DID YOU KNOW?

With SiteLink® Technology an engineer performs real-time field-to-office Pile Driving Monitoring or Dynamic Load Testing data transmission via the internet- saving time and money.

GRL engineers, inc. Pile Dynamics, Inc.

Newsletter No. 87 - March 2018

Pile Diameter Modeled Using Thermal Integrity Profiling Verified with Extracted Pile Measurements

By Daniel Belardo and Camilo Alvarez, P.E.

By definition, any type of drilled deep foundation is buried in the ground, hiding its constructed shape from visual inspection. This complicates the quality assurance process, leaving reasonable potential foundation performance questions. Fortunately, a very quick, reliable, and convenient means of indirect cast-in-situ pile visualization is available: The Thermal Integrity Profiler or TIP.

Thermal Integrity Profiling is a non-destructive integrity test method used for evaluating the post-construction quality of cast-in-place foundations. This method uses the temperature measurements, or hydration energy, from the curing cement to assess integrity. These measurements are obtained using embedded Thermal Wire® cables attached to the reinforcing cage for drilled shafts or to a center bar for smaller diameter auger cast-in-place (ACIP) piles. In general, reductions in temperature correlate to reductions in the effective radius or the presence of lower quality concrete/grout. Increases in temperature correlate to increases in cover or areas of increased cross-section. TAP boxes automatically record the temperature every 15 minutes at each thermal sensor location (one foot or 300 mm depth increments). This process is typically complete within 10 to 48 hours after initial concrete/grout placement.

On a project in Los Angeles, California, GRL Engineers, Inc., contracted by Shoring Engineers, was given a rare opportunity to observe the entire ACIP pile after construction. Project specifications required both a static load test to determine the bearing capacity and shaft resistance distribution (using embedded strain gages), and TIP for pile integrity evaluation. After completion of the tests, the contractor extracted the pile for inspection (**Figure 1**) and comparison with the TIP predicted pile shape, as shown in **Figure 2**.

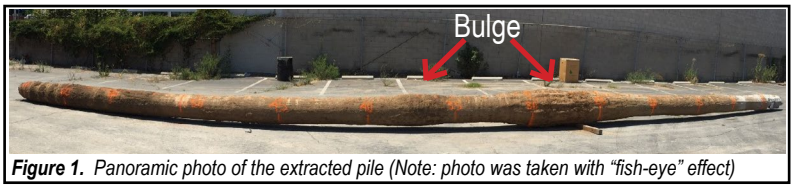


Figure 1. *Panoramic photo of the extracted pile (Note: photo was taken with "fish-eye" effect)*

The installed pile had a planned pile diameter of 18 inches (450 mm) and a length of 65 feet (19.8 m). The reported soil profile consisted of lean clay (CL) from 0 to 23 feet (7.0 m), underlain by silty sand (SM) from 23 to 40 feet (7.0 m to 12.2 m), and then again lean clay (CL) to the pile base. The center bar was instrumented from 0 to 62 feet (18.9 m) with a single Thermal Wire® cable. The installed grout volume was reported to be 5.4 cubic yards (4.1 cubic meters) or approximately 127 percent of the theoretical volume.

The as-constructed pile diameter was calculated using circumference measurements at one foot intervals from 5 to 62 feet (1.5 m to 18.9 m) below pile top. These visual inspections and field measurements indicated a relatively uniform pile from 5 to 21 feet (6.4 m) and from 40 feet (12.2 m) to the pile base. A sizable increase in the pile cross section was observed from 25 to 30 feet (7.6 m to 9.1 m). A second, smaller bulge in the pile was observed near 37 feet (11.3 m).

The "T-Soil" analysis method was utilized to calculate the effective pile diameter (**Figure 2**) which is correlated from the measured temperature and total grout volume. This T-Soil method is recommended for single-wire (i.e. center bar) applications on piles up to 24 inches (610 mm) in diameter. It differs from the analysis technique used for drilled shafts where temperatures are typically monitored on a reinforcing cage rather than a central location. A plot of the Effective Diameter vs. Depth based on both TIP and circumference measurements is presented in **Figure 2**. Overall, the effective diameter based on the TIP results deviated by approximately 2% from the actual measurements over the instrumented length of the center bar.

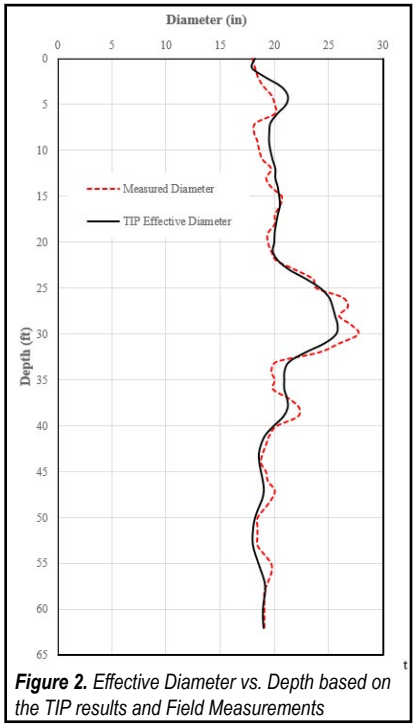
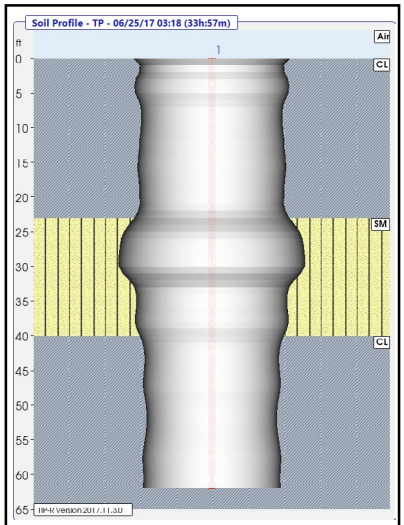


Figure 2. *Effective Diameter vs. Depth based on the TIP results and Field Measurements*

Where shaft resistance has to be calculated from strain values measured during a static load test, a reasonably accurate pile cross sectional area is important. The accuracy of the TIP calculated effective diameter surpasses that of simply assuming a uniform pile, which often times becomes conventional practice without any additional information available.

Naturally, TIP is an indirect evaluation method and there are potential error sources such as an inaccurate reported total grout or concrete volume, or a center bar which is not placed near the center of the pile (thus yielding a non-centralized Thermal Wire cable). However, with proper care, these error sources can be easily minimized with reliable results obtained within a very short time of concrete/grout placement. The experienced test engineer can also detect whether or not the center bar was properly installed from the temperature vs. depth profile. If within a few hours after concrete/grout placement TIP suggests a pile bulge, then appropriate remedial actions can be promptly implemented (e.g. another static test pile can be selected) avoiding costly test duplications or construction delays.



Three-Dimensional Representation of the Pile Shape (as computed in TIP-Reporter©)

It is hoped that more opportunities for pile extraction and shape comparisons will occur in the future. In this way the profession will gain confidence in the various testing methods which may benefit owners, engineers and contractors with a higher level of confidence in the foundation and, therefore, better economy.

State of Practice: Quality Control of Deep Foundations Workshop Tour

PDI is hosting One Day Workshops throughout the US and Canada to review the importance and benefits of Deep Foundation testing from pre-installation to post-installation, the economics and codes involved. The workshops offer 6.5 PDHs and the ability to take the PDA Proficiency Test in most cities. However, space is limited to the first 30 registrants.

- Assess capacity of drilled shafts by various field testing applications including Dynamic Load Testing, Static Load Tests and Bi-Directional Load Tests
- Assess integrity of drilled shafts by various NDT methods including Crosshole Sonic Logging, Low Strain Integrity Testing, Thermal Integrity Profiling and other inspection methods
- Learn the advantages and limitations of various integrity and capacity methods in drilled shafts, while choosing the appropriate methods for each analysis
- Understand basic concepts of PDA testing and advancements in Dynamic Load Testing
- Learn the appropriate interpretation of integrity testing results and the integrated method of data collection, processing, management and presentation of results

PDI industry pioneers and experts will be instructing the workshops and discussions. Choose the location that's right for you. Register today!

BOSTON – 3/20/18	MEMPHIS – 9/11/18
HARTFORD – 3/21/18	KANSAS CITY – 9/13/18
NEW YORK CITY – 3/23/18	CHICAGO – 9/14/18
TORONTO – 4/24/18	RALEIGH, NC – 11/13/18
OTTAWA – 4/26/18	COLUMBIA, SC – 11/14/18
MONTREAL – 4/27/18	ATLANTA – 11/15/18

"...This workshop was excellent. George, Garland and Ryan were great. Their respective presentations were very informative as was their response to the many questions. Their answers... were sprinkled with related incidents and anecdotal references... They were at ease with the topics and attendees, which to me, indicated they are truly experts in their field...This workshop had a great value and was very professionally presented! Thank you!"

- David W. Patterson, PE, PLS, Sec.
Susquehanna Supply Co., Inc.

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Upcoming Events

Complete list of 2018 events available at www.pile.com/events

MARCH

5-9: IFCEE (Booth #136 & 138)
13-14: Webinar: Dynamic Pile Testing for Non-PDA Users (Register Today!)
20-23: Workshops: QC of Deep Foundations: Boston, Hartford and NYC (Register Today!)
21-23: Design Build in Transportation (Booth # 707)
26-28: The Big5 Heavy, Dubai
27: Webinar: Accelerated QC of Drilled Shafts Prior to Casting (Register Today!)

APRIL

3-6: International Offshore Wind Partnering Forum
11: Seminar: Deep Foundation Integrity Testing & Wave Equation Analysis in Orlando, Florida (Register Today!)
12-13: Workshop: High Strain Dynamic Foundation Testing and Proficiency Test in Orlando, Florida (Register Today!)
17-18: Webinar: Wave Equation Analysis / GRLWEAP part 1 (Register Today!)
19-20: Construction Congress (Vienna, Austria)
24-25: Webinar: Wave Equation Analysis / GRLWEAP part 2 (Register Today!)
24-27: Workshops: QC of Deep Foundations: Toronto, Ottawa, and Montreal (Register Today!)

MAY

2: Webinar: QC of ACIP and CFA Piles (Register Today!)
8: Seminar: Deep Foundation Integrity Testing & Wave Equation Analysis in Calgary, Alberta (Register Today!)
9-10: Workshop: High Strain Dynamic Foundation Testing and Proficiency Test in Calgary, Alberta (Register Today!)
17: Webinar: All Driven Piles- ASCE
22-24: Workshop: QA/QC of Deep Foundations; PDA Training and Proficiency Test in Paris (Register Today!)

GRL at IFCEE: Deep Foundation Testing Sessions

GRL Engineers, Inc. will be sharing their experiences in Deep Foundation analyses via short courses, papers and panel participation at the upcoming International Foundations Congress and Equipment Expo, March 5-10 in Orlando, Florida. To learn more on each topic, or to continue the conversation please visit us at **Booth 136.**

Thursday, March 8, 2018

TECHNICAL SESSION – 8:30am – 10:30 am – Sabal A
- *Savings from Testing the Driven Pile Foundation for a High-Rise Building,* Van Komurka, P.E., D.GE.
- *Bonner Bridge Replacement Project – Pile Driving Experience,* Scott Webster, P.E.

TECHNICAL SESSION – 8:30am – 10:30 am – Sabal C
- *50 Years of FHWA Geotechnical Panel,* Garland Likins, P.E.

TECHNICAL SESSION – 10:30am – 12:00 pm – Sabal F

(Moderator: Anna Sellountou, PhD, P.E.)
- *State of Practice and Advances in Quality Control Methods from Drilled Shafts,* George Piscsalko, P.E and Pat Hannigan, P.E.
- *Recommendations of Two Acceleration Measurements with Low Strain Dynamic Test,* Marty Bixler, P.E.
- *Quantitative Assessment of Drilled Shafts Base Cleanliness Using the Shaft Quantitative Inspection Device (SQUID),* Rozbeh Moghaddam, PhD, P.E. and Pat Hannigan, P.E.

Friday, March 9, 2018

TECHNICAL SESSION – 8:00am – 9:30am - Sabal C
- *Driven Piles: A Solution for Difficult Soil and Site Conditions,* Mohamad Hussein, P.E.

In addition to the above, GRL **Booth 136** will feature Bi-Directional Load Test with the GRL Cell, along with a vast array of Deep Foundation solutions.

DID YOU KNOW?

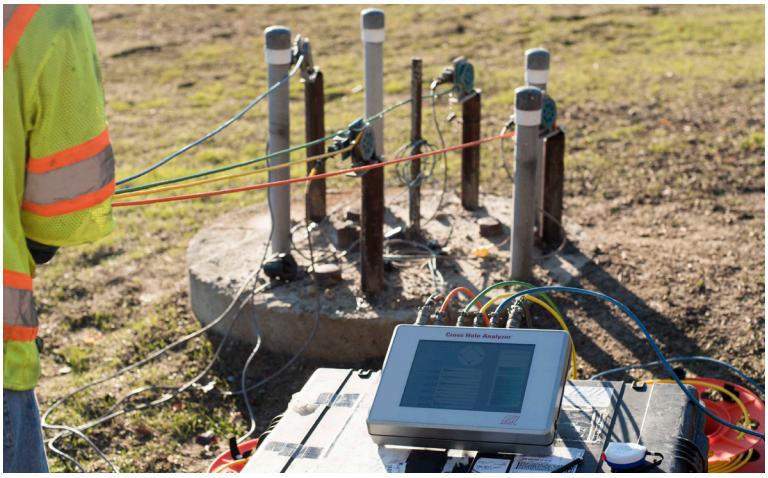
The Crosshole Sonic Logging (CSL) method was developed by Jean Paquet of CEBTP as a down-hole variation of the Ultrasonic Pulse Velocity (UPV) test in 1969, but wasn't widely used until the 1980s with the advent of the portable digital computer.

Newsletter No. 88 - July 2018

Saving Testing Time and Cost for Crosshole Sonic Logging with the CHAMP-Q 4-Probe System

by Ryan Allin, P.E. and Alex Ryberg, P.E.

Crosshole Sonic Logging, or CSL, has become a standard non-destructive test method for the bored (drilled) foundation industry. Traditionally, the method requires the installation of nominal 2-in (50 mm) access tubes (preferably steel) in a shaft, attached to the inside of the reinforcing cage. The access tubes are filled with water, and transmitter and receiver probes are lowered to the bottom of two parallel tubes, then pulled simultaneously to the top of the shaft. At regular vertical increments, the probes measure the transit time for a sonic pulse to travel through the concrete from one probe to another. The entire data set, from shaft bottom to top between two access tubes, is generally referred to as a "profile". If the transit time is consistent throughout the entire profile, it would indicate concrete of consistent quality. Any degradation to the concrete quality, including any inclusions, would result in an increase in transit time.



Four Is Better Than Two

With Pile Dynamic's new CHAMP-Q 4-probe system for crosshole sonic lgging, six CSL profiles can be scanned simultaneously.

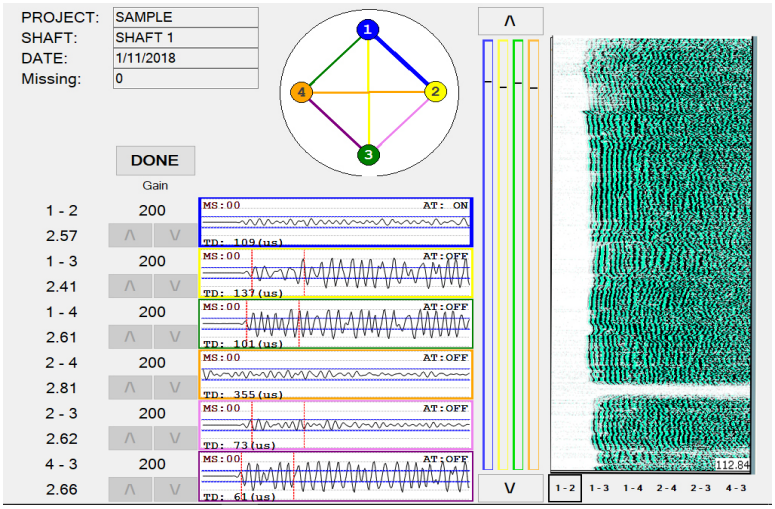
Most crosshole systems depend on separate transmitter and receiver probes to collect data. The typical 2-probe configuration includes the two aforementioned probes placed into two parallel access tubes, collecting data for a single profile, and then repeating the process until all tube combinations have been tested. This process is very time consuming onsite. The CHAMP-Q 4-probe system accelerates this process by replacing the individual transmitter and receiver probes with "transceivers" - which function as both a transmitter and receiver. By increasing the number of probes to four, the system can sequentially alternate which probe is transmitting while the other probes receive the transmitted signal. All of this happens seamlessly for the user, allowing for real-time data collection without any time lag.

The CHAMP-Q 4-probe system can be used with a tripod or depth encoders placed directly on the access tubes (see photo above). Having the encoders at the tubes eliminates any possible slack in the cables which could affect the depth measurements.

"With improved testing efficiency, data can be evaluated and reports submitted...allowing construction to continue at an accelerated rate, potentially reducing costs..."

With the CHAMP-Q 4-probe system's ability to scan six profiles in one pull, the number of necessary pulls or iterations with the CSL probes is significantly decreased. This allows for more shafts to be tested per day, and testing sequences to become streamlined. With improved testing efficiency, the data can be evaluated and reports submitted in an expedited manner, allowing construction to continue at an accelerated rate, and potentially reducing testing costs, as more shafts can be tested in one day.

For example, a 72-inch (1.8 m) diameter shaft with six CSL access tubes requires 15 scans or iterations with a 2-probe system. Using the Champ-Q 4-probe system, the same 72-inch (1.8m) shaft can be tested with only three complete iterations of lowering the probes and scanning the shaft - 15 iterations are now reduced to three.



New Software for a New Generation of Testing

Two additional probes and five additional data sets simultaneously collected gives the CHAMP-Q user an intuitive and simple way to assess the data during collection and review with the CHA-S software. File set-up is simplified, requiring minimal user inputs prior to data collection. Probe placement can be defined by simply dragging the probe to the appropriate access tube in file set-up. CHAMP-Q provides a recommended testing sequence to minimize the number of pulls required to test all profiles.

For additional information on the CHAMP-Q 4-probe system or any other PDI QA testing product, please visit www.pile.com.

GRL Completes Two Bi-Directional Static Load Tests in 24 Hours

GRL Engineers, Inc. recently completed two bi-directional static load tests (BDSLT) within a 24 hour period. The two bi-directional tests were located 6,650 miles apart with one test in the US on a 6-foot (1.8 m) diameter drilled shaft and the second test in the Middle East on a 5-foot (1.5 m) diameter drilled shaft. Both tests utilized three 1,100 ton **GRL-Cells** in a single layer jack assembly. In this configuration, both bi-directional static load tests were capable of applying a maximum test load of 6,600 tons. The tests utilized PDI's Static Load Tester datalogger system to read and store all of the BDSLT electronic instrumentation readings including digital levels, pressure transducer, vibrating-wire displacement transducers, and vibrating-wire strainmeters. Both drilled shaft tests also utilized PDI's Thermal Wire Cables and Thermal Integrity Profiling system to assess the concrete quality and to delineate the as-built drilled shaft geometry for use in load-transfer evaluation and construction of the equivalent top-loading curve.

In Memory of David Klingberg of Wagstaff Piling Pty Ltd

The piling industry is in shock after the sudden passing of David Klingberg as a result of a site accident on 14th June. A moving commemorative service in Brisbane, attended by over 300 friends and colleagues, demonstrated the high esteem in which he was held. David was a PDA testing expert, with 30 years field experience. His professional niche in PDA testing satisfied his need to be involved in leading technology, to exercise his mental capabilities in the science of stress-waves and the art of connecting this to real-world engineering solutions, all with an uncompromising commitment to honesty and integrity. He was a patient teacher and mentor to many young engineers. David was at the forefront of his field internationally and contributed widely to conferences, seminars and to the development of the innovative 2009 Australian Piling Code. However, David was successful in far more than his professional achievements. He was honoured for his academic achievements, and successful in many sporting endeavors such as football (soccer), golf, netball, ten pin bowling, cycling, skiing and distance running. He loved four-wheel drives, camping, fishing and singing in his church choir. David was an all-round man who successfully embraced life, and yet was as humble and unassuming as one could be. Carpe Diem! Sieze the Day! David embraced this philosophy and made the most of his time here on Earth. He leaves his wife and two children, with their memories of his pride and encouragement of their achievements.

- By Julian Seidel, Nick Medley, Dion Denes, Hossein Ahmadi

Upcoming Events

Complete list of 2018 events available at www.pile.com/pdi-events

AUGUST

7: **Webinar:** SPT Hammer Energy Measurements (Register Today!)
7: **Seminar:** Deep Foundation Integrity Testing and Wave Equation Analysis in **Indonesia** (Register Today!)
8-9: **Workshop:** High Strain Dynamic Foundation Testing and Proficiency Test in **Indonesia** (Register Today!)
13-15: **Seminar & Workshop:** QC in Deep Foundations in **Vietnam** (Sold Out)
27: **Seminar:** Deep Foundation Integrity Testing and Wave Equation Analysis in **India** (Register Today!)
28-29: **Workshop:** High Strain Dynamic Foundation Testing and Proficiency Test in **India** (Register Today!)

SEPTEMBER

5: **Webinar:** Quality Control of Drilled Shafts (Register Today!)
11-14: **QC of Deep Foundations - Workshops**: Memphis, Overland Park and Chicago (Register Today!)
19: **Webinar:** Benefits on Thermal Integrity Profiling/Review of Top and Bottom Roll-off Adjustments (Register Today!)
19: **Workshop:** QC/QA of Deep Foundations in **London** (Register Today!)
19-20: **DICEP** 2018 Baltimore, MD (Booth #5)
21: **Workshop:** QC/QA of Deep Foundation in **Dublin** (Register Today!)
23-26: **GeoEdmonton** 2018 Edmonton, Alberta

OCTOBER

3: **Seminar:** Deep Foundation Intregity Testing and Wave Equation Analysis in **Cleveland, OH** (Register Today!)
4-5: **Workshop:** High Strain Dynamic Foundation Testing and Proficiency Test in **Cleveland, OH** (Register Today!)
12: **Workshop:** QA of Deep Foundations, **Winnipeg, Canada** (Register Today!)
15: **Seminar:** Deep Foundation Integrity Testing and Wave Equation Analysis in **Dubai** (Register Today!)
16-17: **Workshop:** High Strain Dynamic Foundation Testing and Proficiency Test in **Dubai** (Register Today!)
18: **Webinar:** LRFD and Testing Economics (Register Today!)
24-27: **43rd Annual DFI Conference** - Anaheim, California (Booth #407)

Elvis Ishimwe, PhD joins GRL-Chicago

Elvis is a recent Ph.D. graduate in Civil Engineering from the University of Arkansas, Fayetteville. He previously earned his MS and his BS degrees in Civil Engineering from the University of Arkansas, Fayetteville in 2014, and 2013, respectively. As part of his recent Ph.D. studies, Elvis evaluated the effects of liquefaction-induced dragload and downdrag on drilled shafts and driven piles within the New Madrid Seismic Zone of northeastern Arkansas and southeastern Missouri. He is an active member of Deep Foundation Institute (DFI) and ASCE Geo-Institute (G-I). Elvis has published many articles spanning various geotechnical topics, and is fluent in both French and English.

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