DID YOU KNOW? *Newsletter No. 112 - December 2024*

There is a comprehensive support page for the Thermal Integrity Profiler (TIP™) system. Learn more: https://www.pile.com/tip-support-page/

GRL Engineers, Inc. Pile Dynamics, Inc.

The Benefits of Multiple Integrity Testing Methods at the Chain of Rocks Bridges

by Travis Coleman, P.E. and Alex Ryberg, P.E.

Crosshole Sonic Logging (CSL) is performed by transmitting and then receiving an ultrasound wave across specific profiles (via access tubes) as probes are typically raised through a foundation element. The results provide a general qualitative view of the concrete/grout along the specific tested pathways/profiles based on arrival time and signal strength. Obtaining representative results is dependent on the bond between the access tube and the material being tested (concrete/grout), which is developed during the curing process of the cementitious material. If CSL testing occurs too early in the hydration process, results may be adversely affected as the proper bond may not have yet formed which would impede signal transmittal through a tested medium. If CSL testing is performed much later, it may have an increased risk of de-bonding occurring over time. As such, Thermal Integrity Profiling (TIP™) can and is successfully used as a standalone testing method on many projects for evaluating concrete/grout integrity. If used in conjunction with CSL, the two methods can combine to provide a more thorough assessment of foundation element integrity.

Interstate I-270 spans the Mississippi River with an approximately one-mile-long bridge, referred to as the Chain of Rocks Bridge. In 2022, a project to replace the bridge began. Both the eastbound and westbound bridges are supported by 75 shafts with a diameter of 9 feet (3M) and lengths ranging from approximately 50 to 100 feet (15M – 30M). Due to the critical nature of these shafts, it was decided to utilize multiple non-destructive testing methods to assess shaft integrity. Both CSL and TIP tests were specified for every shaft. These allowed the shafts to be assessed with different methods, at different times post concrete placement.

TIP testing was performed with eight wires attached to the reinforcing cage. Immediately following concrete placement data collectors were attached to each wire and the data began to populate in PDI's ATLAS™ secure cloud server. This allowed for the TIP engineer to make a rapid qualitative assessment of the shaft integrity within 48 hours of concrete placement, which was discussed with the client. Data collection continued until the shaft concrete had clearly passed peak temperature, which occurred approximately three days after placement. Rather than a full TIP analysis for each shaft, the temperatures for all three shafts at a bridge pier were presented. Anomalous temperatures were noted, and only these shafts were selected for full TIP analysis. (Figure1)

CSL testing was also performed and was considered the primary integrity test, requiring a full analysis and report for each shaft. The shafts were constructed with 8 CSL tubes, and testing was performed for every tube combination

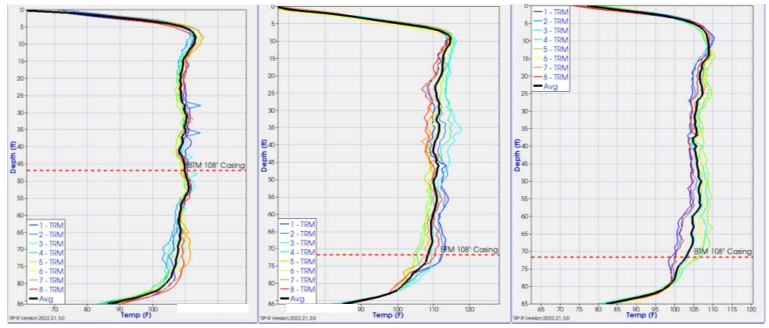

Figure 1. Thermal Integrity Profiling (TIP) temperatures for three shafts at one pier

approximately 7 to 14 days after concrete placement. Per Illinois DOT specifications, CSL results with signal delays were subject to further analysis using Tomography methods. Tomography is the best fit of all of the CSL results over the full shaft length, which allows for a 3-D analysis of the location and magnitude of anomalous zones. Figure 2 provides the results of a typical tomography analysis showing 2-D slices of the calculated effective area.

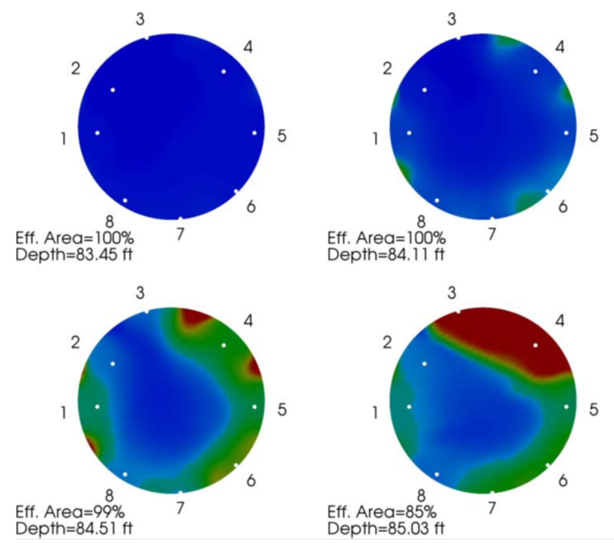

Figure 2. Tomography results showing Effective Area at selected depths near shaft bottom

The foundation installation began with the shafts placed along the bridge approach sections, which were over land. For these shafts, both TIP and CSL indicated shafts without significant anomalies, or when significant anomalous zones were identified they were generally equally noted in both testing methods. The benefits of two testing methods became evident as the shaft installation progressed to shafts placed in the river crossing section of the bridge. The flowing water, passing along the permanently cased section of the shafts, clearly caused a reduced temperature in the TIP results. This is well understood as a change of boundary conditions that must be accounted for to accurately present effective radius TIP results. However, the CSL results also had anomalous results in the same zone. The results were not indicated by loss of signal, as would be expected for integrity issues, but zones of energy reductions (weak signals), particularly with greater distances between tubes. (Figure 3)

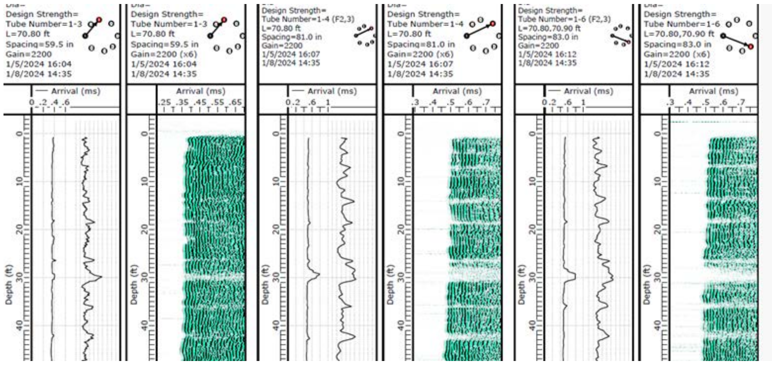

Figure 3. Sample CSL results with zones of weak signal

Due to the weak and inconsistent signal strength, tomography analysis did not provide further insight. Multiple CSL tests were completed over various time intervals. For some shafts, cores were advanced in between the CSL tubes in the upper portions of the shaft, and CSL testing was performed between the core holes. This additional CSL testing did not provide definitive conclusions on the shaft integrity. It was also observed that the core samples retrieved did not indicate any integrity issues.

Without conclusive CSL results, TIP results were further scrutinized. Corrections to boundary conditions must be used appropriately, as they can significantly affect the results. In this case, the temperature reduction was uniform within the flowing water zone. This further supported the proper application of the change in environmental conditions. Anomalous concrete zones, if present, would be accompanied by abrupt, and likely inconsistent, temperature changes. (Figure 4)

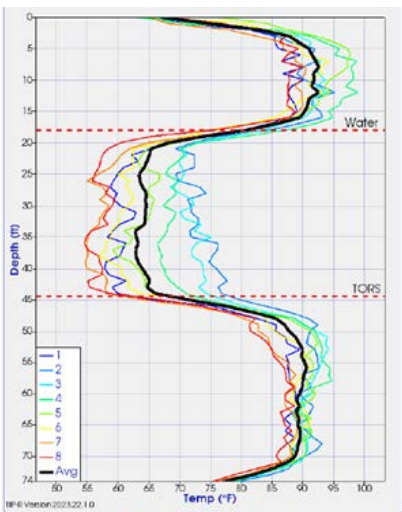

Figure 4. TIP results with Temperature Loss in flowing water zone

The combination of CSL and TIP results, along with the cores, allowed for acceptance of the drilled shafts on this project. Information was gleaned from both testing methods at significantly different time intervals after placement. Due to the cost of the foundations and the significant effect on the construction schedule, multiple test methods may be an attractive approach on major projects as they allow for a more complete assessment of shaft integrity by providing insight to hydration processes and overall integrity assessment via different methods.

Upcoming Events

Jan 26-28	ADSC Annual, Coronado, CA Learn More
Feb 4-6	PDCA Annual, San Antonio, TX: Booth 209 Learn More
Feb 4-6	AREMA Railroad Bridge Symposium 2025 Learn More
Feb 11-12	FTBA Construction Symposium, Orlando, FL Learn More
Feb 20-21	Pfahl Symposium, Braunschweig, Germany Learn More
Mar 2-5	GeoFrontiers, Louisville, KY: Booth 907 Learn More
Mar 10	**PDCA & PDI Seminar: Deep Foundation Integrity Testing & Wave Equation Analysis, Orlando, FL** *Contact Kathy@piledrivers.com for additional information.*
Mar 11-12	**PDCA & PDI Workshop: High Strain Dynamic Testing & Proficiency Test Option, Orlando, FL** *Contact Kathy@piledrivers.com for additional information.*
Mar 17-19	GeoVirginia, Smithfield, VA Learn More
Mar 26-27	West Virginia Construction & Design Expo, Charleston, WV; Booth Learn More
Apr 7-13	Bauma 2025, Munich, Germany Learn More
Apr 9-11	Structures Congress 2025, Phoenix, AZ Learn More
Apr 24-25	Christian Veder Kolloquium, Graz, Austria Learn More

A complete list of PDI and GRL events can be found on pile.com or grlengineers.com

GRL Engineer's Hawaii Office Expands Team

Rafael Ernesto Vila Lizmov

In September, Rafael Ernesto Vila Lizmov joined the GRL Hawaii office. Rafael is a Civil Engineer with specialization in Construction Management. Throughout his career he has managed construction operations and maintenance activities for project sites including roads, bridges, channels, irrigation projects, pipelines, and water and sewage systems. Welcome Rafael!

PDI ATLAS™ SECURE CLOUD SERVICES

PDI Introduces ATLAS™, a new secure cloud database management service for Thermal Integrity Profiling (TIP™) and Saximeter-Q.

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Happy Holidays!