LRFD Resistance Factors for Auger Cast In-Place (ACIP) Piles
FDOT BDV31 Two 977-12

Principal Investigator
Michael McVay, PhD

Primary Researcher
Scott Wasman, PhD

Project Manager
Rodrigo Herrera, PE
Scope of Work

Task 1 – Prepare and distribute data request letter to contractors, consultants, and DOTs

Task 2
- Review construction techniques and current design methods
- Organize and upload data into FDOT database
- 40 to 60 load tests required!

Task 3
- Select design methods for analysis
- Determine bias (and CV) for selected design methods
- Assess sample (dataset) size
- Determine LRFD $F$ for best performing methods and AASHTO loading conditions

Task 4 – Assess minimum number of load tests per site

Task 5 – Final report
- Recommendations for LRFD $F$ for total, skin and tip resistances
- Recommendations for minimum number of load tests
Dear Madam/Sir,

The Florida Department of Transportation is partnered with the University of Florida in a study to calibrate geotechnical Load and Resistance Factor Design (LRFD) resistance factors for Auger Cast-In-Place (ACIP) Piles for FDOT design. As part of the project, we are collecting any of the following data from all possible sources for ACIP type foundations:

1) Soil exploration data (in-situ (SPT, CPT, etc.), and laboratory results: soil classification and rock strength if available);
2) Load test and boring locations relative to pile load tests;
3) Pile resistance prediction method, and capacity assessment used (Davison, 3% diameter, etc.);
4) Load test results (static or dynamic) and any tip, skin friction and total load displacement data. Data does not need to be limited to projects in Florida;
5) Installation logs for the piles tested;
6) Results of any integrity testing of load tested piles;
7) Sample certification or acceptance letters;
8) Load test and foundation cost estimates;
9) Additional pertinent information.

All project sites will be identified by the county and a number; information identifying private owners or exact addresses is not requested and will not be disclosed if included.

Success of the project depends on collecting enough information to develop a statistically significant database from which to calibrate resistance factors. As such, we kindly request the relevant data of projects your office has been involved with that used the ACIP pile and where a load test has been performed. In order to transfer the data, a FTP website, hosted by the University of Florida, will be made available for transfer of electronic files. And for hardcopy files, arrangements can be made at no expense to your business.

Following receipt of this letter, either the primary researcher on the project, Scott Wassman, or the project manager, Rodrigo Herrera, will contact you regarding any questions you might have. If you have any questions beforehand, please do not hesitate to contact either one at:

Primary Researcher: Scott Wassman, Ph.D., (352) 273-4609, swassman@ufl.edu
Project Manager: Rodrigo Herrera, P.E., (850) 414-4377, Rodrigo.Herrera@doa.state.fl.us

We greatly appreciate your time and participation.
Task 1 – Contributors To Date

- Universal Engineering Sciences
- GEOSOL, Inc
- Dunkelberger Engineering and Testing, Inc. (Terracon)
- Ebsary Foundation Co.
- Nodarse (Terracon)

Thank You!
Task 2 – ACIP Pile Data

2 Projects

3 Projects

4 Projects
Task 2 – Site Data

- Number of borings
  - 4 – 11 per site
  - 50 SPT borings

- Soil types
  - SC, SM, SP
  - CH, CL
  - SP-SC, SP-SM, SM-SC
  - Intermediate (limerock)
Task 2 – ACIP Pile Data

- Number of load tests
  - 16 compression tests (11 instrumented for skin)
  - 6 Tension tests
  - 6 Lateral tests

- Installation Data
  - Pile grouting on 6 project sites

- Pile diameters
  - 14, 16, 18, 24 and 30 inch
### FDOT Database-ACIP Data

**Number of borings**: 4 – 11 per site

**Soil types**:
- SC, SM, SP
- CH, CL
- SP, SC, SM

<table>
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<tr>
<th>Line</th>
<th>Soil Pre-decriptor</th>
<th>Soil Type</th>
<th>Soil Post-decriptor</th>
<th>USCS</th>
<th>MASHIC</th>
<th>Note</th>
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<td>Asphalt concrete</td>
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<tr>
<td>2</td>
<td>Clean lime sludge</td>
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<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Clean lime sludge</td>
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<tr>
<td>5</td>
<td>50% settling fluid circulation loss</td>
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<td>Limestone Soft</td>
<td>Clayey sand</td>
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<td>8</td>
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<td>SP</td>
<td>SP</td>
<td>SP-LIM</td>
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<td>SP-LIM</td>
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<td>SP</td>
<td>SP-LIM</td>
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<tr>
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<td>SP</td>
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<td>SP-LIM</td>
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</table>

- Notes:
  - SP-CL: SP classified as CL
  - 60 ft, the USCS was classified as SP
  - 65 and 75 ft, the USCS was classified as SP
  - LIM: Limestone formation

**Diagram**

- Graph showing soil depth and SPT measurements. The X-axis represents SPT in, and the Y-axis represents depth in feet.
ACIP Pile Load Test Data

- Pile Settlement after 15 minute loading period
- Estimated elastic compression of 16-inch diameter by 61 foot long pile

Graphs showing:
- Compression load vs. pile head settlement
- Depth below pile head vs. compression load
Task 2 – Background and Review

- Current guidelines require LRFD $\Phi = 0.6$ for ACIP piles
- Brown et al. (2007) reviewed methods to estimate side and tip resistance based on:
  - SPT
  - CPT
  - DCPT (Dynamic CPT)
  - Undrained shear strength
  - Unconfined compressive strength of geomaterials
- FDOT guidelines limit capacity estimation to side resistance only; neglecting tip resistance
- Torque, crowd force, penetration rate, tip pressure and concrete volume monitoring on rigs available
- Useful for real time side and tip capacity and adjust pile length
- However; not frequently used and lack of data
Task 2 – Background and Review
Thank You!

Questions?