A Simplified Field Method for the Capacity Evaluation of Driven Piles

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ABSTRACT

Dynamic analyses of piles are methods aimed at the prediction of pile behavior under static loads based on the pile response during installation. These methods are founded upon the concept that pile penetration under each blow induces failure of the soil, hence, an instantaneous load test is performed. The reliability of these analyses is enhanced through data obtained by dynamic measurements during driving. Two methods are currently employed for the analysis of the measured data. Both methods are based on the solution of the one dimensional wave equation for the stress wave travelling through the pile following the hammer's impact. One, an office analysis, utilizes a numerical solution of a mathematical model for the pile-soil system under measured boundary conditions (e.g. the computer codes CAPWAP or TEPWAP). The other, a field analysis known as the "Case Method" which is based on a simplified closed form solution and empirical correlations, provides an instantaneous evaluation of the pile capacity following each hammer blow.

Substantial experience suggests the existence of major limitations to the field method. In addition, no large scale evaluation has been carried out for the office methods since their development. A simplified method based on energy balance is proposed as an alternative field method. The Energy Approach method assumes elasto-plastic load displacement pile-soil relations. Calculated transferred energy and maximum pile displacement from the measured data are used as input parameters for the Energy Approach.

Two large data sets were gathered at the University of Massachusetts at Lowell. One, PD/LT, contains 208 dynamic measurement cases on 120 piles monitored during driving, followed by a static load test to failure. The data were obtained from various sources and reflects variable combinations of soil-pile-driving systems. The other, PD, contains data on 403 piles monitored during driving and was provided by Pile Dynamics Inc. of Cleveland Ohio. All cases were examined and analyzed.

The results of the presented study invalidate the concept of a "unique" recommended correlation between the viscous damping parameters and soil type in both wave-based analyses. It is shown that energy losses should be attributed more to soil inertia rather than soil damping. As such, energy losses are pile shape and driving resistance dependent in addition to the soil type influence. The Energy Approach method was found to provide excellent evaluations of pile capacity. The method is therefore proposed to be used in the field for instantaneous capacity determination. The predictions of this method were found on the average to provide more accurate evaluations than the sophisticated office methods, especially for records obtained at the end of initial driving. The Energy Approach is therefore also proposed to be used as an independent tool to evaluate the office methods. Through evaluation of the current dynamic analyses, pointing out their sources of deficiencies and offering an alternative method, this study contributed to the increase in safety and decrease in cost of driven pile foundation systems.