A STUDY OF THE SETUP BEHAVIOR OF DRILLED SHAFTS

PROBLEM STATEMENT

Engineers routinely test the capacity of deep foundation elements during and/or after their installation, using both static and dynamic methods. These tests often indicate a change in side shear capacity with time after the completion of driving. The terms "setup" and "freeze" describe an increase in capacity, which is commonly observed for driven piles. Research by Bullock (1999) indicates that a minimum capacity increase of 10-20 percent per log cycle of time occurs in Florida soils, with potentially much greater increases in cohesive soils. Therefore, if included in design, setup could provide significant cost savings by reducing the number and/or size of driven piles used for foundation support (see BC354-27). Since drilled shafts foundations typically have much greater side area than driven piles, their construction costs could also be reduced using setup. However, there is little documentation to support side shear setup for drilled shafts, probably due to the expense of testing these high capacity foundation elements.

The Florida Department of Transportation (FDOT) set aside five drilled shafts at the site of the new SR20 eastbound bridge for future tests following the initial tests performed during construction to verify their design capacity. These shafts ranged in size from 5 to 7 ft in diameter and 85 to 104 ft in length, with rock socket lengths in limestone 18 to 35 ft long. They were constructed using temporary casing and mineral slurry through overburden soils including sand, clay, and mixed soils.

OBJECTIVES

The primary goal of this research is to measure the change in side shear, if any, which may have occurred with the drilled shafts tested during construction of the SR20 Blountstown Bridge. Specific objectives include the following:

1. Obtain Previous SR20 Test Results and Check Viability of Test Equipment
2. Literature Review
3. Perform (4) Initial O-cell Retests at the SR20 Site
4. Analyze Initial Retests
5. Perform (4) Final O-cell Retests at the SR20 Site
6. Analyze Final Retests

FINDINGS AND CONCLUSIONS

Loadtest Inc. performed the initial tests in 1996, 6 to 11 days after construction, using multi-level Osterberg Cell tests (O-cell). Strain gages cast into the shafts provided a shaft load profile from which to estimate shaft side shear for approximately nine segments in each test shaft, three in the rock socket and six in the overburden soils. The University of Florida (UF) performed a second set of tests in 2002, approximately 5.4 years later, focusing on the setup of the shaft segments in the overburden soils. The O-cells and strain instrumentation performed well during the second test set, which was accomplished by staff and students from UF without heavy equipment. The final report includes both the 1996 and 2002 tests to insure equivalent test analyses. The average side shear setup factor identified for 30 shaft segments in clay, sand, mixed sand and clay, and limestone was A = 0.18. However, the measured setup was both negative and positive, with a median of essentially zero setup—i.e., there was effectively no gains in shaft capacity. A number of factors, including construction techniques and residual stresses, may have affected the SR20 test results. Ultimately, reliable side shear setup could not be verified based on these tests.

BENEFITS

Based on this study, side shear setup does not appear to be reliable for shaft design. Setup was measured for some of the shaft segments at the SR20 site, and potential mechanisms for drilled shaft side shear setup do exist, but the benefits are uncertain.

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