

DID YOU KNOW?



Driven monopiles for offshore wind turbines reach 6m in diameter?



THERMAL INTEGRITY PROFILER

Gray Mullins, FGE, Garland Likins, PDI and George Piscalko, PDI

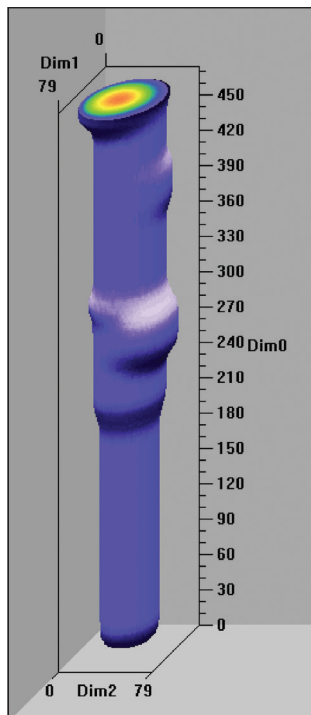
The integrity of drilled shafts (bored piles) is of vital importance. Low strain integrity testing (also called PIT and Pulse Echo), Cross Hole Sonic Logging (CSL) and Gamma-Gamma logging (GGL) are known integrity assessment methods, and each has its unique advantages. Each of these methods also has limits in evaluating the quality of the foundation: CSL assessments are restricted to the area inside the reinforcing cage, GGL assesses only the area within a few inches of access tube, and PIT results may be limited by shaft length and difficult data interpretation below major non-uniformities.

The Thermal Testing Method has been developed in response to these challenges. It uses the heat generated by the curing cement to assess the quality of cast-in-place concrete foundations such as drilled shafts, augered cast-in-place (ACIP) or continuous flight auger (CFA) piles. The Thermal Integrity Profiler (TIP) incorporates the Thermal Testing Method to evaluate concrete quality over the entire cross-section and shaft length.

TIP measures temperature either by an *Infrared Probe*ⁱ containing 4 orthogonal sensors and inserted into access tubes, or by *Thermal Wires*ⁱⁱ that have uniformly spaced sensors and are tied to the rebar cage. The recommended number of tubes or thermal wires is the same as for CSL or GGL applications. A single thermal wire is attached to a center rebar to test smaller diameter ACIP or CFA piles.

With the Probe Method, temperature data are collected typically 24 to 48 hours after concrete casting. With the Thermal Wire Method data are automatically (and, if possible, remotely) sampled at user defined intervals (e.g. 15 minutes), thereby continuously monitoring the concrete curing process. Thermal Testing by either method provides concrete quality data at a very early time, allowing construction to progress more quickly, because engineers no longer need to wait for the concrete to fully cure to assess shaft integrity.

In general, a shortage of competent concrete is registered by relatively cool regions (necks, inclusions or poor concrete); extra concrete (over-pour bulging into soft soil strata) is registered by relatively warm regions. The average temperature at any depth is proportional to the shaft diameter.



3D rendering of shaft generated by Thermal Modeling



Thermal testing by probe method, courtesy FGE

Temperature measurements at the cage, obtained by either the Probe or Thermal Wire method, may also be used to evaluate concrete cover and cage alignment. The measured temperatures have an almost linear relationship to the concrete cover: if the cage is closer to one side of the excavation (less cover) its temperature is lower than average while sections closer to the shaft center will exhibit higher than average temperatures.

Field measurements alone already highlight significant foundation problems, since a plot of the average temperature versus depth is an approximate image of the shaft geometry. This level of review may reveal cage alignment irregularities, casing or rock socket location, and locations of over-pour bulges or necking. Further refinement of concrete cover location is possible by measuring the gradient between 2 thermal sensors offset over a known, radial distance. Thermal Modeling is the highest level of analysis, estimating temperatures of the entire shaft based on the surrounding soil type, climatic history and specific heat generation for a particular concrete mix. Simulated temperatures are matched to field measurements, generating a probable concrete shape, a 3-D rendering of the as-built shaft, 2-D slices of the shaft cross section at any depths of interest and vertical slices through any radial orientation.

The Thermal Testing Method was developed at the University of South Florida under the direction of the first author, who also directed its practical implementation by Foundation & Geotechnical Engineering (FGE) of Plant City, FL. Further research and development is a joint effort of FGE and Pile Dynamics, Inc.

This article is partially based on Mullins, G., "Thermal Integrity Profiling of Drilled Shafts", DFI Journal Vol. 4, No.2, December 2010, available at www.pile.com/references.

ⁱ Mullins, A. G. and Kranc, S. C., (2004), "Method for Testing the Integrity of Concrete Shafts," US Patent 6,783,273

ⁱⁱ Cotton, D., Ference, M., Piscalko, G., and Rausche, F., (2010) "Pile Sensing Device and Method of Making and Using the Same" Patent Pending

Upcoming 2011 Events – for a complete listing visit www.pile.com/events

- May 19-21, Sacramento, CA: Frank Rausche will present at the ADSC West Coast Chapter Annual Meeting. Info: www.adsc-iafd.com/RegionalChapters/WestCoast.aspx
- June 22-26, Orlando, FL: Mohamad Hussein will present at the ASHE National Conference. Info: www.ash2011.org
- July 27-30, Charleston, SC: ADSC Summer Meeting 2011. Info: www.adsc-iafd.com
- August 20-24, Louisville, KY: Visit the PDI exhibit booth at the 70th Annual Meeting of the Southeastern Association of State Highway and Transportation Officials. info: www.sashto.org/SASHTO2011
- September 29-30, Washington DC Metro Area : Mohamad Hussein will teach the ASCE seminar Deep Foundations: Design, Construction and Quality Control. Info: <https://secure.asce.org/ASCEWebsite/Webinar/ListSeminar.aspx?CatCode=CED-GEOT>
- October 2-6, Toronto, Canada: Visit the PDI exhibit booth at the XIV PanAmerican Conference on Soil Mechanics and Geotechnical Engineering and 64th Canadian Geotechnical Conference. Sponsored by ISSMGE, the International Society of Soil Mechanics and Geotechnical Engineering. Info: www.panam-cgc2011.ca
- October 18-21, Boston, MA: Visit the PDI exhibit booth at the DFI 36th Annual Conference on Deep Foundations. Info: www.dfi.org
- November 3, Orlando FL: PDCA presents Design and Installation of Cost Effective Piles (DICEP)

PIR VIEWER FOR THE PILE INSTALLATION RECORDER

There is a new accessory for the PIR, PDI's Automated Monitoring Equipment for Augered Cast-in-Place and CFA piles. The PIR Viewer is a hand-held wireless device that allows an inspector or piling foreman to view what the main unit of the PIR is displaying (the main unit is installed in the crane cabin). The progress of the drilling and grouting operation is seen in real time on both the main unit and on the PIR Viewer. In addition to receiving data, the PIR Viewer allows the inspector to enter the observed grout return, which is then recorded in the PIR along with the entire installation record.

SOLD OUT EVENTS PAVE THE WAY TO MORE EDUCATIONAL ACTIVITIES IN THE SECOND HALF OF 2011

Last February a PDI / PDCA seminar and workshop in New Orleans sold out, as did a presentation on Dynamic Foundation Testing that Jorge Beim made in São Paulo, Brazil. The GRLWEAP Webinar given by Frank Rausche topped at more than 100 attendees!

During the second half of 2011 Pile Dynamics is planning to hold Deep Foundation Testing and Analysis seminars and/or workshops in locations around the world, including at its beautiful new headquarters in Cleveland, Ohio, USA.

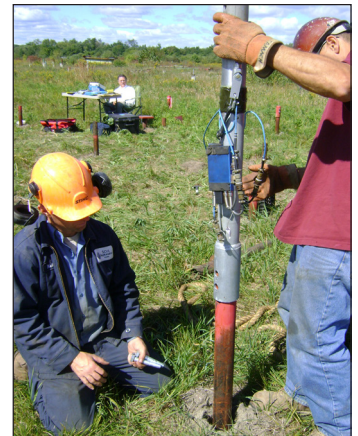
The PDI / PDCA Dynamic Measurement and Analysis Proficiency Test will be offered at the workshops.

We will keep you informed of dates and locations via the Events page of our website (www.pile.com/events) and by email. Make sure to update us on your contact information, including email address, so you don't miss out...and register early, as we could sell out again.

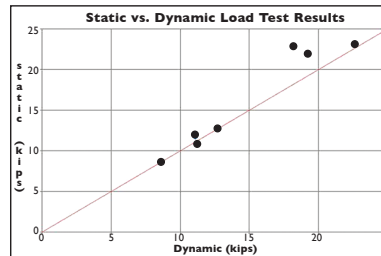
REMEMBER TO RETURN THE CARD THAT CAME WITH THIS NEWSLETTER!

DYNAMIC TESTING ON HELICAL PILES

PDI's Jorge Beim partnered with Severino Carlos Luna from Geotechnical Consultants, Inc. to evaluate the performance of Dynamic Load Tests on Helical Piles. Helical piles of less than 8 cm in diameter were installed in the National Geotechnical Experimental Site of the University of Massachusetts – Amherst Campus, and Dynamic and Static tests were conducted on 7 of them. Good agreement between static and dynamic test results was achieved (see below). The dynamic test setup on such a small diameter pile required some ingenuity, and was



Wireless sensors on helical piles transmit force and velocity data to PDA (on background) photo courtesy of Geotechnical Consultants Inc.



similar to the setup used for calibration of SPT hammers using a PDA. Test details, correlations and recommendations were presented at the DFI Helical Piles Seminar in March.

NEW REPRESENTATIVES, NEW TERRITORIES

We welcome Geotech Engineering as Pile Dynamics representative in Indonesia, EMP Piletec Pty Ltd as a representative for Australia and New Zealand, and AGRI as our new representative for Japan.

Long time representative GSP had its territory expanded, and now represents PDI in Germany, Austria, Switzerland, The Netherlands, Belgium, and Luxembourg.

PDI CUSTOMERS HAVE THEIR SAY

Parakrama Jayasinghe, Geotech Testing Services (Pvt) Ltd., Sri Lanka: "I am pleased to confirm that it (the Cross Hole Analyzer) has given us yeoman service (exceptionally good service) over the past seven years or so and we certainly acknowledge with gratitude the ready support you have given us at all times."

Mike Kightley, Director, MKM Technical Services Ltd, United Kingdom: "The service was excellent. Teamviewer allowed me to talk to the PDI experts (...) I was able to re-commence working on urgent GRLWEAP and CAPWAP® analyses within hours of the problem arising. PDI's support was spot on and allowed me to meet my deadlines (...) Excellent support from PDI who has served me well for 32 years."

Phillip Kapronczai, P.Eng. DFI Edmonton, AB, Canada: "I just wanted to let you know that I have been using the radios (PDA wireless sensors) with the remote option (SiteLink®) and it's working great! I am really happy with this technology. The site we are working on is about 300kms away from my office and we are having to complete one to 3 tests every 4 or 5 days, which would mean a lot of driving for me...and time is very precious right now. I trained one of my operators to install the equipment properly and things are working really well. I just completed one test this morning and it took me all of 20 minutes or even less to get it done. Anyways, just thought I would thank you again for making my work life a little more manageable."

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GRL
engineers, inc.

GRL Engineers, Inc.
Central Office: 30725 Aurora Road
Cleveland, Ohio 44139 USA
info@pile.com

Tel: +1-216-831-6131
Fax: +1-216-831-0916

Pile Dynamics, Inc.

Pile Dynamics, Inc.
30725 Aurora Road
Cleveland, Ohio 44139 USA
info@pile.com

Tel: +1-216-831-6131
Fax: +1-216-831-0916