Research Need for Structures, Hydraulics & Geotechnical Technical Advisory Group

Effective/Updated: August 14, 2015

ISSUE: Evaluating the Accuracy of Integrity Testing for Drilled Shafts in Illinois

SUMMARY OF PROBLEM: Over the past five to ten years, the use of drilled shafts for deep foundations in Illinois has increased. One of the primary advantages of drilled shafts is elimination of the need for many cofferdams or braced excavations, which are expensive and time consuming to build. Drilled shafts have proven to be economically competitive compared with driven pile foundations.

Quality of drilled shaft construction can be an issue. A drilled shaft simply involves drilling a hole, typically down to bedrock, and placing a reinforcing steel cage into the hole followed by placement of concrete to complete the shaft. When water is not present in the excavated hole (i.e., dry method), the quality of concrete in the drilled shaft is usually not a concern, and visual inspection can suffice to ensure a good product. However, for those cases with water present in the hole (i.e., wet method), it is very difficult to ensure quality because visual inspection is limited or even impossible. Therefore, integrity testing is used throughout the country for acceptance of drilled shaft construction. By far, the most common non-destructive integrity testing method used in drilled shaft construction is cross-hole sonic logging (CSL), which involves placing a series of steel tubes down the entire length of a drilled shaft (one tube per foot of diameter of the shaft, tied to the reinforcing steel cage). After the required curing period, a transmitting acoustical probe is lowered down one of the tubes and a receiver is lowered down another tube. The signals are processed to determine the presence of potential defects in the shaft. One of the problems with CSL testing is that there can be false indications of defects. Debonding of the tubes to the drilled shaft concrete is a fairly common problem that would cause these false indications.

An alternative non-destructive integrity test that is fairly new on the market is thermal integrity profiling (TIP). This test involves installing a series of thermocouples, similar to the number of steel tubes used with CSL testing, down the entire length of the drilled shaft. As the concrete in the shaft cures, the heat of hydration is monitored and recorded by the thermocouples. Concrete quality variations can be determined by assessing differences in the heat of hydration throughout the shaft. This technology is relatively new throughout the country, but it does show promise.

Recent experience in Illinois drilled shaft projects found that many shafts tested using CSL showed false indications. Follow-up confirmation coring proved that many potential defects were not true defects after all. To improve integrity testing in Illinois, it may be necessary to explore additional techniques such as TIP testing. Because that technology is still in its infancy, it may be too early to use in Illinois as the only type of integrity testing. For now, it may be prudent to use both technologies on a series of projects to compare test results obtained from CSL testing with results obtained from TIP testing.
basis of those comparisons, IDOT can make an informed decision on the future integrity testing requirements for drilled shafts.

**EXPECTED IMPLEMENTABLE OUTCOME:** The results of this research would be an evaluation of the accuracy of cross-hole sonic logging and thermal integrity profile testing on various test shafts. A comparison of the two methods on the same shafts would allow for a recommended testing protocol in the future. A literature search would be necessary to see whether similar studies have been conducted elsewhere. With the knowledge gained through the research study, an experimental program should be set up with actual scaled-down drilled shafts constructed. Location of the experimental shafts could be arranged near an active drilled shaft project so that mobilization costs of a drilled shaft contractor would be minimal. The research should consider the incorporation of “intentional” defects built into the shaft(s). The “engineered” defects should be of various sizes, shapes, and types. The defects should be incorporated both inside and outside of the reinforcing steel cage. Both testing methods should be used in an attempt to define the known defects. An analysis should be made to assess accuracy of the methods. Ultimately, a recommendation should be made on the future use of integrity testing in Illinois, whether it is the continued use of cross-hole sonic logging, the use thermal integrity profiling, or a combination of the two technologies.

To submit a research idea for consideration at the spring 2016 Executive Committee meeting, prepare and submit a Proposed Research Idea form to IDOT (DOT.BMPR.RESEARCH@illinois.gov) no later than October 1, 2015.