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Geological Engineering Survey and Geotechnical Analysis of Substrate Soil of Erbil Steel Fusion Company

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Abstract

Construction projects steps among the vast and varied construction has remarkable significance range in civil industry. Foundation as an important part of building the, is made of various systems in order to transfer the load from the superstructure to basis. In order to subsurface location checks could be used of identifiers such as boreholes, wells, trenches and in situ tests and laboratory tests. Project facilities are the most important factors to identification the equipment and tools. In this study, by using the results of the exploratory boreholes, field observations, in situ tests and laboratory studies have been consider to evaluate geotechnical condition of Erbil Altun kupri project site. According to this by studying the Geological Engineering condition of site project and Lefran tests, spt and cutting feathers standing on samples taken from boreholes from drilled and comparing results together, which generally consists of sand and gravel with fine particles of silt and Clay, has been determined geotechnical parameters of location. In the calculations after 6.5 meters excavation, location soil considered pre-consolidation and for settlement calculation, under layer soils were divided into several layers. The detailed results of calculations to verify foundation settlement before and after soil improving operation that used DSM method and it's analysis by using Plaxis 3D software, showed the elastic settlement 0.0105 mm in the center of foundation.

Keyword: geo technics, altun kupri project, foundation settlement, Plaxis 3D software, engineering geology

1. Introduction

Geotechnical Science, study the different layers of the earth and groundwater as a factor in the stability and behavior of the structures favors. In fact, geotechnical investigations will cause the optimum design of the structure if the bearing capacity of soil, be more than which assumed in the structural design, the project will be uneconomic and if the bearing capacity of the bed soil cause the soil disrupt and less than the given amount, certainly issues such as settlement, reversal and will at least create cracks instruments. Thus the geotechnical investigations are one of the most important steps for construction activities and the construction without local geotechnical studies can bring irreparable damages. Building foundations transfer the loads from building or other structures to the land. Geotechnical engineers design foundations on the base of structural characteristics of structure load or soil or bedrock characteristics at the site. Using the criteria, rules and standards in the creation of feasibility studies steps, basic and detailed design, implementation, commissioning, delivery and start of operation of investment projects in compliance with the technical and economic feasibility of projects, ensuring quality design and run (lifetime) and reducing maintenance and operation costs has particularly importance. Domain and geotechnical investigations expansion should be determined according to the land location condition and dimensions of the structures and foundation. Basically, these discoveries should be done in stages and details of each stage should be determined according to data from the previous stage. Due to the need for geotechnical studies, consultant have to set these studies included in the schedule of the proposed project and to do necessary predictions .in this study in order to geotechnical assessment of excavation site soil of Erbil project, after surface identification stage ,excavate four bore in soil of project location and have been tested the samples taken of various depths physically and mechanically and determined porterage degree and settlement of project location soil according to the tests results.

2. Geographical Location and Access Roads

In terms of geographical distribution this area is located in Iraq country Erbil state and in the southern of Erbil city and near the Altun kupri Cooper city.

Figure 1. Cabriolet of connecting roads leading to the area

Figure 2. View of the site location

3. The Geological of Location

In general, according to the geological map, Arbil area is a flat and completely covered with alluvial deposits, including deposits Posts granulated clay, silt and sand. Under these sediments which have a thickness about of 10 to 50 meters, is located thick conglomerate units.

4. The Studies of Surface Identify Stage

At this stage by using surface identification and use of present trenches in the area, general decision-making about the studies is done. According to the survey and viewing materials in the area were from the river mixed type. Good roundness of coarse indicates the long transport distance from the creation location as well as fine-grained matrix that is mostly sand. It is concluded that the environment is a river delta environment. Visited from location of tranches made by shovel in the vicinity of the structures and were taken to the report.

5. Geotechnical Studies of Location

In order to identify the geotechnical properties of the overburden material and foundation for the field operation in the first stages of exploratory boreholes and in situ tests (blow and standard penetration and permeation) was performed. At this stage of the studies, 4 holes totaling 50 m drilling done by rotary method (Figure 1).

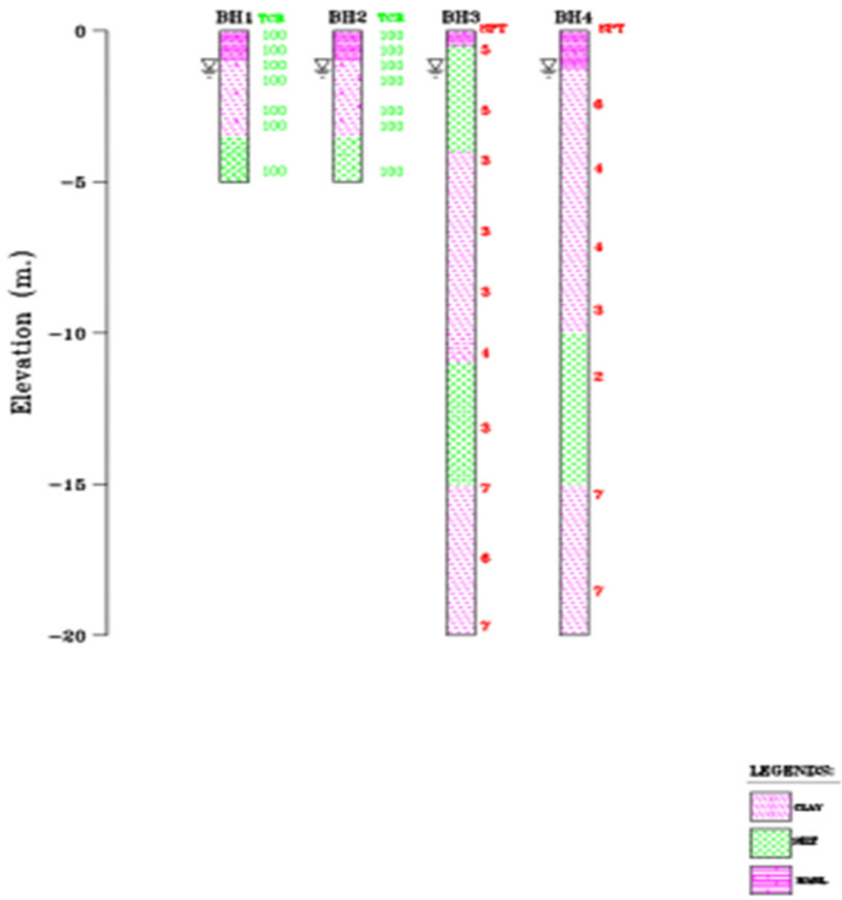

Figure 3. The profile of geotechnical boreholes

SPT (Standard Penetration Test, SPT)

Standard Penetration Test (SPT) in the boreholes of BH3 and BH4 in accordance with standard of ASTM D1586 is done by counting number of required blows to standard penetration sampler to length of 45 cm by hammer 76 cm in weight of 63.5 kg and crash height of 76 cm.

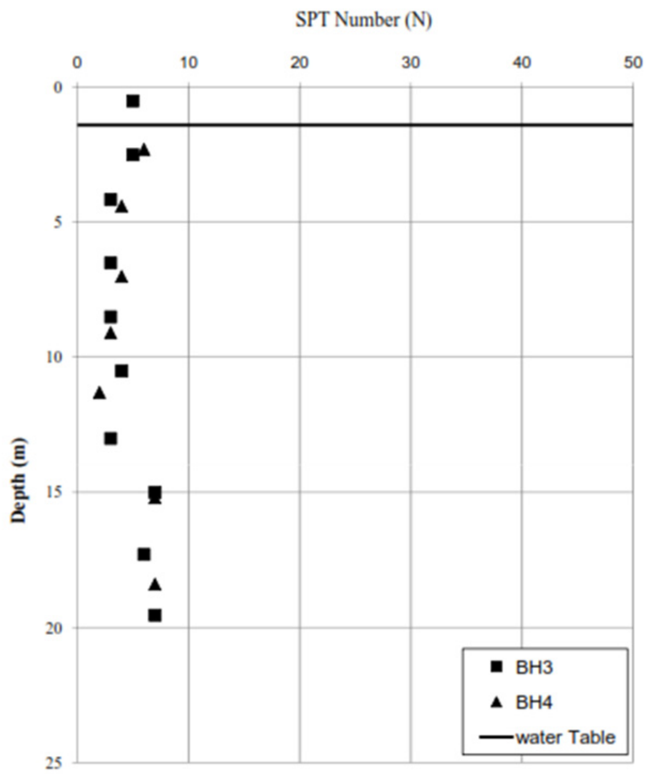

Figure 4. Diagram of SPT changes than the depth

Laufer Penetration Test (LefrancTest)

Laufer Penetration Field Test were performed by falling head method (Falling Head) inside holes of BH1 and BH2 (Table 1).

Table 1. Laufer permeability test Results for soil excavation area

BORING No.	TEST No.	DEPTH (m)	TEST METHOD	PERMEABILITY (cm/sec)		
				Rising Head	*Falling Head*	*Constant Head*
BH1	1	1.00−1.50	G		Kh=2.82E−3	
	2	2.50−3.00	G		Kh=4.06E−3	
	3	4.50−5.00	G		Kh=4.50E−5	
BH2	1	1.00−1.50	G		Kh=6.88E−5	
	2	2.50−3.00	G		Impermeable	
	3	4.50−5.00	G		Kh=1.15E−3	

Situ vane shear test

In boreholes of BH3 and BH4-situ vane shear test was conducted in accordance with ASTM D2573 standard. The readings results are in place obtained as torsional resistance (Torque) in terms of in-1bs or kg.cm that after calibration by device torque-meter (Torque meter) and using the following equations is calculated soil shear strength (cohesion):

(1) S =, K = 3.66 D3

Where S is clay shear strength in terms of kg / cm2, T, is torsional force applied in terms of kg.cm, D is blade diameter in centimeters. Plot of S changes (after calculation and correction) than the depth is shown in Figure.

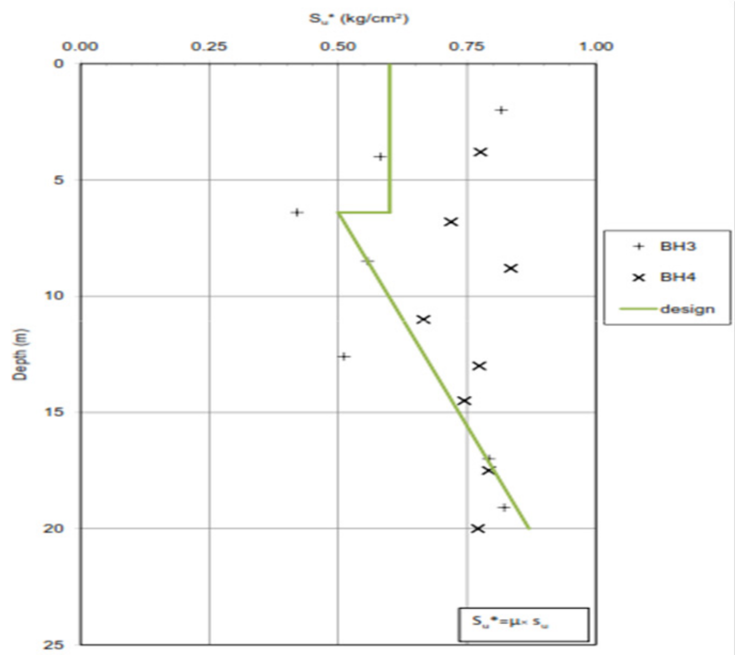

Figure 5. plot of S changes (SSS) than the depth

5.1 Short-Term and Long-Term Geotechnical Properties of Soil

The geotechnical parameters based on results of the Standard Penetration Test (SPT) and laboratory tests carried out in the first and second stages of Geotechnical studies and field observations of project location and engineering judgment of project consultants are provides in table (2) and (3) for both short-term and long-term state.

It should be noted that the groundwater level in the first phase of studies at the depth of 2 meters from the natural ground level and in the second level of studies reported normal at the depth of 4.1 meters from the ground level. In all calculations, the groundwater levels are considered at normal ground level.

Table 2. Short-term geotechnical parameters.

Layer No.	Soil Type	Depth (m)	γ (kN/m3)	cu (kg/cm2)	E (kg/cm2)	ν
1	Clay	0-4	20	0.5	750 Cu= 375	0.4
2	Clay	4-20	20	0.2-0.5	1000 Cu= 200-500	0.4
3	Sand	20-30	20	0	500	0.3
4	Clay	30-35	20	0.7-0.8	1000 Cu = 700-800	0.4
5	Clay	35-40	Inevitable to settlement			

Table 3. Long-term geotechnical parameters.

			c′	φ′
I	0-10	20	0.12	**22**
II	10-20	20	0.12	**20**
III	20-30	20	0.07	**33**

6. Extensive Foundation Settlement

Extensive foundation bearing capacity should be controlled based on two criteria of shear strength and settlement and at least these should be presented as an allowable bearing capacity. In the settlement calculations, were considered both, consolidate settlement of clay layers and elastic settlement of both clay and sandy layers. To calculate the consolidation and elastic settlement have been used the classic relations as follows:

$$\text{If } P_o,\ P_o + \Delta p > P_c:\ S_c = \frac{C_c}{1+e_\circ} H \operatorname{Log} \frac{P_\circ + \Delta p}{P_\circ} \tag{2}$$

$$\text{If } P_o,\ P_o + \Delta p < P_c:\ S_c = \frac{C_s}{1+e_\circ} H \operatorname{Log} \frac{P_\circ + \Delta P}{P_\circ} \tag{3}$$

$$\text{If } P_o < P_c,\ P_0 + \Delta p > P_c:\ S_c = \frac{C_s}{1+e_\circ} H \operatorname{Log} \frac{P_c}{P_\circ} + \frac{C_c}{1+e_\circ} H \operatorname{Log} \frac{P_\circ + \Delta P}{P_c} \tag{4}$$

$$S_e = P.B.\ \frac{1-\nu^2}{E}\ I_p \tag{5}$$

$$S_t = \mu_g \cdot S_c + S_e \tag{6}$$

Where in:

Po: effective pressure

Δp: increased pressure due to surcharge

Pc: strengthened pressure

H: thickness of consolidation able layer

$\frac{C_c}{1+e_\circ}$: Coefficient of density index (0.120)

$\frac{C_s}{1+e_\circ}$: Rate of inflation index (0.015)

B: Base width

v: Poisson's ratio

E: modulus of soil elasticity

IP: Impact Factor (dimensionless)

P: net pressure applied (at times)

Sc: consolidation settlement

Se :elastic settlement

St: general settlement

μg: skampton and birom factor=0.7

A - Calculation of consolidation settlement				
Present overload pressure	Pre-consolidation pressure	Loud increasing on foundation surface	3D consolidation factor	Consolidation settlement
P_0 (kPa)	Pc (kPa)	ΔP (kPa)	μ	Sc (mm)
122.00	197.00	39.60	0.66	6.95

b-elastic settlement calculation					
Alignment under the column DSM	Foundation length	Foundation width	Length to width ratio	Foundation shape factor	Overhead press In different levels
y	L (m)	B (m)	m	Ip	Δq
0.00	75.30	31.50	2.39	1.64	43.60
4.40	79.70	35.90	2.22	1.60	36.15
14.40	89.70	45.90	1.95	1.52	25.12

After 6.5 m excavation in done calculations of location soil, considered consolidation and for settlement calculation the under layer soil is divided into several layers. Detailed calculation results in accordance with above relations as in table 4 and also software analysis in order to foundation settlement before and after location soil improvement operation is done by DSM method and it's analysis is done by Pllaxis 3D application (Table 5).

Table 4. Settlement calculation in foundation center based on corrected geotechnical data and overhead loud (100 kPa)

b-elastic settlement calculation					
Alignment under the column DSM	Foundation length	Foundation width	Length to width ratio	Foundation shape factor	Overhead press In different levels
y	L (m)	B (m)	m	Ip	Δq
0.00	75.30	31.50	2.39	1.64	43.60
4.40	79.70	35.90	2.22	1.60	36.15
14.40	89.70	45.90	1.95	1.52	25.12

Continued Table 4: settlement calculation in foundation center based on corrected geotechnical data and overhead loud (100 kPa)

Settlement below the Reinforced Block (Δh_2)					
A - Calculation of consolidation settlement					
Present overhead pressure	Pre-consolidation press	Loud increasing at foundation center	3D consolidation factor	Consolidation settlement at foundation center	
P_0 (kPa)	Pc (kPa)	ΔP (kPa)	μ	Sc (mm)	
112.00	187.00	48.81	0.66	13.01	
B-elastic settlement calculation					
Alignment under the column-DSM	Foundation length	Foundation width	Length to width ratio	Shape foundation factor	Overhead press in various levels
y	L (m)	B (m)	m	Ip	Δq
0.00	75.30	31.50	2.39	1.64	56.05
6.40	81.70	37.90	2.16	1.58	42.94
16.40	91.70	47.90	1.91	1.50	30.27

Soil type	Undrained adhesion-standard penetration number	Elasticity module	Poisson's ratio	Elastic settlement in foundation center	Elastic settlement in foundation center
	Number-(kg/cm^2)	E (kg/cm^2)	ν	Se (m)	Se (mm)

clay	0.79	790.00	0.40	0.0035	3.52
sand	20.00	500.00	0.30	0.0070	7.02
total				0.0105	10.54
Settlement below the Reinforced Block (Δh_2) (mm)			23.54		
Total Settlement (Δh)		**42.11**	≤ 50 mm OK		

Table 5. Results of centre settlement

	Plaxis 3D Foundation mm	Plaxis 3D 2012 mm	Plaxis 3D 2012 equivalent method mm	SES Method mm
Undrained with DSM	**24.54**		**28.61**	**29.1**
Drained with DSM	**49.75**	**44.83**	**46.29**	**42.11**
Undrained Without DSM	**28.82**		**29.98**	
Drained with DSM	**60.74**	**55.03**	**54.98**	

7. Results

In order to Geotechnical studies the soil of project location were drilled in 4 boreholes that were performed physical and mechanical tests on them that their results are as follows:

- The level of underground water at the project site is at the depth of 1.30 meters.

- The type of soil at the site are consists of fine clay and silt (CL and ML).

-Relative density of site soil to of depth 40 meters is equal to 20 KN per square meter.

- Uniformity coefficient of soil is increasing by depth increases gradually and is between 0.5 to 0.8 kilograms per square centimeter.

- elasticity modulus also increases with depth increasing as in shallow is 375 and in depth of 30 meters to 375 reach to 800 kg per square centimeters.

- according to the results of uniaxial test the soil resistance will be reduced gradually than the depth as in shallow depths is equal to 1.44 and in higher depths reach to 0.7 kg per centimeters .

- Elastic settlement in the foundation center is 0.0105

- Foundation settlement according to the analytical results of software before and after upgrading operations show different results as the foundation settlement reduced to about half after the improvement.

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