DETERMINING THE EFFECT OF STAGE TESTING ON DIMENSIONLESS PILE SIDE SHEAR SETUP FACTOR

PROBLEM STATEMENT

This relatively small project follows previous FDOT research reported by McVay, Schmertmann, Townsend, & Bullock in 1999 (Contract B7967, WPI# 0510632), which investigated the change in side shear capacity, over a period of four years, of five piles driven in Florida soils. The goal was to provide recommendations for the practical utilization of side shear freeze in the design of driven displacement piles. “Freeze,” also termed “setup,” describes an increase in pile capacity that occurs over time, almost exclusively as the result of an increase in side shear. Unfortunately, this increased capacity is poorly understood and often ignored during the design and installation of a pile foundation. However, by calculating the pile setup in the foundation capacity, an engineer can reduce the number, length, or size of the piles used for a given project, and so reduce the construction cost of the foundation.

The previous research measured only increasing capacity with positive setup factors (A), and the researchers recommended the design use of A = 0.2, a relative capacity increase of 20% per log cycle of time starting at one day after driving. However, these tests were performed repeatedly on the same pile, a commonly accepted test method, referred to as "staged" testing or “set check” (as per FDOT’s Standard Specification Section 455), and generally an economic necessity because of the high cost of separate tests on individual piles. The possible effects of staged testing were not determined, however, and so questions remained that needed to be resolved in order for setup to be included in the design process.

OBJECTIVES

One of the results of Contract B7967 was the introduction of the standard penetration test with torque measurement (SPT-T) as a cost-effective insitu test for the prediction of pile setup. The research provided SPT-T results for the two Vilano Beach test sites. The objective of the current research project is to use the SPT-T to investigate staged testing effects on the driven SPT sampler adjacent to the Seabreeze Bridge test pile in Daytona Beach, Florida, one of the five piles originally tested for setup. Twelve borings provided SPT-T results at similar elevations in two soil layers: a silty sand and a shelly clay. Staged SPT-T tests were conducted in three of the borings at nominal times of 5, 30, 180, and 1080 minutes after the driving of the SPT sampler, and unstaged tests were conducted in the remaining nine borings at similar times.

FINDINGS AND CONCLUSIONS

Similar to the SPT-T results in the sands at the Vilano Beach test sites (although the Seabreeze test pile exhibited long-term setup in the sand layer), the SPT-T performed over the relatively

short time period of only 1080 minutes (18 hours) did not exhibit setup. Thus, it was not useful for investigating staged testing effects. Conversely, the Seabreeze clay indicated significant unstaged side shear setup, and the staged tests measured a 150% increase beyond the unstaged side shear, which yields a ratio of ($A_{Unstaged}/A_{Staged}$) = 0.4. These findings are supported by test pile data published in the literature. A reference time of 5 minutes for the SPT-T setup compared well with the pile setup calculated using a reference time of 1 day. The previous conservative design side shear setup factor of A = 0.2 (without field tests) should be adjusted to A = 0.1 to compensate for stage testing effects. Side shear setup from staged pile tests in clay at the Seabreeze and Vilano Beach sites also correlated well with staged SPT-T side shear setup, further validating the SPT-T as a setup predictor test. An Appendix included in the final report presents recommended procedures for the use of pile setup in design.

BENEFITS

Pile side shear setup may have a potentially significant economic impact on FDOT bridge foundations. The researchers believe that sufficient research has now been done in Florida, and elsewhere, for the FDOT to make routine practical use of setup in design. The design setup factor of A = 0.1 will likely increase with the use of actual measurements, such as those from the SPT-T predictor test, with previous site experience, and/or with results from a design phase static and/or dynamic test pile program. In addition, the current construction practice of performing multiple restrikes on the same pile is a form of staged testing. Therefore, engineers may use repeated restrikes with limited penetration (<0.25" each restrike, based on research pile data) during construction to measure the increase of side shear capacity of marginal piles, beyond that obtained from the initial driving and subsequent unstaged setup.

This research project was conducted by Paul Bullock, Ph.D., P.E. of the University of Florida. For more information on the project, contact Mr. Peter Lai, P.E., Project Manager, at (850) 414-4306, peter.lai@dot.state.fl.us.