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Project Managers
David Horhota
FDOT Materials Office

Principal Investigator
Dennis R. Hiltunen
University of Florida

Florida Department of Transportation Research

Implementation of Down-Hole Geophysical Testing for Rock Sockets

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Current Situation

Many structures are built on foundations constructed by drilling a hole down to the local rock layer and filling it with steel-reinforced concrete. These foundations are called drilled shafts, and the portion of the length that is drilled into the local rock for the base of the shaft is called a rock socket, which provides the majority of the drilled shaft's capacity. To properly design and install drilled shafts, engineers must understand the nature of the soil in which they will be placed and, particularly, the variability of rock near the rock socket. Traditional invasive exploration methods sample only a small volume of material and insufficiently assess the spatial variability of the rock socket. Surface-based methods such as seismic reflection are an alternative to invasive exploration, and they can identify large-scale spatial variability; however, because they are surface based, they may fail to provide sufficient detail of the rock quality at the intended depth of the socket.

An auger is set in place to drill a hole into which a drilled shaft will be placed.

Research Objectives

University of Florida researchers produced a prototype instrument and software analysis system for conducting geophysical characterization of subsurface conditions from within a single borehole.

Project Activities

In a previous project, the research team showed that the concept of a special probe in a borehole to identify the location and extent of subsurface features could be successful. For this project, the researchers created a prototype probe and accompanying software. The probe had two main components: a source that sends seismic waves into the soil and rock near the borehole and a receiver to detect waves reflected back to the probe. Versions of the source were constructed with different wave sources: (1) high frequency piezoelectric cylinders, (2) a barrel stave flextensional transducer, and (3) a low frequency source using pneumatic solenoids. For receivers, one system was constructed using accelerometers coupled to the borehole wall, and another system used three-dimensional geophones. Software was developed to analyze the signals from the receiver and create an image of the material adjacent to the borehole using full-wave inversion (FWI) technology.

The researchers tested the probes in lab-scale setups and at a field site. Cycles of testing and adjustment resulted in a working concept for a borehole probe and analysis software. Both the piezoelectric and pneumatic solenoid sources and the accelerometer and geophone detectors successfully generated wavefields and received reflected waves within a single borehole. The reflected waves were successfully interpreted by the analysis software to produce images of the material surrounding the borehole. Further equipment developments and both model and laboratory tests are warranted to help validate the new procedure.

Project Benefits

The method developed in this project both simplifies and improves the imaging needed for reliable drilled shaft acceptance to ensure as-built foundations meet or exceed design requirements.

For more information, please see www.fdot.gov/research/.