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Research Article

The effect of ground water on determining the foundations of a building through soil investigations

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Abstract:

The main objective of soil testing is to make sure of that the transported loads exerted by a building which is to be built is below the ultimate strength of the soil. In addition, the partial falling in the soil level caused by building process is still within the accepted limits. In this research, we have studied the properties of soil by making three holes with different depth in order to know the strength of soil to the exerted loads. Having taken all physical and chemical tests using both dynamic and static methods, we got to the conclusion that the suitable foundation is shallow (matt like or continuous).we also suggest making or construct two layers 25 cm thick each with an at least compaction percentage of 95% for constructing the building mentioned. The man objective of soil investigation is to ensure of that the magnitude of applied loads which transporting by a building through a sots is below the magnitude of ultimate strength of soil, in addition, the differential settlement of the soil caused by constructing a building is still within the accepted limits.

1. Introduction

Geotechnical investigation work was envisaged to assess the subsoil strata from secure bearing capacity point of view and to establish subsoil profile at the project location. Site research in one shape or the other is needed for every engineering project[1]. The goal of the Soil Investigation Program is to gain the following information and data: - 1- An evaluation of the site's standard suitability for the proposed project. 2- The intensity and type of the rules of the project, in proportion to the characteristics of the soil and the dimensions of the project. 3-The quantity of soil tolerance for the predicted hundreds from the project. 4- The quantity of predicted fall of the rules because of the project masses. 5- Damage that may arise to the area adjacent to the project as a result of excavations and different implementation works. In order to evaluate them and find suitable solutions for them [2].

2. Boring Methods and Standard Penetration Test

Set the take a look at pits to give a general idea about the soil layers and their properties, and the distances between the points are taken from 50m to 500m, depending at the website online area, the form of structures and the stratification of the soil, as well as the distances among each 4 points are taken to cover 10% of the web page area within the stage of exact investigations[3]. The distances between the factors are reduced via adding an average factor to the factors that were previously completed in the initial research degree. The distances among the points rely upon the form of structure and the stratification of the soil, and the distance may reach 10 m at times, such as (regions of cavities) voids and burial sites[4].

3- Undisturbed Samples and Laboratory Test

Sub-soil conditions described below are based on drilling and sampling in a total of three boreholes at the proposed site. A generalized sub-soil profile at the project location is described in various layers as follows. In the table 1 the thickness of various layers encountered (in mts) along with SPT N or RQD range as the case may be is tabulated. Masan province is part of flood plain region, which represent the recent surface formation of Iraq geology, since it contains the resent alluvial

sedimentation deposit from the three rivers, tigers and Euphrates [5-7].

4-Field Investigation

4.1 Boring and Method of Drilling

The boring equipment used to carrying out the field investigation were a rotary drilling machine which uses a flying auger and the rotary drilling with the use of core barrel for continues coring and thin wall tube samplers. The drilling used is (Han Jin) type which is a power driven machine. The method of drilling was performed according to the standards of the American Society for Testing and Materials (ASTM-D5783).

4.2 Recovery of samples

Undisturbed Samples
Undisturbed samples (U.S) (Shelby tubes), was obtained because of soil layers mainly consists of silt layers. Undisturbed samples are used to determine the strength and compressibility characteristics of soil, permeability, density and dynamic properties.

Disturbed Samples
Disturbed samples (DS) were collected at different depths along the boring depth from the cutting of auger at any depth. The samples that were secured by the standard split spoon samplers used in the Standard Penetration Test (SPT were also use as disturbed samples. All samples were put in labeled nylon bags and sent to t rye for further examination and testing. Disturbed samples are used for classification tests such as I classification grain size analysis and Atterberg limits) and physical test such as specific gravity and unit weight) and compaction characteristics of soil.

4-3 Standard Penetration Test (SPT)

In this study, the consistency of the soil was measured at several depths by Standard Penetration Test (SPT). The test was performed in all types of soil especially in sandy layers. The test involves recording the number of blows of 140 lb. (63.5Kg) standards hammer with a 30-inch (760mm) drop to drive the 2-inch. (50.8mm) diameter standard split spoon sampler into the soil a distance of 12- inch (305mm).

5-Laboratory Testing

5-1 types of Testing

Laboratory tests were conducted on most disturbed and undisturbed samples were delivered to the laboratory. A laboratory testing program was conducted to classify soil and to evaluate the physical, mechanical, and chemical properties of the sub-surface soil.

6-Tests Results And Analysis

The details of test results for boreholes are presented in the form of a data sheet (able) and given in Appendix (B). From the test results the following conclusions can be drawn:
1-The visual classification and grain size analysis results indicate that the soil ranged in classification and composed of one type of soil as dark red to light brown soft to medium High plasticity elastic silt (MH) with a trace of dark red to light brown soft to medium low plasticity silt (ML) According to (USCS), the soil can be classified as (MH)
2-The Atterberg limits results of the soil layers indicated that the values of and the values of plastic liquid limits L.L are ranged between (42.6 – 58.3)% while the values of the plasticity limits are ranged (27.9 – 32.5)% between the soil is indexes are ranged between
(19-25.8)% , the soil is high plastic material.
3 -The physical tests results indicated that the values of the specific gravity (Gs) is (2.75)
4-The results of Standard Penetration Test (SPT) indicated that the values of number of blows are between (9-14) blows The modified value of SPT can be adopted in bearing capacity calculations and settlement analysis.
5 -shear tests can be done for this type of soil, the settlement analysis and the shear parameters can be found depending on the test results of the soil and the correlations of soil mechanics The values of the initial void ratio (eo) are ranged between (0.544-0.6) %, the values the compression index (cc) are ranged between (0.083-0.091)%, Regarding to the SP results, the soil high plasticity elastic silt.
6- The results of chemical test for the soil samples indicated that the range of the total soluble salts content (TSS) varies between (2.21-2.42)% The range the gypsum content (Gyp) varies between (1.4-1.44)% These results indicated that the soil consists of low to medium content of salts.

7.Sub Soil Stratification

7.1 Soll Profile Description

The borehole logs shown in Appendix (A) indicate that the soil is composed of one layer as dark red to light brown soft medium high plasticity silt (MH) with a trace of Dark red light brown soft to medium

low plasticity silt (ML), according to (USCS) the soil can be classified as (MH). The grain size distribution of the first layer shows that the soil layer consists of about 58% silt, 23% clay, 10% sand

7.2 Ground Water Level

The underground water level is found at depth (1.5m) below the natural ground surface (N.G.S) This during the time of boring at (November \ 2014) level may be changed during the coming seasons by effect of rainfall

8. Recommendations And Precautions

Geotechnical investigations have been conducted for (modern Butchery Building Project \ Al-Musharah City) geotechnical boreholes were constructed to give total depth of boring geotechnical field and laboratory tests were conducted on boreholes. Based on geotechnical investigations results, the following recommendations and precautions can be drawn.

8.1 Bearing Capacity

important to mention that the allowable bearing capacity of the soil depends on the proposed foundation type. Consequently are changeable and different values for bearing capacity when the trpe of foundation to use is changed. However, depending on the SPT and the soil Lab results, the following bearing capacities are recommended with depth:

Allowable Bearing Capacity for shallow foundations

Regarding to the site tests (SPT) and the Lab tests, the shear strength parameter is adopting to evaluate the allowable Bearing capacity (BC) for shallow foundations using Terzaghi formula and the modification suggested by Meyerhof (1963) with factor of safety equals (3.0).The allowable gross bearing capacity for the borehole

Table 1. *The thickness of various layers encountered along with SPT N or RQD range.*

Depth (m)	$Q_{all(gross)}$ *(Ton/m²)*
1.0	*4.1*
2.0	*4.5*
3.0	*4.9*
4.0	*5.2*

However, according to structure type, the following recommendations are drawn:

1- shallow reinforced Foundation (isolated, continues or raft) is recommended for the building which should be placed at depth not less (1.0m) below the natural ground level and width not less than continues foundations, beneath the proposed foundation 0.25m of well compacted cobble and 2 layers, 0.25m thickness for each layer of Well compacted sub-base to be the total depth of excavation more than 1,75m, the allowable bearing capacity of foundations are ranged between (4.2 Ton/m2) at this depth.

2- The final decision concerning the selection of the more suitable type of foundation is the structural designer task. The actual design stress is not computed yet for structure but it should be taken into consideration that the imposed design load should not exceed the allowable bearing capacity of soil.

3-The dimensions of proposed foundation should be designed where the applied pressure not exceed the allowable net soil bearing capacity which was given in this report regarding to the depth and furthermore the settlement should be within the acceptable limits, for safe design, the settlement should be not exceed 45.0mm.

8.2 Recommendations

To improve the allowable bearing capacity it is suggested to replace(0.75m) beneath the base of the foundation to be the total depth of excavation (1.74 m)below the natural ground level by a one layer of excavation cobble and two layers of well compacted sub-base;

Type B: (0.25m) for each layer with the following requirement:

a- The value of CBR not less than 35% (ASTM D1883) at 95% of the max.

b-Liquid limit 35% maximum.

c-Relative compaction not less than 95% modified.

De-watering

The field tests indicate that the depth of ground water level is (1.5m) below the natural ground, so de-watering is required in case excavation more than 1.5m.

The ground water should be pumped out, in case of excavation more than 1.5m using adequate trenches and sumps.

Preparing Works

The site shall be cleaned, leveled and all debris, bricks, orgiastic matter, salts, unsuitable soils and deleterious materials shall be removed disposed out of the site.

Placement

Due to presence of salts in soil, the following precautions should be done:

1-Cement slurry (5% cement) should be poured before compaction or use a (10.0 M) blinding concrete.
2-All concrete in contact with soil should be coated with bitumen's materials in three layers to prevent the effect of salts on the foundation.
3-Precautions should be taken to protect the steel reinforcements and any metal type
4-it is recommended to use sulfate Resisting Portland cement not less than 4 kg m and maximum (w/c) is 0.45
5-Placing the foundations at a depth is minimum (1.0 m) below the natural ground surface and width not less than (1,25 m) in case of continues foundation.

Type of Cement

For the concrete of foundation, the following points are written for convenience:
1- Sulfate-resisting cement Type must be used in all concrete works in contact with the soil.
2- Minimum cement content is (400kg/m3)
3- Maximum free water cement ratio of (0. 45) by weight should be used.
Figure 1 shows soil Profile for Boreholes.

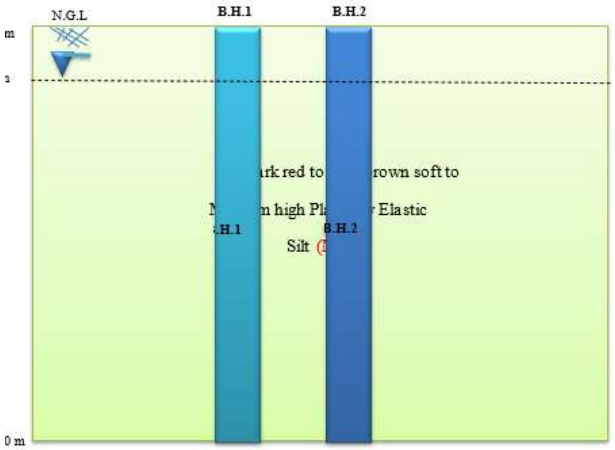

Figure 1. *Soil Profile for Boreholes (1) and(2)*

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

[1] American Society for Testing Materials (ASTM), (1989).
[2] Bowles, J.E.,(1996), Foundation Analysis and Design *5th Edition McGraw Hill Book Company*.
[3] Lambe, T.W. and Whitman, R.V., (1951), Soil Testing for Engineers *john Wiley & Sons*.
[4] Lambe, T.W. and Whitman, R.V., (1969), "Soil Mechanicals", *John Wiley & Sons.*
[5] Terzaghi, K. and Peck, R.B., (1967), "Soil Mechanics in Engineering Practice, 2nd Edition, *John Wiley & Sons, New York*.
[6] Terzaghi, K. & R. B. Peck (1948) "Soil Mechanics in Engineering Practice", 1st Edition, John Wiley & Sons. Inc., *New York of natural*
[7] Bur land, J B. (1990). On the compressibility and shear clays, *Géotechnique,* 40(3): 329-378