EXTENDED ABSTRACT

The Analytical and Experimental Study on the Settlement of Cast-in-Situ Concrete Piles in Sand

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1. Introduction

Generally, prediction and calculation of the settlement of piles are complicated due to soil change during pile construction and many uncertainties inherent in the load distribution along the shaft and base of the pile. Therefore, most of the suggested relations about the settlement of piles are empirical. The results of some load tests in sand are available in reports. The empirical and semi-empirical relations have been used for the calculation of pile settlement previously by researchers. However, nowadays, calculation of pile settlement is carried out by load-transfer, elasticity theory and numerical (such as finite element) methods. Pile load test is one of the accurate methods for evaluation of pile settlement that is generally applied for important projects. In this study, settlements of piles were measured by performing compression load tests on 12 small scale cast-in-situ concrete piles in sandy soils and the obtained results were compared with the results of some other settlement calculation methods.

2. Methodology

2.1. Site characterization

The area of study is located in Sorkhroud city. The soil of this region consists of coastal deposits. The groundwater table was below the base of piles. Therefore, the effect of groundwater on piles was not considered in this study. Then, laboratory and in-situ tests were carried out.

2.2. Load tests on piles

The compression load tests were carried out using constant rate of penetration (CRP) method and in accordance with ASTM D 1143-81[1]. In this study, 180*80*80 cm concrete blocks were used to provide reaction for the applied load. The weight of each block was about 2.7 ton. The blocks were placed on a 6-m long beam. The piles were loaded by utilizing a 50 ton capacity hydraulic jack having a stroke of 15 cm, placed below the beam. Figs. 1-3 show the equipment.

2.4. Pile settlement calculation methods

In the present research, the settlements of piles were calculated by Meyerhof’s empirical and Vesic’s semi-empirical methods [2, 3]. On the other hand, recently, computer programs can numerically model piles and evaluate their settlements. In the numerical modeling, selection of soil modulus of elasticity is usually difficult considering soil’s elastic behavior. Therefore, different relations have been suggested for estimation of this parameter. The study shows that by performing pile load test and considering soil’s elastic behavior, the soil modulus of elasticity can be estimated using back analysis. For this purpose, the piles were numerically modeled using the computer program PLAXIS 2D and the obtained load-settlement curves were compared with the corresponding curves obtained by pile load tests.

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3. Results and discussion

The load-settlement curves of piles were determined by performing pile load tests. The settlement calculation was performed for the selected piles using empirical and semi-empirical methods. The results show that empirical and semi-empirical methods are in a good agreement with the results obtained by pile load tests. Since soil behavior is modeled using Mohr-Coulomb elastic-plastic model, the settlements of piles depend on soil modulus of elasticity significantly. In this paper, soil modulus of elasticity was determined using back analysis and trial and error methods for the selected piles considering their allowable loads.
4. Conclusions

In this study, the settlements of piles in sandy soils were evaluated by performing pile load tests. At first, soil modulus of elasticity was estimated using finite element method. The results depict that the obtained soil modulus of elasticity is in a good agreement with Schmertmann method [4]. The obtained sand modulus of elasticity with medium relative density is about 12000 kPa. Vesic’s semi-empirical and Meyerhof’s empirical methods [2, 3] evaluate the settlements of piles acceptably which can be used for practical purposes. However, Meyerhof [2] method was more accurate. The results show that by selecting an acceptable empirical coefficient $C_p$ in the Vesic [3] method, pile settlement can be predicted more accurately. The disturbance of soil during pile construction greatly affects this coefficient. In the present study, the empirical coefficient ($C_p$) was estimated 0.035 for in-situ piles constructed in slightly disturbed sandy soils with medium relative density.

5. References