



Re-evaluation of LRFD Resistance Factors for Driven Piles

May 2019

Project Number

BDV25-977-53

Project Manager

Larry Jones

FDOT Geotechnical Office

Principal Investigators

Manjriker Gunaratne

Gray Mullins

University of South Florida

Scott Wasman

University of Florida

Current Situation

Structural foundations are tested during installation to verify that their factored bearing resistance exceeds the factored design load. Load and Resistance Factor Design (LRFD) is the current method for structural analysis, which includes factors to account for the uncertainty of the design loads on, and the expected resistance of, structural foundations. These factors are derived from statistical analyses of databases comparing design methods and load tests on real components. They are re-examined and updated regularly as new methods of testing and new methods of calculation are developed.

Research Objectives

Researchers from the University of South Florida and the University of Florida compared static load test results to those of two dynamic load testing methods: embedded data collectors (EDC) and the Pile Driving Analyzer with Case Pile Wave Analysis Program (PDA CAPWAP). Their goal was to establish appropriate LRFD resistance factors for use with methods currently accepted by the Florida Department of Transportation (FDOT).

Project Activities

The researchers compared capacity estimates for 27 test piles dynamically load-tested using EDC and PDA test methods with the results of static load tests later performed on the same piles. Data was gathered from testing conducted during 2008-2017. Previously published data for test piles using data from static load and PDA tests was incorporated into the project.

Static load testing involves placing increasing, massive weight on a pile and monitoring the pile's movement. Data collected from this type of testing is considered the most accurate means to determine the bearing capacity of a pile in its construction location.

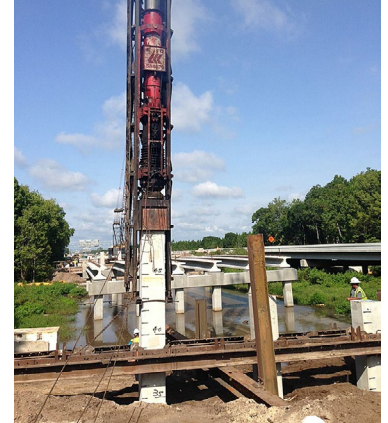
EDC and PDA CAPWAP are dynamic pile testing methods, in which the pile's response to the falling weight that drives the pile into the ground is monitored, and the measurements are used to estimate the pile's bearing capacity. In EDC, the pile's response is measured by instrumentation embedded in the pile when it is cast. PDA CAPWAP uses data from strain gauges and accelerometers attached to the outside of the pile combined with special software to analyze the pile's behavior and estimate its capacity. Both methods use mathematical models that take into account the nature of the soil into which the piles are driven. Dynamic methods require less setup and equipment than static methods, and usually, several dynamic tests can be done in the same time required for a single static test.

The researchers developed LRFD resistance factors from test data using statistical analysis methods based on reliability theory. A reliability analysis was also conducted to compare the two dynamic methods, CAPWAP and EDC. The analysis method historically used by FDOT indicates similar resistance factors should be used for both methods.

Project Benefits

The resistance factors developed in this project confirm that FDOT is using appropriate resistance factors for these dynamic testing methods when verifying that the factored bearing resistance of foundation piles exceeds the factored design load.

For more information, please see www.fdot.gov/research/.



Driven piles are essential foundations for many structures.