DEVELOPMENT OF A DOWNHOLE NONDESTRUCTIVE TESTING SYSTEM TO EVALUATE CONDITIONS BENEATH A DRILLED SHAFT EXCAVATION USING SEISMIC STRESS WAVES

Joseph Coe, Temple University; Alireza Kordjazi

The conditions underlying a drilled shaft play a large role in its capabilities to generate the anticipated base resistance from geotechnical analysis. Anomalous features such voids and zones of weakness below the drilled shaft can negatively affect base resistance. In certain geological environments such as areas with significant karst topography or highly weathered bedrock with residual soils, it may be very difficult to confidently ascertain the conditions underlying a drilled shaft. Typical techniques that are used to verify base conditions during construction are invasive and often rely on point sources of information (e.g., rock coring or probing) that may not adequately assess the lateral or vertical extent of anomalous features below the shaft excavation. To address this concern, a non-destructive testing system was developed in this study that would evaluate the base conditions beneath a drilled shaft excavation in the field. The system consists of a source-receiver pair placed at the bottom of the excavation. The system functions by generating elastic waves and measuring their corresponding reflections from boundaries between materials with different stiffness. By analyzing these waveforms using typical geophysical analytical techniques, the system can generate a profile of the underlying earth material stiffness to verify the extent of any anomalous features beneath the excavation. In this study, testing was performed with a prototype of the system in a large laboratory model constructed with cemented sand to represent a karstic limestone with underlying weak materials. A summary of hardware components, system operation, and model construction/geometry is presented as well as the resulting profiles developed using the recorded waveforms. A discussion is also presented regarding efforts necessary to scale up the laboratory system for future field applications.