

## Deep Foundation Testing, Analysis and Consulting Services

- PDA Testing and Monitoring
- Dynamic Load Testing- APPLE
- Thermal Integrity Testing
- Crosshole Sonic Logging
- SPT Energy Calibration

- Low Strain Integrity Testing
- Static Load Testing
- Bi-Directional Load Testing
- Wave Equation Analysis
- Becker Drill Instrumentation



We live by our motto: Quick response, Results you can trust!

#### PDA Dynamic Pile Monitoring and Testing

GRL Engineers use the Pile Driving Analyzer® (PDA) system to perform dynamic pile monitoring of test piles and production piles. These dynamic pile tests determine the soil resistance at the time of testing, pile installation stresses, pile hammer performance, and pile structural integrity. The testing can be performed with an engineer operating the PDA on-site, or with the engineer performing the test in real time from the office via SiteLink<sup>®</sup>. After the test, the dynamic test data is processed as a function of the observed pile driving blow count and pile penetration depth, thereby summarizing the pile installation. CAPWAP<sup>®</sup> analyses of selected dynamic test records are also performed to further refine the soil resistance distribution and dynamic test results through signal matching. Dynamic pile monitoring results and supporting CAPWAP analyses are summarized in a test report along with pile installation recommendations.

#### CAPWAP<sup>®</sup> Signal Matching Analysis

CAPWAP is a signal matching program for capacity evaluation. It is supported by a significant database

mhg f 1.670 6/A of static load test correlation results. The CAPWAP program uses wave equation type

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pile and soil models with the measured force and velocity records from the dynamic test replacing the hammer. From the dynamic measurements, it calculates the mobilized capacity, the soil resistance distribution, the dynamic soil properties, and a simulated static load-movement curve.



#### **GRL Bi-Directional Cell Testing** Services

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The GRL-Cell is a high capacity device installed within a deep foundation to statically load test the foundation. As the GRL-Cell is pressurized, it loads the foundation in two directions. The portion of the foundation element above the GRL-Cell is pushed upward against its shaft resistance at the same time that the foundation element below the GRL-Cell is pushed downward against its shaft resistance and toe resistance. GRL Engineers

constructs an estimated foundation top load-movement curve from the measured load-movement responses. The results can be used to optimize the foundation length and design. Bi-Directional load tests are not restricted by the structural or geotechnical limit of a load frame, a reaction beam, or the reaction piles.

#### Wave Equation Analysis (GRLWEAP)

The GRLWEAP wave equation program is used by GRL Engineers to assist in the selection of pile driving equipment, optimization of pile installation accessories and procedures, and evaluation of pile driveability to the required pile penetration depth and/or capacity. Analysis results are presented in the form of bearing graphs,

inspector's charts or driveability analyses as appropriate for the project requirements. These results are submitted along with a report describing the analyses details. The report typically includes recommendations for pile driving criteria and driving stress control.



#### **Shaft Profiling Services**

Drilled shafts are rarely ideal cylinders and irregularities can affect capacity and design. GRL Engineers conduct cost-effective quality assurance sonic caliper shaft tests



with the Shaft Area Profiler Evaluator (SHAPE) to better characterize the threedimensional shape of drilled shafts and other excavated deep foundation elements. The SHAPE test will provide a visual representation of the shaft prior to placing concrete in dry or wet conditions.

## SQUID Testing Services (Shaft Quantitative Inspection)

GRL Engineers can perform an evaluation of the base cleanliness of a drilled shaft foundation and the associated debris thickness

using the SQUID device. The SQUID device can also be used to measure the resistance to penetration at the base of drilled shafts and bored piles. These tests provide construction professionals quick and reliable information about the cleanliness of



the drilled shaft and the strength of the interface between a bearing layer and the base of a drilled shaft.



#### Dynamic Load Testing – APPLE Services

GRL Engineers has several APPLE systems equipped with modular drop weights. These APPLE systems can quickly and efficiently apply an appropriate dynamic impact force if a pile driving hammer is

not available or if the available hammer is insufficiently sized to mobilize the soil resistance. Dynamic load tests can be performed on driven piles, drilled shafts, augered cast-in-place piles, helical piles, and micropiles. GRL's APPLE systems can be configured for a wide range of weights (1 to 80 tons) and are quickly transportable to project location. A shaft or pile top transducer or load cell can also be used when testing drilled foundation elements to quickly acquire quality force measurements. Dynamic load tests with GRL's APPLE systems are a quick, cost effective, and attractive alternative to static load testing of deep foundations.

#### Low Strain Dynamic Testing (PIT)

GRL Engineers use low strain pulse echo testing to evaluate the integrity length of drilled shafts, augered cast-in-place piles, precast concrete piles, concrete filled pipe piles and timber piles. Typically, several piles can be tested in a day allowing a quick assessment of integrity or length. Major integrity

issues from necking, soil inclusion, concrete placement problems, or voids may be identified, as well as major cracks that do not permit passing of the low strain signal. Unknown foundation

lengths can be assessed when a reflection from the foundation toe is recorded based on an assumed representative wave speed for the pile material.



#### Static Load Testing Services (SLT)

Static load tests are performed to validate foundation design assumptions regarding the axial compression or axial tension resistance provided by a deep foundation element or its deflected shape under a lateral load. GRL Engineers perform both highly instrumented static load test to meet the need of project design tests, as well as basic load tests, for construction quality assurance. After the collected load test data is processed, GRL

prepares a final report summarizing the load movement results that can be compared to the specified load test interpretation criteria to determine the deep foundation's capacity or nominal resistance.





#### Thermal Integrity Profiling (TIP)

TIP technology utilizes the heat generated by curing concrete to assess the integrity and quality of drilled shafts, augered cast-in-place piles, barrettes, and slurry wall panels. GRL Engineers assess the totality of the cross-section of the deep foundation element, inside and outside of the cage, relatively quickly. The data collected soon after casting provides results detecting necks, bulges, and variations in concrete cover. For

the effective radius of the shaft and shaft shape is provided. TIP has no depth limitations and can potentially accelerate the construction schedule, saving time and money.

bulges, and variations in concrete cover. For drilled shafts, e shaft and TIP has no potentially on schedule,

#### Crosshole Sonic Logging (CSL)

CSL testing is performed by sending an ultrasonic signal from a transmitter in one access tube to a receiver in another access tube. The arrival time and strength of the received ultrasonic signal is used to evaluate the integrity and homogeneity of the concrete placed in the drilled shaft, barrette, or slurry wall panel. The steel or PVC access tubes are attached to the rebar cage and installed in the foundation element prior to

concrete placement. CSL testing is typically performed 3 to 7 days after concrete placement. The testing is relatively quick and has no depth restrictions. GRL Engineers perform an evaluation of concrete quality within the area defined by the tube geometry. If anomalies are detected, an estimate of anomaly location and severity is reported. For drilled shafts, the collected CSL data can be further analyzed



with 3-Dimensional Tomographic software for a more detailed test report.

# GRL engineers, inc.

# Quick Response... Results You Can Trust!



# **OUR STORY**

In Cleveland, Ohio, 1964, visionary researchers embarked on the project that pioneered dynamic pile testing by the Case Method (derived from the Case Institute of Technology, now Case Western Reserve University). In 1976, the research team incorporated a firm to provide consulting and analysis services utilizing the Pile Driving Analyzer® (PDA) system for deep foundation quality control. Since that incorporation, GRL has continued to expand its capabilities in this field, most notably in the areas of dynamic load testing and monitoring, wave equation technology, hammer performance evaluation, low strain integrity testing, crosshole sonic logging, thermal integrity testing, static load testing, bi-directional load testing, and other non-destructive test methods and foundation testing services.

Today, GRL Engineers service all types of deep foundation elements, including driven piles, drilled shafts, ACIP/CFA piles, micropiles, helical piles, slurry walls, barrettes and more. Our services range from small specialty testing projects to large-scale mega projects requiring the monitoring and analysis of hundreds of deep foundation elements. In addition, GRL continues to engage in deep foundation testing research and education. GRL maintains a quick, costeffective responsiveness to client needs throughout the United States, the Caribbean, Central America and Northern South America. GRL performs foundation testing and analysis services for land based, near shore marine and offshore foundations in countries across the globe.

### Corporate Office: 216.831.6131

## www.GRLengineers.com

CA:	323.441.0965	FL:	407.826.9539	IL:	847.221.2750	NC:	704.593.0992	PA:	610.459.0728
CO:	303.666.6127	GA:	678.371.4911	LA:	985.640.7961	OH:	216.831.6131	TX:	832.389.1156
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