



**Project Number**

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# Load and Resistance Factor Design Resistance Factors for Auger Cast in Place Piles

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**Current Situation**

Augered cast-in-place (ACIP) piles are approved by the Florida Department of Transportation (FDOT) only as foundations for noise walls. This limitation is largely due to the lack of resistance factors for ACIP piles in the AASHTO design code.

ACIP pile construction begins with a hollow-stem continuous flight auger drilling a hole, which is then grouted from the auger tip as the drilling tool is withdrawn. Steel reinforcement is then inserted into the grout while it is still fluid. No temporary steel casing or slurry is needed, resulting in higher production efficiency under favorable subsurface conditions, for example near surface limestone.

ACIP piles have been used in Florida's private sector for over 20 years, mostly to support high-rise buildings, yielding favorable results and cost savings. With the vast amount of data gathered by the private sector on ACIP resistance, particularly in limestone layers, FDOT embarked on a data collection and analysis program with the University of Florida, aimed at calibrating existing and proposed design methods. Parallel efforts to expand existing construction specifications and nondestructive testing methods (e.g., thermal integrity) will provide a comprehensive platform for possible implementation of ACIP piles for support of bridge structures.



*ACIP piles at a bridge interchange.*

**Research Objectives**

Calibrate resistance factors for various design methods under Load and Resistance Factor Design (LRFD), using the corrected First Order Second Moment (FOSM) approach.

**Project Activities**

With the aid of FDOT staff, the researchers requested data from several design companies and contractors. Data from 78 load test sites in five Florida counties were collected, and they included a reasonable cross-section of the anticipated soil profiles where ACIP piles are typically the preferred foundation alternative.

Not all tested piles were instrumented with strain gauges along their length so the researchers implemented a t-z approach for data analysis, thus accounting for nonlinear resistance of the layers. This allowed them to estimate the distribution along the length of uninstrumented piles. The method was then calibrated against piles that did have internal instrumentation to compute bias in the t-z approach, which was incorporated into the final analysis and development of resistance factors. The methods analyzed in this project focused on typical Florida practice where subsurface explorations for deep foundations are generally conducted through a combination of standard penetration test (SPT) borings and rock coring.

The researchers provided resistance factors and recommended a required number of load tests per site and the preferred design methods for various subsurface conditions. This highly successful effort places Florida among the leaders in development of LRFD design for this foundation type.

**Project Benefits**

Better understanding of design methods for ACIP in a reliability-based environment will allow for eventual introduction of another deep foundation alternative for bridge support and may improve efficiency and reduce cost of foundation construction in certain areas of the state.

*For more information, please see [dot.state.fl.us/research-center](http://dot.state.fl.us/research-center)*