

DID YOU KNOW?

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



Forever Wave Equation

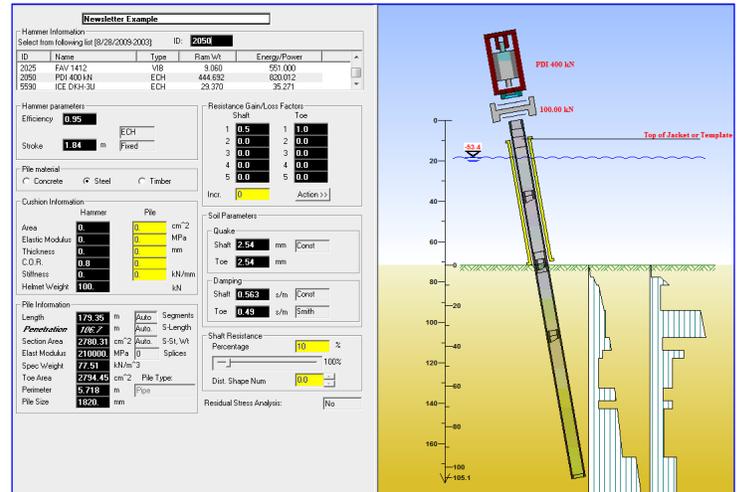
Frank Rausche and Liqun Liang

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!