Florida Department of Transportation Research

Optimizing the Use of the Thermal Integrity System for Evaluating Auger-Cast Piles

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Current Situation

Auger-cast-in-place (ACIP) piles offer an efficient method of constructing and installing piles, but because the ACIP process is essentially blind and the configuration of the final pile cannot be assured, applications for ACIP piles have been limited by the Florida Department of Transportation.

Research Objectives

University of South Florida researchers studied the use of thermal sensors in a technique called thermal integrity profiling (TIP) to verify the final shape and provide quality assurance of ACIP piles.

Project Activities

The researchers reviewed the literature about quality control for ACIP piles and about all aspects of TIP, including methods, equipment, theory, analysis, and modeling. In addition to the findings from the literature review, two types of modeling were chosen for analysis of project data: forward models that predict the pile's thermal field measurements from the design and conditions of casting; and models based on curve-fitting data from past ACIP pile projects.

An auger-cast pile rig.

The researchers also conducted field tests using different configurations of thermal wires and access tubes (for probe system measurements). In addition, gyroscopic inclination measuring systems were developed and evaluated to resolve issues related to the position of the reinforcing cage during testing. These preliminary findings produced encouraging results. When the auger is withdrawn, the reinforcement steel is lowered into the concrete, where it can shift. This movement of the steel reinforcing cage presents a challenge to accurate modeling of the thermal field measurements of an ACIP pile. Movement of the cage can affect thermal integrity profiling (TIP) by changing the position of the thermal probes or wires within the pile; therefore, the analysis must identify if changes in temperature measurements are the result of actual changes in the pile shape or a result of misalignment of the reinforcement steel.

In field trials, TIP was conducted on both drilled shafts and ACIP piles. For each type of foundation, several instrumentation configurations were used, including (1) embedded wire sensors, where one, two or four locations within the pile were monitored, (2) single access tube (centered), and (3) a cluster of four embedded thermal sensors located around a center bar. In addition, a wide range of analysis methods were used for each monitoring scheme. The number of monitoring locations (either using the wire or probe system) was found to be important, with the four-wire (or probe) system providing the most robust data. However, the most commonly used ACIP pile designs are typically too small in diameter for the proper placement of reinforcement to accommodate four wires or probes.

Project Benefits

Overall, the methods developed in this project provide advances in thermal integrity profiling (TIP) and in the quality assurance of ACIP piles. Additional testing will help confirm these advances. Development of a reliable and robust quality assurance system for ACIP piles would make this a useful and efficient technology available in a wider variety of designs.

For more information, please see dot.state.fl.us/research-center