DRILLED SHAFT BASE CLEANLINESS AND GEOMETRY FROM NEWLY DEVELOPED EQUIPMENT

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Drilled shaft foundations are used to support large axial and lateral loads transmitted from the superstructure to the subsurface. One of the important factors influencing the drilled foundations performance is the construction method and procedure. Dry and wet excavation procedures are two widely used methods for drilled shaft construction. In situations where the stability of the soil material is questionable, and the groundwater table is shallow, the wet method approach is generally preferred over the dry method. In the wet method, slurry is placed into the hole to maintain stability. To ensure proper construction, Quality Assurance

(QA) methods are applied during and after drilled foundations installation. Considering the construction process, the evaluation of the drilled hole prior to cage insertion and concrete or grout placement has to be performed using appropriate testing methods. The current state-of-practice includes several quality control inspection devices, and non-destructive test (NDT) methods to assess the quality and integrity of drilled shafts. Newly developed methods, can quantitatively measure the shaft base cleanliness, cross-section area, and verticality of cast-in-place concrete foundations. Collectively, results from these tests and devices can be interpreted to evaluate the overall quality and integrity of the drilled shaft foundations.

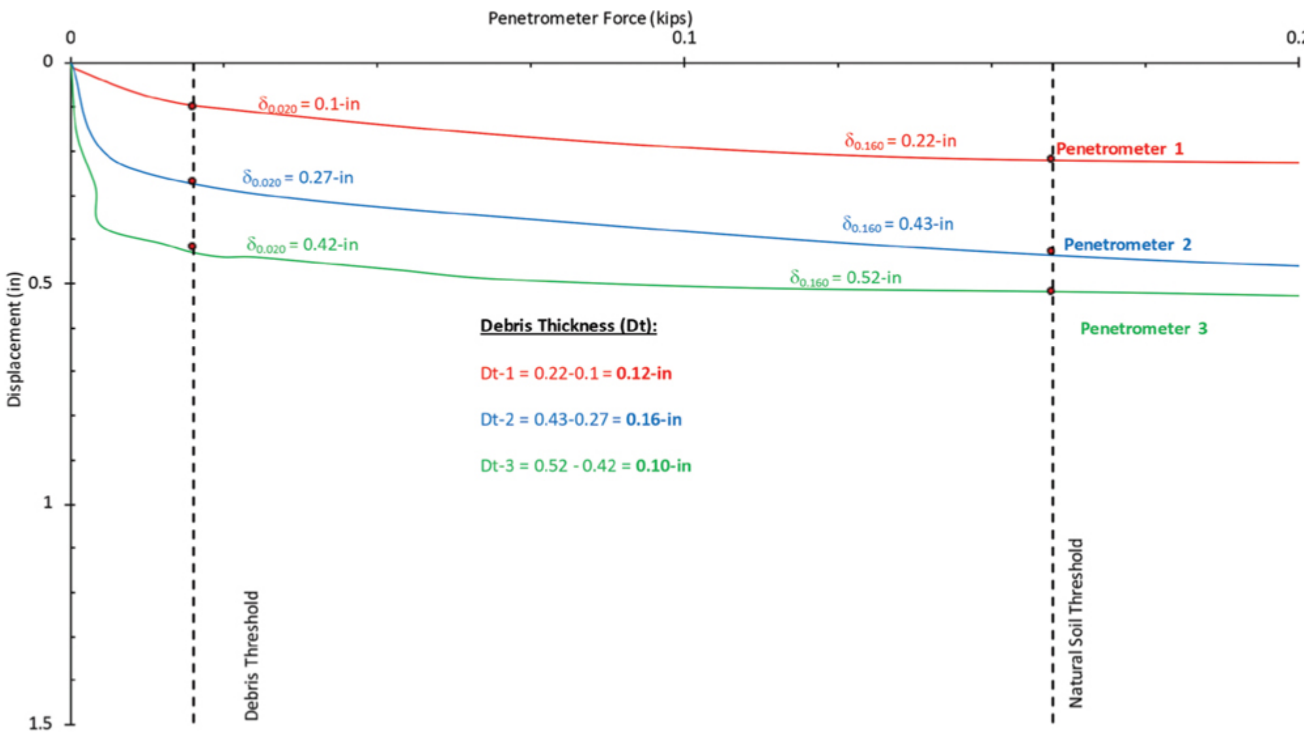
foundations.

Since the 1970s, Pile Dynamics, Inc. (PDI) and GRL Engineers, Inc. (GRL) have been contributing to the deep foundation industry by developing state-of-the-art quality control methods and devices, and providing deep foundation testing expertise both domestically and internationally. In general, project specifications and guidelines provide details regarding the quality control for the pertinent deep foundation system. In the particular case of drilled shafts, details are provided regarding base cleanliness, and geometry of the drilled shaft foundation including verticality. PDI newly developed Shaft Quantitative Inspection Device (SQUID) and the Shaft Area Profile Evaluator (SHAPE) provide necessary information for a quantitative assessment of the drilled shaft base cleanliness as well as the general drilled hole geometry.

Drilled shaft bottoms are frequently checked prior to concrete placement to determine debris layer thickness and base cleanliness. Traditional test methods for measuring debris thickness are time intensive and subjective to the viewer, with no quantitative results. The SQUID is a device used for measuring the extent of the debris layer at the base of a drilled shaft. The device is equipped with three penetrometers and three retractable displacement plates which are used to record force and displacements simultaneously. The test procedure consists of attaching the SQUID device to the Kelly bar and lowering it into the drilled hole, as shown in figure 1. Once the device is located at the bottom of the hole, the weight of the Kelly-Bar will transfer sufficient force to allow the penetrometers to penetrate through the debris layer and into the bearing layer. Simultaneously, the displacement plates retract measuring the corresponding displacements. Based on established thresholds, the debris layer is determined from the force and displacement plots as shown in figure 2. The typical total time required to complete the standard base cleanliness evaluation tests at the shaft center and at the four orthogonal sides is on the order of 15 to 30 minutes. The resulting force versus displacement information provide a quantitative measure of the debris thickness at the foundation base.

SQUID TESTING FOR A 72-IN DIAMETER DRILLED SHAFT

Depending on the foundation diameter, the verticality plays an important role during load transfer process and in cases where the foundation is rock socketed, the verticality could significantly impact the foundation performance under eccentric loads at the transition zone between soil and rock. The excavation shape, cross-sectional area, and verticality are being inspected using various techniques to verify design compliance. The Shaft Area Profile Evaluator (SHAPE) is a new device used for profiling the drilled shaft sidewalls under wet construction method using high frequency ultrasonic pulses. The SHAPE has a total of ten from which, eight of the transducers are positioned in a ring facing outward for mapping the radial profile of the drilled shaft. The two remaining transducers are positioned facing toward each other, at a known distance, to measure the variable wave speed at the various depths. In both cases, an ultrasonic signal is generated by applying a high voltage signal to the transducer causing the piezoelectric sensing elements inside of the transducers to change in geometry. This change in geometry results in an ultrasonic pressure wave being created. The wave travels out perpendicular from the surface of the transducer into the slurry until it reaches the shaft wall, at which point the wave is reflected back toward the transducer. Using the measured wave-speed in slurry and the time required for the wave to travel to the excavation wall and back, the distance is calculated.

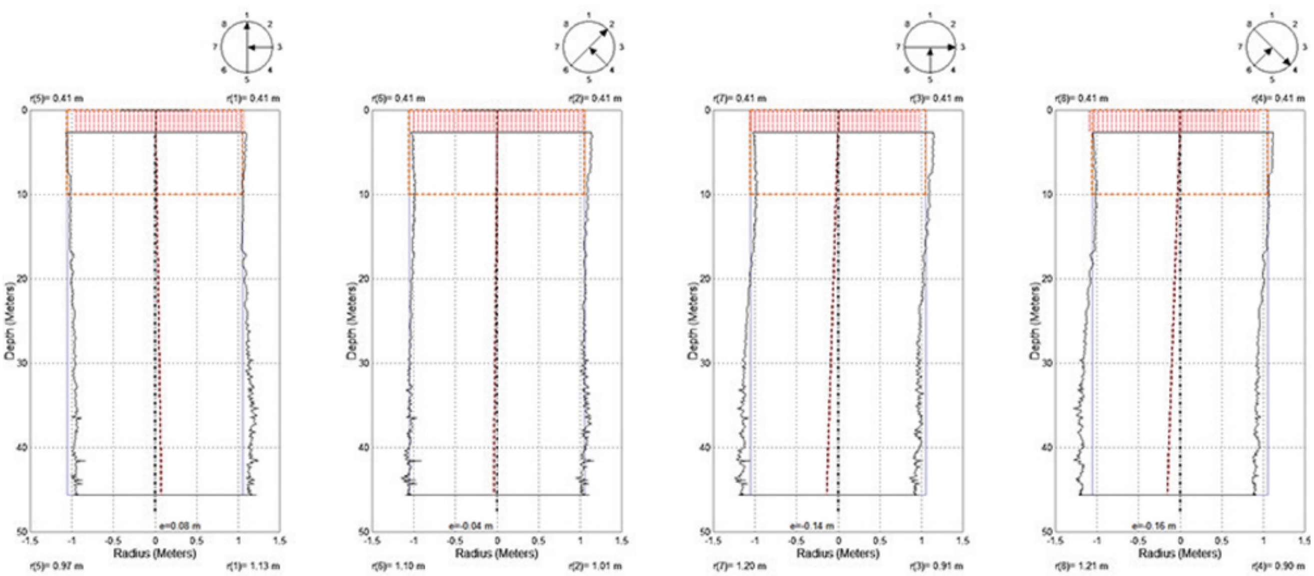


SQUID TEST RESULTS AND DEBRIS THICKNESS DETERMINATION AT THE DRILLED SHAFT BASE

The SHAPE device is attached directly to the drilling stem or the Kelly bar and lowered into the drilled hole as shown in figure 3. Advancement rate is approximately one foot per second (1 ft/sec), obtaining the drilled hole profile. The SHAPE is fully wireless and transmits and receives ultra-sonic signals from eight individual sensors simultaneously which are located at 45° apart. An integrated self-calibrating feature automatically adjusts for changes in wave speed if the slurry should be denser with depth, greatly improving the accuracy of the

computed radii. Once all radii have been determined, the overall profile, verticality, and volume can be determined as shown in figure 4.

SHAPE DEVICE BEFORE DEPLOYMENT FOR TESTING



SHAPE TEST PROFILE RESULTS