Florida Department of Transportation Research

Field Testing of a Jet-Grouted Pile

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In many areas of Florida, local geology dictates the use of deep foundations for transportation structures — bridges, noise walls, signage, etc. When concrete piles are used, they are either prestressed at the casting yard, cast in situ through a hollow stem auger, or cast in place into an excavated shaft. The deep foundation type studied in this project aims to increase the resistance of soils along the side and tip of a pre-cast pile to accelerate construction and decrease material costs through the use of shorter elements.

University of Florida researchers tested a deep foundation concept developed for the Florida Department of Transportation (FDOT), the jet-grouted precast pile. This pile type is constructed in four stages: (1) Casting the concrete pile with built-in piping for jetting and grouting; (2) Jetting the pile into the ground using pressurized water; (3) Side grouting the pile; and (4) tip grouting. Precasting, jetting, and grouting may improve on currently used foundations for appropriate subsurface conditions: jetting minimizes noise and vibration, compared to driven piles; precasting reduces pile integrity issues, compared to cast-in-place piles; and side and tip grouting improve skin and tip resistance.

The precast pile is jetted into the ground.

The researchers conducted full-scale, field studies to compare jet-grouted precast piles with traditional drilled shaft piles in typical Florida soils. Piles supported high mast lighting and signage structures. Three drilled shafts and two jet-grouted piles were constructed and then subjected to axial as well as combined lateral and torsional loading. For combined loading, a heavy-duty mast arm (FDOT's E7-T6 type) was loaded with a crane. Field and laboratory data were collected for the sand, silt, and clay layers to assess properties and predict axial and torsional capacities, based on FDOT and FHWA methods.

In the case of the axially loaded drilled shafts, FHWA's rational approach agreed most closely with measured results, followed by FHWA's β method; however, for combined loading, the β method was closest, followed by the rational approach. Under combined loading, the short shaft failed laterally and rotationally; a longer shaft failed rotationally with a nonlinear lateral response.

Jet-grouted piles were grouted up to lateral dimensions similar to the drilled shafts. In top-down testing, the 18-ft long jet-grouted piles did not fail axially before the 40-ft reaction shafts experienced pullout failure. Under combined loading, the jet-grouted piles had three times the capacity of the drilled shafts. Statnamic testing obtained an axial capacity of 1000 kip for one pile, of which 450 kip was skin friction. Both torsional and axial skin friction of the piles were predicted based on pressuremeter testing and grout pressures observed during construction. Comparison with similar capacity drilled shafts showed that jet-grouted piles were 20% to 40% more economical.

This project represents the culmination of years of work on jet-grouted precast piles, now shown to be a viable foundation for FDOT pole and mast arm structures in Florida soils. With greater capacity and construction economy, this foundation type will be an important new addition to transportation construction in Florida.

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For more information, visit http://www.dot.state.fl.us/research-center