CLIENT :

PROJECT DIRECTOR

DHAKA POWER SYSTEM EXPANSION & STRENGTHENING PROJECT IN DESCO AREA

REPORT ON SUB-SOIL INVESTIGATION FOR THE CONSTRUCTION 6- STORIED 33/11 KV SUBSTATION AT PLOT # 59, PARK ROAD, BARIDHARA DIPLOMATIC ZONE, BARIDHARA, DHAKA-1212, BANGLADESH.

JULY : 2022

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LIST OF ABBREVIATIONS

Q_a = *Allowable Bearing Capacity,*

Q_u = *Ultimate Bearing Capacity,*

SPT = *Standard Penetration Test*

N_{corr} = *Corrected SPT for overburden pressure*

c = *Cohesion of soil*

γ_s = *Effective unit weight of soil*

γ_w = *Effective unit weight of Water*

D = *Depth of footing*

B = *Width of footing*

$Nc = \cot\phi(Nq - 1)$,

α = *empirical adhesion factor or friction constant*

ϕ = *Angle of internal friction* (degrees).

$\boldsymbol{\delta}$ = *Angle of Wall friction* (degrees).

$N_q = e^{2(3\pi/4-\phi/2)\tan\phi} / [2\cos^2(45+\phi/2)]$,

$N_\gamma = (1/2)\tan\phi(k_p/\cos^2\phi - 1)$,

k_p = *Passive pressure coefficient*

e = *Napier's constant* = 2.718...,

s_c, s_r, s_q = *Shape Factors*

d_c, d_r, d_q = *Depth Factors*

i_c, i_r, i_q = *inclination Factors*

Q_s = *Ultimate Skin Friction of pile*

Q_p = *Ultimate End Bearing capacity of pile*

A_s = *Circumferential area of pile*

A_p = *Toe area of pile*

Fd = Depth factor $= 1+0.33*(D/B) \leq 1.33$

LL = Liquid Limit

PL = Plastic Limit

PI = Plasticity Index

C_u = *Coefficient of Uniformity*

C_c = *Coefficient of Curvature*

REPORT ON SUB-SOIL INVESTIGATION

INTRODUCTION

This report has been prepared and submitted to present the sub-soil and geotechnical features of the following project:

Client	:	**Project Director**
Name of Project	:	**Construction 6- Storied 33/11 KV Substation**
Site Location	:	**Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**
Basic wind Speed	:	**62.5 m/s (As per BNBC Code 2020)**

Technical soil data obtained from the field investigations are presented in this report along with the analyses of bearing capacity of foundations of a different range of size and depth.

ENGINEERING SURVEY & DESIGN, NHB ¾ (Ground Floor), Mirpur-14, Dhaka-1216 is a renowned company & was engaged with the geotechnical investigation work for the above mentioned site by the concerned authority**.**

SCOPE OF WORKS

The purpose of the investigation was to obtained information relating to foundation condition and natural construction materials commensurate with the magnitude and type of structure may be involved within the project.

- The investigation program included drilling boreholes and collecting soil samples from field at desired intervals for subsequent observation and laboratory testing.

- The soil investigation both in the field and laboratory were carried out in detail to evaluate the mechanical, physical and geotechnical properties of safe and economic foundation for the with a view to recommend the safe and economic foundation for the proposed structures to be constructed within the investigation site.

- The report contained the works program, methodology of the field and laboratory investigation works, discussions on physical and engineering properties of sub-soil formation encountered during investigation, evaluation of laboratory test data, analysis of bearing capacities, foundation recommendations and charts and graphs representing the field and laboratory test results.

The laboratory test results, analysis, discussion and recommendations which are presented in this report are valid only for the locations where the actual investigations have carried out.

SEISMOLOGY

Bangladesh has been divided into four seismic zones with different levels of ground motion. A map of Bangladesh showing the boundaries of the three zones is provided. It indicates the seismic zoning map of Bangladesh. Each zone has a seismic zone coefficient (Z) which represents the maximum considered Peak Ground Acceleration (PGA) on very stiff soil/rock. The zone coefficients of the four zones are:

Z = 0.12 (Zone 1)
Z = 0.20 (Zone 2)
Z = 0.28 (Zone 3)
Z = 0.36 (Zone 4)



Seismic Zoning Map of Bangladesh
(As per BNBC 2020)

INVESTIGATION PROGRAM

The sub-soil and geotechnical investigation works program for this report is presented below-

A. Field Investigation

Number of Boring	:	4	Max Depth of Boring	:	36 m
SPT Execution	:	84	Interval of SPT execution	:	1.5 m
Disturbed sample	:	84	Undisturbed Sample	:	Nil
Compaction Test	:	Nil	Water Table Level below	:	1.2 m
Permeability Tests	:	N/A	Other Tests	:	N/A

B. Laboratory Investigation

The laboratory tests on soil samples were started immediately after the receipt of the same in the laboratory.

Grain Size Distribution	:	8	Atterberg Limits Test	:	4
Specific Gravity	:	4	Moisture Content	:	4
Unconfined Compression Test	:	Nil	Consolidation Test	:	Nil
Direct Shear Test	:	4	Standard Proctor Test	:	Nil
Free Swell Index	:	Nil	Chemical Test	:	Nil
Unit weight of soil	:	4	Other Tests	:	N/A

METHODOLOGY

The methodology of conducting field and laboratory investigation and evaluations for determining bearing capacities of shallow and deep foundations is discussed thoroughly with the following pages.

FIELD INVESTIGATION

Execution of Borings

The boring was conducted using 100 mm diameter casing. The method consists in first driving a casing through which a hollow drill rod with a sharp chisel or chopping bit at the lower end is inserted. Water is forced under pressure through the drill rod which is alternatively raised and dropped, and also rotated. The soil cuttings are forced upto the dropped and also rotated. The soil cuttings are forced upto the ground in the drilled rod and casing. Before taking SPT and collection of disturbed and undisturbed soil samples, the bore hole is cleaned with repeated circulation of mud slurry.

Standard Penetration Tests (SPT)

The standard Penetration Tests (SPT) was performed in all the bore holes locations. In SPT testing, the rope-and-pulley (R-P) method would be used. This consisted of a hollow cylindrical mass sliding over a steel rod. It is operated by lifting the mass with a rope over a cat head. The tests were executed by using 63.5 kg hammer falling freely from a constant height of 760 mm. The SPT value (N-value) was taken as the summation of blows required in 2nd and 3rd 15 cm of penetration of sampler. The SPT values (N-values) are shown on the borehole logs against the respective interval of tests.

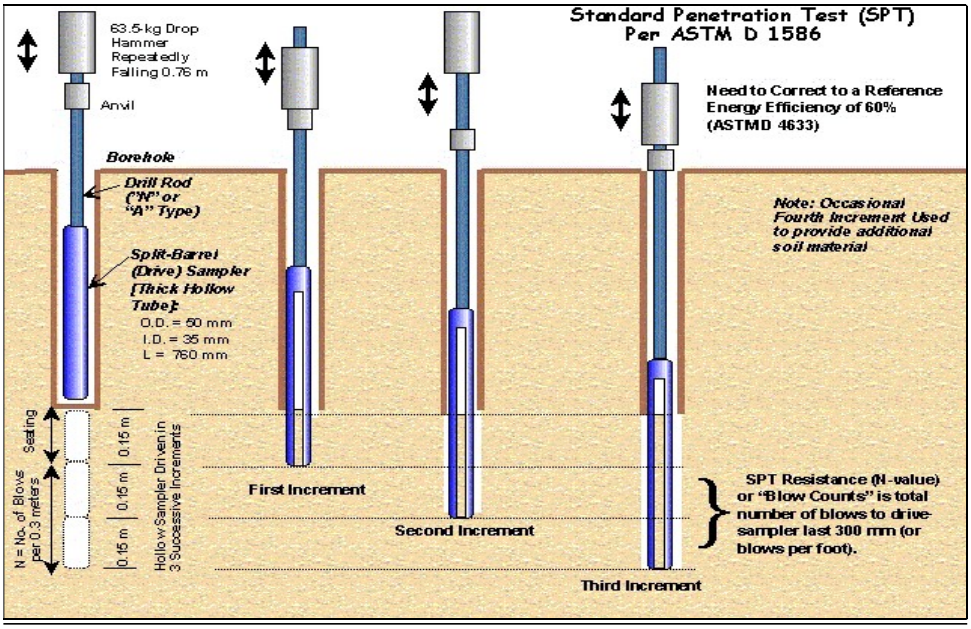


Figure for Standard Penetration Tests Process

- The Standard Penetration Tests provide a fair knowledge on the density and consistency of the soil layer encountered and in addition yields disturbed/ semi-disturbed soil samples from within the split spoon sampler used during the tests.

Disturbed Sample Collection

The disturbed samples were collected with the help of split spoon sampler used during Standard Penetration Tests. The collected samples were classified in-situ and were preserved in water tight polythene bags with proper identification marks for onward transmission to the laboratory for further analysis.

The disturbed samples were also used to reconstruct depth wise stratification of bore holes depending on its classifications.

Undisturbed Sample Collection

The undisturbed samples were collected whenever feasible from the cohesive layers with the help of thin walled Shelby tubes 76 mm diameter thin walled Shelby tubes are penetrated into the undisturbed soil formation at the bottom of the borehole by applying rapid but continuous force. The samples recovered within the Shelby tubes were wax sealed at both ends and transmitted to the laboratory with proper identification marks.

Recording of Ground Water Table

Groundwater is one element that affects in the stability and foundation analyses. The ground water table was recorded in each of the boreholes by rope / rod sounding after 24 hours of completion of the drilling and sampling operation.

However, the low permeability of the soil will mean that the water level in the borehole is controlled more by drilling fluid rather than by the ground water itself. Significant fluctuations in the location of ground water table should be anticipated throughout the year, depending upon the amount of precipitation, evaporation and surface runoff.

Other Field Tests

Any other field tests, which were conducted at site was done as per AASHTO/ASTM standard specifications.

LABORATORY INVESTIGATION

Different types of geotechnical laboratory tests were performed in the laboratory to evaluate the physical and engineering properties of the sub-soil formation to facilitate determination of soil bearing capacities and to recommend foundation type and magnitude.

- Soil Classification, Grain Size Analysis, Atterberg Limit and Specific Gravity Tests were performed to ascertain the detail composition of the soil and to evaluate the physical parameters of the formation. These tests also help in classifying the soils properly for geological and geotechnical interpretation.
- Unconfined Compression, unit weights of soils**,** moisture contents and Direct Shear tests were done to evaluate the shear characteristics of the soils, angle of internal friction φ which directly help in bearing capacity calculation.
- Consolidation tests provide data on consolidation behavior of the sub-soil formation which help to calculate the settlement of the structure.

The laboratory tests were performed as per AASHTO/ASTM Standard specifications. The soils will be also classified based on the Unified Soil Classification System (USCS).

CALCULATION OF SOIL MECHANICS PARAMETERS

- **Bearing capacity** of soil is the value of the average contact pressure between the foundation and the soil which will produce shear failure in the soil.
- **Ultimate bearing capacity** is the theoretical maximum pressure which can be supported without failure.
- **Allowable bearing capacity** is what is used in geotechnical design, and is the ultimate bearing capacity divided by a factor of safety.

The bearing capacity of shallow and deep foundation parameters were evaluated using field and laboratory tests. For cohesionless soil and for instances where undisturbed samples could not be collected, the field SPT values after necessary correction were used to obtained soil constants like cohesion (c), angle of internal friction (φ) and unit weight (γ).

CORRELATIONS

A. The following definitions are used in this report to describe the soil compositions:

Trace :	1% to 10%	Sandy :	> 36% to 60% Sand
Little :	> 10% to 20%	Clayey :	> 36% to 60% Clay
Some :	> 20% to 36%	Silty :	> 36% to 60% Silt

B. Correlation among SPT values (N) with Different Engineering Properties of Cohesion less (Sandy) soil :

N Value	Compactness or Consistency	Angle of Internal Friction (φ)	Relative Density	Moist unit weight, pcf	Allowable Soil Pressure, ton/sft
0 to 4	Very Loose	25^o to 32^o	0% to 15%	70 to 100	0.00 to 0.40
4 to 10	Loose	27^o to 35^o	15% to 35%	95 to 125	0.40 to 0.70
10 to 30	Medium	30^o to 40^o	35% to 65%	110 to 130	0.70 to 2.60
30 to 50	Dense	35^o to 45^o	65% to 85%	110 to 140	2.60 to 4.60
Over 50	Very Dense	> 45^o	85% to 100%	> 130	> 4.60

C. Correlation among SPT values (N) with Different Engineering Properties of Cohesive (Clayey) soil:

N Value	Compactness or Consistency	Consistency Index (%)	Unconfined Compressive Strength(q_u), ton/sft	Allowable Bearing Capacity (q_a), ton/sft	
				Square Footing 1.2 x q_u	Continuous Footing 0.90 x q_u
0 - 2	Very Soft	0 – 25	0.00 - 0.26	0.00 - 0.30	0.00 - 0.23
2 - 4	Soft	25 – 50	0.26 - 0.60	0.30 - 0.72	0.23 - 0.46
4 - 8	Medium Stiff	50 – 75	0.60 – 1.00	0.72 – 1.20	0.54 – 0.90
8 - 16	Stiff	75 – 100	1.00 – 2.00	1.20 – 2.40	0.90 – 1.80
16 - 32	Very Stiff	> 100	2.00 – 4.00	2.40 – 4.80	1.80 – 3.60
> 32	Hard	> 100	> 4.00	> 4.80	> 3.60

DETERMINATION OF BEARING CAPACITY FOR SHALLOW FOUNDATION

The SPT is widely used to obtain the allowable bearing capacity values in the following general equation for soil (for Max 25 mm settlement)

- ***According to Bowles formula:***

Cohesive soil:

$Q_u = 5.14*Cu*(1+0.4* D /B)*(1+0.2*B/L)*B*L$;

Cohesionless soil:

a. for B ≤ 4.0 ft; $Q_a = (N_{corr}/2.5)*(F_d*S)*B*L$;

b. for B > 4.0 ft; $Q_a = (N_{corr}/4.0)*(F_d*S)*((B+1)/B)^2*B*L$;

- ***According to Tarzaghi formula:***

a. For strip or continuous footing, $Q_u = c\,N_c + \gamma D\,N_q + 0.5\,\gamma B\,N_\gamma$

b. For square footing, $Q_u = 1.3\,c\,N_c + \gamma D\,N_q + 0.4\,\gamma B\,N_\gamma$

c. For Circular footing, $Q_u = 1.3\,c\,N_c + \gamma D\,N_q + 0.3\,\gamma B\,N_\gamma$

- ***According to Meyerhof formula (1963):***

$Q_a = Q_u/F.S. = (c.N_c.s_c.d_c.i_c + 0.5.\gamma_1.B.N_r.s_r.d_r.i_r + \gamma_2.D_f.N_q.s_q.d_q.i_q)/F.S.$

Allowable Capacity, $\mathbf{Q_a} = Q_u$ /F.S.

Here Factor of Safety (F.S.) is considered 3.0 for all equation.

DETERMINATION OF PILE CAPACITY (A SINGLE PILE)

The load applied to a single pile is carried jointly by the soil beneath the tip of the pile (End Bearing) and by soil around the shaft (Skin Friction), with deducting the self weight of the pile and the maximum load that the pile can support. The pile capacity is given by-

$$\mathbf{Q_{ult} = Base\ Resistance,\ Q_p + Shaft\ Resistance,\ Q_s - Weight\ of\ pile}$$
$$\mathbf{= A_p{*}E_b + fs{*}\pi{*}D{*}L - Wp}$$

Ultimate Skin Friction Calculation

Cohesive soil: $Q_s = \alpha*C_u*A_s$; [Tomlinson Formula (α method)]

***Cohesionless soil*:** $Q_s = 0.02*N_{corr}*A_s$; [Meyerhof (1976)]

Ultimate End Bearing Capacity Calculation

Cohesive soil: $Q_p = 9*C_u*A_p$; [Skempton's Formula]

Cohesionless soil: $Q_p = 2.66*N_{corr}*A_p$; [Meyerhof (1976)]

Allowable Capacity, $\mathbf{Q_a} = Q_u$ /F.S.

Here Factor of Safety (F.S.) is considered 2.5 for all equation.

- Negative Skin Friction is not considered in calculation of pile capacity. The structural engineer needs to consider negative skin friction due to new fill layer. Negative skin friction would reduce the capacity of piles.

CONCLUSION & RECOMMENDATIONS

This Recommendations submitted in this report are prepared on the basis of supplied SPT & available subsurface Samples from field for the exclusive use of the following project

Client	:	**Project Director**
Name of Project	:	**Construction 6- Storied 33/11 KV Substation**
Location	:	**Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

From the field and laboratory test results, it can be concluded as follows:

- The sub-soil formation encountered at the proposed site is almost homogeneous. The sequence of litho logical composition as well as consistency of the soil at different depths has been depicted in the respective bore logs BH-1 through BH-4.
- RCC Cast-in-situ piles may be installed below the foundation. **Determining effective length of a pile segment requires engineering judgment.** The allowable Load Bearing Capacity (ton) of 20 inch dia RCC cast-in-situ pile is given below for different depth

Dia of pile (inch)	Depth (ft) from EGL	Allowable Load Bearing Capacity (Ton) Considering factor of Safety = 2.5			
		BH – 1	BH - 2	BH - 3	BH - 4
20	80	61.79	55.79	59.95	52.90
	85	72.39	71.85	81.45	70.15
	90	59.24	60.79	61.39	54.06

- We have enclosed the allowable bearing capacity of soil for shallow foundation capacity through Table 1.0 & RCC Cast-in-situ pile for different depth and diameter respectively with this report through Table- 2.1 to Table- 3.4.
- **Bearing Capacity should be confirmed by Plate Load Test for shallow foundation or Pile Load Test for Deep Foundation.**
- Moreover considering the magnitude of the structure, the expert structural engineer will put his justice and experience to select the suitable type & depth of foundation.

For the precise recommendation, total load comes to the foundation is highly needed. This is not within the scope of this report.

Recommended by

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BEARING CAPACITY FOR SHALLOW FOUNDATION

Table - 1.0

Factor of Safety = 3

CLIENT : **Project Director**

PROJECT : **Construction 6- Storied 33/11 KV Substation**

LOCATION : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

LOCATION	Depth from EGL (ft)	Depth of Water Level (ft)	Field SPT -N	Soil Type	γ_s pcf	γ_w pcf	po' (psf)	N_{corr}	C_u psf	Allowable Capacity, qall (ksf)			Bearing Capacity (ksf)
										Bowles Equation (ksf)	Terzaghi Equation (ksf)	Mayerhof Equation (ksf)	
BH- 01	5.00	4.00	2	Sand	119.92	62.40	537.19	3	-	0.81	0.89	1.02	0.81
	10.00	4.00	2	Sand	119.92	62.40	824.78	3	-	0.76	1.44	1.84	0.76
	15.00	4.00	5	Clay	118.61	62.40	1105.83	5	614.10	2.13	2.55	3.54	2.13
	20.00	4.00	7	Clay	117.90	62.40	1383.33	7	859.74	3.09	3.61	5.54	3.09
BH- 02	5.00	4.00	1	Sand	120.42	62.40	539.69	1	-	0.40	0.65	0.75	0.40
	10.00	4.00	2	Sand	119.92	62.40	827.28	3	-	0.76	1.44	1.84	0.76
	15.00	4.00	5	Clay	118.61	62.40	1108.33	5	614.10	2.13	2.55	3.54	2.13
	20.00	4.00	10	Clay	117.08	62.40	1381.73	10	1,228.20	4.41	5.01	7.82	4.41
BH- 03	5.00	4.00	4	Clay	119.01	62.40	532.67	4	491.28	1.54	1.28	1.36	1.28
	10.00	4.00	8	Clay	117.59	62.40	808.64	8	982.56	3.30	2.90	3.57	2.90
	15.00	4.00	10	Clay	117.08	62.40	1082.03	10	1,228.20	4.27	4.31	6.05	4.27
	20.00	4.00	14	Clay	116.44	62.40	1352.22	14	1,739.95	6.21	6.56	10.37	6.21
BH- 04	5.00	4.00	3	Sand	119.45	62.40	534.85	4	-	1.22	1.07	1.21	1.07
	10.00	4.00	3	Sand	119.45	62.40	820.10	4	-	1.15	1.67	2.12	1.15
	15.00	4.00	9	Clay	117.32	62.40	1094.70	9	1,105.38	3.84	3.88	5.40	3.84
	20.00	4.00	8	Clay	117.59	62.40	1370.67	8	982.56	3.53	4.04	6.23	3.53

TABLE - 2.1 For Bore Hole # 1

Chart for Ultimate Skin Friction & End Bearing

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	Field SPT	Sample Type	γ_s	γ_w	p'_o	Φ	δ	C.F.	N_{corr}	Ultimate Skin Friction	Ultimate End Bearing
ft			pcf	pcf	psf	Degree	Degree			tsf	tsf
0.0											
5.0	2	s	120.77	62.40	291.86	21.00	14.00	1.64	3	0.0329	4.37
10.0	2	s	120.77	62.40	583.72	21.00	14.00	1.41	3	0.0283	3.76
15.0	5	c	119.46	62.40	869.00	25.00	16.00	1.00	5	0.2654	2.81
20.0	7	c	118.74	62.40	1,150.70	26.00	17.00	1.00	7	0.3081	3.94
25.0	10	c	117.91	62.40	1,428.26	29.00	19.00	1.00	10	0.3402	5.63
30.0	12	c	117.52	62.40	1,703.89	30.00	20.00	1.00	12	0.3756	6.75
35.0	14	c	117.27	62.40	1,978.22	31.00	20.00	1.00	14	0.4375	7.88
40.0	35	s	122.43	62.40	2,278.38	37.00	24.00	0.92	32	0.3207	42.65
45.0	10	c	117.91	62.40	2,555.95	29.00	19.00	1.00	10	0.3402	5.63
50.0	14	c	117.27	62.40	2,830.28	31.00	20.00	1.00	14	0.4375	7.88
55.0	16	c	117.14	62.40	3,103.97	31.00	20.00	1.00	16	0.5000	9.00
60.0	18	c	117.14	62.40	3,377.68	32.00	21.00	1.00	18	0.5625	10.13
65.0	19	c	117.19	62.40	3,651.64	32.00	21.00	1.00	19	0.5938	10.69
70.0	17	c	117.12	62.40	3,925.25	32.00	21.00	1.00	17	0.5313	9.56
75.0	16	c	117.14	62.40	4,198.95	31.00	20.00	1.00	16	0.5000	9.00
80.0	25	s	118.18	62.40	4,477.84	34.00	22.00	0.65	16	0.1634	21.73
85.0	38	s	124.35	62.40	4,787.57	38.00	25.00	0.63	24	0.2402	31.95
90.0	20	c	117.27	62.40	5,061.95	33.00	22.00	1.00	20	0.6250	11.25
95.0	22	c	117.54	62.40	5,337.64	33.00	22.00	1.00	22	0.6875	12.38
100.0	25	c	118.18	62.40	5,616.53	34.00	22.00	1.00	25	0.7813	14.06

Calculation Done :
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Sample Note:

"C" -- Cohesive soil (50% or more silt & clay-sized soil)
"S" --Cohesionless Soil (50% or more Sand Type soil)
"R" -- Rubbish/ Brick Bats, "W" -- Water
"O" -- Organic Soil/Peat

TABLE - 3.1 For Bore Hole # 1

ALLOWABLE LOAD FOR SINGLE CAST IN SITU RCC PILE

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	**18** inch Dia Cast in Situ Pile				**20** inch Dia Cast in Situ Pile				**24** inch Dia Cast in Situ Pile			
	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load
ft	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton
0.0	-	-	-	-	-	-	-	-	-	-	-	-
5.0	0.62	7.73	0.66	**3.08**	0.69	9.54	0.82	**3.77**	0.83	13.74	1.18	**5.36**
10.0	1.15	6.64	1.33	**2.59**	1.28	8.20	1.64	**3.14**	1.54	11.81	2.36	**4.39**
15.0	6.15	4.97	1.99	**3.65**	6.84	6.14	2.45	**4.21**	8.21	8.84	3.53	**5.40**
20.0	11.96	6.96	2.65	**6.51**	13.29	8.59	3.27	**7.44**	15.95	12.37	4.71	**9.44**
25.0	18.37	9.94	3.31	**10.00**	20.42	12.27	4.09	**11.44**	24.50	17.67	5.89	**14.51**
30.0	25.45	11.93	3.98	**13.36**	28.28	14.73	4.91	**15.24**	33.94	21.21	7.07	**19.23**
35.0	33.70	13.92	4.64	**17.19**	37.45	17.18	5.73	**19.56**	44.93	24.74	8.25	**24.57**
40.0	39.75	75.38	5.30	**43.93**	44.16	93.06	6.54	**52.27**	52.99	134.00	9.42	**71.03**
45.0	46.16	9.94	5.96	**20.05**	51.29	12.27	7.36	**22.48**	61.54	17.67	10.60	**27.45**
50.0	54.40	13.92	6.63	**24.68**	60.45	17.18	8.18	**27.78**	72.54	24.74	11.78	**34.20**
55.0	63.83	15.90	7.29	**28.98**	70.92	19.63	9.00	**32.62**	85.11	28.27	12.96	**40.17**
60.0	74.43	17.89	7.95	**33.75**	82.70	22.09	9.82	**37.99**	99.24	31.81	14.14	**46.77**
65.0	85.62	18.89	8.61	**38.36**	95.14	23.32	10.64	**43.13**	114.17	33.58	15.32	**52.97**
70.0	95.64	16.90	9.28	**41.30**	106.26	20.86	11.45	**46.27**	127.52	30.04	16.49	**56.43**
75.0	105.06	15.90	9.94	**44.41**	116.74	19.63	12.27	**49.64**	140.08	28.27	17.67	**60.27**
80.0	108.14	38.40	10.60	**54.38**	120.16	47.41	13.09	**61.79**	144.19	68.27	18.85	**77.45**
85.0	112.67	56.46	11.27	**63.14**	125.19	69.70	13.91	**72.39**	150.23	100.36	20.03	**92.23**
90.0	124.45	19.88	11.93	**52.96**	138.28	24.54	14.73	**59.24**	165.94	35.34	21.21	**72.03**
95.0	137.41	21.87	12.59	**58.68**	152.68	27.00	15.54	**65.65**	183.21	38.88	22.38	**79.88**
100.0	152.14	24.85	13.25	**65.49**	169.04	30.68	16.36	**73.34**	202.85	44.18	23.56	**89.39**

Calculation Done :

Engr. Samir K. Sutradhar
B. Sc. in Civil Engineering (BUET)
Mob : +8801683586089

Remarks :

Factor of Safety Considered 2.5
Pile Cut-off Level is at the Existing Ground Level
Negative Skin Friction is not considered in the calculation

TABLE - 2.2 For Bore Hole # 2

Chart for Ultimate Skin Friction & End Bearing

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	Field SPT	Sample Type	γ_s	γ_w	p'_o	Φ	δ	C.F.	N_{corr}	Ultimate Skin Friction	Ultimate End Bearing
ft			pcf	pcf	psf	Degree	Degree			tsf	tsf
0.0											
5.0	1	s	121.28	62.40	294.38	19.00	12.00	1.64	2	0.0164	2.18
10.0	2	s	120.77	62.40	586.24	21.00	14.00	1.41	3	0.0282	3.75
15.0	5	c	119.46	62.40	871.52	25.00	16.00	1.00	5	0.2654	2.81
20.0	10	c	117.91	62.40	1,149.08	29.00	19.00	1.00	10	0.3402	5.63
25.0	11	c	117.70	62.40	1,425.59	29.00	19.00	1.00	11	0.3566	6.19
30.0	13	c	117.38	62.40	1,700.49	30.00	20.00	1.00	13	0.4063	7.31
35.0	33	s	121.32	62.40	1,995.10	36.00	24.00	0.98	32	0.3231	42.98
40.0	30	s	119.90	62.40	2,282.59	36.00	24.00	0.92	27	0.2746	36.53
45.0	16	c	117.14	62.40	2,556.28	31.00	20.00	1.00	16	0.5000	9.00
50.0	21	c	117.39	62.40	2,831.23	33.00	22.00	1.00	21	0.6563	11.81
55.0	18	c	117.14	62.40	3,104.94	32.00	21.00	1.00	18	0.5625	10.13
60.0	17	c	117.12	62.40	3,378.56	32.00	21.00	1.00	17	0.5313	9.56
65.0	14	c	117.27	62.40	3,652.89	31.00	20.00	1.00	14	0.4375	7.88
70.0	16	c	117.14	62.40	3,926.58	31.00	20.00	1.00	16	0.5000	9.00
75.0	15	c	117.19	62.40	4,200.51	31.00	20.00	1.00	15	0.4688	8.44
80.0	18	c	117.14	62.40	4,474.22	32.00	21.00	1.00	18	0.5625	10.13
85.0	32	s	120.81	62.40	4,766.29	36.00	24.00	0.63	20	0.2027	26.96
90.0	17	c	117.12	62.40	5,039.91	32.00	21.00	1.00	17	0.5313	9.56
95.0	18	c	117.14	62.40	5,313.62	32.00	21.00	1.00	18	0.5625	10.13
100.0	22	c	117.54	62.40	5,589.31	33.00	22.00	1.00	22	0.6875	12.38

Calculation Done :
Engr. Samir K. Sutradhar
B. Sc. in Civil Engineering (BUET)
Mob : +8801683586089

Sample Note:

"C" -- Cohesive soil (50% or more silt & clay-sized soil)
"S" --Cohesionless Soil (50% or more Sand Type soil)
"R" -- Rubbish/ Brick Bats, "W" -- Water
"O" -- Organic Soil/Peat

TABLE - 3.2 For Bore Hole # 2

ALLOWABLE LOAD FOR SINGLE CAST IN SITU RCC PILE

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	**18** inch Dia Cast in Situ Pile				**20** inch Dia Cast in Situ Pile				**24** inch Dia Cast in Situ Pile			
	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load
ft	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton
0.0	-	-	-	**-**	-	-	-	**-**	-	-	-	**-**
5.0	0.31	3.86	0.66	**1.40**	0.34	4.76	0.82	**1.72**	0.41	6.86	1.18	**2.44**
10.0	0.84	6.63	1.33	**2.46**	0.94	8.19	1.64	**3.00**	1.12	11.79	2.36	**4.22**
15.0	5.84	4.97	1.99	**3.53**	6.49	6.14	2.45	**4.07**	7.79	8.84	3.53	**5.24**
20.0	12.26	9.94	2.65	**7.82**	13.62	12.27	3.27	**9.05**	16.34	17.67	4.71	**11.72**
25.0	18.98	10.93	3.31	**10.64**	21.09	13.50	4.09	**12.20**	25.30	19.44	5.89	**15.54**
30.0	26.64	12.92	3.98	**14.23**	29.59	15.95	4.91	**16.26**	35.51	22.97	7.07	**20.57**
35.0	32.73	75.95	4.64	**41.61**	36.36	93.76	5.73	**49.76**	43.64	135.02	8.25	**68.16**
40.0	37.90	64.55	5.30	**38.86**	42.11	79.69	6.54	**46.10**	50.54	114.75	9.42	**62.35**
45.0	47.33	15.90	5.96	**22.91**	52.59	19.63	7.36	**25.94**	63.10	28.27	10.60	**32.31**
50.0	59.70	20.87	6.63	**29.58**	66.33	25.77	8.18	**33.57**	79.60	37.11	11.78	**41.97**
55.0	70.30	17.89	7.29	**32.36**	78.11	22.09	9.00	**36.48**	93.73	31.81	12.96	**45.03**
60.0	80.31	16.90	7.95	**35.70**	89.24	20.86	9.82	**40.11**	107.09	30.04	14.14	**49.20**
65.0	88.56	13.92	8.61	**37.55**	98.40	17.18	10.64	**41.98**	118.08	24.74	15.32	**51.00**
70.0	97.99	15.90	9.28	**41.85**	108.87	19.63	11.45	**46.82**	130.65	28.27	16.49	**56.97**
75.0	106.82	14.91	9.94	**44.72**	118.69	18.41	12.27	**49.93**	142.43	26.51	17.67	**60.51**
80.0	117.42	17.89	10.60	**49.89**	130.47	22.09	13.09	**55.79**	156.57	31.81	18.85	**67.81**
85.0	121.25	47.65	11.27	**63.05**	134.72	58.82	13.91	**71.85**	161.66	84.71	20.03	**90.54**
90.0	131.26	16.90	11.93	**54.49**	145.84	20.86	14.73	**60.79**	175.01	30.04	21.21	**73.54**
95.0	141.86	17.89	12.59	**58.87**	157.63	22.09	15.54	**65.67**	189.15	31.81	22.38	**79.43**
100.0	154.82	21.87	13.25	**65.37**	172.02	27.00	16.36	**73.06**	206.43	38.88	23.56	**88.70**

Calculation Done :

Engr. Samir K. Sutradhar
B. Sc. in Civil Engineering (BUET)
Mob : +8801683586089

Remarks :

Factor of Safety Considered 2.5
Pile Cut-off Level is at the Existing Ground Level
Negative Skin Friction is not considered in the calculation

TABLE - 2.3 For Bore Hole # 3

Chart for Ultimate Skin Friction & End Bearing

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	Field SPT	Sample Type	γ_s	γ_w	p'_o	Φ	δ	C.F.	N_{corr}	Ultimate Skin Friction	Ultimate End Bearing
ft			pcf	pcf	psf	Degree	Degree			tsf	tsf
0.0											
5.0	4	c	119.86	62.40	287.31	23.00	15.00	1.00	4	0.2259	2.25
10.0	8	c	118.43	62.40	567.47	27.00	18.00	1.00	8	0.3069	4.50
15.0	10	c	117.91	62.40	845.03	29.00	19.00	1.00	10	0.3402	5.63
20.0	14	c	117.27	62.40	1,119.36	31.00	20.00	1.00	14	0.4375	7.88
25.0	12	c	117.52	62.40	1,394.98	30.00	20.00	1.00	12	0.3756	6.75
30.0	11	c	117.70	62.40	1,671.50	29.00	19.00	1.00	11	0.3566	6.19
35.0	18	s	117.14	62.40	1,945.20	32.00	21.00	0.99	18	0.1785	23.74
40.0	22	s	117.54	62.40	2,220.89	33.00	22.00	0.93	20	0.2042	27.16
45.0	18	c	117.14	62.40	2,494.60	32.00	21.00	1.00	18	0.5625	10.13
50.0	10	c	117.91	62.40	2,772.17	29.00	19.00	1.00	10	0.3402	5.63
55.0	13	c	117.38	62.40	3,047.06	30.00	20.00	1.00	13	0.4063	7.31
60.0	18	c	117.14	62.40	3,320.77	32.00	21.00	1.00	18	0.5625	10.13
65.0	17	c	117.12	62.40	3,594.38	32.00	21.00	1.00	17	0.5313	9.56
70.0	19	c	117.19	62.40	3,868.34	32.00	21.00	1.00	19	0.5938	10.69
75.0	18	c	117.14	62.40	4,142.05	32.00	21.00	1.00	18	0.5625	10.13
80.0	20	c	117.27	62.40	4,416.42	33.00	22.00	1.00	20	0.6250	11.25
85.0	40	s	125.78	62.40	4,733.34	39.00	26.00	0.64	25	0.2543	33.82
90.0	13	c	117.38	62.40	5,008.24	30.00	20.00	1.00	13	0.4063	7.31
95.0	20	c	117.27	62.40	5,282.61	33.00	22.00	1.00	20	0.6250	11.25
100.0	23	c	117.72	62.40	5,559.21	33.00	22.00	1.00	23	0.7188	12.94
105.0	14	c	117.27	62.40	5,833.54	31.00	20.00	1.00	14	0.4375	7.88
110.0	17	c	117.12	62.40	6,107.16	32.00	21.00	1.00	17	0.5313	9.56
115.0	14	c	117.27	62.40	6,381.49	31.00	20.00	1.00	14	0.4375	7.88
120.0	15	c	117.19	62.40	6,655.42	31.00	20.00	1.00	15	0.4688	8.44

Calculation Done :
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B. Sc. in Civil Engineering (BUET)
Mob : +8801683586089

Sample Note:

"C" -- Cohesive soil (50% or more silt & clay-sized soil)
"S" --Cohesionless Soil (50% or more Sand Type soil)
"R" -- Rubbish/ Brick Bats, "W" -- Water
"O" -- Organic Soil/Peat

TABLE - 3.3 For Bore Hole # 3

ALLOWABLE LOAD FOR SINGLE CAST IN SITU RCC PILE

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	**18** inch Dia Cast in Situ Pile				**20** inch Dia Cast in Situ Pile				**24** inch Dia Cast in Situ Pile			
	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load
ft	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton
0.0	-	-	-	-	-	-	-	-	-	-	-	-
5.0	4.26	3.98	0.66	**3.03**	4.73	4.91	0.82	**3.53**	5.68	7.07	1.18	**4.63**
10.0	10.04	7.95	1.33	**6.67**	11.16	9.82	1.64	**7.74**	13.39	14.14	2.36	**10.07**
15.0	16.45	9.94	1.99	**9.76**	18.28	12.27	2.45	**11.24**	21.94	17.67	3.53	**14.43**
20.0	24.70	13.92	2.65	**14.39**	27.45	17.18	3.27	**16.54**	32.93	24.74	4.71	**21.19**
25.0	31.78	11.93	3.31	**16.16**	35.31	14.73	4.09	**18.38**	42.37	21.21	5.89	**23.08**
30.0	38.50	10.93	3.98	**18.18**	42.78	13.50	4.91	**20.55**	51.34	19.44	7.07	**25.48**
35.0	41.87	41.95	4.64	**31.67**	46.52	51.79	5.73	**37.03**	55.82	74.58	8.25	**48.86**
40.0	45.72	47.99	5.30	**35.36**	50.80	59.24	6.54	**41.40**	60.96	85.31	9.42	**54.74**
45.0	56.32	17.89	5.96	**27.30**	62.58	22.09	7.36	**30.92**	75.09	31.81	10.60	**38.52**
50.0	62.73	9.94	6.63	**26.42**	69.70	12.27	8.18	**29.52**	83.64	17.67	11.78	**35.81**
55.0	70.39	12.92	7.29	**30.41**	78.21	15.95	9.00	**34.07**	93.85	22.97	12.96	**41.55**
60.0	80.99	17.89	7.95	**36.37**	89.99	22.09	9.82	**40.91**	107.99	31.81	14.14	**50.26**
65.0	91.01	16.90	8.61	**39.72**	101.12	20.86	10.64	**44.54**	121.34	30.04	15.32	**54.43**
70.0	102.20	18.89	9.28	**44.72**	113.55	23.32	11.45	**50.17**	136.26	33.58	16.49	**61.34**
75.0	112.80	17.89	9.94	**48.30**	125.33	22.09	12.27	**54.06**	150.40	31.81	17.67	**65.82**
80.0	124.58	19.88	10.60	**53.54**	138.42	24.54	13.09	**59.95**	166.11	35.34	18.85	**73.04**
85.0	129.37	59.77	11.27	**71.15**	143.75	73.79	13.91	**81.45**	172.50	106.25	20.03	**103.49**
90.0	137.03	12.92	11.93	**55.21**	152.26	15.95	14.73	**61.39**	182.71	22.97	21.21	**73.79**
95.0	148.81	19.88	12.59	**62.44**	165.35	24.54	15.54	**69.74**	198.42	35.34	22.38	**84.55**
100.0	162.36	22.86	13.25	**68.79**	180.40	28.23	16.36	**76.91**	216.48	40.64	23.56	**93.43**
105.0	170.61	13.92	13.92	**68.24**	189.56	17.18	17.18	**75.83**	227.48	24.74	24.74	**90.99**
110.0	180.62	16.90	14.58	**73.18**	200.69	20.86	18.00	**81.42**	240.83	30.04	25.92	**97.98**
115.0	188.87	13.92	15.24	**75.02**	209.85	17.18	18.82	**83.29**	251.82	24.74	27.10	**99.79**
120.0	197.70	14.91	15.90	**78.68**	219.67	18.41	19.63	**87.38**	263.61	26.51	28.27	**104.74**

Calculation Done :

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B. Sc. in Civil Engineering (BUET)
Mob : +8801683586089

Remarks :

Factor of Safety Considered 2.5
Pile Cut-off Level is at the Existing Ground Level
Negative Skin Friction is not considered in the calculation

TABLE - 2.4 For Bore Hole # 4

Chart for Ultimate Skin Friction & End Bearing

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	Field SPT	Sample Type	γ_s	γ_w	p'_o	Φ	δ	C.F.	N_{corr}	Ultimate Skin Friction	Ultimate End Bearing
ft			pcf	pcf	psf	Degree	Degree			tsf	tsf
0.0											
5.0	3	s	120.30	62.40	289.50	22.00	14.00	1.65	5	0.0494	6.57
10.0	3	s	120.30	62.40	579.01	22.00	14.00	1.42	4	0.0425	5.65
15.0	9	c	118.16	62.40	857.79	28.00	18.00	1.00	9	0.3214	5.06
20.0	8	c	118.43	62.40	1,137.95	27.00	18.00	1.00	8	0.3069	4.50
25.0	10	c	117.91	62.40	1,415.51	29.00	19.00	1.00	10	0.3402	5.63
30.0	12	c	117.52	62.40	1,691.13	30.00	20.00	1.00	12	0.3756	6.75
35.0	42	s	127.35	62.40	2,015.90	39.00	26.00	0.97	41	0.4091	54.42
40.0	36	s	123.04	62.40	2,319.09	37.00	24.00	0.91	33	0.3270	43.49
45.0	33	s	121.32	62.40	2,613.70	36.00	24.00	0.86	28	0.2823	37.55
50.0	13	c	117.38	62.40	2,888.59	30.00	20.00	1.00	13	0.4063	7.31
55.0	13	c	117.38	62.40	3,163.49	30.00	20.00	1.00	13	0.4063	7.31
60.0	12	c	117.52	62.40	3,439.11	30.00	20.00	1.00	12	0.3756	6.75
65.0	14	c	117.27	62.40	3,713.44	31.00	20.00	1.00	14	0.4375	7.88
70.0	16	c	117.14	62.40	3,987.13	31.00	20.00	1.00	16	0.5000	9.00
75.0	18	c	117.14	62.40	4,260.84	32.00	21.00	1.00	18	0.5625	10.13
80.0	20	c	117.27	62.40	4,535.21	33.00	22.00	1.00	20	0.6250	11.25
85.0	35	s	122.43	62.40	4,835.38	37.00	24.00	0.63	22	0.2201	29.28
90.0	13	c	117.38	62.40	5,110.27	30.00	20.00	1.00	13	0.4063	7.31
95.0	21	c	117.39	62.40	5,385.22	33.00	22.00	1.00	21	0.6563	11.81
100.0	26	c	118.46	62.40	5,665.51	34.00	22.00	1.00	26	0.8125	14.63

Calculation Done :
Engr. Samir K. Sutradhar
B. Sc. in Civil Engineering (BUET)
Mob : +8801683586089

Sample Note:

"C" -- Cohesive soil (50% or more silt & clay-sized soil)
"S" --Cohesionless Soil (50% or more Sand Type soil)
"R" -- Rubbish/ Brick Bats, "W" -- Water
"O" -- Organic Soil/Peat

TABLE - 3.4 For Bore Hole # 4

ALLOWABLE LOAD FOR SINGLE CAST IN SITU RCC PILE

CLIENT : Project Director
PROJECT : Construction 6- Storied 33/11 KV Substation
LOCATION : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

Depth from EGL	**18** inch Dia Cast in Situ Pile				**20** inch Dia Cast in Situ Pile				**24** inch Dia Cast in Situ Pile			
	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load	Cum Skin Friction	End Bearing	Pile Weight	Allowable Load
ft	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton	Ton
0.0	-	-	-	-	-	-	-	-	-	-	-	-
5.0	0.93	11.62	0.66	**4.75**	1.04	14.34	0.82	**5.82**	1.24	20.65	1.18	**8.29**
10.0	1.73	9.98	1.33	**4.15**	1.92	12.32	1.64	**5.04**	2.31	17.74	2.36	**7.08**
15.0	7.79	8.95	1.99	**5.90**	8.66	11.04	2.45	**6.90**	10.39	15.90	3.53	**9.10**
20.0	13.58	7.95	2.65	**7.55**	15.08	9.82	3.27	**8.65**	18.10	14.14	4.71	**11.01**
25.0	19.99	9.94	3.31	**10.65**	22.21	12.27	4.09	**12.16**	26.65	17.67	5.89	**15.37**
30.0	27.07	11.93	3.98	**14.01**	30.07	14.73	4.91	**15.96**	36.09	21.21	7.07	**20.09**
35.0	34.78	96.16	4.64	**50.52**	38.64	118.72	5.73	**60.65**	46.37	170.95	8.25	**83.63**
40.0	40.94	76.85	5.30	**44.99**	45.49	94.87	6.54	**53.53**	54.59	136.62	9.42	**72.71**
45.0	46.26	66.35	5.96	**42.66**	51.40	81.92	7.36	**50.38**	61.68	117.96	10.60	**67.62**
50.0	53.92	12.92	6.63	**24.09**	59.91	15.95	8.18	**27.07**	71.90	22.97	11.78	**33.23**
55.0	61.58	12.92	7.29	**26.88**	68.42	15.95	9.00	**30.15**	82.11	22.97	12.96	**36.85**
60.0	68.66	11.93	7.95	**29.05**	76.29	14.73	9.82	**32.48**	91.54	21.21	14.14	**39.45**
65.0	76.90	13.92	8.61	**32.88**	85.45	17.18	10.64	**36.80**	102.54	24.74	15.32	**44.79**
70.0	86.33	15.90	9.28	**37.18**	95.92	19.63	11.45	**41.64**	115.11	28.27	16.49	**50.75**
75.0	96.93	17.89	9.94	**41.95**	107.70	22.09	12.27	**47.01**	129.24	31.81	17.67	**57.35**
80.0	108.71	19.88	10.60	**47.20**	120.79	24.54	13.09	**52.90**	144.95	35.34	18.85	**64.58**
85.0	112.86	51.74	11.27	**61.34**	125.40	63.88	13.91	**70.15**	150.48	91.98	20.03	**88.98**
90.0	120.52	12.92	11.93	**48.61**	133.91	15.95	14.73	**54.06**	160.69	22.97	21.21	**64.98**
95.0	132.89	20.87	12.59	**56.47**	147.66	25.77	15.54	**63.15**	177.19	37.11	22.38	**76.77**
100.0	148.21	25.84	13.25	**64.32**	164.67	31.91	16.36	**72.09**	197.61	45.95	23.56	**88.00**

Calculation Done :

Engr. Samir K. Sutradhar
B. Sc. in Civil Engineering (BUET)
Mob : +8801683586089

Remarks :

Factor of Safety Considered 2.5
Pile Cut-off Level is at the Existing Ground Level
Negative Skin Friction is not considered in the calculation

BORE HOLE LOG

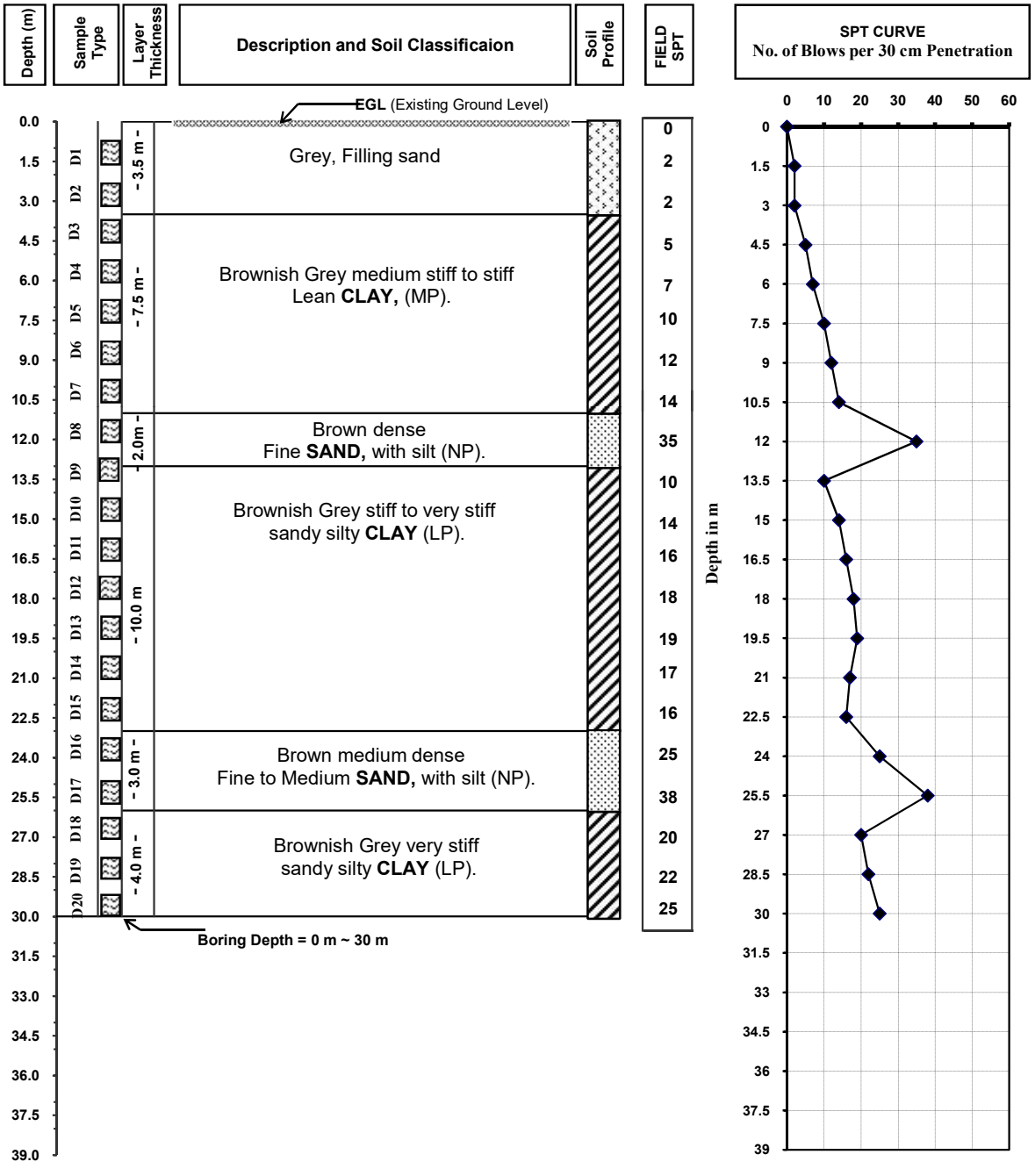
ESD

CLIENT : **Project Director**
PROJECT : **Construction 6- Storied 33/11 KV Substation**
LOCATION : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

BORE HOLE # 01

Start Date : 07.07.2022 **R. L.** : (±) 0.00 from Road Level
Finish Date : 07.07.2022 **W. L.** : (-) 1.20 m From EGL.

Drilling Method: Wash Boring Method
Executed by:



Disturbed Sample (D) | CLAY | SAND | Filling

Undisturbed Sample (U) | SILT | ORGANIC

FIGURE 02

BORE HOLE LOG

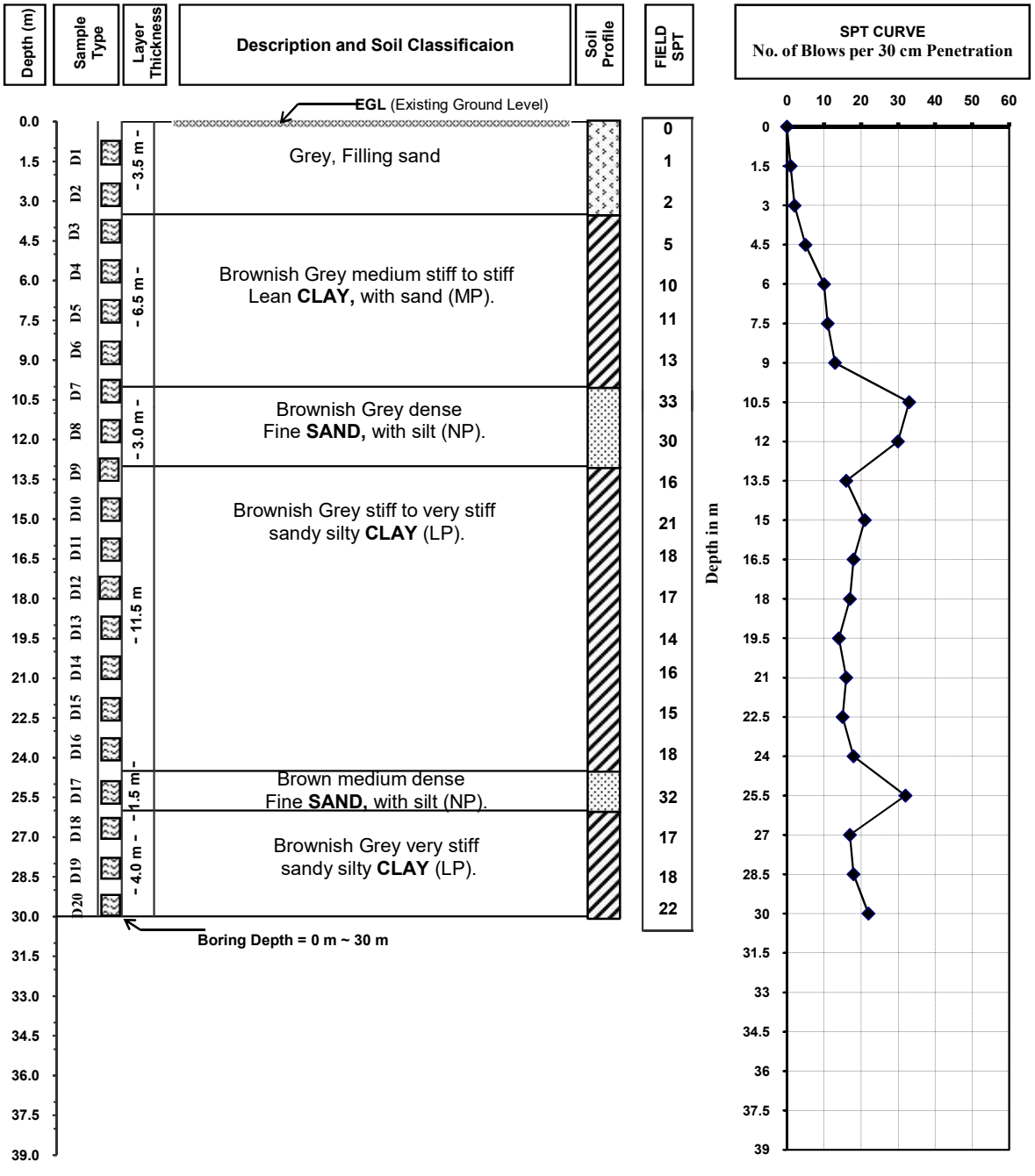
ESD

CLIENT : **Project Director**
PROJECT : **Construction 6- Storied 33/11 KV Substation**
LOCATION : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

BORE HOLE # 02

Start Date : 07.07.2022 **R. L.** : (±) 0.00 from Road Level
Finish Date : 08.07.2022 **W. L.** : (-) 1.20 m From EGL.

Drilling Method: Wash Boring Method
Executed by:



Disturbed Sample (D) | CLAY | SAND | Filling

Undisturbed Sample (U) | SILT | ORGANIC

FIGURE 03

BORE HOLE LOG

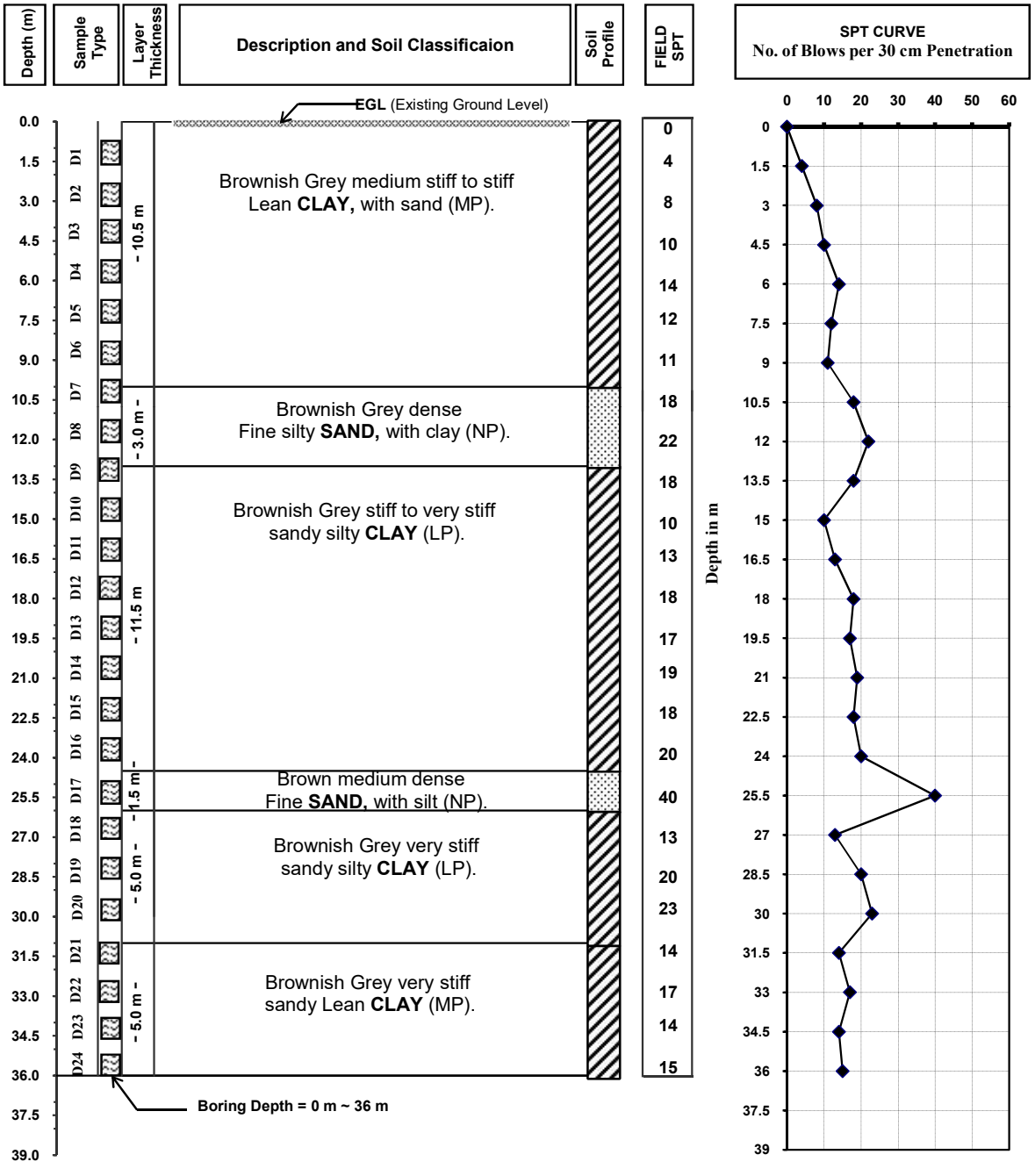
ESD

CLIENT : **Project Director**
PROJECT : **Construction 6- Storied 33/11 KV Substation**
LOCATION : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

BORE HOLE # 03

Start Date : 08.07.2022 **R. L.** : (±) 0.00 from Road Level
Finish Date : 09.07.2022 **W. L.** : (-) 1.20 m From EGL.

Drilling Method: Wash Boring Method
Executed by:



Disturbed Sample (D) | CLAY | SAND | Filling

Undisturbed Sample (U) | SILT | ORGANIC

FIGURE 04

BORE HOLE LOG

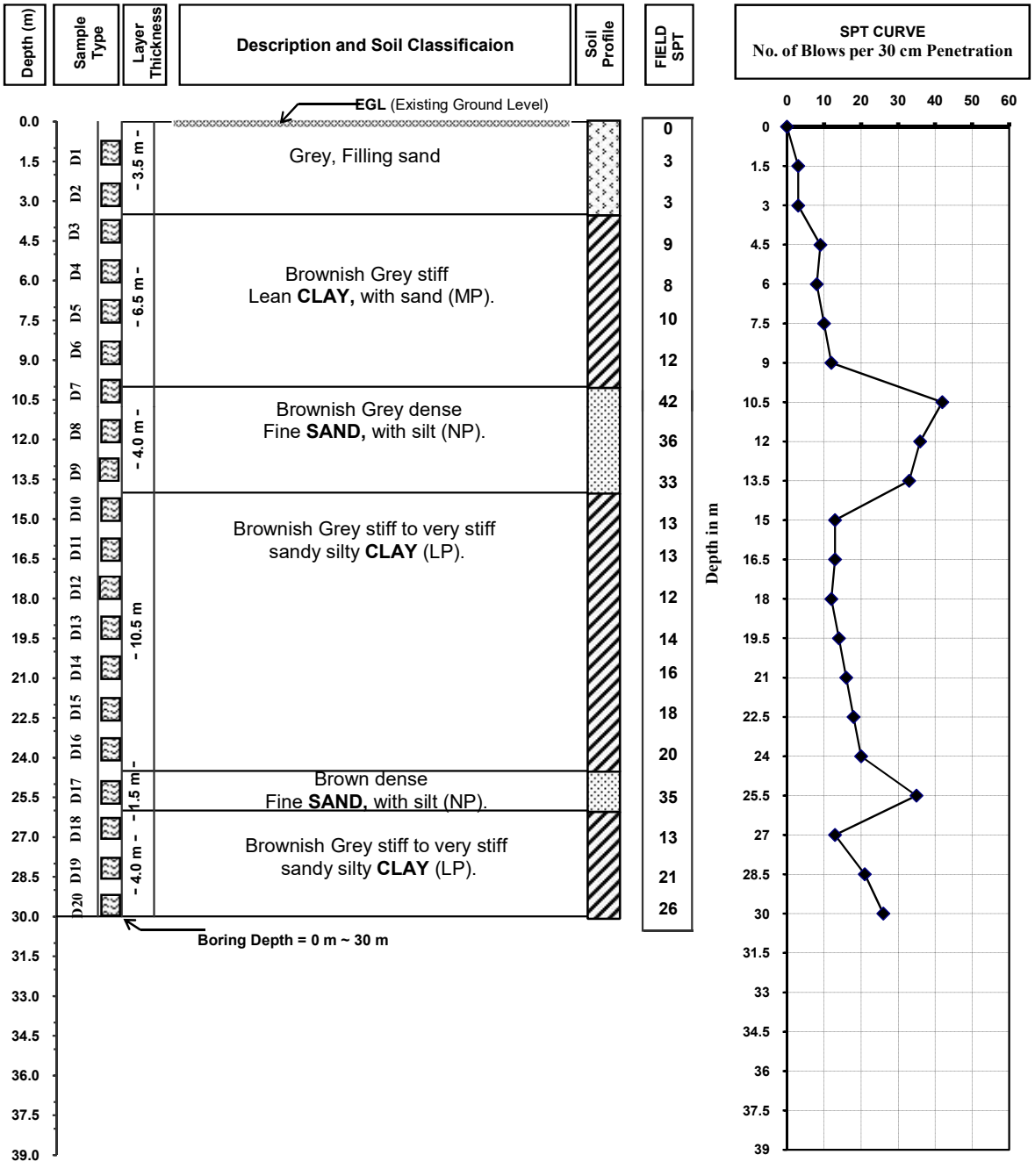
ESD

CLIENT : **Project Director**
PROJECT : **Construction 6- Storied 33/11 KV Substation**
LOCATION : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

BORE HOLE # 04

Start Date : 09.07.2022 **R. L.** : (±) 0.00 from Road Level
Finish Date : 09.07.2022 **W. L.** : (-) 1.20 m From EGL.

Drilling Method: Wash Boring Method
Executed by:



Disturbed Sample (D) | CLAY | SAND | Filling

Undisturbed Sample (U) | SILT | ORGANIC

FIGURE 05

Particle Size Analysis Report

As Per ASTM D422-63 (2007)

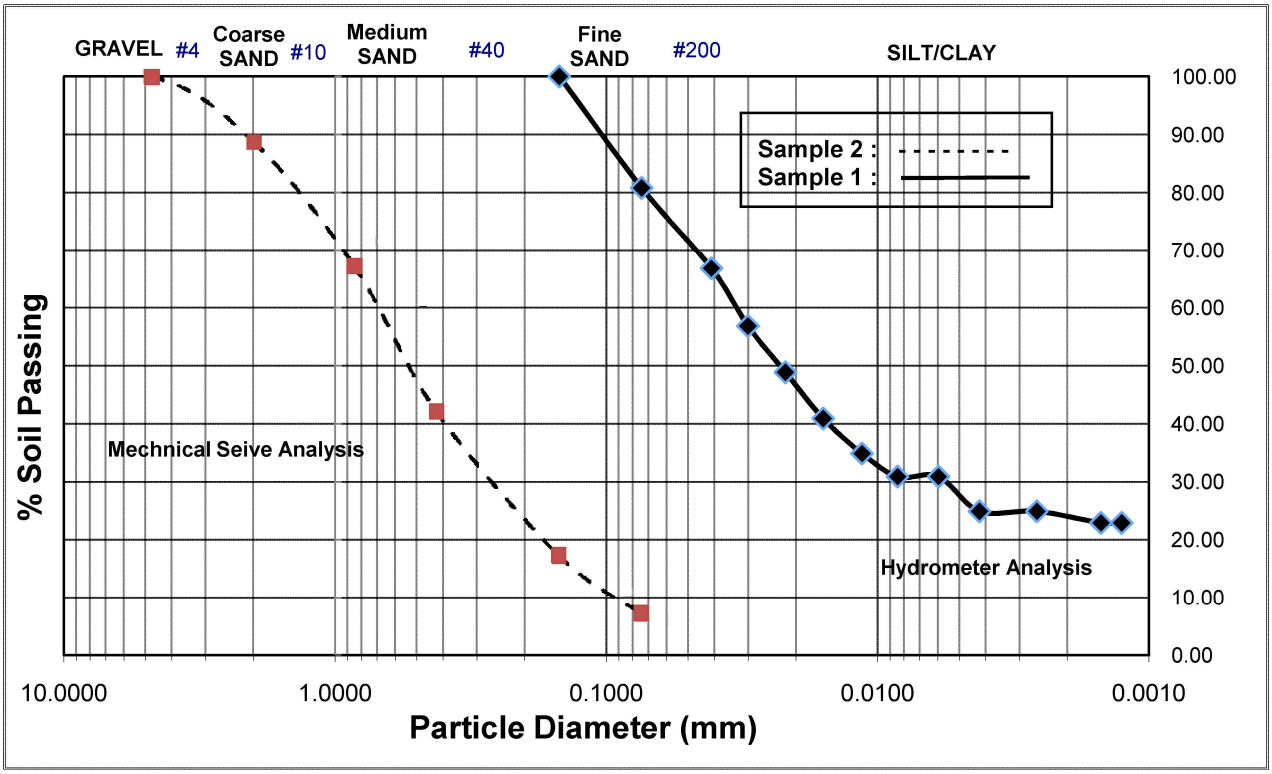
Client : **Project Director**

Project : **Construction 6- Storied 33/11 KV Substation**

Location : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

Boring No :	**BH- 01**
Depth of Sample 1 from EGL :	(-) 4.50 m
Weight of Container :	125.0 gm
Weight of Container & Soil 1 :	175.0 gm
Weight of Dry Sample 1 :	50.0 gm

Boring No :	**BH- 01**
Depth of Sample 2 from EGL :	(-) 12.00 m
Weight of Container :	125.0 gm
Weight of Container & Soil 2 :	196.2 gm
Weight of Dry Sample 2 :	71.2 gm



Grain Size Distribution Curve Results :

Seive Analysis	**% Gravel :**	0.00	**D_{10} :**	0.095	**C_u :**	7.635
	% Sand :	92.72	**D_{30} :**	0.290	**C_c :**	1.214
	% Fines :	7.28	**D_{60} :**	0.727		
	USCS Soil Classification:		**SW-SM - Well Graded Sand with Silt**			

Hydrometer Analysis	**% Sand :**	19.2	**% Silt :**	57.0	**D_{50} :**	0.082
			% Clay :	23.9	**Silt Factor :**	**0.502**

Figure: GSA - 01

Particle Size Analysis Report

As Per ASTM D422-63 (2007)

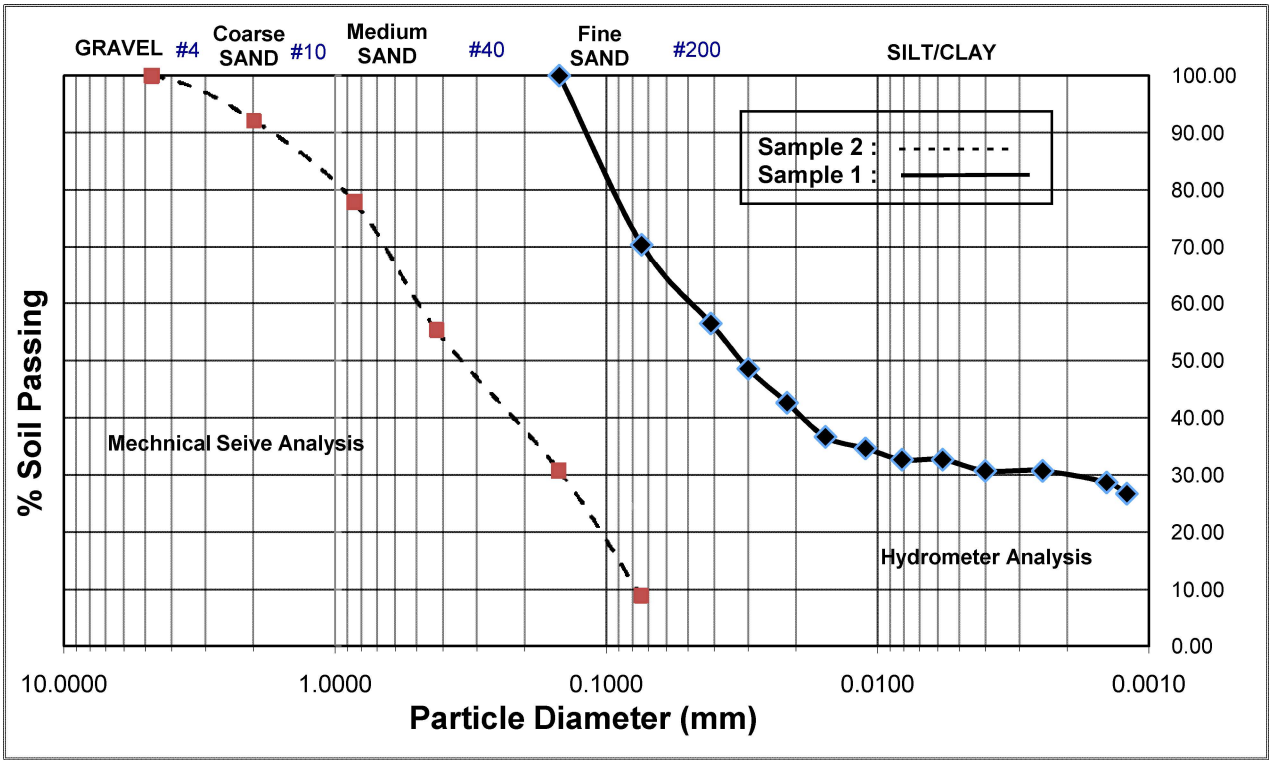
Client : **Project Director**

Project : **Construction 6- Storied 33/11 KV Substation**

Location : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

Boring No :	BH- 02
Depth of Sample 1 from EGL :	(-) 15.00 m
Weight of Container :	125.0 gm
Weight of Container & Soil 1 :	175.0 gm
Weight of Dry Sample 1 :	50.0 gm

Boring No :	BH- 02
Depth of Sample 2 from EGL :	(-) 25.50 m
Weight of Container :	125.0 gm
Weight of Container & Soil 2 :	199.8 gm
Weight of Dry Sample 2 :	74.8 gm



Grain Size Distribution Curve Results :

Seive Analysis	% Gravel :	0.00	D_{10} :	0.078	C_u :	6.544
	% Sand :	90.94	D_{30} :	0.147	C_c :	0.541
	% Fines :	9.06	D_{60} :	0.512		
	USCS Soil Classification:		SP-SM - Poorly Graded Sand with Silt			

Hydrometer Analysis	% Sand :	29.6	% Silt :	40.5	D_{50} :	0.112
			% Clay :	29.8	Silt Factor :	0.589

Figure: GSA - 02

Particle Size Analysis Report

As Per ASTM D422-63 (2007)

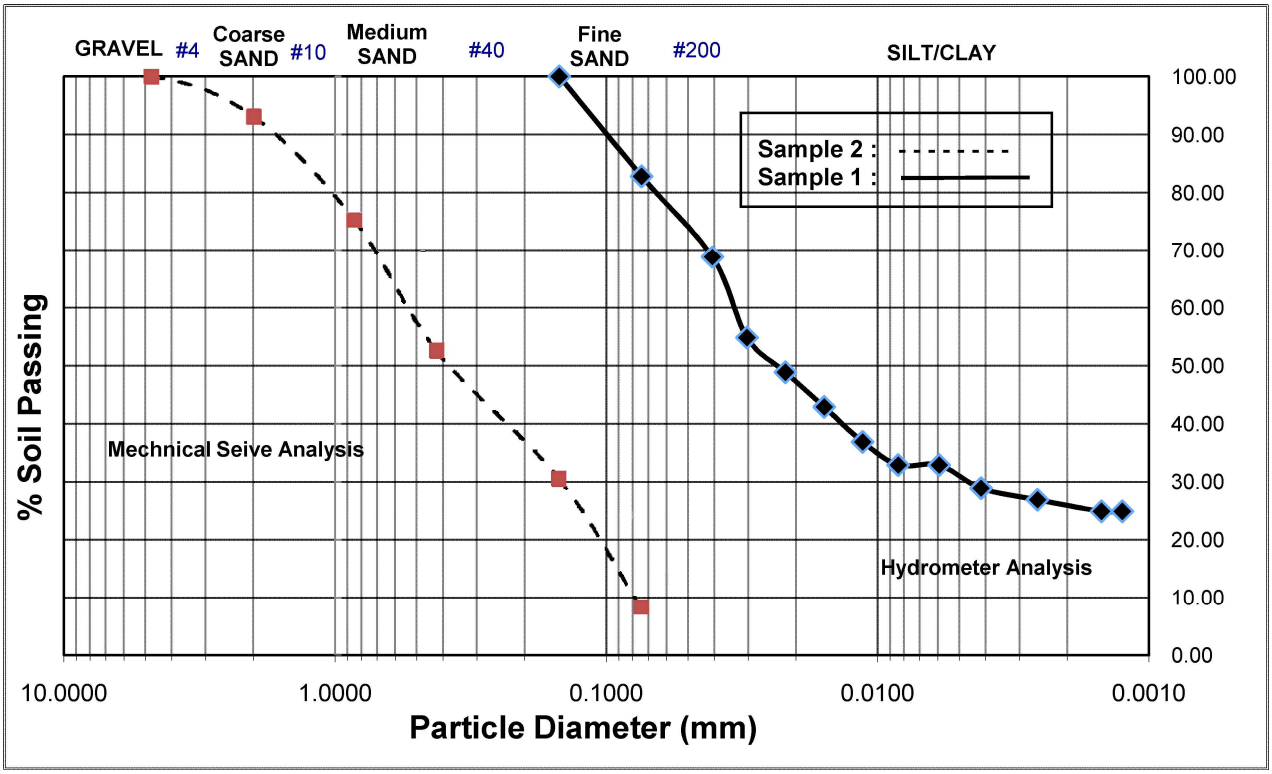
Client : **Project Director**

Project : **Construction 6- Storied 33/11 KV Substation**

Location : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

Boring No :	**BH- 03**
Depth of Sample 1 from EGL :	(-) 6.00 m
Weight of Container :	125.0 gm
Weight of Container & Soil 1 :	175.0 gm
Weight of Dry Sample 1 :	50.0 gm

Boring No :	**BH- 03**
Depth of Sample 2 from EGL :	(-) 25.50 m
Weight of Container :	125.0 gm
Weight of Container & Soil 2 :	200.5 gm
Weight of Dry Sample 2 :	75.5 gm



Grain Size Distribution Curve Results :

Seive Analysis	**% Gravel :**	0.00	**D_{10} :**	0.080	**C_u :**	6.991
	% Sand :	91.60	**D_{30} :**	0.148	**C_c :**	0.484
	% Fines :	8.40	**D_{60} :**	0.562		
	USCS Soil Classification:		**SP-SM - Poorly Graded Sand with Silt**			

Hydrometer Analysis	**% Sand :**	17.2	**% Silt :**	56.9	**D_{50} :**	0.101
			% Clay :	25.9	**Silt Factor :**	**0.558**

Figure: GSA - 03

Particle Size Analysis Report

As Per ASTM D422-63 (2007)

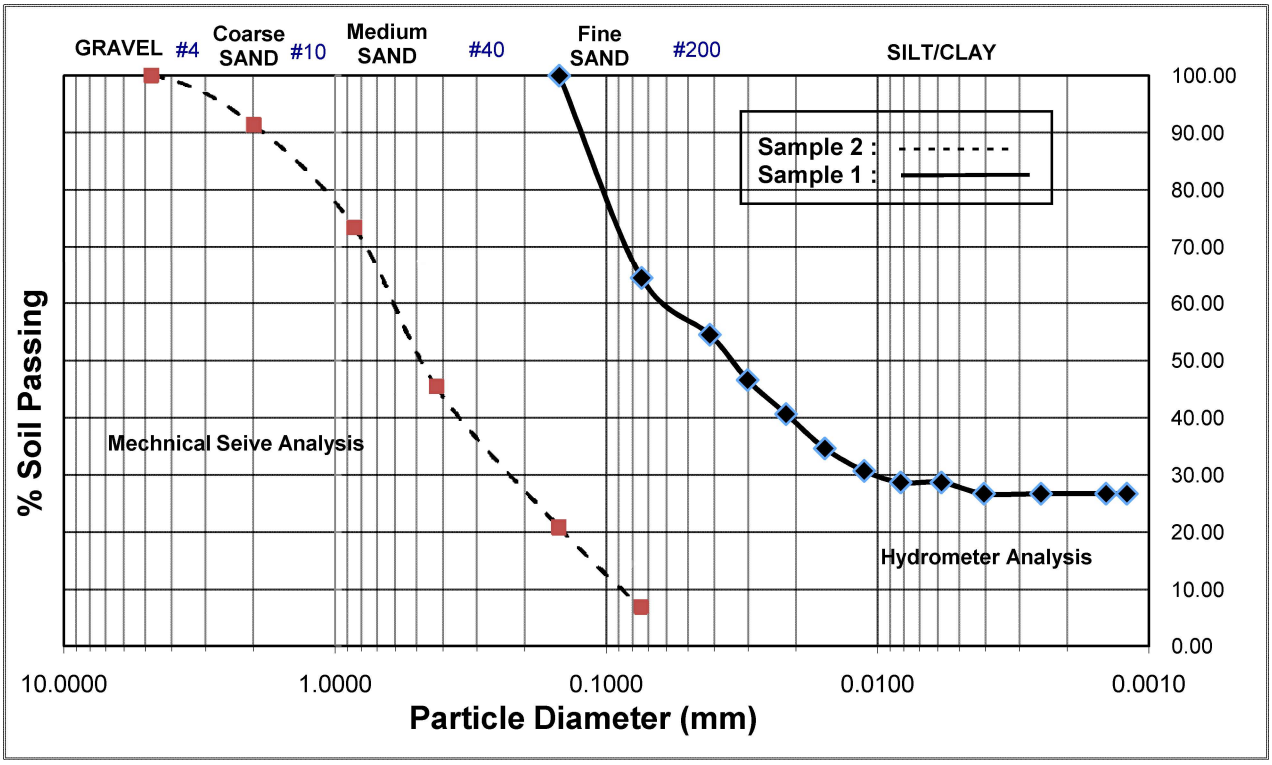
Client : **Project Director**

Project : **Construction 6- Storied 33/11 KV Substation**

Location : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

Boring No :	**BH- 04**
Depth of Sample 1 from EGL :	(-) 30.00 m
Weight of Container :	125.0 gm
Weight of Container & Soil 1 :	175.0 gm
Weight of Dry Sample 1 :	50.0 gm

Boring No :	**BH- 04**
Depth of Sample 2 from EGL :	(-) 10.50 m
Weight of Container :	125.0 gm
Weight of Container & Soil 2 :	199.2 gm
Weight of Dry Sample 2 :	74.2 gm



Grain Size Distribution Curve Results :

Seive Analysis	**% Gravel :**	0.00	**D_{10} :**	0.091	**C_u :**	7.070
	% Sand :	93.04	**D_{30} :**	0.251	**C_c :**	1.073
	% Fines :	6.96	**D_{60} :**	0.645		
	USCS Soil Classification:		**SW-SM - Well Graded Sand with Silt**			

Hydrometer Analysis	**% Sand :**	35.6	**% Silt :**	37.7	**D_{50} :**	0.113
			% Clay :	26.8	**Silt Factor :**	**0.592**

Figure: GSA - 04

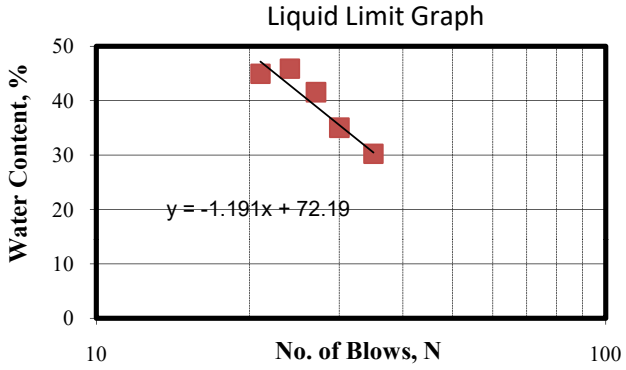
ATTERBERG LIMIT TEST (ASTM D 4318)

Client : Project Director

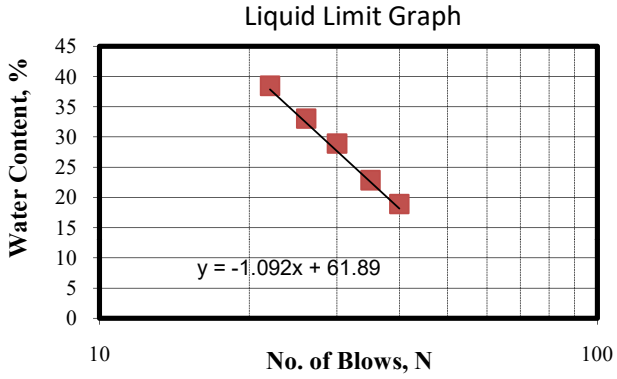
Project : Construction 6- Storied 33/11 KV Substation

Location : Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212

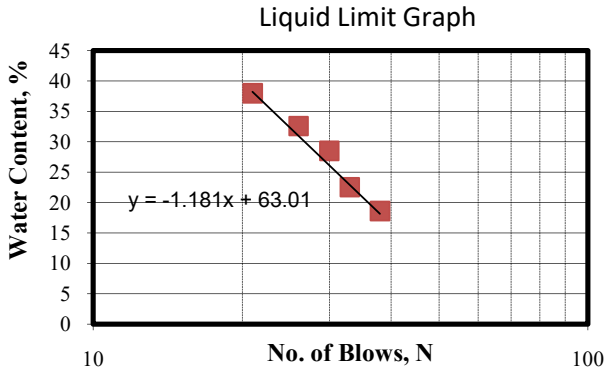
Bore Hole Location, BH - 1		
Sample ID	D - 4	
Sample Depth	20.0	ft
Liquid Limit, LL =	42.0	%
Plastic Limit, PL =	32.8	%
Plasticity Index I_p =	9	%
Natural Water Content =	42.0	%



Bore Hole Location, BH - 2		
Sample ID	D - 14	
Sample Depth	70.0	ft
Liquid Limit, LL =	34.4	%
Plastic Limit, PL =	29.0	%
Plasticity Index I_p =	5	%
Natural Water Content =	29.0	%



Bore Hole Location, BH - 3		
Sample ID	D - 20	
Sample Depth	100.0	ft
Liquid Limit, LL =	33.0	%
Plastic Limit, PL =	27.1	%
Plasticity Index I_p =	6	%
Natural Water Content =	31.6	%



Bore Hole Location, BH - 4		
Sample ID	D - 5	
Sample Depth	25.0	ft
Liquid Limit, LL =	37.3	%
Plastic Limit, PL =	26.3	%
Plasticity Index I_p =	11	%
Natural Water Content =	26.3	%

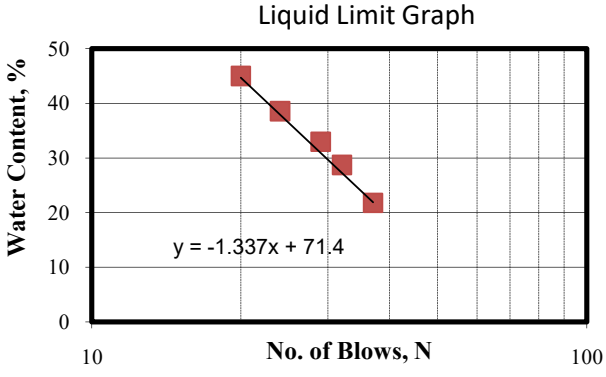


Figure- ALT # 01

DIRECT SHEAR TEST (ASTM D3080–90)

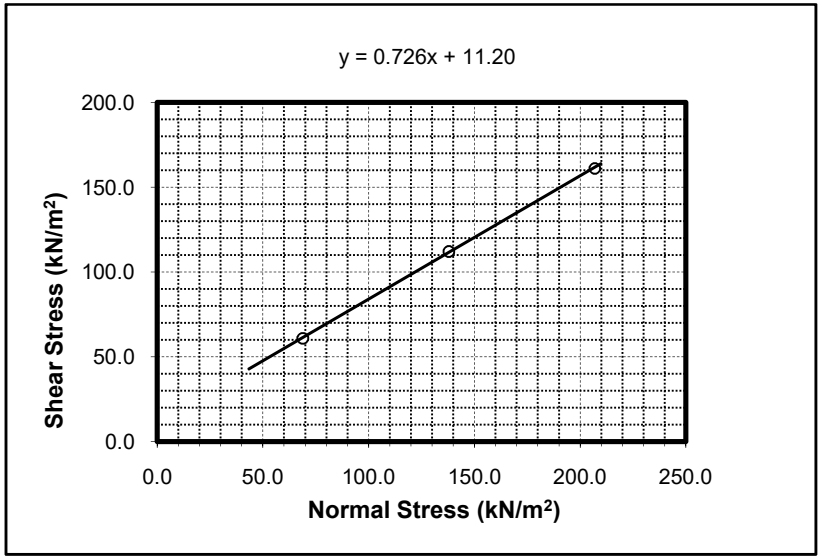
CLIENT : **Project Director**

PROJECT : **Construction 6- Storied 33/11 KV Substation**

LOCATION : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

Bore Hole Location, BH - 1		
Sample ID	D - 8	
Sample Depth	12.0	m
Specimen Length, L_1 =	50	mm
Specimen Width, L_2 =	50	mm
Area of Specimen =	2500	sqmm
Height of Specimen =	25	mm
Dry Unit weight, γ_{dry} =	15.99	kN/m^3
Moisture Content, w =	20.4	%
Angle of Shearing Resistance	36	Degree
Cohesion intercept	11.207	kN/m^2

Bore Hole Location, BH - 2		
Sample ID	D - 17	
Sample Depth	25.5	m
Specimen Length, L_1 =	50	mm
Specimen Width, L_2 =	50	mm
Area of Specimen =	2500	sqmm
Height of Specimen =	25	mm
Dry Unit weight, γ_{dry} =	14.47	kN/m^3
Moisture Content, w =	31.3	%
Angle of Shearing Resistance	35	Degree
Cohesion intercept	13.141	kN/m^2



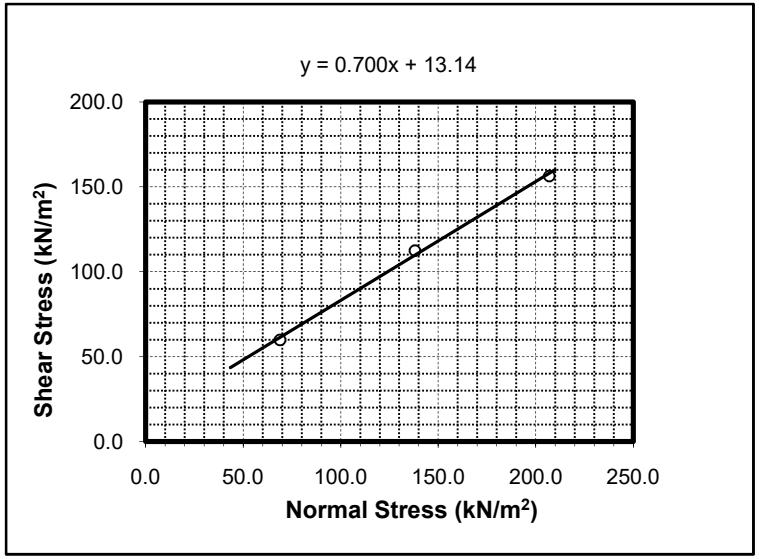


Figure- DST 01

DIRECT SHEAR TEST (ASTM D3080–90)

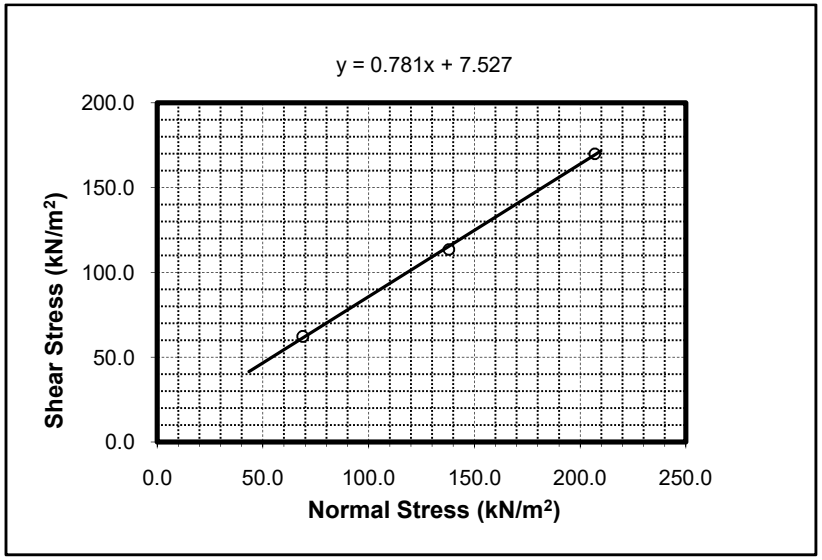
CLIENT : **Project Director**

PROJECT : **Construction 6- Storied 33/11 KV Substation**

LOCATION : **Plot # 59, Park Road, Baridhara Diplomatic Zone, Baridhara, Dhaka-1212**

Bore Hole Location, BH - 3		
Sample ID	D - 17	
Sample Depth	25.5	m
Specimen Length, L_1 =	50	mm
Specimen Width, L_2 =	50	mm
Area of Specimen =	2500	sqmm
Height of Specimen =	25	mm
Dry Unit weight, γ_{dry} =	15.41	kN/m^3
Moisture Content, w =	28.3	%
Angle of Shearing Resistance	38	Degree
Cohesion intercept	7.527	kN/m^2

Bore Hole Location, BH - 4		
Sample ID	D - 9	
Sample Depth	13.5	m
Specimen Length, L_1 =	50	mm
Specimen Width, L_2 =	50	mm
Area of Specimen =	2500	sqmm
Height of Specimen =	25	mm
Dry Unit weight, γ_{dry} =	14.73	kN/m^3
Moisture Content, w =	29.5	%
Angle of Shearing Resistance	36	Degree
Cohesion intercept	13.830	kN/m^2



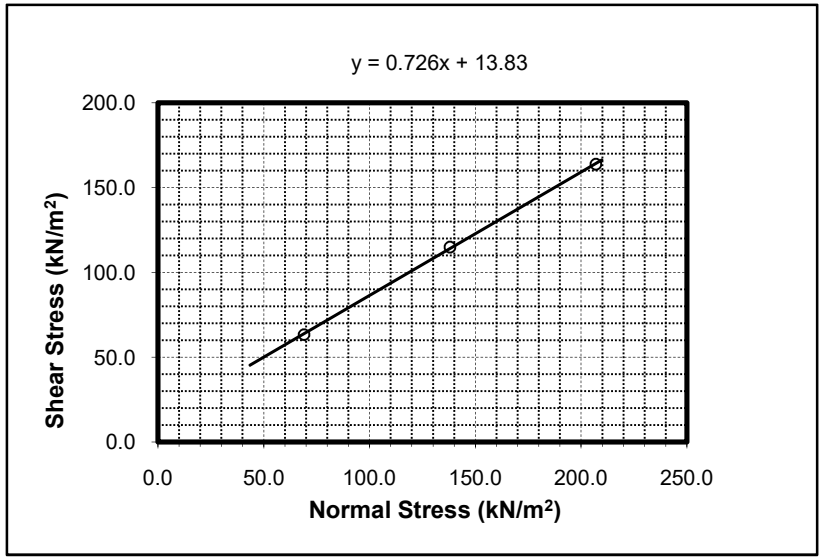


Figure- DST 02