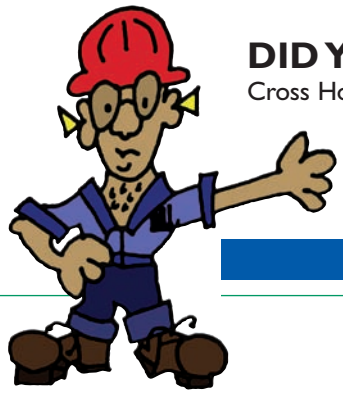

DID YOU KNOW:
Cross Hole Sonic Logging is standardized by ASTM D6760.

Pile Dynamics, Inc.

GRL engineers, inc. Dynamic Measurements and Analyses

Criteria for Evaluating CSL Data

Gina Beim and Garland Likins

Cross Hole Sonic Logging (CSL) evaluates the concrete quality and construction adequacy of drilled shafts. CSL may identify poor quality concrete due to mixing with drilling slurry, honeycombing, necking, soil intrusions, and soft toe conditions.

CSL is performed on drilled shafts built with access tubes by lowering a transmitter into one access tube while simultaneously lowering a receiver into a second tube. The transmitter generates ultrasonic pulses that travel through the concrete to the receiver. Received signals are processed and displayed by CSL equipment such as Pile Dynamics' Cross-Hole Analyzer, and evaluated by a test engineer. The test generates shaft profiles and is repeated for each pair of tubes.

The most common criterion for evaluating CSL data in the USA is the First Arrival Time (FAT). FAT is defined as the time elapsed between when the signal is generated and when it is first sensed by the receiver. The concrete wave speed is calculated by dividing the distance between tubes by FAT. A higher than expected (or delayed) FAT results in a lower concrete wave speed. Concrete wave speed is related to concrete quality.

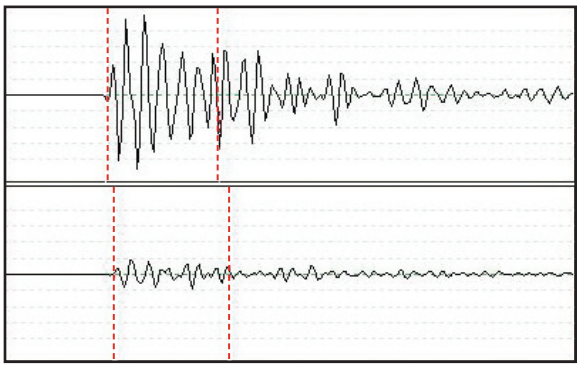

Figure 1: Signal from location with good concrete (top) and signal from location of known defect at 5 m depth (bottom).

One problem with using only FAT as a method of interpretation is demonstrated in Figures 1 and 2, from a 12m long shaft purposely built with a defect at 5 m. Figure 1 shows the received signals versus time (time 0 corresponds to the time when the signal is generated by the transmitter) at two different depths. While both plots show well defined, and nearly identical, FATs (first dotted red line) the signal on the bottom has significantly lower strength (or "energy", indicated by the signal amplitude). This is an indication of an interruption on the transmission path or of transmission through contaminated concrete.

An improved drilled shaft evaluation criterion was proposed for use in the USA by Likins et al (2007). Similar to French and Chinese standards, it considers not only FAT, but also the reduction in signal energy which, like FAT, is related to the quality of the concrete between transmitter and receiver. Once the FAT increase and signal energy reduction have been determined for the entire profile, the shaft may be evaluated according to the following criterion:

Evaluation	FAT increase		Energy reduction
(G) Good	*0 to 10%*	***and***	*< 6 dB*
(Q) Questionable	*11 to 20%*	***or***	*6 to 9 dB*
(P/F) Poor/Flaw	*21 to 30%*	***or***	*9 to 12 dB*
(P/D) Poor/Defect	*> 31%*	***or***	*> 12 dB*

This evaluation builds on a FAT based defect classification used by several USA Departments of Transportation. It refines that classification by distinguishing Flaws from more serious Defects, and it adds a quantitative Energy Reduction criterion to the evaluation.

Likins et al (2007) recommended that Flaws (P/F) be addressed if present in more than half of the profiles, while Defects (P/D) be addressed if present in two or more profiles. Addressing a flaw or defect should include tomography evaluation and could require excavation (if near the top of the shaft), core drilling, or pressure grouting. Defects or flaws present over the entire cross section usually require repair or shaft replacement.

Figure 2 further exemplifies the proposed evaluation criterion. The bold line on the left side of the figure plots FAT, and the thin line energy, both versus depth. While there is little FAT variation - less than 10% - over the entire length of the shaft, the energy decreases by 8.4dB at 5 m (red horizontal line). The waterfall diagram on the right side of the figure confirms the existence of a signal of low energy at about 5 m depth. A FAT-only criterion would evaluate this shaft as "Good". Under the proposed FAT and Energy based criterion, however, the 8.4 dB energy reduction places this knowingly defective shaft at the upper end of the "Questionable" evaluation, closer in fact to an evaluation of Poor/Flaw.

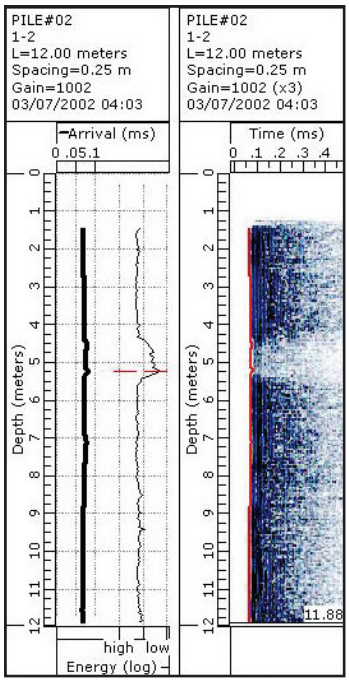

Figure 2: output of a CSL test between tubes 1 and 2 of the same 12m long defective at 5m shaft.

By contributing to a more positive identification of defects, this new criterion enhances CSL based quality control practices in drilled shaft construction.

Reference: Likins, G. E., Rausche, F., Webster, K., Klesney, A., February, 2007. Defect Analysis for CSL Testing. Geo-Denver 2007 New Peaks in Geotechnics: Denver, CO. (CD-ROM). Available at www.pile.com/reference

Calendar of Events

please visit www.pile.com/events for a complete listing

2007

September 27, Ellicott City, MD: Design and Installation of Cost Effective Piles. Sponsored By PDCA. Garland Likins will present. Visit the PDI exhibit booth. Info: www.piledrivers.org

October 8-12, Bowling Green, Kentucky: 39th Annual Southeastern Transportation Geotechnical Engineering Conference (STGEC). Sponsored by The Kentucky Transportation Cabinet. Visit the PDI/GRL exhibit booth. Info: www.transportation.ky.gov/bridges/STGEC/STGEChome.htm.

October 10, Colorado Springs, CO: Augered Cast-in-Place Pile Design, Construction and Quality Control Seminar. Sponsored by DFI. George Piscsalko will present. Info: www.dfi.org/conference.asp.

October 11-13, Colorado Springs, CO: 32nd Annual Conference on Deep Foundations. Sponsored by DFI. Visit the PDI exhibit booth. Info: www.dfi.org/conferences.asp.

October 18-19, Baltimore, MD: ASCE Deep Foundations: Design, Construction & Quality Control. Mohamad Hussein will present. Info: www.asce.org/conted.

October 31, Atlanta, GA: Every Thing You Always Wanted to Know About PDA Testing . . . But Were Too Afraid to Ask. Sponsored by PDCA and Foundation QA. Lecturer: Julian Seidel, Info: www.piledrivers.org.

November 1-2, Atlanta, GA: PDA Test Interpretation and CAPWAP Analysis Skills Development. Sponsored by PDCA and Foundation QA. FQA High-Strain Dynamic Pile Testing Examination offered. Lecturer: Julian Seidel, Info: www.piledrivers.org.

November 6-7, Dublin Area, Ireland: PDA and CAPWAP Workshop. Sponsored by PDI and Lloyd Acoustics. Foundation QA HSDPT Exam will be offered. Lecturers: Frank Rausche, Garland Likins and others. Email Lynne@lloydacoustics.co.uk.

November 8, Dublin Area, Ireland: Seminar on Foundation Testing and Analysis. Sponsored by PDI and Lloyd Acoustics. Lecturers: Frank Rausche and Garland Likins and others. Email Lynne@lloydacoustics.co.uk.

2008

January 26 (tentative), Dubai, United Arab Emirates: Every Thing You Always Wanted to Know About PDA Testing . . . But Were Too Afraid to Ask. Sponsored by Foundation QA. Lecturer: Julian Seidel, Info: www.foundationqa.com.

January 27-28 (tentative), Dubai, United Arab Emirates: PDA Testing Data Evaluation Workshop. Sponsored by Foundation QA. HSDPT Exam scheduled for 1/29/2008. Lecturer: Julian Seidel, Info: http://www.foundationqa.com.

February 20-23, Phoenix, AZ: PDCA 12th Annual International Conference and Exposition. Info: www.piledrivers.org.

PILE DYNAMICS ANNOUNCES WIRELESS PILE DRIVING ANALYZER® SENSORS

Pile Dynamics will be releasing a new generation of accelerometers and strain transducers for the PDA model PAX later this year. These new sensors, by making use of wireless transmission, will eliminate the need for a cable to connect them to the PAX. The PDA model PAX may remain up to 90 meters (300 ft) away from the foundation being tested.

GRL NEW HIRES

GRL welcomes Matt Nagy to its engineering staff. Matt will be working from GRL's Main Office in Cleveland, OH. While a student Matt worked as a co-op for GRL and for Pile Dynamics.

PDI REPRESENTATIVES NEWS

PDI welcomes Al Bayan Technical Equipment L.L.C. as its commercial representative in the United Arab Emirates, Qatar, Oman, Kuwait and Bahrain.

PDI representative in France, G-Octopus, will now represent PDI in Spain as well.

CONTINUING EDUCATION UPDATE

Several US Boards of Professional Engineers now require continuing education credits for registration renewal. The Florida Office of GRL Engineers has been reauthorized as a continuing education provider in the State of Florida. The New York State Board for Engineering and Land Surveying has informed us that IACET authorized providers of continuing education are automatically accepted as New York providers. With these two developments, courses and training sessions offered by GRL and / or PDI are acceptable to all US Boards of Professional Engineers. Please refer to the Calendar of Events on this page or at www.pile.com/events for educational opportunities.

REFERENCE PAPERS NEWS

Papers in languages other than English are now included in the much visited virtual library of PDI and GRL, www.pile.com/reference. If you would like us to consider adding one of your published papers (deep foundations related subjects only), and you have the publisher's permission to reproduce it, please contact media@pile.com.

STRESSWAVE CONFERENCE

Plan to attend the 8th International Conference on the Application of Stress Wave Theory to Piles, sponsored by ISSMGE, the Portuguese Society for Géotechnique, and the Instituto Superior Técnico of the Technical University of Lisbon. It will take place in Lisbon, Portugal, on September 8-10 2008. Info: www.stresswave2008.org.

Stress Wave Lisbon | 2008

8-10 | September

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