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Development And Assessment Of A New Method For Interpreting Bidirectional Pile Load Test Results

by

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Date & Venue

02:30 PM

Tuesday, 31 January 2023

F1-1117

Abstract

This thesis is concerned with interpreting the bidirectional (O-cell) pile load test results. The O-cell test is a recent pile load test that utilizes a sacrificial loading cell placed at or near the bottom of the pile to apply a bidirectional load. Thus, it differs from the conventional top-load test by the nature of the applied load and the produced results. The conventional test results in a single curve that shows the applied top load versus the corresponding settlement of the pile's top, which is used to estimate the settlement at expected working loads and the ultimate carrying capacity of the pile. However, the O-cell test results in three different curves. The first curve shows the applied downward load versus the downward settlement at the bottom of the pile. The second and third curves show the upward applied load versus the top of the cell and versus the top pile displacement, respectively. To benefit from the bidirectional pile load test results, they should be interpreted and converted to what is known as the Equivalent Top-Load (ETL) curve, which should be representative of the load-settlement curve that would be produced from a conventional pile-load test. There are many empirical methods suggested in history to construct the ETL curve. In this research, the available methods for interpretation of the O-cell test results to construct the ETL curve were reviewed and assessed. The assessment was performed by applying these methods to several well documented cases in the literature for the O-cell pile load test to estimate the corresponding ETL curves. These estimated curves were compared to the curves (reference curves) produced from simulated corresponding conventional tests using the finite element method. The judgment was mainly based on finding the error in the settlement at expected working loads and the ultimate carrying capacity of the pile estimated from the ETL curve. Throughout the assessment, it was noted that the ETL curve estimated from the different interpretation methods produces a significant error in the estimated values. Thus, this research also aimed at developing a new method of interpretation based on optimizing those errors. That was achieved by statistically studying the effect of proposed correction factors on the errors produced in the estimated ETL curve using General Linear Models (GLMs). A relationship between the proposed correction factors and the pile slenderness ratio is established. The proposed method was applied to five well documented case studies of O-cell pile load test. For each case study, the ETL curve estimated using the proposed method was compared to the ETL curves estimated from seven available interpretation methods and to the ETL curve produced from simulated equivalent top loaded pile test (the reference test). Results of error comparison of the estimated settlement at working load and estimated ultimate pile capacity showed that the proposed method is superior to the existing available methods and consistently minimized the prediction errors to very small values. However, it should be noted that the proposed method was developed based on the analysis of the O-cell pile load tests in drained soil layers. Therefore, it is expected to work well with tests in soil layers that are mainly sand and rock. The application of the proposed method in soil composed mainly of clay layers needs further investigation.

Keywords: Piles; O-cell; bidirectional pile load test; Conventional pile top-load test; Equivalent Top-Load (ETL) curve; General Linear Models.