DID YOU KNOW? *Newsletter No. 111 - September 2024*

Frank Rausche, PhD, P.E. DG.E., developed and wrote the code for the industry standard CAPWAP® program as his PhD thesis, encouraged by Dr. Fred Moses, at Case Western Reserve University.

GRL Engineers, Inc.

Pile Dynamics, Inc.

The More You Know...

by Ryan C. Allin, P.E., Brent Robinson, P.E., PhD., Benjamin White, P.E.

Dynamic load tests on drilled shaft (bored pile) foundations have been successfully implemented on projects globally for over forty years. One concern regarding the application of dynamic load testing for drilled foundations is how to properly model (area, wave speed, modulus) the pile for CAPWAP® analysis. Driven piles, being generally uniform in area and material properties, are easier to model as reflected waves from the pile and the soil can be easily differentiated. A bored pile presents complications, as the pile's area and material properties versus depth may not be uniform. The analysis of data collected with a Pile Driving Analyzer® or PDA from a bored pile requires a user to create a reasonable model to account for these changes. This is often done by employing pertinent soil boring and concrete placement records. This information offers some, but not all, insight as to what has occurred during pile construction. It has been stated somewhat tongue in cheek that - "This is where one leaves the science and enters the artistry of dynamic testing" as a solution relies on a model created from limited information. Modern technology, however, offers us additional insight that can lead to higher confidence in our analyses.

Recently, GRL performed dynamic and static load testing on 36 in (90 cm) nominal diameter, 35 ft (10.7 m) long drilled shafts. The test program included high strain dynamic testing with GRL's APPLE drop weight system, a static test using GRL's 1000T load test frame, and pile integrity assessments by Low Strain Integrity tests (PIT) and Thermal Integrity Profiling (TIP). The latter provides insight into the effective geometry of the completed test shaft. Results from the PIT testing indicated a strong toe reflection and no indication of impedance variations along the shaft length. Thermal Integrity results (***Figure 1***), while confirming sound integrity, also indicated an oversized shaft based on the concrete volume, with the effective radius increasing versus depth.

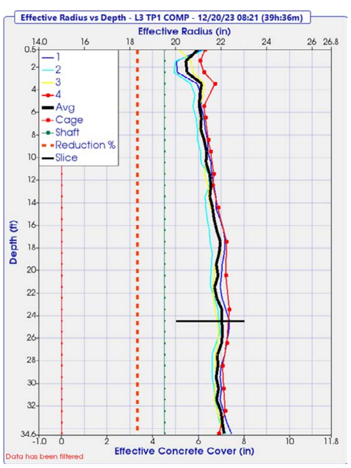


Figure 1. Effective Radius Analysis from TIP

Both the static and dynamic load test included multi-level instrumentation to better evaluate the resistance distribution. One consideration for embedded strain sensors is estimating force from measured strain which requires the cross-sectional area at the sensor elevation which is unknown. The effective radius calculation from Thermal Integrity Profiling results is influenced by the concrete quality and volume. If the concrete quality is uniform across the width of the pile, the calculated effective radius provides the radius/area increase or reduction that would be appropriate for modeling in the CAPWAP® program. Using data from TIP results would improve the often-incorrect assumption that the pile is uniform. Effective radius profiles have a significant influence on the analysis with respect to resistance distribution along the shaft and toe. The TIP results, when combined with installation logs and soil boring information, improve confidence in the CAPWAP® pile model.

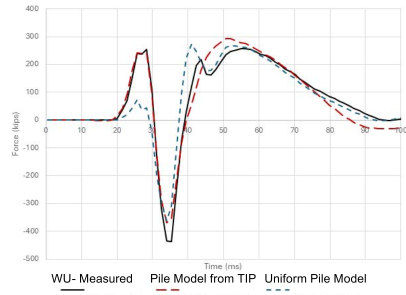


Figure 2. CAPWAP Analysis comparison – Uniform vs. TIP Pile Model

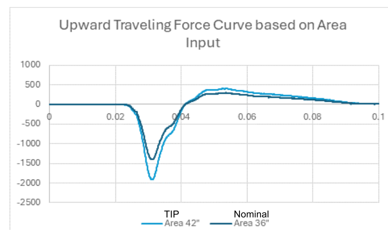


Figure 3. For the embedded measurements, assuming the area from TIP increased the force by 30%

For the CAPWAP® analysis presented in ***Figure 2***, the dashed-blue curve shows an analysis assuming a uniform pile. The dashed red curve represents the same analysis using a pile radius/area based upon the TIP results. The TIP radius/area has further implications when it comes to embedded measurements. The analyses indicate that the force in the pile would be approximately 30% greater for the smaller pile radius/area (see ***Figure 3***). When the larger pile radius/area is considered, the dynamic load test indicated better correlation with the static load testing performed on this pile.

Figure 4 provides the plotted results from the calculated internal force profiles from the static and dynamic load test, when using the larger shaft radius from the TIP analysis. While some variations are apparent the correlation is reasonably close. One reason for the variation may have been a result of the relatively large permanent set (2.5 in / 6.4 cm) encounter during the static load testing, which was performed prior to the dynamic load testing.

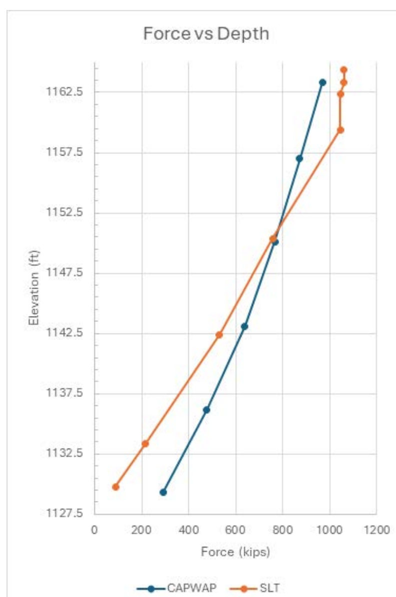
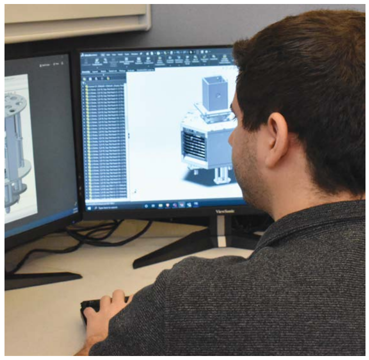


Figure 4. Calculated internal force profile from the static load test embedded strains (orange line) and CAPWAP (blue line).

Testing of any drilled shaft is not a simple task, given the magnitude of the loads, and generally limited scope of the test program. The test must not only be performed well in the field, but subsequent analysis must use all available information to create a reasonable pile model and resistance distribution. Thermal Integrity Profiling (TIP), and other integrity and geometry methods, are useful tools that should be used to increase confidence in resistance distribution and capacity predictions.

For additional information, please visit www.grlengineers.com or send an inquiry to info@pile.com.



Preparing Future Engineers Through Internships and Co-Ops

In the competitive field of civil engineering, gaining practical experience through internships or cooperative education programs (co-ops) is crucial for aspiring professionals. These opportunities bridge the gap between academic knowledge and real-world application, providing invaluable benefits that can shape a successful career.

1. Hands-On Experience
Apply theoretical concepts learned in the classroom to real-life projects to enhance problem-solving skills and foster critical thinking.

2. Industry Exposure
Observe daily operations, learn about project management, and understand the regulatory frameworks that govern engineering practices. Exposure to different sectors enables students to identify their interests and career aspirations.

3. Professional Networking
Interns/Co-ops have the chance to connect with industry professionals, mentors, and peers, creating relationships that can lead to job opportunities after graduation. Networking also allows students to gain insights into industry trends and best practices.

4. Skill Development
Beyond technical skills, internships help develop essential soft skills such as communication, teamwork, and project management.

5. Resume Enhancement
Having an internship or co-op on a resume distinguishes candidates in the job market, demonstrating not only practical skills but also a commitment to the profession.

GRL Engineers and Pile Dynamics, Inc. are committed to a robust internship/co-op program. They are an integral part to the growth of the individual and the organizations providing essential experience, networking opportunities, and skill enhancement that are critical for building a successful career. As the engineering landscape continues to evolve, those who actively seek out and engage in these opportunities will be better equipped to meet the challenges of the future.

For additional information or to express interest in a GRL/PDI internship/co-op, please contact info@grlengineers.com.

Upcoming Events

Oct 7-10	DFI49 Annual Conference, Aurora, CO: Booth 213 Learn More
Oct 8	**Estado Actual de las Practicas: Soluciones Avanzadas para Cimentaciones Profundas, Ciudad de Mexico, Mexico Register Now**
Oct 8-9	Ohio Transportation Engineering Conference, Columbus, OH: Booth 237 Learn More
Oct 21-23	**Workshop: Advanced Pile Testing and Quality Control, İstanbul, Türkiye Register Now**
Oct 23-24	**Workshop: Engineers Driven Pile Institute (EDPI), Salt Lake City, UT Register Now**
Oct 24	**Congreso de Auscultación para Cimentaciones Profundas, Madrid, Spain Register Now**
Oct 30-Nov 1	Central Pennsylvania Geotechnical Conference, Hershey, PA: Booth C4 Learn More
Nov 1	Rocky Mountain GeoConference, Westminster, CO Learn More
Nov 6	**Seminar: Deep Foundation Integrity Testing & Wave Equation Analysis, Cleveland, OH Register Now**
Nov 7-8	**Workshop: High Strain Dynamic Testing & Proficiency Test Option, Cleveland, OH Register Now**
Nov 12-16	Panamerican Conference on Soil Mechanics & Geotechnical Engineering, Chile: Booth 40 Learn More
Nov 13	Ohio River Valley Soils Seminar, Cincinnati, OH Learn More
Nov 18-21	Southeastern Transportation Geotechnical Engineering Conference (STGEC), Baton Rouge, LA: Booth 39 Learn More
Nov 20-22	5th International Conference on Transportation Geotechnics, Sydney, Australia Learn More
Nov 25-26	**Workshop: Deep Foundations Workshop PDA Training & Proficiency Test, Melbourne, Australia Register Now**
Nov 28-29	**Workshop: Deep Foundations Workshop PDA Training & Proficiency Test, Selangor, Malaysia Register Now**

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

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