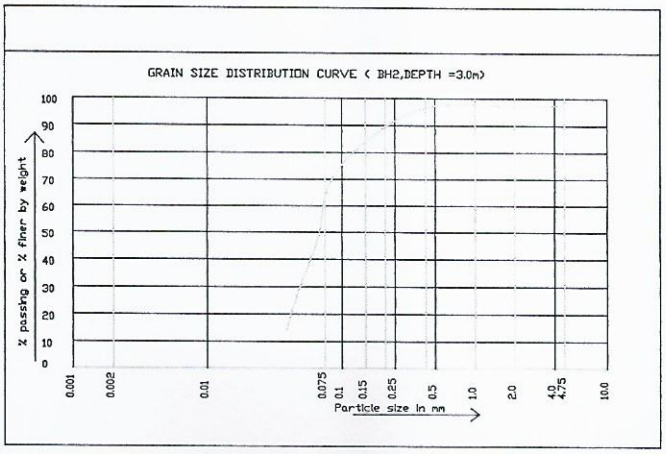
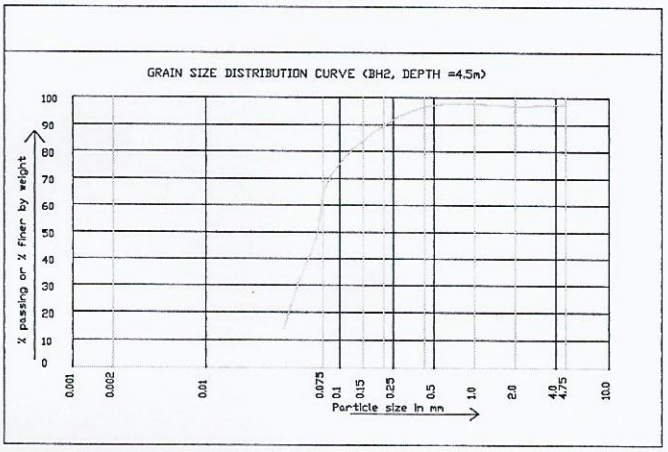
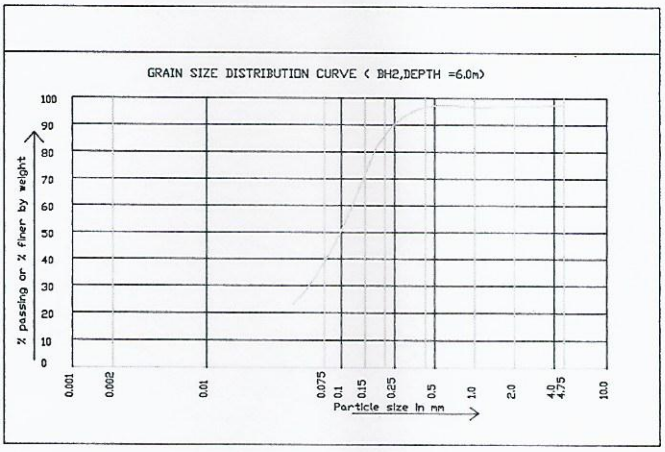
% passing or % finer by weight
Particle size in mm


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


GRAIN SIZE DISTRIBUTION CURVE (BH2, DEPTH =4.5m)
% passing or % finer by weight
Particle size in mm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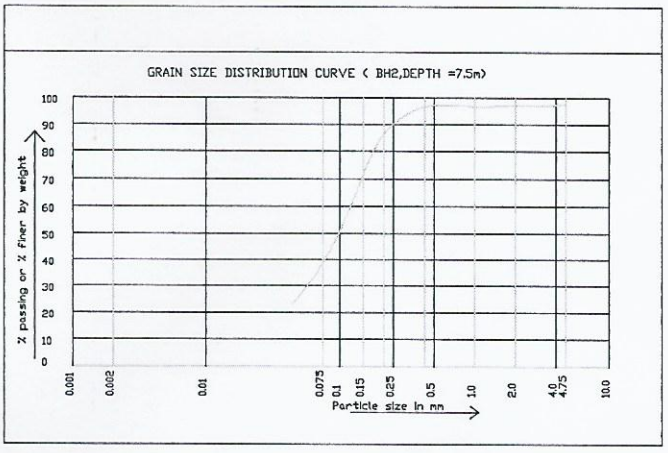
% passing or % finer by weight
Particle size in mm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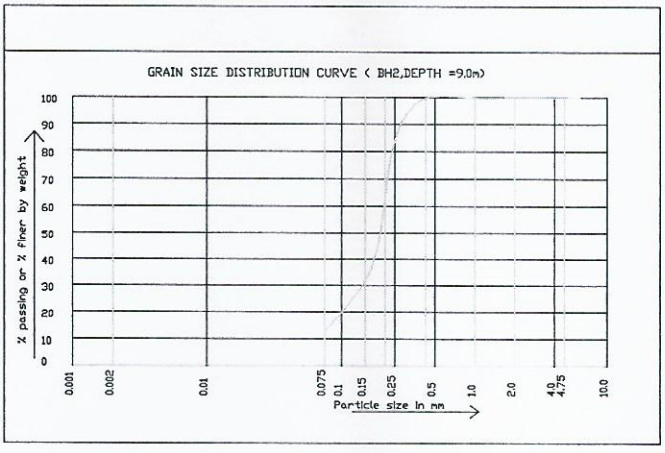
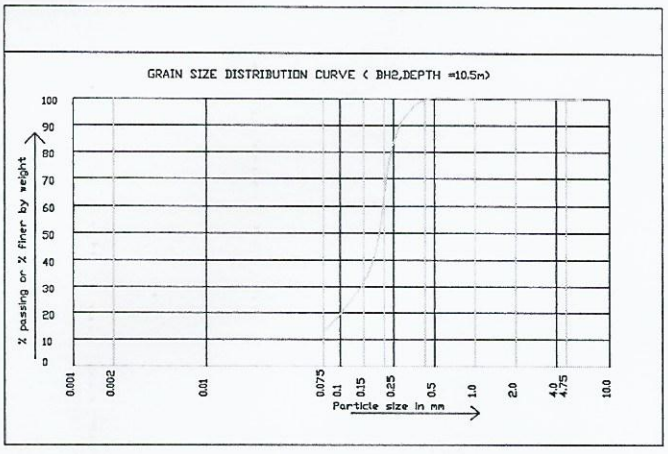
% passing or % finer by weight
Particle size in mm


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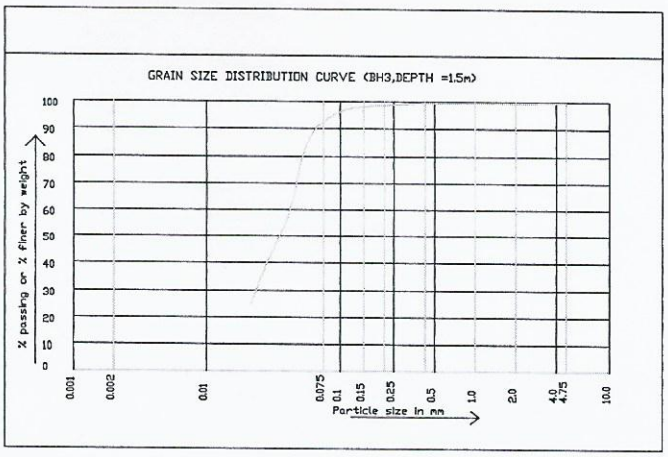
Particle size in mm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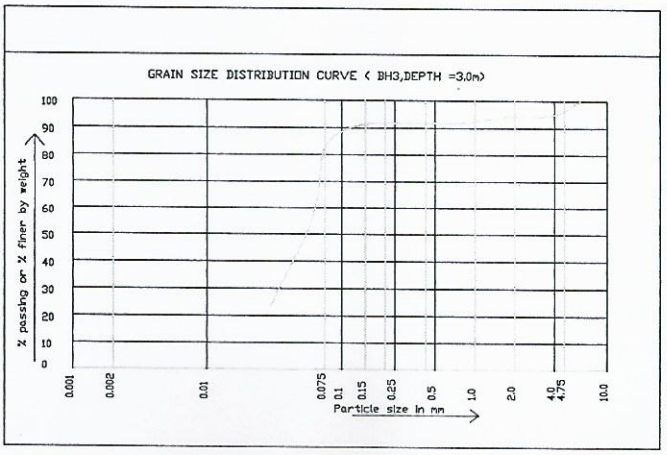
% passing or % finer by weight
Particle size in mm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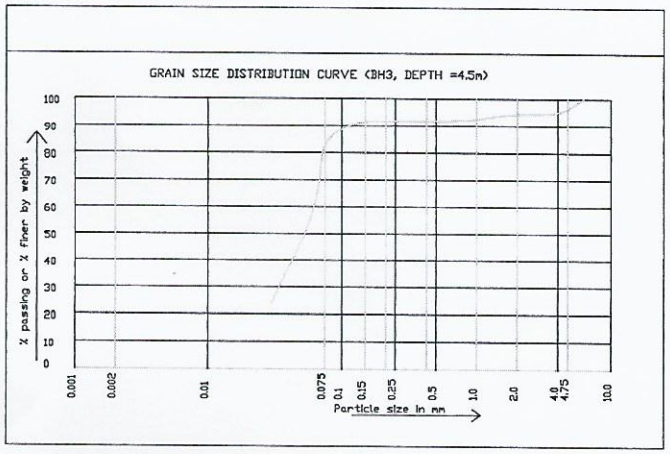
Particle size in mm


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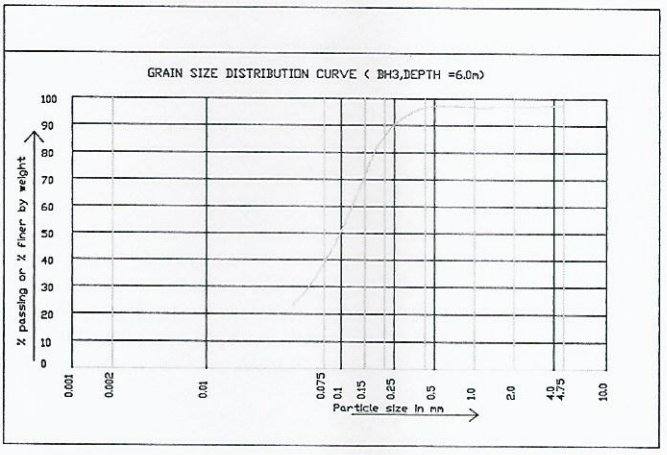
Particle size in mm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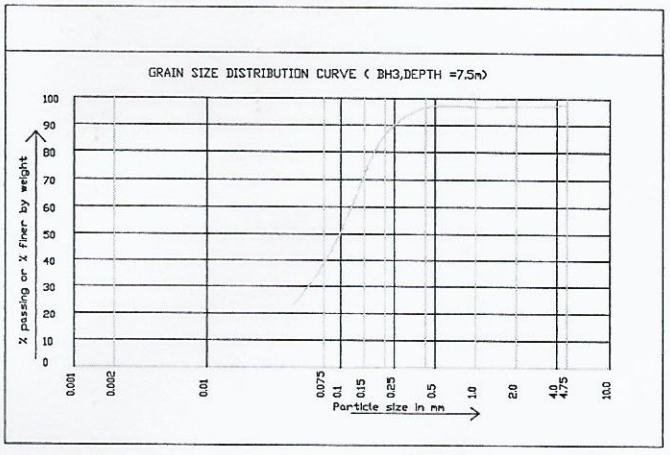
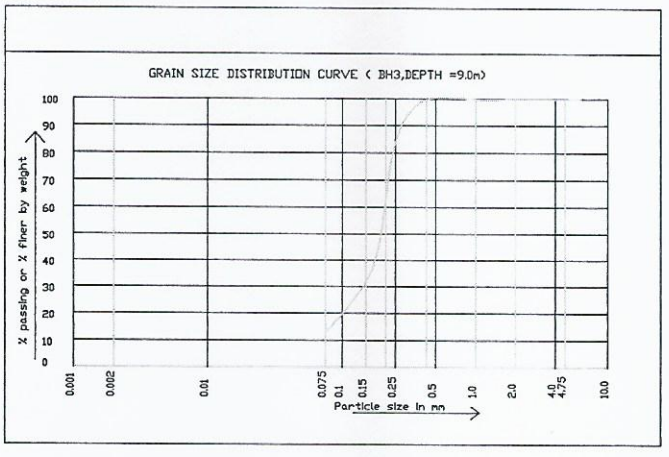
% passing or % finer by weight
Particle size in mm


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


GRAIN SIZE DISTRIBUTION CURVE (BH3,DEPTH =9.0m)
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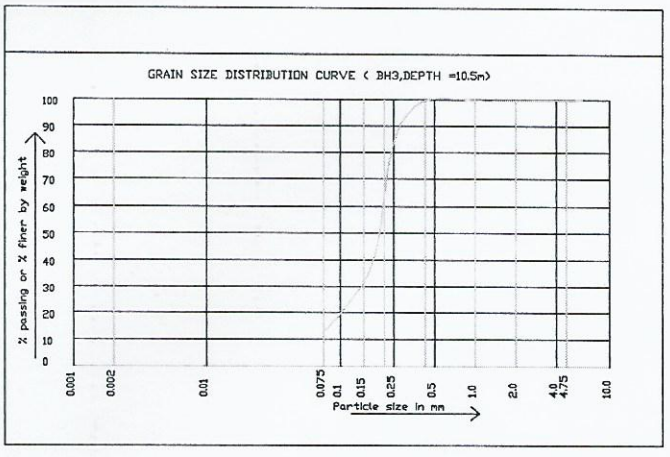
Particle size in mm


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

NAME OF PROJECT : SOIL INVESTIGATION FOR CONSTRUCTION OF GIRL,BOY HOSTEL EDUCATIONAL BHAWAN, PRINCIPAL-CUM-STAFF QUARTER BUILDING(G+4) AT DIET,RAMBAGH, MUZAFFARPUR,BIHAR

Calculation of Net safe Bearing Capacity for Strip Footing

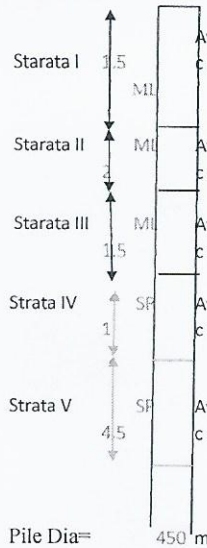
Table 1 BEARING CAPACITY FACTORS AS PER IS 6403 : 1981

Angle of shearing resistance of soil, phi	Nc	Nq	Ny
0	5.14	1	0
5	6.49	1.57	0.45
10	8.35	2.47	1.22
15	10.98	3.94	2.65
20	14.83	6.4	5.39
25	20.72	10.66	10.88
30	30.14	18.4	22.4
35	46.12	33.3	48.03
40	75.31	64.2	109.41
45	138.88	134.88	271.76
50	266.89	319.07	762.89

Depth of footing below GL in	1.5			Water Table assumed=	1.5	m
Width of footing in meter,B=	3					
Effective depth of soil formation	3.5					
Average cohesion of soil mobilised in Ton/m2=	1.40					
unit weight of soil in ton/m2,y=	1.97					
Angle of shearing resistance of soil, phi,in degree =	22.00	Corresponding Nc/N'c=	11.10	Corresponding Nq/N'q=	4.01	Corresponding Ny/N'y= 2.73
Effective Angle of shearing resistance of soil, phi,in degree =	15.15	Corresponding Nc/N'c=	11.10	Corresponding Nq/N'q=	4.01	Corresponding Ny/N'y= 2.73

Depth factor,dc=	1.13	dc=1+0.2*(Df/B)*tan(45+phi/2)
Depth factor,dq=	1.07	dq=1+0.1*(Df/B)*tan(45+phi/2) if phi >10 otherwise dq=1
Depth factor,dy=	1.07	dy=1+0.1*(Df/B)*tan(45+phi/2) if phi >10 otherwise dy=1
effective surcharge at base level of foundation,q=yD	3.0	q=yD
Q1 ton/m2 =	11.71	Q1=(2/3)*c*N'c*dc
Q2 ton/m2 =	9.66	Q2=q*(N'q-1)*dq
Q3 ton/m2 =	2.13	Q3=(1/2)*B*y*N'y*dy*W'
ultimate bearing capacity Q ton/m2 =	23.5	Q=Q1+Q2+Q3
Factor of safety,F.S. =	3	
Net Safe Bearing Capacity in ton/m2 q=	7.8	q=Q1/F.S.

Pile Design



	Average c=	1.3	ϕ=	22	
	c at end=	1.3	ϕ=	22	
		γ=	1.97	t/m3	
	Average c=	1.3	ϕ=	22	
	c at end=	1.5	ϕ=	22	
		γ=	1.97	t/m3	
	Average c=	2.3	ϕ=	23	
	c at end=	2.3	ϕ=	23	
		γ=	1.97	t/m3	
	Average c=	0	ϕ=	29	
	c at end=	0	ϕ=	29	
		γ=	1.92	t/m3	
	Average c=	0	ϕ=	30	
	c at end=	0	ϕ=	30	
		γ=	1.92	t/m3	

Pile Dia= 450 mm

A_p =base area= 0.159 mm2

Overburden Pressure corresponding to L(6.75m)= 6.5475 t/m2

****

Strata I

ϕ	Nc	Nq	Ny	Average c=	c at end	α	γ
22	17.19	8.100	7.59	1.3	1.3	1.00	1.97

Top of Strata Average γ= 1.97 t/m3

Depth= 0.000

Pressure= 0.000 due to submerged soil

Effective length for overburden estimation=(15x0.45m)= 6.75 m

Pressure(Limiting at top of Strata)= 6.550 t/m2

End of Strata

Overburden Pressure corresponding to L(15x0.45m)=6.75m 6.55 t/m2

Depth= 1.500 Average γ= 1.97 t/m3

Pressure= 1.455 t/m2 due to submerged soil

Pressure at end of strata= 1.455 not grater than limiting

Avearage Pressure in Strata for end bearing= 4.0025 t/m2

Avearage Pressure in Strata for skin bearing= 4.0025 t/m2

Surface area of Starata I= 2.121 m2

Capacity due to fine grained soil

Q skin= £ α c As = 2.8 t

Q end= Ap Nc Cp= 3.6 t

Ø	30	40	For Ø=22 Degree
K	1	1.5	1
Critical Depth factor	15	20	15.0

Capacity due to coarse grained soil

k= 1 delta= 22 Nq = 8.1

Skin friction in ton Qs=k*Pd*tan(delta)*As=

=1x4.0025xTAN(π x22/180)x2.121= 3.4 t

End bearing in ton =Qb=Ap*[0.5*D*y*Ny+Pd*Nq]=

=0.159x(0.5x(0.45)x(1.97-1)x7.59 + 1.455x8.1)= 2.1 t

****

Strata II

ϕ	Nc	Nq	Ny	Average c=	c at end	α	γ
22	17.19	8.100	7.59	1.3	1.5	1.00	1.97

Top of Strata

Depth= 1.500 Average γ= 1.97 t/m3

Pressure= 1.455 due to submerged soil

Effective length for overburden estimation=(15x0.45m)= 6.75 m

Pressure(Limiting at top of Strata)= 1.455 t/m2

End of Strata

Overburden Pressure corresponding to L(15x0.45m)=6.75m 6.55 t/m2

Depth= 3.500 Average γ= 1.97 t/m3

Pressure= 3.395 t/m2 due to submerged soil

Pressure at end of strata= 3.395 not grater than limiting

Avearage Pressure in Strata for end bearing= 2.425 t/m2

Avearage Pressure in Strata for skin bearing= 2.425 t/m2

Surface area of Starata II= 2.827 m2

Capacity due to fine grained soil

Q skin= £ α c As = 3.7 t

Q end= Ap Nc Cp= 4.1 t

Ø	30	40	For Ø=22 Degree
K	1	1.5	1
Critical Depth factor	15	20	15.0

Capacity due to coarse grained soil

k= 1 delta= 22 Nq = 8.1

Skin friction in ton Qs=k*Pd*tan(delta)*As=

=1x2.425xTAN(π x22/180)x2.827= 2.77 t

End bearing in ton =Qb=Ap*[0.5*D*y*Ny+Pd*Nq]=

=0.159x(0.5x(0.45)x(1.97-1)x7.59 + 3.395x8.1)= 4.6 t

****

Strata III

ϕ	Nc	Nq	Ny	Average c=	c at end	α	γ
23	18.36	8.960	8.68	2.3	2.3	0.93	1.97

Top of Strata

Depth= 3.500 Average γ= 1.97 t/m3

Pressure= 3.395 due to submerged soil

Effective length for overburden estimation=(15x0.45m)= 6.75 m

Pressure(Limiting at top of Strata)= 3.395 t/m2

End of Strata

Overburden Pressure corresponding to L(15x0.45m)=6.75m 6.55 t/m2

Depth= 5.000 Average γ= 1.97 t/m3

Pressure= 4.850 t/m2 due to submerged soil

Pressure at end of strata= 4.850 not grater than limiting

Avearage Pressure in Strata for end bearing= 4.1225 t/m2

Avearage Pressure in Strata for skin bearing= 4.12

Surface area of Starata III= 2.121 m2

Capacity due to fine grained soil

Q skin= £ α c As = 4.537 t

Q end= Ap Nc Cp= 6.714 t

Ø	30	40	For Ø=23 Degree
K	1	1.5	1
Critical Depth factor	15	20	15.0

Capacity due to coarse grained soil

k= 1 delta= 23 Nq = 8.96

Skin friction in ton Qs=k*Pd*tan(delta)*As=

=1x4.12xTAN(π x23/180)x2.121= 3.709 t

End bearing in ton =Qb=Ap*[0.5*D*y*Ny+Pd*Nq]=

=0.159x(0.5x(0.45)x(1.97-1)x8.68 + 4.85x8.96)= 7.211 t

Strata IV

ϕ	Nc	Nq	Ny	Average c=	c at end	α	γ
29	28.26	16.850	20.10	0	0	1.00	1.92

Top of Strata

Depth= 5.000 Average γ= 1.97 t/m3

Pressure= 4.850 due to submerged soil

Effective length for overburden estimation=(15x0.45m)= 6.75 m

Pressure(Limiting at top of Strata)= 4.850 t/m2

End of Strata

Overburden Pressure corresponding to L(15x0.45m)=6.75m 6.21 t/m2

Depth= 6.000 Average γ= 1.9575 t/m3

Pressure= 5.745 t/m2 due to submerged soil

Pressure at end of strata= 5.745 not grater than limiting

Avearage Pressure in Strata for end bearing= 5.2975 t/m2

Avearage Pressure in Strata for skin bearing= 5.30

Surface area of Starata IV= 1.414 m2

Capacity due to fine grained soil

Q skin= £ α c As = 0.000 t

Q end= Ap Nc Cp= 0.000 t

Ø	30	40	For Ø=29 Degree
K	1	1.5	1
Critical Depth factor	15	20	15.0

Capacity due to coarse grained soil

k= 1 delta= 29 Nq = 18

Skin friction in ton Qs=k*Pd*tan(delta)*As=

=1x5.3xTAN(π x29/180)x1.414= 4.154 t

End bearing in ton =Qb=Ap*[0.5*D*y*Ny+Pd*Nq]=

=0.159x(0.5x(0.45)x(1.92-1)x2 t 17.104

****

Strata V

ϕ	Nc	Nq	Ny	Average	c at end	α	γ
30	30.14	18.400	22.40	0	0	1.00	1.92

Top of Strata

Depth= 6.000 Average γ= 1.9575 t/m3

Pressure= 5.745 due to submerged soil

Effective length for overburden estimation=(15x0.45m)= 6.75 m

Pressure(Limiting at top of Strata)= 5.745 t/m2

End of Strata

Overburden Pressure corresponding to L(15x0.45m)=6.75m 6.21 t/m2

Depth= 10.500 Average γ= 1.95 t/m3

Pressure= 9.975 t/m2 due to submerged soil

Pressure at end of strata= 6.210 not grater than limiting

Avearage Pressure in Strata for end bearing= 5.9775 t/m2

Avearage Pressure in Strata for skin bearing= 6.21

Surface area of Starata IV= 6.362 m2

Capacity due to fine grained soil

Q skin= £ α c As = 0.000 t

Q end= Ap Nc Cp= 0.000 t

Ø	30	40	For Ø=30 Degree
K	1	1.5	1
Critical Depth factor	15	20	15.0

Capacity due to coarse grained soil

k= 1 delta= 30 Nq = 20

Skin friction in ton Qs=k*Pd*tan(delta)*As=

=1x6.21xTAN(π x30/180)x6.362= 22.810 t

End bearing in ton =Qb=Ap*[0.5*D*y*Ny+Pd*Nq]=

=0.159x(0.5x(0.45)x(1.92-1)x22.4 + 6.21x20)= 20.485 t

****

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Capacity of Pile

Dia=	450 mm		
Depth=	5.000 M		
Capacity=	(6.2)+(6.47) + (22.171)=		34.84 t
F.S.=	2.500		
Safe Capacity=	13.9 t		

Table 8

Soil stratification

DEPTH	SOIL TYPE	CONSISTANCY	CLASSIFICATION
0-6.5	SANDY SILT	MEDIUM	ML
6.5-10.5	SAND	MEDIUM	SP

Water Table has been found at 3.2m depth below NGL as reported in September'2023.

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 BSEIDC and shown in the bore hole location plan.

The laboratory test of soil samples obtained in all bore holes are given in Tables 2-7. Study of these tables reveals that the sub-soil strata :

(a) Top 6.5m Soil strata consists of fine grained soil. Rest of strata is silty sand.

Therefore, foundation should be placed at 1.50m or beyond the ground level. Both, shallow as well as deep, foundations are feasible. Bore Hole may cave in. Therefore, Bentonite slurry or casing is required for the bore hole stabilization.

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)	Maximum expected settlement (mm)	Allowable Bearing capacity (t/m2)
1.5	3.0	50	7.5
2.0	3.0	50	8.5

SQUARE FOOTING

Depth below GL (m)	Length x Width of foundation (m)x(m)	Maximum expected settlement (mm)	Allowable Bearing capacity (t/m2)
1.5	3.0	50	8.0
2.0	3.0	50	9.0

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By way of example the calculated value of safe capacity of certain diameter of plane pile using IS : 2911 (Part I, Sec. 2) 2010, Appendix B. Clause B-1 are being tabulated below: -

PLANE PILE

Depth of Pile below GL(m)	Dia of Plane Pile (m)	Allowable Capacity (Ton)
5.5	0.45	12.5
5.5	0.5	15.0

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.

Bearing capacity shall be confirmed by plate load test as per relevant Indian codes.

Pile capacity shall be confirmed by Initial and Routine pile load test, before starting the work, as per relevant Indian codes.

Subodh Kumar Sinha

SUBODH KUMAR SINHA
Partner. Shamvwi consultant