DID YOU KNOW?

A recent, comprehensive, QA paper: "Dynamic Loading Tests: A State of the Art of Prevention and Detection of Deep Foundation Failures" by Alvarez, Rausche, and Likins can now be found at www.grlengineers.com/reference-papers

GRL engineers, inc. Pile Dynamics, Inc.

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BENEFITS OF DYNAMIC PILE TESTING

By Garland Likins, P.E.

Any structure is only as good as its foundation. For a deep foundation to perform satisfactorily, it must have adequate geotechnical capacity to support the applied load and lack structural defects. If the foundation fails, it must be remediated or the structure demolished and eventually replaced; either option is tremendously expensive. Therefore, it is desirable to employ construction control methods which demonstrate a deep foundation's geotechnical capacity and structural integrity.

For driven piles, a static load test checks the capacity, but due to cost and time considerations the number of static tests is generally very limited. Conversely, a dynamic formula is inexpensive and quick, but also notoriously inaccurate. These considerations prompted research over 50 years ago that resulted in dynamic testing, which can be applied at a relatively modest cost to a significant number of piles at multiple site locations to improve site characterization. The Pile Driving Analyzer® (PDA) with subsequent CAPWAP® signal matching has become state-of-practice. Dynamic testing is also applied to cast-in-situ piles (drilled shafts, bored piles, CFA/augercast piles) by employing a drop weight of sufficient size.

For larger projects, dynamic testing programs can optimize the foundation. Test program data can be used to select the best pile type and size by determining the geotechnical capacity at various depths and quantifying capacity changes with time (usually gains due to set-up) by testing both at end of drive and on restrike days, or even weeks later. Production piles are driven to criteria (usually a blow count tied to hammer performance) matching the successful dynamic test pile installation. Periodic testing during a long production pile installation documents that the hammer is performing consistently. For smaller projects, dynamic testing of the first production piles is generally sufficient to provide essential construction control criteria for the project.

The cost of dynamic testing is a small fraction of static load testing costs, and is minimal when considering the potential savings. Lacking testing, the pile design must be very conservative and thus overly expensive. With testing, many codes allow lower factors of safety to be used for allowable stress designs (or higher resistance factors for LRFD) resulting in shorter piles, or fewer piles, reducing pile material costs which is the main expense of the foundation. (FIG.1) As an example, the Ohio Department of Transportation (ODOT) tracked driven pile expenses over a six year period (Narsavage, 2011). By dynamically testing typically two piles per foundation, significantly higher LRFD resistance factors (ODOT uses φ = 0.70; for D/L=3 the equivalent factor of safety is 1.96) were used for friction piles (piles not driven to rock) compared with a design governed by dynamic formula (φ = 0.40; equivalent factor of safety is 3.44). The resulting savings can be estimated at 43% while the testing cost was only 2.5 % of pile costs, a small price to pay for such significant savings.

The PDA also assists in evaluating driving procedures. Dynamic measurements allow the engineer to assess driving stresses during installation. This is particularly important

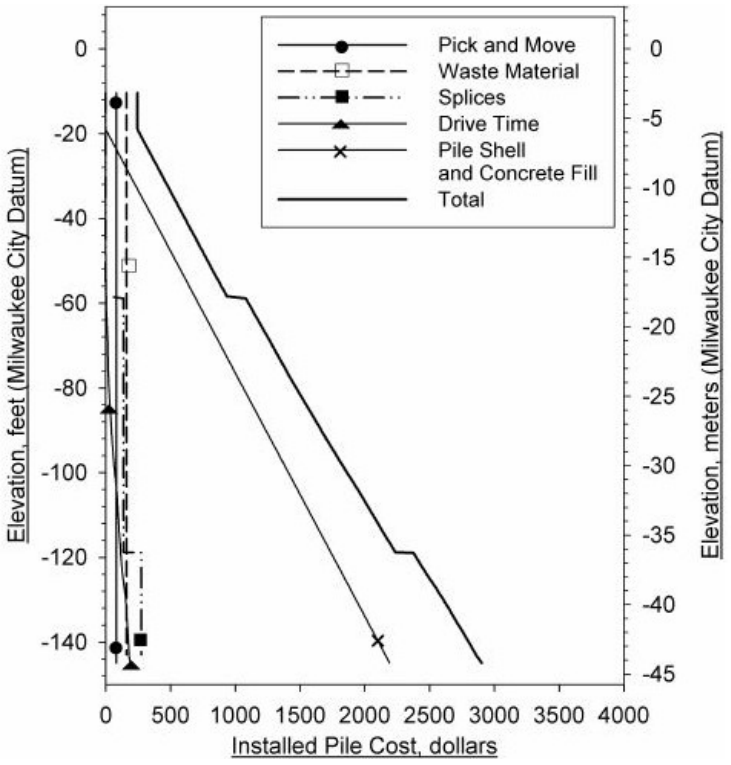

***FIG.1**- Production pile cost vs elevation*
Delmag D19-42-10.75-inch pipe pile.

Continued on Page 2...

BENEFITS OF DYNAMIC LOAD TESTING (Cont.)

Benefits of Dynamic Pile Testing
Each blow helps detect or prevent problems by determining:

- Capacity
- Pile Stresses
- Pile Integrity
- Hammer Performance

for concrete piles where tension and compression stresses are critical. Knowing the concrete pile driving stresses allows the engineer to adjust the installation procedures, such as limiting hammer stroke height or changing pile cushion thicknesses to keep stresses under rational limits and reduce the risk of structural damage to the pile. Procedures can similarly be developed for steel pile projects where high compression stresses can be problematic. The PDA is used to detect if damage occurred on any pile exhibiting unusual blow counts or terminating at significantly different lengths.

PDA testing information can be evaluated both for capacity and for installation procedures. Such knowledge is invaluable for a satisfactory final foundation installation that appropriately services its supported structure. Dynamic testing provides facts and reduces the potential risk of unsatisfactory foundation performance.

* Peter Narsavage, 2011 PDCA DICEP program, Orlando Florida

Download the Pile Driving Analyzer® Details

GRL WELCOMES THREE ENGINEERS

GRL Engineers has expanded with the addition of Lin Huang, E.I, Seth Robertson, PhD, E.I., and Jesse Roof.

Lin Huang obtained his Masters of Engineering, Civil Engineering at the University of Florida, where he focused in Geotechnical Engineering. Lin has been practicing high strain dynamic load tests (PDA testing), crosshole sonic logging (CSL), design services for structural analysis, as well as highway strategic development planning and engineering feasibility studies for the last several years, bringing his experience to the GRL Florida office.

Seth Robertson is located in the GRL Central office and holds a B.S., M.S. and Ph.D. in Civil and Environmental Engineering from the University of Massachusetts Lowell. Seth's experience has included the design and implementation of drop weight dynamic load tests on drilled deep foundations, involving the structural analyses related to the testing device design, and pre-testing simulations/post-test interpretation of the dynamic measurements.

Jesse Roof is the newest member of the GRL Pennsylvania office and a recent graduate of Texas Tech University with a Masters and Bachelors of Science in Civil Engineering. He is a member of the American Society of Civil Engineers and looks forward to furthering his deep foundations testing knowledge.

UPCOMING EVENTS

For a complete list of 2017 events and contact information, please visit www.pile.com/events

SEPTEMBER

17-20: AREMA Railway Interchange (Booth #3888)

19: Webinar: Quality Control of Drilled Shafts

20-21: 18th Annual PDCA DICEP Conference (Booth #3)

OCTOBER

1-4: GeoOttawa 2017 (Booth #224)

11-13: Seminar & Workshop: PDCA & PDI Deep Foundation Integrity Testing & Wave Equation Analysis; High Strain Dynamic Testing & Proficiency Test Cleveland, Ohio

17: Webinar: Integrity Assessment of Deep Foundations- Principals and Limitations

19: Workshop: State of Practice- Quality Control of Deep Foundations

24-27: 42nd Annual Conference on Deep Foundation (Booth #409)

DECEMBER

11-14: 48th Annual Southeastern Transportation Geotechnical Engineering Conference (Booth #30)

2017 REMAINING PDH OPPORTUNITIES

PDI Quality Control of Drilled Shafts Webinar, September 19, 2017. Internet and phone connection required. Register today!

PDCA/PDI Seminar & Workshop on Deep Foundation Integrity Testing & Wave Equation Analysis; High Strain Dynamic Testing is being offered for the last time in 2017 on October 11 -13, in Cleveland. The **PDI/PDCA Proficiency Test** will be offered the last day of the workshop. Early bird registration ends 9/20/17. Register today!

Integrity Assessment of Deep Foundations – Principals and Limitations Webinar, October 17, 2017. Internet and phone connection required. Register today!

State of Practice: Quality Control of Deep Foundations Workshop at the Sheraton Columbia Town Center Hotel near Baltimore, MD, on Thursday, October 19, 2017. This FREE Workshop offers 6.5 PDHs. Space is limited. Register today!

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