Journal of Engineering and Applied Sciences 13 (10): 3657-3662, 2018
ISSN: 1816-949X

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 Software

Khalid Waleed Hadi
Science College, University of Al-Qadisiyah, Diwaniyah, Iraq

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 Software. 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, 240 kPa/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, foundation, loads

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 *et al*., 1974). In this study, we will discus 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 study, 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-Najaf Al-Ashraf City.

The objective of this study 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.

MATERIALS AND METHODS

Field work: Including the following works.

Drilling of boreholes: The boring method used in carrying out the field work were the Auger drill method according to ASTM D1452&D5783 (ASTM., 1970).

Sampling: The disturbed samples included samples which taken from drilling auger according to ASTM D-1586, also SPT. Samples while 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 (SPT): It was done in the field which conducted according to ASTM D1586-99. 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 laboratory tests of soil samples of the studied area, the subsoil layers at the investigated locations are shown on the boreholes logs Fig. 1-3, 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 study contain different ratios of gypsum and Total Soluble Salts (TSS). 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.

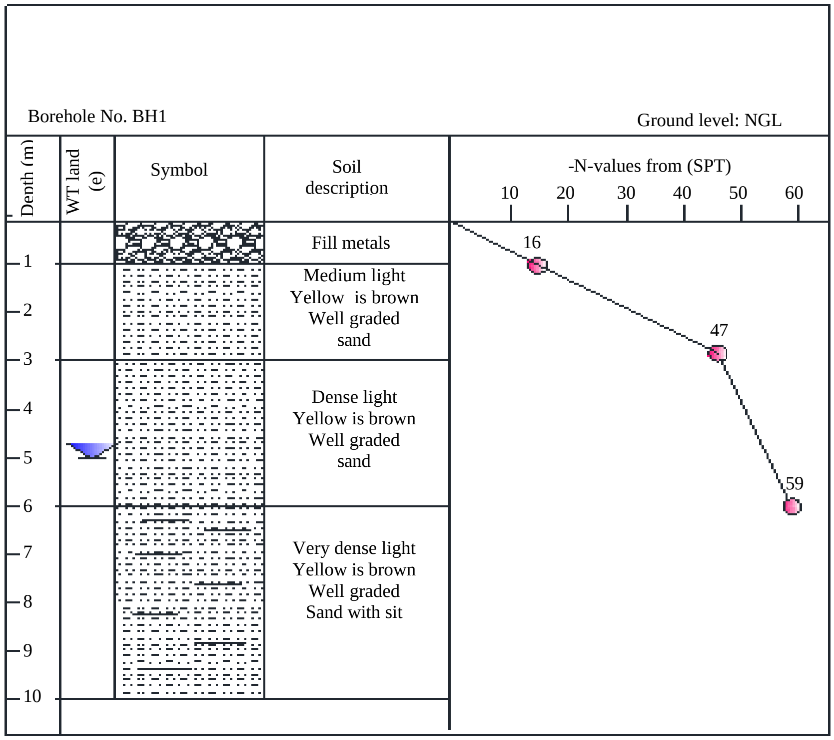

Fig. 1: Soil layers with SPT values in BH1

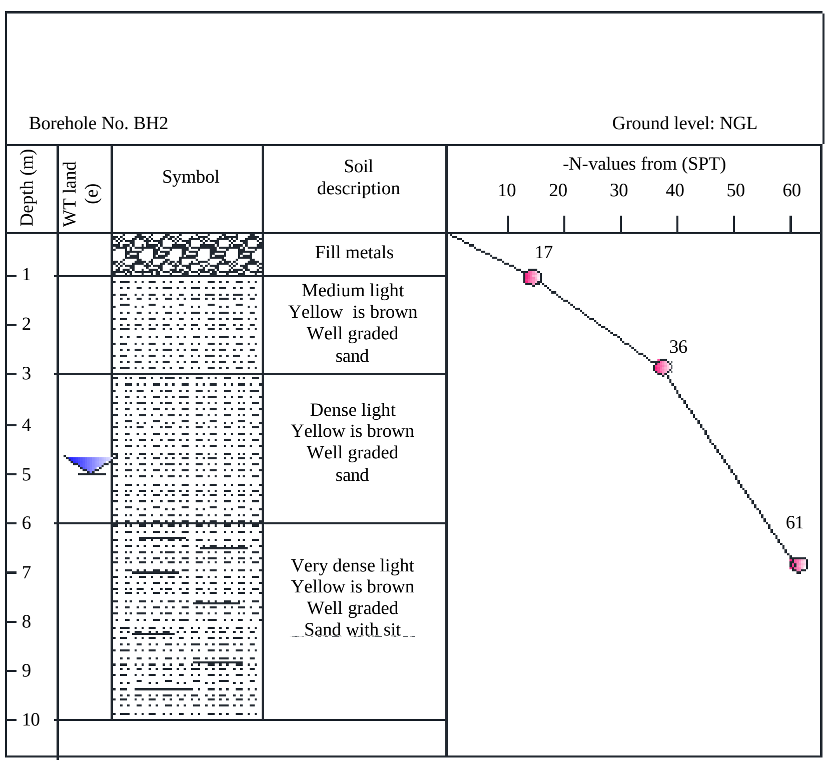

Fig. 2: Soil layers with SPT values in BH2

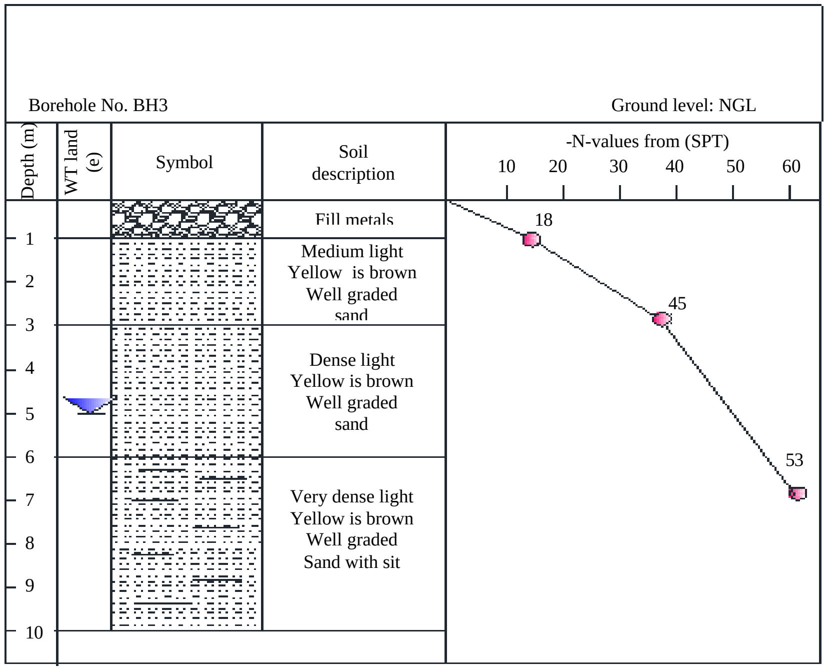

Fig. 3: Soil layers with SPT values in BH3

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:

- Moisture Content (MC) and unit weight: (ASTM D-2216)
- Specific Gravity SG: (ASTM D-854)
- Grain Size Distribution: (ASTM D-422)
- Liquid Limit (LL) and Plastic Limits (PL): (ASTM D-4318)
- Shear test
- Direct shear test ASTM D 3080-04
- Chemical Analyses on soil
- Sulphate (SO_3) content
- OM content
- Gypsum content
- TSS content

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 finite element 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, 24 kPa/m^2. 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.

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°
Cohesion (kN/m^2)	0

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.

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

When a load of 120 kPa/m^2 was applied on the model footing, the maximum settlement value was 9.5 mm 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

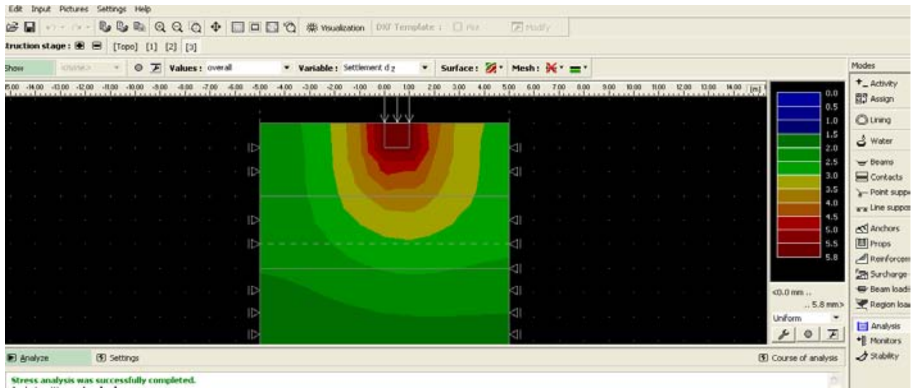

Fig. 4: Vertical settlement under applied load = 80 kPa/m^2

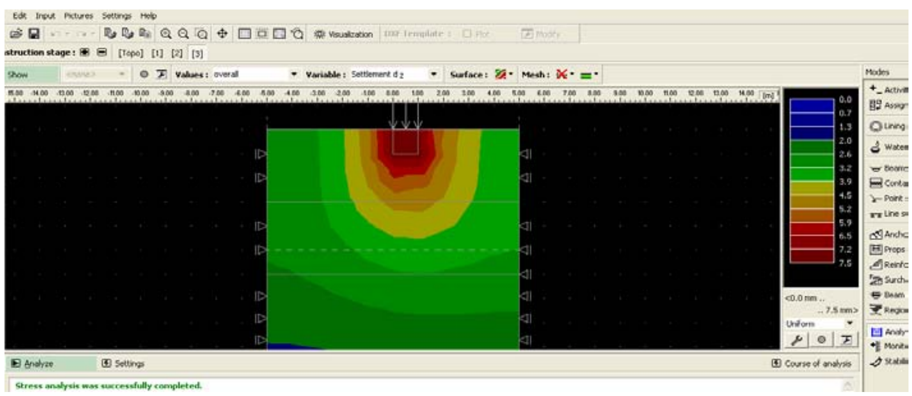

Fig. 5: Vertical settlement under applied load =100 kPa/m^2

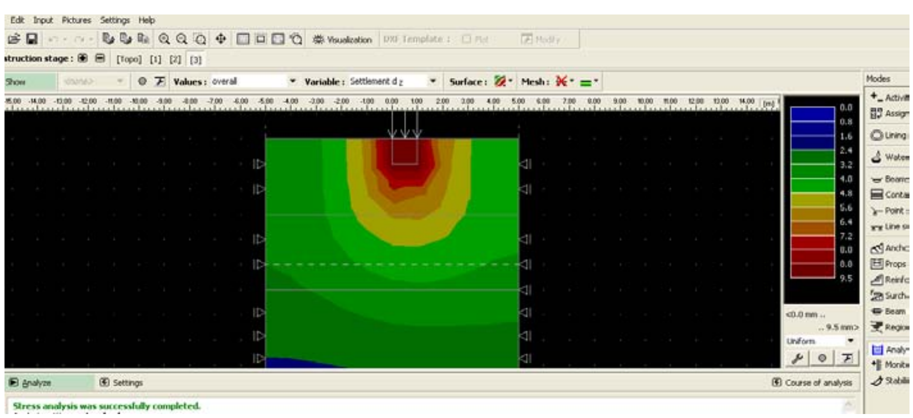

Fig. 6: Vertical settlement under applied load =120 kPa/m^2

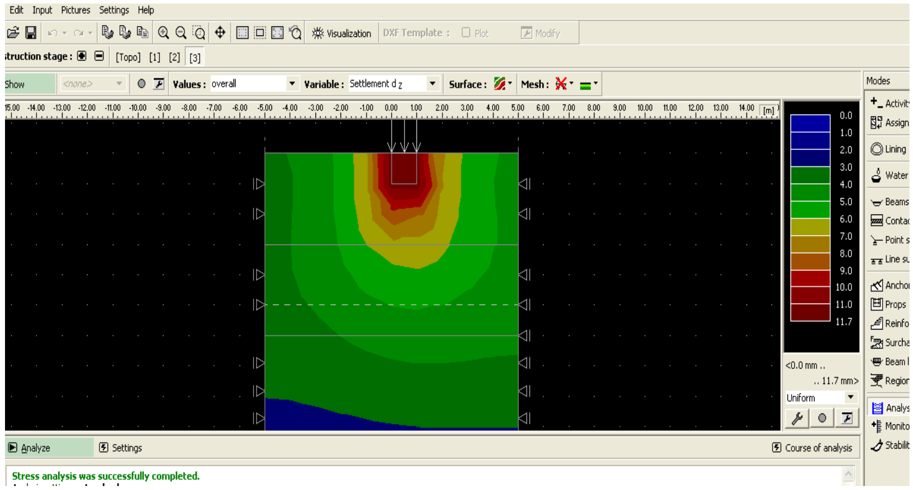

Fig. 7: Vertical settlement under applied load = 140 kPa/m²

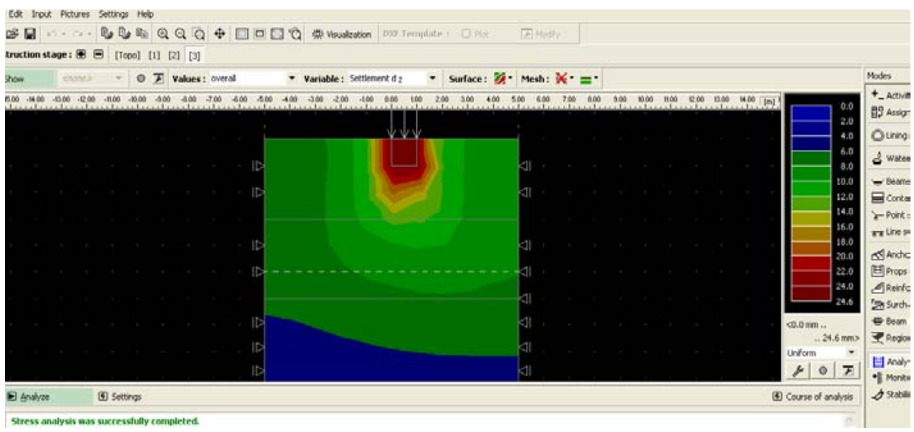

Fig. 8: Vertical settlement under applied load = 240 kPa/m²

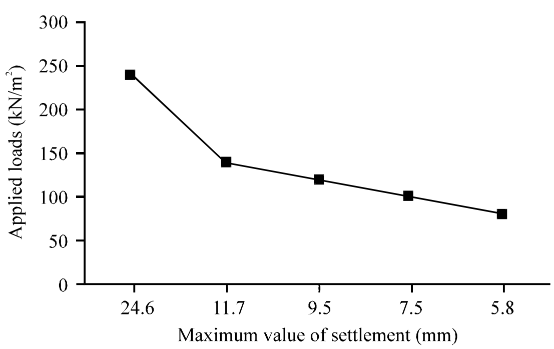

Fig. 9: Relationship between vertical settlement values and vertical applied loads

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 study (Terzaghi and Peck, 1967).

CONCLUSION

The objective of this study 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.

REFERENCES

ASTM., 1970. Manual Book Part II. American Standards for Testing and Materials (ASTM), West Conshohocken, Pennsylvania, USA.,.

Das, B.M., 1999. Priciples of Foundation Engineering. 4th Edn., PWS Publishing, Melbourne, Australia, ISBN:9789814040228, Pages: 862.

Peck, R.B., W.E. Hanson and T.H. Thornburn, 1974. Foundation Engineering. 2nd Edn., John Wiley & Sons, Hoboken, New Jersey, USA.,.

Terzaghi, K. and R.B. Peck, 1967. Soil Mechanics in Engineering Practice. 2nd Edn., John Willey and Sons, New York, USA., pp: 729.

Tomlinson, M.J., 1991. Foundation Design and Construction. Addison-Wesley, Boston, Massachusetts, USA.,