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CALCULATION OF VERTICAL SETTLEMENT VALUES FOR SHALLOW FOUNDATION IN SANDY SOIL UNDER THE INFLUENCE OF DIFFERENT VERTICAL LOADS BY FINITE ELEMENT METHOD AND GEO 5 SOFT WEAR

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Abstract

Settlement values for shallow foundation in sandy soil in Al-Nasir District in Al-Najaf Al-Ashraf city under the influence of different vertical loads had been calculated by finite element method and GEO 5 soft wear. Research methods included field, laboratory and office works. The model had been designed to represent sandy soil with direct contact by reinforced concrete footing and the loads values was applied on this footing were (80, 100, 120, 140, 240kPa / m^2) and the maximum settlement values for shallow foundation were (5.8, 7.5, 9.5, 11.7, 24.6 mm.) respectively, which were acceptable for general values of settlement for shallow foundation with these applied loads.

Key words : Settlement, soil, finite element, GEO 5 software.

Introduction

Calculations of settlement of shallow foundation in different types of soil is very important in design of buildings and structures for different projects (Das, 1999) and the settlement caused by different types of applied loads (Peck and Hanson, 1974). In this study, we will discuss the vertical loads .the calculations of settlement depend on physical and mechanical and chemical properties of soil which obtained by field and laboratory tests for soil samples (Tomlinson, 1991). In this paper, soil properties and parameters obtained from drilling 3 boreholes to a depth of 10 m below natural ground level in the Al-Naser district in Al-NajafAl-Ashraf city.

The objective of this paper is to calculate shallow foundations settlement under 5 different applied vertical loads on footing and soil by using finite element method with GEO 5 models.

Study area

Al-Najaf city located in Al-Najaf province which is characterized by (Pliocene – Pleistocene) deposits in upper part of Geologic cross section, which represent by Dibdibba Formation and the study area located in Al Nasir district which is residential and commercial district .

Field work

Including the following works :

Drilling of Boreholes

The boring equipments used in carrying out the field work were the Auger drill method which is used for taking the samples.

The depth of boring were selected to extend to underneath the zone of influence of significant foundation pressure to materials that were relatively incompressible.

The method of drilling was carried out according to the standards of the American Society for Testing and Materials (ASTM D1452 & D5783).

Sampling

Disturbed samples

The disturbed samples were obtained, according to (ASTM D-1586) and as required to determine the classification of the soil layers. The samples that were secured by the Standard Split Spoon Sampler were also used as disturbed samples. All disturbed samples were sent to the Laboratory for further examination and testing. Samples were placed in waterproof plastic bags.

Undisturbed samples

Undisturbed samples didn't obtained from the soil layers in this site because of the fact that most of the layers in the soil section composed of cohesionless soils which it hard to obtained as undisturbed samples.

***In situ* Testing**

Standard Penetration Test

In the course of drilling work, the consistency of the soil was measured at several depths by Standard Penetration Test (S.P.T), which conducted according to ASTM D1586-99. The test was performed in all types of soil. The test involves recording the number of blows of 140 lbs. (63.5 kg) Standard Hammer with a 30-inch (76 cm) drop to drive the 2-inch (50.8 mm) diameter Standard Split Spoon Sampler into the soil a distance of 12 inches (30.5 cm).

Soil description

According to the *in situ* and some of laboratory testing carried out on the soil of the studied area, the subsoil strata encountered at the investigated locations are detailed on the boreholes logs (figs. 1, 2, 3, it was found that the subsoil in the project site is mostly medium light yellowish brown Well graded SAND layers overlaying dense light yellowish brown Well graded SAND layers overlaying very dense light yellowish brown well graded SAND with silt layers, which extended to the end of boring .The soil layers in this section contain different ratios of gypsum and total soluble salts (T.S.S.). The water table was encountered ,as observed at about 5 m. below the existing ground level in the project site.

The water level measurement was conducted according to (ASTM D-4750).

Laboratory tests

Laboratory soil testing was carried out on soil samples taken from the boreholes in order to design the finite element model.

The testing program included the following major tests on representative samples:

1. Natural Moisture Content and Unit Weight. (ASTM D-2216)

2. Specific Gravity. (ASTM D-854)

3. Grain Size Distribution. (ASTM D-422)

4. Liquid and Plastic Limits. (ASTM D-4318)

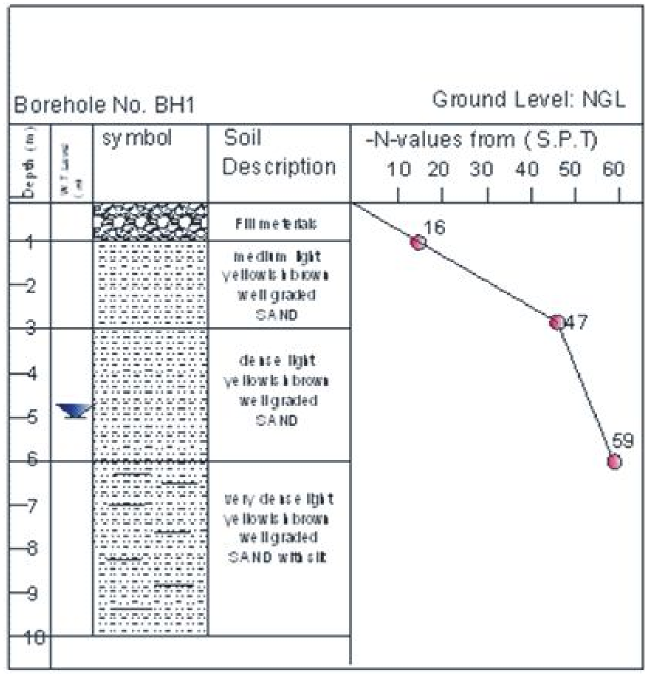

Fig. 1 : show soil layers with SPT values in B.H.1

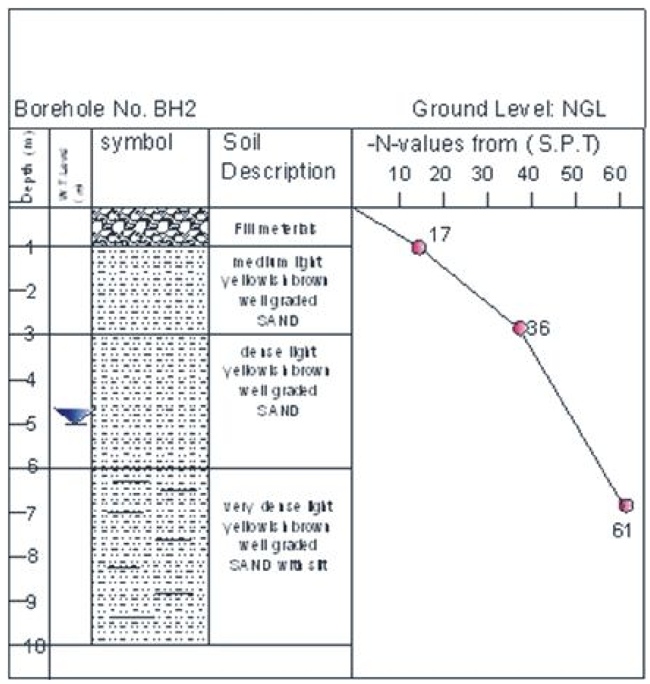

Fig. 2 : show soil layers with SPT values in B.H.2

Table 1 : Values of soil parameters.

Soil parameters	Values
Unit weight kN/m^3	21
Elastic modulus Mpa	25
Poisson's ratio	0.28
Model	Mohr - Coulomb
Angle of internal friction o	34^o
Cohesion kN/m^2	0

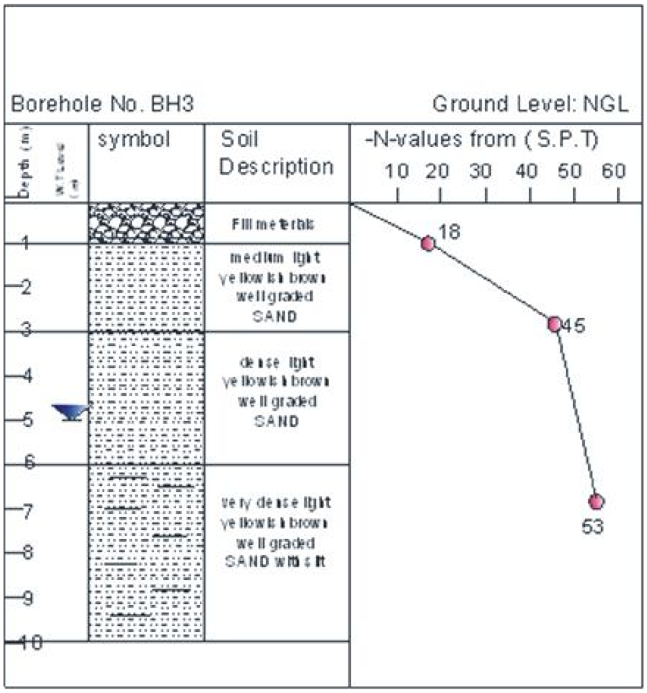

Fig. 3 : show soil layers with SPT values in B.H.3

5. Shear Test

(a) Direct shear test ASTM D 3080-04

6. Chemical analysis on soil

(a) Sulphate Content as SO_3 for soil.

(b) Organic content

(c) gypsum content

(d) TSS content

All the tests were conducted according to the current Standards of the American Society for Testing and Materials (ASTM), mentioned against each test.

6- Calculation of settlement

The finite element method is common for analysis in engineering works . GEO 5 software used in this research for calculations .The concrete footings were modeled using plate elements with linear elastic behavior. The size of the finiteelement mesh was 10 m (length) × 10 m (depth), while that of the strip footing was 1.0 m width and 1 m depth . For the boundary condition, fixed and roller conditions were applied at the bottom and lateral boundaries, respectively. The simulation of soil settlement under strip foot done by applied loads were 80, 100, 120, 140, 24kpa/m2. Mohr-coulomb model used for analysis process .the parameters that were used for the soil model listed in table 1, which derived from the values of laboratory tests of soil layers specially the upper layers in contact with footing base which extended to the depth of 3 m below.

Results and Discussion

Settlement values of soil were increased by increasing the loads on footing. When a load of 80 kpa/m^2 was applied on the model footing, the maximum settlement value was 5.8 mm below the base level directly. These values decreased as a zones of values to reach lowest values 1.5 mm, as shown in fig. 4.

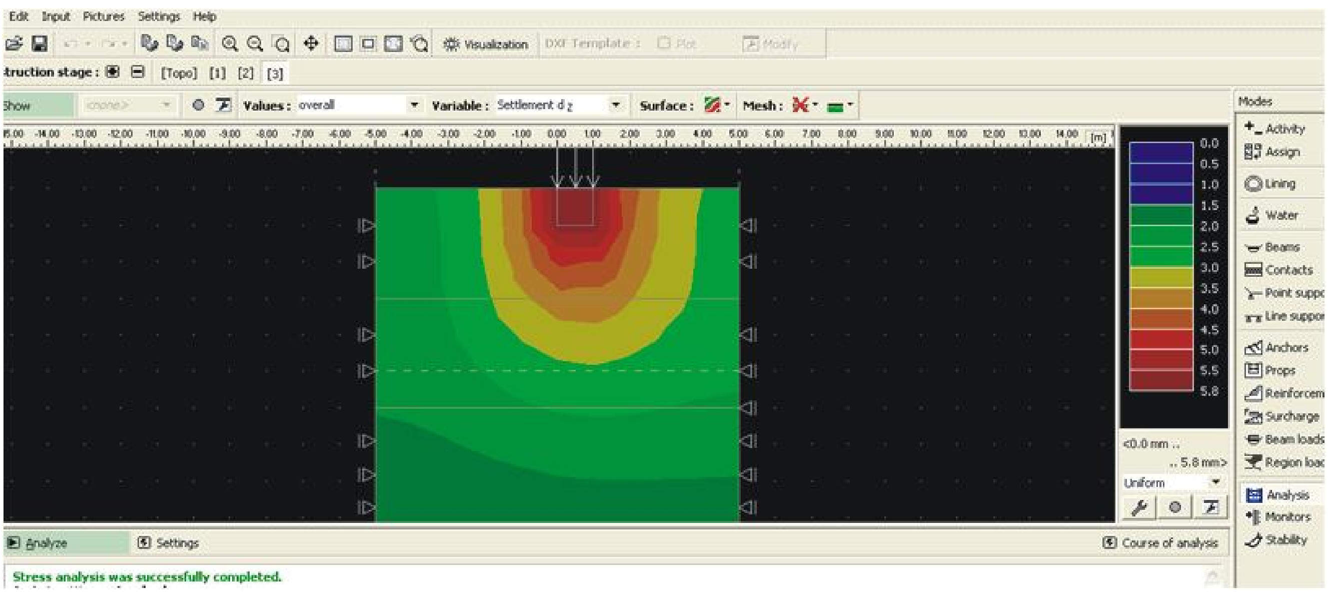

Fig. 4 : shows vertical settlement under applied load = 80kPa/m^2.

When a load of 100 kpa/m^2 was applied on the model footing , the maximum settlement value was 7.5mm below the base level directly. These values decreased as a zones of values to reach lowest values 2 mm, as shown in fig. 5.

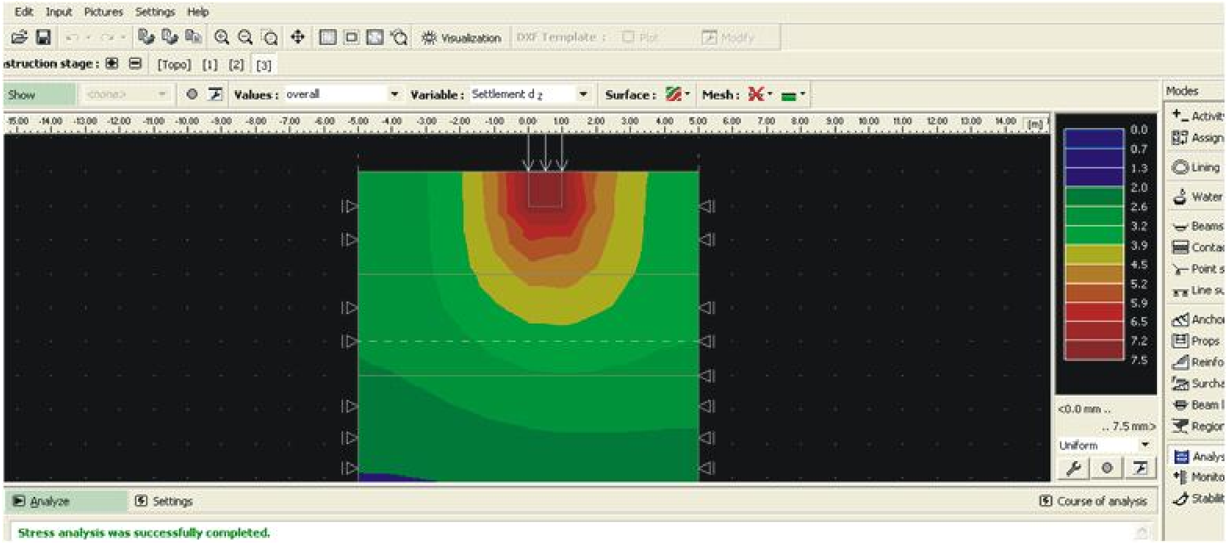

Fig. 5 : shows vertical settlement under applied load =100 kPa/m^2.

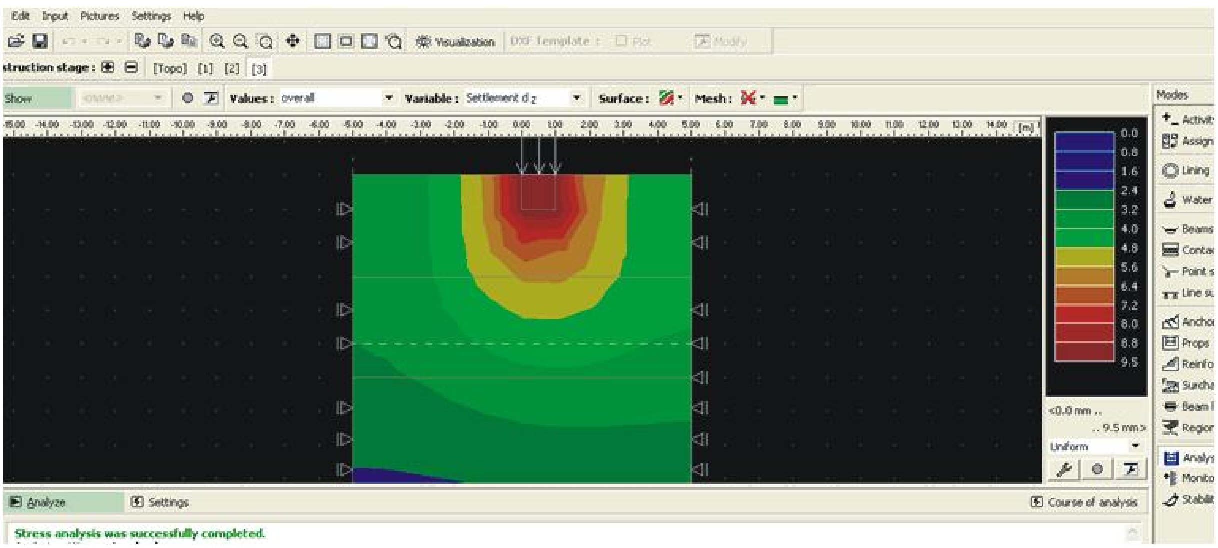

Fig. 6 : shows vertical settlement under applied load =120 kPa/m^2.

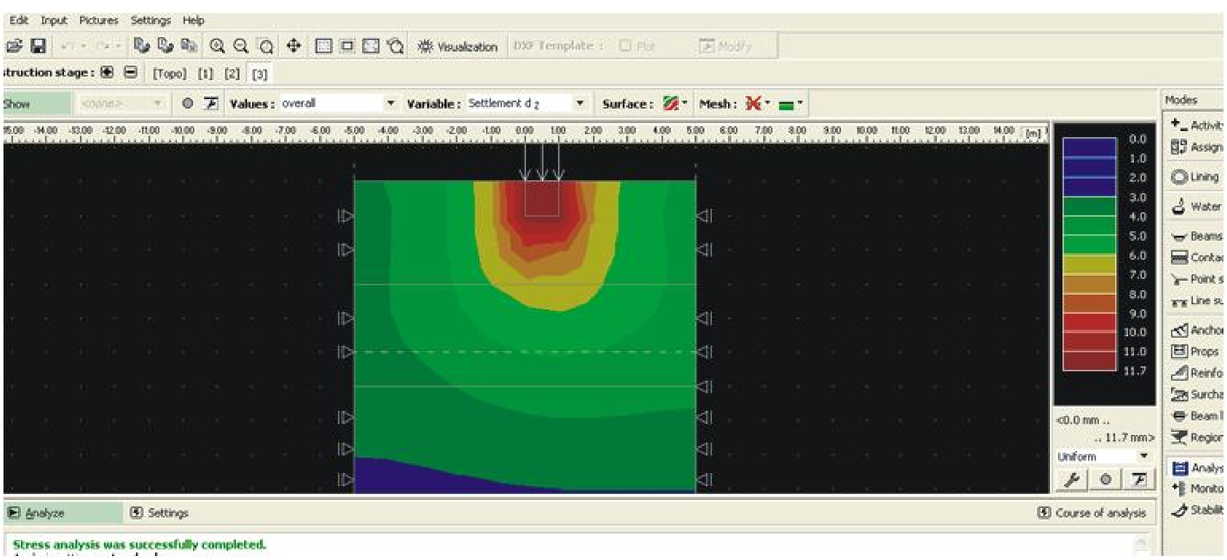

Fig. 7 : shows vertical settlement under applied load =140 kPa/m^2.

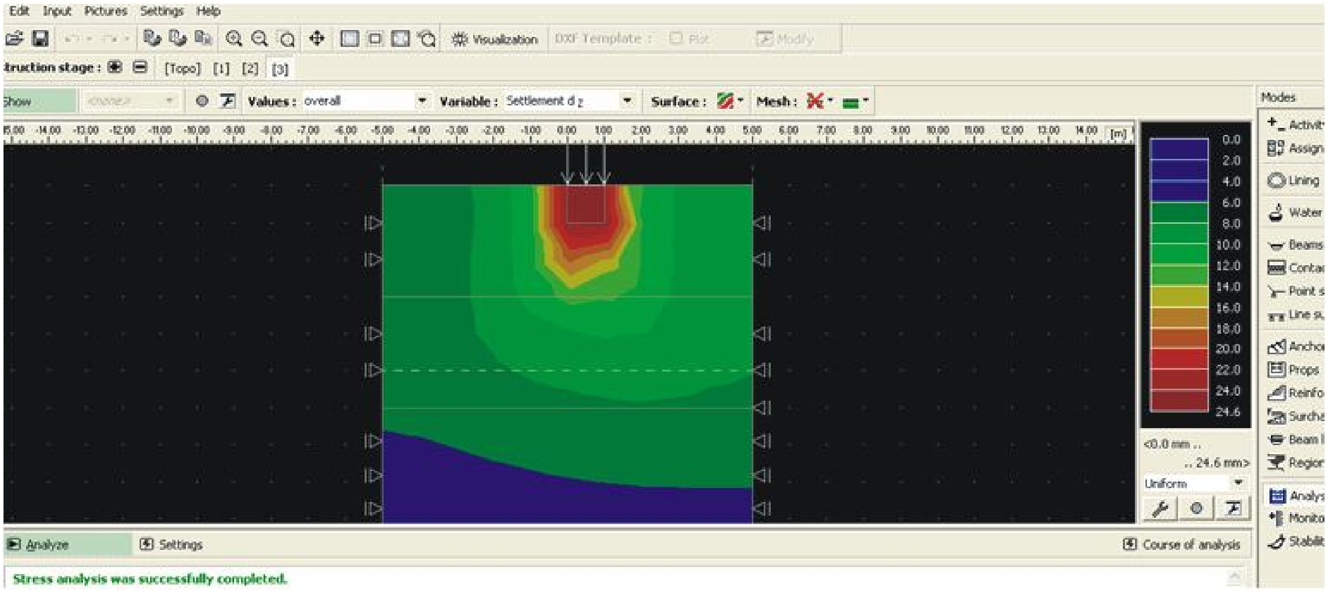

Fig. 8 : shows vertical settlement under applied load =240 kPa/m^2.

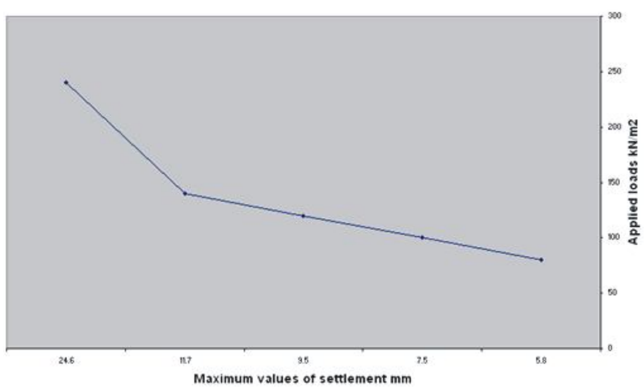

Fig. 9 : shows relationship between vertical settlement values and vertical applied loads.

When a load of 120 kpa/m^2 was applied on the model footing , the maximum settlement value was 9.5mm below the base level directly. These values decreased as a zones of values to reach lowest values 2.4 mm, as shown in fig. 6.

When a load of 140 kpa/m^2 was applied on the model footing, the maximum settlement value was 11.7 mm below the base level directly. These values decreased as a zones of values to reach lowest values 3 mm, as shown in fig. 7.

When a load of 240 kpa/m^2 was applied on the model footing, the maximum settlement value was 24.6 mm below the base level directly. These values decreased as a zones of values to reach lowest values 6 mm, as shown in fig. 8.

The relationship between vertical settlement and vertical applied loads had been shown in fig. 9.

The above calculated values were acceptable for general values of settlement for shallow foundation with these applied loads used in this paper (Terzaghi and Peck, 1967).

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