REPORT#
9836/GSK

GEOTECHNICAL INVESTIGATION REPORT

Location	Islamabad
Project	Construction of ANF Building
Date of Drilling	May, 2021
No. of Borehole	03
Depth of Borehole	50ft
Borehole Dia	03 Inches
Drilling Method	Rotary
Reporting Officer	Engr. Ghassan Sattar Khan
Submitted to:	ANF through UNDP
Ground Water Table Depth	Not encountered

PLANNING – TESTING – DESIGNING & DEVELOPMENT

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General Notes

1. This report will be prepared for the exclusive use of the client named in the document and copyright will subsist with M/S GSK Engineerz. Prior written permission must be obtained to reproduce all or part of the report. It will be prepared on the understanding that you will disclose its contents to parties directly involved in the current investigation, preparation and development of the site

2. The report and /or opinion will be prepared for the specific purpose stated in the document and in relation to the nature and extent of proposals made available to us at the time of your enquiry. The recommendations should not be used for other schemes on or adjacent to the site without further reference to M/S GSK Engineerz. The assessment of the factual data will be provided to assist the client and his Engineer and/or advisors in the preparation of their designs.

3. The report will be based on the ground conditions encountered in the exploratory holes/test pits together with the results of field and laboratory testing in the context of the proposed development. There may be special conditions, appertaining to the site, however, which may not be revealed by the investigation, and which may not be taken into account in the report. Foundation design features can later be discussed with the reporting officer by the structural engineer, commenting on its influence on the various layers encountered or effect of these layers on the foundation selection & type according to the applied loading.

4. Methods of construction and/or design other than those proposed by the designers or referred to in the report may require consideration during the evolution of the proposals and further assessment of the geotechnical data would be required to provide discussion and recommendation appropriate to these methods.

5. The accuracy of the results reported will depend upon the technique of measurement, investigation and test used and these values should not be regarded necessarily as characteristic of the strata as a whole. Where such measurements are critical, the technique of the investigation will need to be reviewed and supplementary investigation undertaken in accordance with the advice of the company where necessary.

6. Ground conditions should be monitored during the construction of the works and the recommendations of the report re-evaluated in the light of these data by the supervising geotechnical engineers.

7. Any comments on groundwater conditions will be based on observations made at the time of the investigation, unless specifically stated otherwise. It should be noted that groundwater levels will vary due to seasonal or other effects.

8. Unless specifically stated, the investigation will not take into account of possible effects of mineral extraction.

9. The economic viability of the proposals referred to in the report, or of the solutions put forward to any problems encountered, will depend on very many factors in addition to geotechnical considerations hence its evaluation will be outside the scope of the report.

CLIENT'S REQUIREMENTS

1	Test Requirement	: Determination of Shear Bearing Capacity as per Field & Laboratory Tests.
2	Project	:Construction of ANF Building
3	Location	: Islamabad
4	Deptt /Person Requiring Test	: ANF through UNDP
5	Soil Report No.	: 9836/GSK

Contents

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1.0 INTRODUCTION

1.1 GENERAL

M/S GSK Engineerz was hired by ANF through UNDP for the project "Construction of ANF Building" at location of Islamabad. For the same purpose necessary Geotechnical Investigations as given in the scope of work were carried out. This individual task comprised of both field and laboratory activities, discussed in detail in the sections below.

1.3 PURPOSE AND SCOPE

Purpose of Geotechnical investigation is to conduct soil investigation for the site where building construction needs to take place.

The activity comprises of soil exploration and determining suitability of the site for proposed construction. It mainly helps in estimating which type of foundation is required or what safety measures should be taken. The geotechnical site investigation is carried out to obtain sufficient and correct site information for economical selection of foundation.

In general, geotechnical investigations provide the following:

1- Information to determine the type of foundation required (shallow or deep).

2- Information to allow the geotechnical consultant to make a recommendation on the allowable bearing capacity of the soil.

3- Sufficient data/ laboratory tests to make settlement and swelling predictions.

4- Location of the groundwater level.

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5- Information so that the identification and solution of excavation problems can be made.

2.0 SITE CONDITIONS

2.1 DESCRIPTION

The site is located at Islamabad. No high voltage, electrical or telephone poles, sewer or water pipes were observed within the depth of the drilled boreholes.

2.2 SUBSURFACE CONDITIONS

The formation within the depths of the drilled borehole consists mostly of Sand Stone and Clay Stone.

2.3 GROUNDWATER AND CAVITIES

Ground water was not encountered.

3.0 FIELD EXPLORATION AND TESTING

3.1 DRILLING OF BOREHOLE:

Exploration of site subsurface conditions at the construction area through drilling of 03 boreholes up to a depth of 50ft each of existing ground level.

Drilling has been carried out utilizing rotary drilling equipment with the possibility of continuous sampling at different depths and at each litho logical change of the strata.

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3.2 SAMPLING

Two types of samples were collected:

a- Disturbed samples; for identification and index property testing purposes at various depths.

b- Undisturbed samples & Core samples; for the determination of shear strength parameters.

Representative samples were placed in sealed plastic bags and core boxes and then transported to the laboratory for further testing.

4.0 LABORATORY TESTING

The tightly sealed samples were safely transported to GSK Engineerz Laboratory in Peshawar.

4.1 TESTS CARRIED OUT

The following tests were performed to evaluate the engineering properties of the soils and rocks influencing the performance of the proposed structure:

1- Natural moisture contents were determined in accordance with ASTM D-2216.

2- Atterberg limits (Liquid and Plastic) in accordance with ASTM D-4318-10. Liquid and plastic limit tests were conducted on the powder of the obtained samples and the plasticity index (PI) was determined.

3- Partical Size Distribution in accordance with ASTM D422, D1140.

4- Unconfined Compression Test.

5- Direct Shear Test.

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5.0 BEARING CAPACITY ANALYSIS

Two approaches were utilized to calculate the bearing capacity:

5.1 Utilizing the bearing capacity Equations:

The bearing capacity was calculated using the shear test parameters of cohesion and angle of internal friction and the soil density of the specimens extracted from the boreholes. The following well known Terzaghi's equation with correction terms suggested by Meyerhof can be used to calculate the bearing capacity of rectangular foundation of any sides ratio B:L

$$Qu = 1.3cNc + qNqRw_1 + 0.4\,\gamma BN\gamma Rw_2$$

where:

C = Cohesion of soil, γ = unit weight of soil,

D = depth of footing, B= width of footing

C,Ø - Strength parameters of the soil below foundation level.

L - Length of foundation.

Nc, Nq, N_γ - Bearing capacity coefficients dependent on the angle of internal friction of the soil below foundation level (dimensionless).

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

$N_q = e^{\pi \tan\phi} \tan^2(45+\phi/2)]$

$N_\gamma = (Nq - 1) \tan (1.4\phi)$

$Kp = \tan^2(45 + \phi/2)$

The Tolerable Settelment Proposed is 25mm

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Mayerhoff's Bearing Capacity Factors

Ø	Nc	Nq	Ny
0	5.1	1	0
5	6.5	1.6	0.1
10	8.3	2.5	0.4
15	11	3.9	1.2
20	14.9	6.4	2.9
25	20.7	10.7	6.8
30	30.1	18.4	15.1
35	46.4	33.5	34.4
40	75.3	64.1	79.4

5.2 Utilizing the SPT Data for Bearing Capacity Calculation:

Mayerhoff's equation was used for the determination of bearing capacity from 'N' values obtained from SPT and corrected. The assumed footing width is 6ft. The following formula has been used.

$$Qa = \frac{\left(\frac{N}{6}\right)\left[\frac{B+1}{B}\right]^2}{K}$$

Where,

K = 1 + 0.33(D / B)

70% efficiency correction used for 'N' using the following;

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$$N70 = \frac{ECsCrCbN}{0.7}$$

Furthermore the depth corrections applied are;

$$N70\ (Corr) = N70\sqrt{\frac{2000}{(\gamma)(Df)}}$$

FPS System

Refer to Borehole log for details & Bearing Capacity from SPT

6.0 EVALUATION OF LAB & FIELD TEST RESULTS

6.1 Discussion on Borehole:

a. Classification from 0ft to 35ft depth shows that the soil encountered in borehole was found to be Sand Stone.

b. Strata beyond 35ft were found to be a type of sedimentary rock called 'Clay Stone'. This Clay stone was found to possess high compressive strength and non-plastic to low plastic in nature.

c. The cores obtained were studied for their shear strength properties and not pulverized for gradation purpose due to its stony properties. Color of this strata was greyish brown.

d. Ground water table was not encountered throughout drilling depth.

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e. Penetration resistance was found high throughout drilling depth. Refusal was recorded at the litho-logy showed presence of Sand stone.

f. Unconfined compression test was conducted at various depths from 5ft to 10ft depth for the determination of un-drained shear strength of soil to be further used for the computation of bearing capacity of soil using factor of safety '03' in Terzaghi's equation.

7.0 ENGINEERING RECOMMENDATIONS

As a result of field and laboratory activities carried out and the analysis of the available data and test results, the following engineering recommendations can be made:

7.1 ALLOWABLE BEARING CAPACITY

According to the analysis of the materials encountered, field and the laboratory test results, the recommended Gross allowable bearing capacity, which would also be safe against settlement is **2.00TSF** at 8ft depth, while Net bearing capacity at 8ft depth is **1.25 TSF.**

7.1.1 Recommendations

i. It is recommended to compact the surface prior to laying foundation.

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7.2 DRAINAGE OF THE SITE

It is recommended to design an effective rainwater drainage system to get rid of the consequences of the rainwater percolation into the layers *(i.e. provision of parametric drains)*. The site should be graded so as to direct rainwater and water away from all planned structures. Under no circumstances, the foundation shall get inundated during the whole period of construction.

7.3 MATERIALS FOR BACKFILL – COMPACTION CRITERIA

In general, materials for the backfilling should be granular, not containing rocks or lumps over 15 cm in greatest dimension, free from organic matter, with plasticity index (PI) not more than 6%. The backfill material should be laid in lifts not exceeding 25 cm in loose thickness and compacted to at least 95 percent of the maximum dry density at optimum moisture content as determined by modified compaction test (Proctor) (ASTM D-1557).

7.4 SEISMIC CONSIDERATIONS

As per Pakistan Building Code, the site is being situated at Islamabad lays in seismic Zone 2B with ground acceleration ranging from 0.16g to 0.24g.

Finally, it should be noted that the results and recommendations of this report are solely based on the collected samples from the drilled boreholes on April, 2021 and assuming that the subsurface conditions do not significantly deviate from those encountered.

Reporting Officer

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SITE PICTURES

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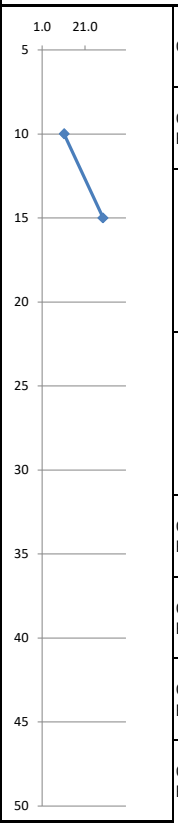
BOREHOLE LOG & STANDARD PENETRATION TESTING (ASTM-1586-54)

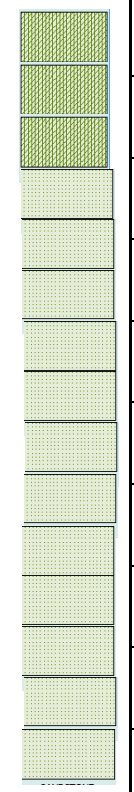
Borehole No. 1
Date of Driling: May , 2021
Assumed footing width (ft)= 6
Borehole diameter (Inches)= 3
$C_{S=}$ 1
$C_{B=}$ 1
$E_{m=}$ 0.55
Select Efficiency Correction N70

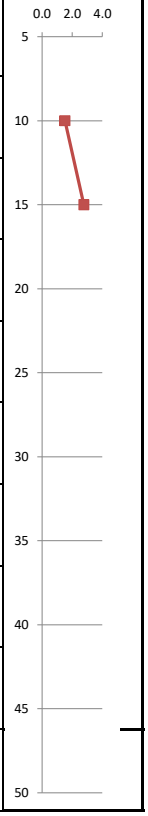
Drilling Method : Rotary Drilling
Report No. 9836/GSK
Name of Project: Construction of ANF Building
Client: ANF through UNDP
Location: Islamabad
Depth of Borehole 50ft
Water Table Depth Not encountered
Name of Geologist: Hamza

Bearing Capacity Equation $Qa = \frac{\left(\frac{N}{6}\right)\left[\frac{B+1}{B}\right]^2}{K}$

Depth	Penetration			N- Value	N70	N70 Vs Depth	Sampling & Cores	Soil Classification	Soil Profile	Bearing Capacity		Bearing Capacity
ft	*6-in*	*6-in*	*6-in*							*Kips / ft²*	*Tons/sft*	Vs Depth
5	Fill Material			-	-		Clayey Fill	Clayey Fill		-	-	
10	6	8	11	19	11.2		CR = 55% RQD = 25 %	Sand Stone. Grey Color. Sample obtaind as cores,		3.396	1.515	
15	16	20	24	44	29.4		UDS, DS, CR = 55% RQD = 24%	Sand Stone. Grey Color. Sample obtaind as cores,		6.239	2.782	
20	24	R	R	-	-					-	-	
25	R	26	R	-	-		CR = 62% RQD = 38%	Non-plastic Mudstone.		-	-	
30	30	R	R	-	-					-	-	
35	Refusal			-	-		CR = 64% RQD = 41 %	Clay Stone		-	-	
40				-	-		CR = 64% RQD = 64%			-	-	
45				-	-		CR = 64% RQD = 30 %			-	-	
50				-	-		CR = 54% RQD = 7 %			-	-	







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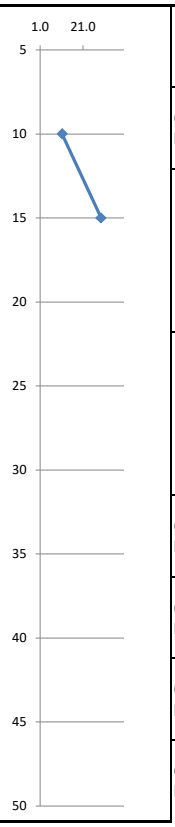
BOREHOLE LOG & STANDARD PENETRATION TESTING (ASTM-1586-54)

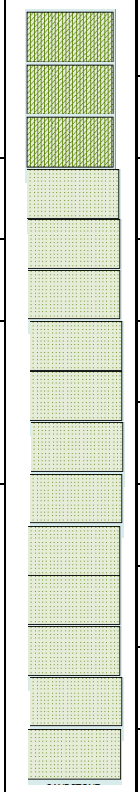
Borehole No. 2
Date of Driling: May , 2021
Assumed footing width (ft)= 6
Borehole diameter (Inches)= 3
$C_{S=}$ 1
$C_{B=}$ 1
$E_{m=}$ 0.55
Select Efficiency Correction N70

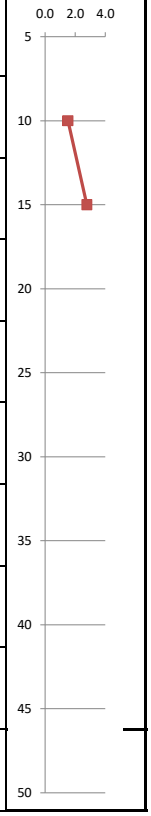
Drilling Method : Rotary Drilling
Report No. 9836/GSK
Name of Project: Construction of ANF Building
Client: ANF through UNDP
Location: Islamabad
Depth of Borehole 50ft
Water Table Depth not encountereed
Name of Geologist: Hamza

Bearing Capacity Equation $Qa = \frac{\left(\frac{N}{6}\right)\left[\frac{B+1}{B}\right]^2}{K}$

Depth	Penetration			N- Value	N70	N70 Vs Depth	Sampling & Cores	Soil Classification	Soil Profile	Bearing Capacity		Bearing Capacity
ft	*6-in*	*6-in*	*6-in*							*Kips / ft²*	*Tons/sft*	Vs Depth
5	Fill Material			-	-		Clayey Fill	Clayey Fill		-	-	
10	6	7	8	15	8.8		CR = 55% RQD = Nill	Sand Stone. Grey Color. Sample obtaind as cores,		2.681	1.196	
15	16	18	21	39	26.0		UDS, DS, CR = 41% RQD = 18%	Sand Stone. Grey Color. Sample obtaind as cores,		5.530	2.466	
20	23	R	R	-	-					-	-	
25	R	25	R	-	-		CR = 60% RQD = 10%	Non-plastic Mudstone.		-	-	
30	30	R	R	-	-					-	-	
35	Refusal			-	-		CR =59% RQD = 14 %	Clay Stone		-	-	
40				-	-		CR = 64% RQD = 64%			-	-	
45				-	-		CR = 80% RQD = 28 %			-	-	
50				-	-		CR = 96% RQD = 96 %			-	-	







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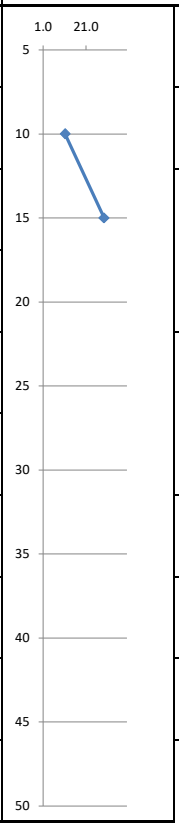
BOREHOLE LOG & STANDARD PENETRATION TESTING (ASTM-1586-54)

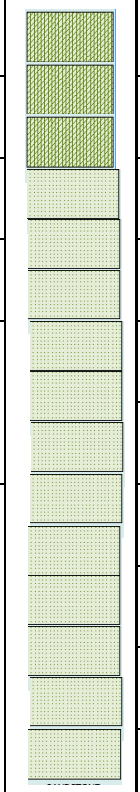
Borehole No. 3
Date of Driling: May , 2021
Assumed footing width (ft)= 6
Borehole diameter (Inches)= 3
$C_{S=}$ 1
$C_{B=}$ 1
$E_{m=}$ 0.55
Select Efficiency Correction N70

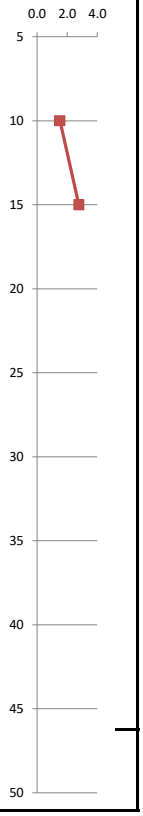
Drilling Method : Rotary Drilling
Report No. 9836/GSK
Name of Project: Construction of ANF Building
Client: ANF through UNDP
Location: Islamabad
Depth of Borehole 50ft
Water Table Depth not encountered
Name of Geologist: Hamza

Bearing Capacity Equation $Qa = \frac{\left(\frac{N}{6}\right)\left[\frac{B+1}{B}\right]^2}{K}$

Depth	Penetration			N- Value	N70	N70 Vs Depth	Sampling & Cores	Soil Classification	Soil Profile	Bearing Capacity		Bearing Capacity
ft	*6-in*	*6-in*	*6-in*							*Kips / ft²*	*Tons/sft*	Vs Depth
5	Fill Material			-	-		Clayey Fill	Clayey Fill		-	-	
10	9	9	9	18	10.6		CR = 53% RQD = 43%	Sand Stone. Grey Color. Sample obtaind as cores,		3.218	1.435	
15	16	21	22	43	28.7		UDS, DS, CR = 64% RQD = 55%	Sand Stone. Grey Color. Sample obtaind as cores,		6.097	2.719	
20	19	R	R	-	-					-	-	
25	R	19	R	-	-		CR = 46% RQD = 38%	Non-plastic Mudstone.		-	-	
30	30	R	R	-	-					-	-	
35	Refusal			-	-		CR =44% RQD = 35 %	Clay Stone		-	-	
40				-	-		CR = 79% RQD = 70%			-	-	
45				-	-					-	-	
50				-	-		CR = 44% RQD = 35 %			-	-	







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