

DID YOU KNOW?

Pile Dynamics and GRL Engineers Corporate & Ohio offices have moved!





Forever Wave Equation

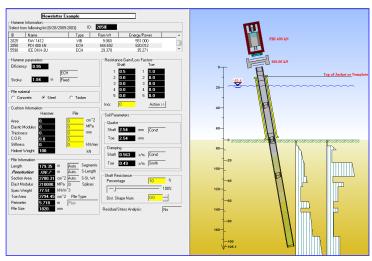
Frank Rausche and Liqun Liang

Good things - not just wine - get better and better with age. GRLWEAP is one of these things although, admittedly, we don't let nature just take its course - Pile Dynamics continuously helps this computer program get more and more refined as the years go by. Constant improvements are possible because of the dedicated field testing and analysis work of GRL Engineers, offshore and on land. They share the insights gained through their daily use of the Pile Driving Analyzer[®], CAPWAP[®] and other hardware and software with the engineers whose mission is to keep GRLWEAP a forever young and useful tool.

Initially written by GRL in the 1970s for the US Federal Highway Administration (FHWA), GRLWEAP is based on the concepts developed by E.A.L. Smith¹ of Raymond International. It simulates the pile driving process and, for each assumed pile capacity, calculates driving resistance (blow count) and dynamic stresses. The program helps check on the adequacy of pile driving equipment, the bearing capacity of an installed pile and it is also helpful when selecting ram weight, drop height and cushion thickness for dynamic load tests on drilled foundations. GRLWEAP is now used all over the world, and has become a standard tool for contractors (particularly for their estimators), construction managers and civil engineers. Our website - www.pile.com/references - contains 20 or more papers describing the basic approach of the program and the solutions it provides.

GRLWEAP 2010, currently in final beta testing phase, takes this software package to a whole new level. As a result of ongoing research efforts, GRLWEAP has evolved from Smith's original approach that calculated a simple Bearing Graph (relationship between blow count and bearing capacity, driving stresses and hammer stroke) to where it is now possible to calculate the soil resistance along shaft and toe as a function of depth, and then estimate a realistic driving time. This driveability analysis option allows the user to input soil type or SPT (Standard Penetration Test) data or - new for 2010 - standard soil strength parameters or results from CPT (Cone Penetration Test). GRLWEAP then performs both static soil analysis and dynamic pile driving simulation, yielding an estimate of SRD (Static Resistance to Driving), long term static capacity, blow count and driving stresses versus depth. Total number of blows and thus driving time estimates are then based on the calculated blow count.

GRLWEAP 2010 also includes powerful new analysis options alongside with simplified input and enhanced interfaces with widely used office software. It more easily accounts for battered piles that do not reach the same depth as a vertical pile of the same length, have reduced hammer energy output, and may experience static bending stresses in addition to the axial dynamic stresses caused by driving. GRLWEAP 2010 also handles analyses for a wide range of driven pile applications, from planning a dynamic load test on a 15 cm



GRLWEAP input screen with a graphical summary of the main input quantities

micropile to simulating the installation of a 4 m diameter monopile designed for lateral loads and driven into extremely dense soils, as is often the situation on offshore wind farms. The number and range of stress cycles caused by the pile driving must be accounted for on offshore wind farms and other large piling projects, and that is easily accomplished with Offshore Wave, a version of GRLWEAP 2010 designed specifically for these situations.

Pile driving optimization should not, however, be exclusive to offshore wind turbines and other large, complex projects. Even piles driven as a foundation for a one or two story building should be analyzed to find an optimal installation method. Engineers who are new to wave equation analysis need not be deterred, as PDI regularly offers workshops and training webinars and offers users significant and helpful support. For those who only occasionally need to analyze the pile driving process, GRL offers GRLWEAP analyses services with a quick turnaround.

Whatever the application, GRLWEAP looks forward to supporting the deep foundations industry with the wave equation -forever.

¹Smith , E.A.L., (1960), "Pile Driving Analysis by the Wave Equation," Journal of the Soil Mechanics and Foundations Division, ASCE, Volume 86

WE'VE MOVED

Pile Dynamics, Inc., the Corporate and Ohio offices of GRL Engineers, Inc. and Inspection Instruments, Inc.

have moved to: 30725 Aurora Road, Cleveland, OH 44139, USA Our phone and fax numbers remain the same.

If visiting our offices please refer to our website for directions. Please remember to use the new address when mailing or shipping to PDI or GRL!

Fall 2010 Calendar of Events – See more at www.pile.com/events

- October 4-7, Charleston, WV: 42nd Annual Southeastern Transportation Geotechnical Engineering Conference. **Visit the PDI/GRL booth.** Info: www.stgec.org.
- October 10-13, Hollywood, CA: Deep Foundations Institute 35th Annual Conference on Deep Foundations. Visit the PDI booth. Info: www.dfi.org.
- October 12-14, Chicago, IL: Roads & Bridges Live: 2010 Bridge Infrastructure.
 Pat Hannigan will present. Info: www.roadsbridgeslive.com.
- October 15, 11:30 am to 1:00 pm Eastern Time: ASCE Webinar on Installation, Verification and Application of Driven Piles. Garland Likins will present. Info: https://secure.asce.org/ASCEWebsite/WEBINAR/LISTWEBINAR.aspx.
- October 19-20, Columbus, OH: Ohio Transportation Engineering Conference.
 Visit the GRL booth. Info:www.otecohio.org.
- October 18-20, Madrid, Spain: Dynamic Foundation Testing Seminar, GRLWEAP Workshop and PDA and CAPWAP Workshop. Presented by PDI and G-Octopus. Frank Rausche and Jorge Beim will present. Visit www.pile.com/events for registration flyer.
- October 21, Ecuador: Dynamic Foundation Testing Seminar. Presented by PDI and Sociedad Ecuatoriana de Mecánica de Suelos y Roca. Camilo Alvarez will present. Visit www.pile.com/events for registration flyer.
- October 22, Warsaw, Poland: Dynamic Foundation Testing Seminar. Presented by PDI and Pile Dynamics Europe. Frank Rausche and
- Jorge Beim will present. Visit www.pile.com/events for registration flyer.
- November 3, Seoul, South Korea : PDA and CAPWAP Workshop. Presented by PDI and the Korean Geotechnical Society. Garland Likins will present. Visit www.pile.com/events for registration flyer.
- November 4, 2010, Charleston, SC: 11th Annual Design and Installation of Cost-Efficient Piles Conference. Presented by PDCA. Mohamad Hussein will present. Info: www.piledrivers.org
- November 8-12, New Delhi, India: Sixth International Congress on Environmental Geotechnics. Presented by The Indian Geotechnical Society (IGS) and International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE).
 Info: www.6iceg.org. Visit the booth of PDI representative AE&C.
- November 10-12, Jakarta, Indonesia: Dynamic Foundation Testing Seminar and PDA and CAPWAP Workshop. Presented by PDI and the Indonesian Society for Geotechnical Engineering. Garland Likins and Jorge Beim will present.
- Visit www.pile.com/events for registration flyer.
- November 15, Da Nang, Vietnam: Dynamic Foundation Testing Seminar. Presented by PDI and the Nguyen Cao Company Limited. Jorge Beim will present. Visit www.pile.com/events for registration flyer.
- November 17, Hanoi, Vietnam: Dynamic Foundation Testing Seminar. Presented by PDI and Inotech JSC. Jorge Beim will present. Visit www.pile.com/events for registration flyer.
- November 23-26, 2010, Shanghai, China: Bauma China 2010. Info: www.bauma-china.com. Visit the booth of PDI representative Earth Products China.
- December 1-3, San Antonio, TX: 7th International Bridge Engineering Conference -Improving Reliability and Safety - Restoration, Renewal and Replacement. Presented by TRB, FHWA and Texas DOT. Visit the PDI booth. Info: www.TRB.org/Conferences/2010/IBEC.

NEW AND REVISED AASHTO SPECIFICATIONS

The 3rd Edition of the American Association of State Highway and Transportation Officials "LRFD Bridge Construction Specifications", as well as the 5th edition of the "LRFD Bridge Design Specifications", were released in the first half of 2010. Both may be purchased from the AASHTO online bookstore. The Bridge Construction Specifications require the contractor to submit a Wave Equation Analysis to the engineer, showing that the piles are drivable. It also specifies that hydraulic hammers be equipped with a system for measurement of ram energy (the E-Saximeter meets those specifications), and requires that dynamic testing with "signal matching" (e.g. PDA with CAPWAP®) be conducted according to ASTM D4945. Garland Likins reviews how the new Bridge Design Specifications reward enhanced foundation testing by allowing the use of more favorable factors in the Q2 issue of PDCA's PILEDRIVER Magazine. Read the article at www.pile.com/reference.

FHWA DRILLED SHAFTS PUBLICATION

The US Federal Highway Administration has released GEC10, "Drilled Shafts: Construction Procedures and LRFD Design Methods", available at www.fhwa.dot.gov/engineering/geotech/index.cfm or in hard copy from www.nhi.fhwa.dot.gov or www.adsc-iafd.com. GEC10 recommends that, when Standard Penetration Test results are to be used for foundation design, the SPT equipment used for the test be calibrated according to ASTM D4633 (the SPT Analyzer or the PDA may be used for the calibration). It also includes a comprehensive chapter on load testing of drilled shafts, with a section on High Strain Dynamic Load Test that recognizes that it "has been used for many years with driven pile foundations" and "can be applied to drilled shaft foundations with some considerations for the different nature of a drilled foundation". (GRL Engineers performs such tests with its APPLE load testing system.) Lastly, it highlights the importance of integrity testing as part of the QA/QC program of drilled shaft construction. Among the various integrity methods mentioned, Cross-Hole Sonic Logging (CSL) performed according to ASTM D6760 is the preferred one (the CHAMP performs this test). It is recognized, however, that Sonic Echo or Impulse Response methods (both can be performed with the Pile Integrity Tester and are standardized by ASTM D5882) may be the best option for shafts not built with the access tubes required for CSL.

GRL WELCOMES NEW ENGINEERS

Dr.Yan Liu has just completed his PhD in Geotechnical Engineering from Case Western Reserve University and has joined the Corporate Office of GRL. Alex Ryberg has just completed his Master's in Civil Engineering from Drexel University and has joined the PA office.

PDI HAS RELEASED A NEW MODEL OF PIR

(Automated Monitoring Equipment for augered cast-in-place, continuous flight auger and drilled displacement piles)

The new model of the PIR has a larger back lit color screen that is much easier to read in bright sunlight and low light conditions. The color display makes it very clear to the pile installer if adjustments to the grouting process are needed – an indicator turns from green to red if targets are not being met. Read about other enhancements to the PIR at www.pile.com/pdi/products/pir.





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