AIN SHAMS UNIVERSITY
FACUALTY OF ENGINEERING
DEPARTMENT OF STRUCTURAL ENGINEERING

A Thesis
Submitted in Partial fulfillment for The Requirement of the Degree of Doctor of Philosophy in Civil Engineering

# Response of Large Diameter Bored Piles in Clayey Soils under Axial Compression Loads

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# STATEMENT

This dissertation is submitted to Ain Shams University for the Degree of engineering science Doctor of Philosophy in Civil Engineering.

The work included in this thesis was carried out by the author, in the Department of Civil Engineering, faculty of engineering from January 2014 and up to date.

No part of this thesis has been submitted for a degree or for a qualification at any other University or Institution.

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Abstract of A Thesis Submitted in Partial Fulfillment for The Requirement of The Degree of Doctor of Philosophy in Civil Engineering.

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Title of thesis

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## ABSTRACT

Recently, significant growth is experienced in construction of the high rises buildings, offshore ports, wind power mills, storage silos and many other types of heavy loaded structures. In these cases, bored piles with large diameters are the most qualified elements of the deep foundations that efficiently can be utilized in various subsurface conditions. They are employed most frequently both to support heavy loads and to minimize settlement. The in-situ full scale pile loading test is the most recommended methodology by several international geotechnical codes to determine the ultimate capacity of large diameter bored piles. However, loading of this type of piles till reaching apparent failure is practically seldom.

In this thesis, the behavior of the large diameter bored piles in clayey soil under axial load was investigated utilizing in situ measurements of two instrumented large diameter bored piles loading tests. Apparent failure was achieved by end of the first loading test. This test was performed on short large diameter bored pile at the Alzey Bridge site in Germany. In contrast, apparent failure was not achieved in the second in situ loading test of Damietta Port New Silo long large diameter bored pile, although this long pile was tested under load of about three times its working load.

On the other hand, numerical study was carried out to investigate the behavior of both bored piles under axial compression loads. Measurements of the first pile load test were used to assess the quality of the numerical models investigated. Sensitivity analyses with respect to mesh size, element type and discretization were conducted and different iteration procedures were assessed. Then, the effect of soil constitutive models and interface approaches were investigated. After calibrating the numerical model, obtained ultimate capacity has been utilized to assess the predicted pile ultimate capacity using different international codes and design methods.

Comprehensive parametric study was performed using the validated finite element model to investigate different factors that affecting ultimate capacity and settlement of the large diameter bored pile in clayey soils. These factors were classified into two main categories. First category included the pile geometry factors: pile diameter (D), and length (L). The second category was concerned with the cohesive soil parameters: clay effective cohesion (C'), effective friction angle (Ø'), lateral earth pressure coefficient (K), soil Young's modulus (E), and soil dilatancy angle (Ψ).

Field measurements of both loading tests have been used to assess the obtained ultimate capacity using Meyerhof (1951) classical method. Based on the performed parametric study, the essential modifications were elaborated on the Meyerhof classical formula to be able to predict of a reliable value of the ultimate capacity for the large diameter bored piles. A validation of the modified Meyerhof method was carried out by comparison with the results of (12) in situ-loading tests. Regarding the settlement of large diameter bored piles, using the numerical simulation results a new method was developed for the prediction of pile settlement under both of failure and working loads. Results of (12) in-situ pile loading tests and (23) numerical models have been used in validation of the proposed pile settlement equations.

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