Did you know?

The PDA was originally named the Pile Capacity Computer. Because FHWA wasn't allowed to purchase computers, the name changed to the Pile Driving Analyzer®.

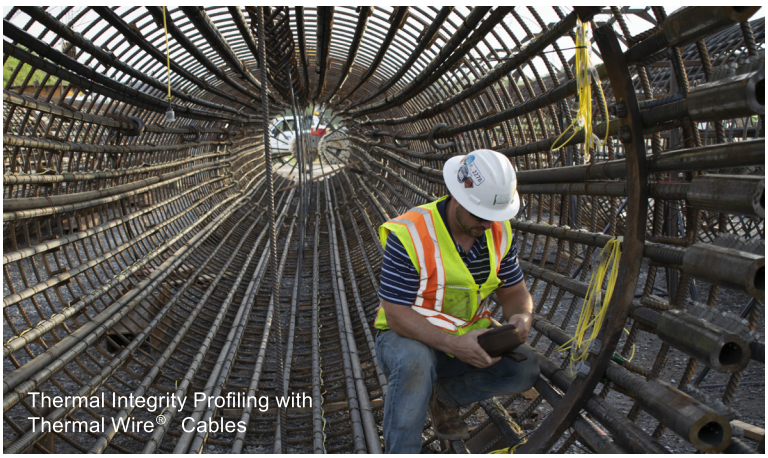
GRL engineers, inc. Pile Dynamics, Inc.

Newsletter No.89 - November, 2018

Advances in Drilled Shaft Quality Control

by Rozbeh B. Moghaddam

Drilled shaft foundations are widely used to support large axial and lateral loads transmitted from the superstructure to the subsurface. 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 within the excavation. In general, project specifications and guidelines provide details regarding the quality control for the pertinent deep foundation system. In the particular case of drilled foundations, depending on local practice, details are provided regarding base cleanliness, integrity, and geometry of the drilled foundation. There are several testing methods currently available which can be used to assess some of these quality control aspects for drilled shafts. PDI now has developed new methods and devices to better evaluate the quality control considerations. The Thermal Integrity Profiler (TIP) is a non-destructive test method



Thermal Integrity Profiling with Thermal Wire® Cables

that utilizes the elevated temperature generated by curing cement (hydration energy) to assess the shaft integrity, reinforcing cage alignment, and concrete cover. The Thermal Integrity Profiling (TIP) method uses Thermal Wire® cables that are attached to the reinforcing cage prior to casting the shaft. The thermal cables have temperature sensors spaced every 305 mm (1 foot) along the length of each wire. One thermal cable is installed for each 305 mm (1 foot) of drilled shaft diameter, cables are evenly spaced around the reinforcing cage.

During the hydration process, the heat generated throughout the shaft is directly related to the concrete volume and cement content of the mix design. This cement content is directly related to the quality and volume of the concrete. The elevated temperatures during the hydration process are measured and analyzed with TIP to assess the shaft integrity and concrete quality. The temperature measurements are automatically taken, typically every 15 minutes beginning just after casting and continuing until the concrete reaches its peak temperature, which typically occurs within 12 to 48 hours after casting, depending on the shaft diameter and mix design. These measurements can be downloaded by on-site personnel and sent to the engineer for analysis, or can be sent directly from the site to a cloud server. The temperature measurements, along with placed volume and installation details, are used to model the effective shaft radius, shaft shape, cage alignment and concrete coverage beyond the reinforcing cage. Evaluation of the temperatures prior to the peak temperature assess the presence or absence of defects that affect the structural integrity. Compared to traditional integrity test methods, Thermal Integrity Profiling greatly shortens the time window from shaft construction to shaft acceptance, accelerating the construction process. TIP test procedures are further described in ASTM standard D7949.

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 consuming and subjective to the viewer, with minimal quantifiable results. The Shaft Quantitative Inspection Device (SQUID) is a device used for measuring the extent of the debris layer at the base of a drilled shaft. The device measures the force independently on each of three instrumented penetrometers as they are advanced through the soil at the shaft base. The displacement is measured using three independent contact plates that remain in contact with the top of the debris layer while the penetrometers move through the debris layer and into the bearing material. This device is quickly deployed by connecting directly to the drilling stem or Kelly bar where it is then lowered to the shaft bottom. The total time typically 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 provides a quantitative measure of the debris thickness at the shaft base.

Shaft Area Profiling with SHAPE
Rude Bridge Replacement Project
Wheeling, West Virginia

Depending on the foundation diameter, the verticality plays an important role during the 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 Shaft Area Profile Evaluator (SHAPE) is a new device used for profiling the sidewalls in wet cast drilled shafts using high frequency ultrasonic pulses. The SHAPE device is attached directly to the drilling stem or the Kelly bar and lowered into the drilled hole. An advancement rate of 305 mm (1 foot) per second allows a drilled hole to be profiled at least twice per 305 mm (1 foot). The SHAPE is fully wireless and simultaneously transmits and receives ultra-sonic signals from eight individual sensors equidistantly mounted every 45° around the perimeter. 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 shape, volume, and the drilled hole verticality can be determined.

Garland Likins Receives DFI Distinguished Service Award 2018

Garland Likins, P.E., was recognized as the recipient of DFI's highest award to an individual, the Distinguished Service Award (DSA). This award originated in 1981 and recognizes individuals who have made exceptionally valuable contributions to the advancement of the deep foundations industry. The award was presented at the Awards Banquet during DFI's 43rd Annual Conference on Deep Foundations in Anaheim, Calif., October 24-27, 2018. Likins was one of PDI's original founders in 1972, and was president from 1977 to 2014. He currently is a principal and senior consultant for PDI, where he has directed the research and development

of transducers, real-time processing equipment and software analysis programs for deep foundations. Likins is widely recognized for guiding the development and implementation of dynamic pile testing as an industry standard in the U.S. and throughout the world. He has improved the state of the art in quality assurance by developing new and improved products, teaching, lecturing and authoring more than 120 publications. "Garland's lifetime work has helped transform the approach, practice and understanding of quality assurance for all types of deep foundations," says Theresa Engler, executive director of DFI. "His work has helped to create the modern testing industry and advance the practice of deep foundation quality assurance." **CONGRATULATIONS GARLAND!**

GRL Opens New Office in Atlanta, GA

GRL Engineers announced the opening of a new branch office near Atlanta, GA, USA. This new location is the 11th office for GRL, strengthening their presence throughout the United States. Like all other GRL offices, the GRL-Georgia office will provide PDA dynamic monitoring and load testing services on driven piles and drilled foundation solutions. The office will also provide integrity testing services by Thermal Integrity Profiling, cross-hole sonic logging, and low strain methods as well as conventional and bi-directional static load testing services. Additional office services include GRLWEAP wave equation analyses as well as SPT energy measurements for drill rig calibrations. The GRL-Georgia office will be managed by Tom Hyatt, P.E. Tom has previously worked for the GRL-Central and GRL-North Carolina offices and now brings that expertise to the GRL-Georgia office. Tom can be contacted at 678-233-1435 or thyatt@grlengineers.com. For additional information or to locate an office near you, visit **www.grlengineers.com/contact-us/**

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Upcoming Events

Complete list of events available at www.pile.com/pile-events/

December

04-06: **Webinar:** Integrity Testing of Concrete Foundations with PIT Technology with Ryan Allin (Link to register)

11: **Webinar:** Pile Driving Hammer Performance with Dr. Frank Rausche (Link to register)

18: **Webinar:** Load Testing and QC of Pile Foundations with Ryan Allin (Link to register)

January

15-23: **Webinar:** Wave Equation Analysis of Piles using GRLWEAP with Ryan Allin (Link to register)

29: **Webinar:** APPLE Dynamic Load Testing with Top Transducer with Dr Seth Robertson (Details forthcoming)

30: **Webinar:** Promo Benefits of TIP for Users with Daniel Belardo (Link to register)

February

04-08: **ADSC Annual Meeting** Nassau, Bahamas

05-06: **Webinar:** Wave Mechanics and Proper Practices for Existing PDA Users with Ryan Allin (Link to register)

19-27: **Webinar:** Advanced Applications of CAPWAP® Software with Brent Robinson (Link to register)

March

12: **Webinar:** Quality Control of Augered Cast-In-Place / Continuous Flight Auger Piles by Wayne Dalton (Link to register)

13: **Seminar:** Deep Foundation Integrity Testing and Wave Equation Analysis in Orlando, FL (Link to register)

14-15: **Workshop:** High Strain Dynamic Foundation Testing Workshop and Proficiency Test in Orlando, FL (Link to register)

24-27: **GeoCongress** 2019 in Philadelphia, PA

26-27: **Webinar:** Basic Principles of High Strain Testing and Understanding Results with Ryan Allin (Link to register)

Gabriela Wong, E.I.T. joins GRL-California

Gabriela is newly graduated with her M.S.C.E. from California State University. As a part of her Master's research, she studied and applied climate variability to NASA's existing Hydrological Simulation Program - Fortran (HSPF). During her time at NASA, Gabriela implemented low-impact development in the Los Angeles watershed to increase infiltration rates using the Hydrological Simulation Program-Fortran, was awarded the winner of the poster presentation at the NASA Direct STEM 24th Annual Student Symposium and spoke at the 25th Annual Student Symposium. She also researched the impact of increasing temperatures on the snowfall-rainfall ratio at Jet Propulsion Laboratory during her internship there.

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