Florida Department of Transportation Research

Group Efficiencies of Grout-Tipped Drilled Shafts and Jet-Grouted Piles
BDK75 977-07

From light poles to interstate bridges, virtually every transportation structure in Florida is supported on piles or drilled shaft foundations. These foundations depend on the resistance, acting at the sides and the tip, offered by soil or rocks in which they are situated. For more support, pile/shaft groups are more effective than a single larger pile/shaft, but spacing is critical. Desirable wider spacing must be balanced against the size and expense of the concrete cap that sits on the pile/shaft group and unifies its effect. Research shows that the optimum center-to-center spacing within a group is three times the individual shaft/pile diameter.

In recent years, the Florida Department of Transportation (FDOT) has used post-grouting technology to improve the tip resistance of drilled shaft foundations. Also, FDOT has developed a jet-grouted pile system that improves both side and tip resistance. Group efficiency factors for these technologies are unknown. Therefore, University of Florida (UF) researchers sought to characterize these factors and to develop analytical approaches for predicting load versus deformation response of post-grouted drilled shafts and jet-grouted pile groups.

A freshly excavated group of jet-grouted piles is readied for removal from the test chamber after testing.

The FDOT test chamber at UF's Coastal Engineering lab was used for all group tests of jet-grouted piles/grout-tipped drill shafts. The chamber, 35 feet deep and 12 feet in diameter, assures replication of pile-soil stresses, permits soil excavation to expose pile/soil grout zones, and allows repetitive testing for parametric investigation. There are two drilled shaft foundations installed parallel to the test chamber to carry reaction loads during top-down testing. A test frame for all group tests was designed according to the AISC Steel Construction Manual, 13th edition.

Two groups of jet-grouted piles were tested: first, a group comprising four 8-inch square, 8-foot-long jet-grouted piles, and second, a group of smaller diameter piles. Installation of each group began with the jetting of precast piles into the soil in the test chamber and then side grouting of each pile from the top down. Prior to tip grouting, top-down group compression load tests were conducted to estimate side resistance of the group. Subsequently, tip grouting of the individual piles was performed, and then, another top-down load test was conducted to estimate total group capacity. Tests involved soil/pile deformation monitoring as well as 14 soil stress measurements to study group behavior. Finite-element modeling of single jet-grouted piles investigated soil stresses around the piles.

Tests similar to those for jet-grouted piles were conducted on grout-tipped drilled shafts. Similar geometries were employed, except that in the second group of drilled shafts, the length was 13 feet. With the first group, researchers studied the axial capacity of the grout-tipped drilled shaft, the grout flow pattern, and the group behavior of the shafts. In the second test, staged grouting was studied as a means to improve the capacity of grout-tipped shafts.

Project Manager: Peter Lai, FDOT Geotechnical Office
Principal Investigator: Michael McVay, University of Florida
For more information, visit http://www.dot.state.fl.us/research-center