DID YOU KNOW? *Newsletter No. 105 - April 2023*

GRL and PDI both have Youtube channels with a library of instructional videos.

Dynamic Load Testing of Drilled Foundations

by Michael Morgano, P.E., PDI and Matthias Schallert, Dr.-Ing., GSP

In 1974, the first dynamic load tests were reported on bored piles/ drilled shafts. In 1977, the same were reported on augercast (CFA) piles. It was not until the 1980s, however, that dynamic load testing was used on a major drilled foundations project. This keynote project, The Sunshine Skyway Bridge replacement in Tampa, Florida, then led to tests at the West Gate Freeway project in Melbourne, Australia. The Melbourne project incorporated over 100 dynamic load tests on 1.1 to 1.5 m (3.6 to 4.9 ft) diameter bored piles socketed into rock.[1] The drop weight system, designed specifically for the dynamic test program, weighed 200 kN (22.5 ton) with a free fall height up to 2.5 m (8.2 ft). The project's drop weight system mobilized CAPWAP® capacities ranging from 14 to 32 MN (1580 to 3370 tons). In the Proceedings of the Second International Conference on the Application of Stress-Wave Theory on Piles, a companion paper Correlation of Static and Dynamic Pile Tests on Large Diameter Drilled Shafts, presented Class A dynamic load test results with correlations to the project's static load tests.[2]

Figure 1. Pile Top Force Transducer

Figure 2. Side-Mounted Strain Transducer on pile-top build-up

In the decades that followed, dynamic load tests on drilled foundations using large drop weight systems became common practice globally. In some regions, dynamic load tests were more often associated with drilled foundations than with driven piles. There were issues obtaining a reliable force measurement, however, when performing a dynamic load test on drilled foundations. This measurement was complicated by the limited exposed foundation length and concrete quality near the top. This sometimes required constructing a pile head extension to encapsulate exposed rebar and/or provide good quality concrete cover at the point of load application and the measurement sensor's location.

In 2018, Pile Dynamics, Inc. released the Pile Dynamics Analyzer® - Dynamic Load Tester (PDA-DLT) system and associated software to address the specific needs of performing dynamic load tests on drilled foundations. Users of the PDA-DLT could acquire force measurement using a pile top force transducer (Figure 1) or by standard side mounted strain transducers (Figure 2). The PDA-DLT software accommodated either force measurement configuration and calculated pile stresses and capacity accordingly.

Pile Dynamics, Inc. representative, GSP, notes that in Germany over the past 30 years dynamic load tests have been common. Depending on the country's region, driven piles or drilled foundations are dynamically load tested. In Northern Germany, dynamic load tests are more common on driven piles (steel piles and precast concrete piles). In Southern Germany, the test is more common on drilled cast-in-place piles. Since 2018, international standard EN ISO 22477-4:2018 ("…Dynamic Load Testing…") outlined dynamic testing execution and data evaluation procedures.

Germany has seen an increase in dynamic load testing of large, drilled shafts with high loads. Currently, in Germany only drop weights with a maximum mass of 11 metric tons (12 tons) are available. Heavier drop masses for bored piles up to 1.5 m (4.9 ft) in diameter and greater than 30 m (100 ft) length were tested with heavier loading devices available from partners outside of the country. These devices activated capacities well above 10 MN (1100 tons).

Low-strain Pile Integrity Testing (PIT) or Crosshole Sonic Logging (CSL) can be performed to evaluate pile integrity for projects where large bored piles were planned without load testing. Furthermore, Thermal Integrity Profiling (TIP™) has become a popular alternative testing solution. GSP notes that dynamic load testing is the method of choice for further evaluation and capacity assessment if integrity tests indicate anomalies or defects in piles.

GSP recently performed dynamic load tests on a project with 1.2 m (3.9 ft) diameter by 17 m (56 ft) long bored piles. The low strain integrity test for one pile indicated a clear tension wave reflection 2 m (6.6 ft) above the 17 m (56 ft) target depth. This pile was classified as Class B according to the German Recommendation on Piling - EA-Pfähle (major defect, approximate ¾ of reduction in impedance). The pile's capacity was brought into question. Dynamic load testing was performed on this pile (on a 10V:1H inclination, Figure 3) as well as on a nearby pile with no integrity issues. Based on the dynamic test, a reduced capacity was assigned to the Class B pile allowing for a quick assessment of the foundation design.

Over the past 10 years, GSP has seen increased dynamic load testing of ductile iron driven piles. For ductile iron pipe tests, dynamic load tests are performed using small drop weights of maximum 5 metric ton along with specially designed plates atop the pile for load transfer. Approximately 70 piles were tested across several projects.

Figure 3. Dynamic load test setup on 10V:1H inclination (courtesy GSP)

Dynamic testing on drilled piles has become widely used in many countries with the increasing availability of drop weight systems. Dynamic testing can be included in the project specifications to check design parameters during a test program or can evaluate capacity of production piles where the pile's integrity is questioned from integrity testing methods.

Nearly 50 years after the first dynamic load test on a drilled foundation, dynamic load tests continue to provide an economical means of drilled foundation capacity assessment and evaluation.

1 Rausche and Seidel, (1984). Design and Performance of Dynamic Tests of Large Diameter Drilled Shafts, Proceedings of the Second International Conference on the Application of Stress-Wave Theory on Piles, Stockholm, pp 9-16.

2 Seidel and Rausche (1984) Correlation of Static and Dynamic Pile Tests on Large Diameter Drilled Shafts, Proceedings of the Second International Conference on the Application of Stress-Wave Theory on Piles, Stockholm, pp 313-318.

New Developments

Anna Sellountou-Rausche, PhD, P.E., was announced as Pile Dynamics, Inc's Director of Global Sales in early January. Anna has been with PDI since 2012 championing PDI's global product research and development. In this role, she will lead PDI's sales and business development, as well as manage PDI's technical operations globally.

Transitioning from GRL Engineers, Inc.'s Ohio Branch Manager to PDI's Education and Training Team is Michael Morgano, Principal Engineer, P.E. Michael joins the growing department in supporting client trainings, technical support, and product development. He has been with the organization since 1985 and brings vast expertise in deep foundation testing.

GRL Engineers, Inc., is proud to announce Benjamin (Ben) White, P.E. will take over as the new manager of GRL-Ohio branch office. Ben has been with GRL Engineers since 2003 providing deep foundation consultation and testing services for a variety of public and private projects across the United States and on international offshore installations.

Anna Sellountou-Rausche, PhD., P.E.

Michael Morgano, P.E.

Ben White, P.E.

Upcoming Events

Apr 5-7 **Central PA GeotechnicalConference - Hershey, PA**
Learn More

Apr 6 **GMEC Conference, Structural Integrity Assessment Methods of Deep Foundation**
Presented by Mohamad Hussein
Learn More

May 8 **PDI/GRL SEMINAR: State of Practice – Providence, RI**
6.5 PDHs available. Space is limited.
Register

May 10 **PDI/GRL SEMINAR: State of Practice – Portland, ME**
6.5 PDHs available. Space is limited.
Register

May 12 **PDI/GRL SEMINAR: State of Practice – NYC**
6.5 PDHs available. Space is limited.
Register

June 7-9 **SuperPile – Atlanta, GA.** *Visit Booth #304*

June 12-14 **International Bridge Conference – National Harbor, MD**

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

Pile Dynamics, Inc.
+1.216.831.6131
info@pile.com
www.pile.com
30725 Aurora Rd,
Cleveland, OH 44139

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GRL Engineers, Inc.
+1.216.831.6131
info@GRLengineers.com
www.GRLengineers.com
California • Colorado • Florida • Georgia • Hawaii
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