



GRLWEAP Versions 2002 and 2003 Improvements and Updates

GRLWEAP Version 2002 added significant features and enhancements to previous versions. The hammer data file has been expanded and revised. The program has been tested on Windows 98, ME, 2000 and XP, and it can be installed on a network. The 2003 version is very similar to the 2002 version, merely modifying certain hammer models in the hammer data file and correcting a few problems (see "2003 Changes" below). Compared to the 1998 GRLWEAP version, GRLWEAP 2003 offers the following new features:

Input

- New project option is now a wizard which helps to create complete input for a simple case.
- The Main Input Form has been reorganized and includes option indicators.
- Hammer list can be sorted by manufacturer name, energy, etc.
- Stroke, pressure and efficiency now appear and are changeable on Main Input Form.
- Diesel pressure can now be specified in percent of maximum.
- Pile and hammer gravities can be entered separately and therefore the 2002 version of the program can work with the full weight of the pile and the full static resistance.
- The graphics on the Main Input Form has been expanded to show depth and penetration indicators, driving system information, etc.
- Analysis options have been separated from resistance distribution input.
- All screens accessible through icons.
- Output icon leads to all output modes.
- Analysis icon runs analysis immediately.
- Current input data when modified will not automatically overwrite original file, the modified data will be saved only when directed by the user.
- Switching from and to Inspector=Chart option is now possible.
- A new Pile Profile Section Input helps enter pile profile consisting of several uniform sections.
- New input file format (*.gww) includes hammer and pile gravitational accelerations.
- A new static analysis tool has been added to help fill soil information for driveability analysis.
- **2003:** The Main Input form and the Hammer Maintenance program now display the date when the Hammer Data file was created.
- **2003:** In the Static Soil Analysis (SA) dialog box, three commands have been added under the command "Profile" to allow the user's to view their input: Print Graph sends a copy of the graph to a printer; Copy to Clipboard copies the input to clipboard for importing into other programs (i.e. Excel) and View Input Data displays the input in WordPad for review or printing.

Analysis

- User choice of pile and hammer gravitational input for more realistic prediction of pile penetration under hammer weight and for consideration of inclined piles or buoyant piles. (Note: standard analysis is now with hammer and pile weight, regardless of analysis type).
- Built-in simple static soil analysis based on SPT and soil type for driveability analyses.
- Initial stresses prior to dynamic analysis now calculated with rigorous static analysis.
- Vibratory analysis with extended analysis duration for greater consistency.



- Driveability analysis now without deduction of dead load since pile gravity is now correctly accounted for in dynamic analysis.
- Residual stress analysis with new convergence criteria for consistent results of very long piles.
- Open end diesel hammers now with new pressures based on "rated stroke". The maximum stroke included in the data file is greater than or equal to the rated stroke and is used for "ram blow out" warning. Ram can overshoot the rated stroke but not the maximum stroke.
- Diesel hammer can now be analyzed without either helmet or hammer cushion.
- Diesel hammer analysis now with fixed starting stroke and tighter convergence criterion for numerically repetitive analyses even for different starting values.

Output

- Numerical results include diesel pressure information and RSA calculated sets per each trial analysis.
- Screen output displayed during analysis reorganized.
- Diesel hammer time plots now starting at time of port closure.
- Output now with improved fonts and line weights.
- Improved plotting of variables vs. time, including a 3-dimensional plot.
- Variables vs. time data now can be saved to an ASCII file so information can be imported into other software.
- Better default values for plotting ranges.
- Stroke of external combustion hammers in driveability output.
- **2003:** The "Copy to Clipboard" command was added to the "View" menu for the output programs, Bearing Graph, Variables vs. Time and Driveability . This command gives the users the ability to copy the active window, either the table or plot, to the clipboard so that it may then be pasted into other applications.
- **2003:** Variable vs. Time plot is now available when "Debug" option is selected for "Numerical Output".
- **2003:** The "Pile Penetration" depth is now shown on the Numeric results file and Bearing Graph plot.

Help

- Expanded help for new examples.
- Added help for drive system which can then be directly transferred to the input file. This help files contain a significant amount of data that has been submitted by hammer manufacturers and equipment sales organizations.
- Area Calculator now included. Additional pile shapes added in Area Calculator.

Other

- The tool "Clean" was added to help reclaim hard disk space by removing or purging the GRLWEAP output and temporary files. These files have the extensions of gwo, gwb, gwv, gwd, tb, gwt and gwx, and are generated when an analysis is performed. From the menu bar the selection of "Tools" then "Clean" will enable the following options: Clean Current Directory, Clean Current Project and Clean Selected Directory.
- Choice of software key, USB port hardware key or parallel port hardware key.
- **2003:** A License Key Type Selection dialog box was added to help the users in selecting a license type with following features (this dialog box will only be shown if no single user hardware key was found initially):
 - Users can manually select license type or let the program search the computer and/or network for



- acceptable license key.
- When the network key is selected, the program will automatically search all computers connected to the network for a hardware key by sending broadcast messages out to each computer. To decrease search time and reduce the use of network resources the user can directly enter the server's IP address so the program will only search that computer for the hardware key.
- The license key type and server's IP address are both saved, (if the user has permission to modify the registry), under HKEY_CURRENT_USER and HKEY_LOCAL_MACHINE. Therefore, if an Administrator or Power User runs GRLWEAP and selects or changes the license key type, all users on the same computer will be setup accordingly. This happens because the GRLWEAP program looks for this information from HKEY_LOCAL_MACHINE where only the Administrator or Power User has permission to modify, when the relative information in HKEY_CURRENT_USER is not available.

Corrections made in the 2003 Version:

- On the Main Input screen the graph of the pile now reverts to uniform after changing back from non-uniform pile.
- In the Main Input form, the Segments field under Pile Information now show "auto" when the Number of Pile Segments was set to "0" or "1" in the Pile Segment Input dialog.
- In "General Options", "Numeric", the unit for Number of Iterations is now correct.
- An entry of more than 3 decimal values for pile penetration is always interpreted correctly.
- All unused parameters are now properly initialized, no longer generating errors when reading an input file (i.e. containing non-uniform data) on some computers running Windows 98 or ME. (Note: These files could already be read without problems on computers running Windows 2000 or XP.)
- For the driveability analysis with variable setup (using waiting times) a change in the handling of the relative energy values has been made as described in the addendum to the GRLWEAP Program Manual.
- For driveability analysis of diesel hammers, GRLWEAP input uses a percentage for the combustion pressure, however, the analysis program was interpreting this number as a fraction of maximum combustion pressure. This has been corrected. The user should check and, if necessary correct the pressure values, particularly the data file was generated by older program versions where the fuel setting number was used.
- When a driveability analysis was performed the first two depth analyses had capacities less than the weight of hammer and pile, results remained zero for the next depth analyses. The user is reminded of the very important difference between the 2002 approach and the pre-2002 GRLWEAP driveability analysis method: by using the gravities in the newer version, the "dead load" did not need subtraction from the capacities calculated; the result tables therefore show the full capacities corresponding to unit shaft resistance and end bearing inputs. Obviously, differences between results have to be expected.
- In the output screen, under the Project Summary the pile length is now in the units the analysis was performed in.
- When the blow count display unit is changed the bearing graph plot label is now always properly updated.
- The Input File Contents section of the Numeric results file no longer misses the stiffness line.

Hammer and Driving System Data Files

- Hammer Data File expansion and revision, many hammers added to data file in particular vibratory hammers.



- **2003:** Driving System Data file: The data entries were reviewed and corrected or completed where possible and/or necessary. To avoid accidentally using no cushion or helmet, zero values were replaced with N/A where no information was supplied by manufacturer.
- **2003:** The Hammer Data file was expanded, updated and corrected along with several drive system data sets, please see separate listing for changes.
- Diesel hammer data now includes rated stroke with maximum stroke; minimum stroke removed.
- Diesel hammer combustion pressures were recalculated based on a procedure more consistent with hammer sizes and new rated stroke values.
- External combustion hammers now without effective area and rated pressure for consistency with double acting or pressure assisted hydraulic hammers.
- Simplified categories for efficiency values for hydraulic hammers.
- Non-uniform ram properties were checked and revised as necessary.
- Hammer data file display now consistent in SI units.
- The following table shows for which hammer makes and models GRLWEAP data was added or updated. This work was based on the following considerations:
 - Existing data of air/steam hammers were generally not changed.
 - Data of Diesel hammers that are no more actively marketed were not changed (e.g. Mitsubishi, Kobe, ..). For other diesel hammer, where new and complete information was received, changes were made based on the data most recently submitted by the manufacturers.
 - For Hydraulic hammers, GRL's measurement results indicated a relatively large scatter of transferred energy values. For that reason, and since the amount of data on the performance of the various hammer makes is still too limited for a meaningful statistical investigation, efficiency values for hydraulic hammers were simplified as follows:
 - Older type double acting hydraulic hammers 0.50; this is consistent with the treatment of air/steam double acting hammers.
 - Hydraulic hammers with internal monitoring 0.95 as before, all other hydraulic hammers 0.80.
 - Thus, there is no more distinction between free fall, power assisted and other types of hydraulic hammers which have no internal monitoring although a few hammer makes are very efficient. The wave equation analyst should be aware that there are fundamental design differences between these hammer types. In particular, low stroke (say less than 0.5 m drop) free fall hydraulic hammers probably have a higher efficiency than those with higher strokes or those that are power assisted on their descent. An increased efficiency of 0.9 or even 0.95, may therefore be realistic for such efficient hammers.
- It is the responsibility of the wave equation analyst, to identify the working principle of the hammer analyzed and select a proper efficiency. If the performance of a hammer model is unknown, then it is recommended to analyze a problem with both high and low efficiency values for conservative stress and blow count predictions. On the average, the standard GRL efficiencies of hydraulic hammers are probably somewhat low.



2002 Hammer Database modifications

Manufacturer	Models	Information obtained and Updates performed
APE	All Models	Complete update performed / Hammer pressures recalculated
	D 19-42, D125-32	New Models Added (OED)
	HI 400U	New Models Added (ECH)
	3, 6, 15, 20, 20E, 50, 50E, 100, 100E, 100HF, 150, 150T, 150HF, 200, 200T, 200HF, 300, 400B, 600, Tandem 400, Tandem 600	New Models Added (VIB*)
Banut	-	No new information obtained / No Updating performed
Berminghammer	All Models	Hammer pressures recalculated
BSP	-	No new information obtained / No Updating performed
Bruce	SGH-0312, SGH-0512, SGH-0712, SGH-1012	New information obtained / New Models added (ECH)
Conmaco	-	No new information obtained / No Updating performed
Dawson	HPH1800, HPH6500	New information obtained / New Models Added
Delmag	All Models	New information obtained / Hammer pressures recalculated
	D19-42, D100-13	New Models added (OED)
DKH	-	No new information obtained / No Updating performed
Fairchild	-	No new information obtained / No Updating performed
FEC	All Models	No new information obtained / Hammer pressures recalculated
Hera	All Models	No new information obtained / Hammer pressures recalculated
HMC	28A, 28B, 62, 86, 119, 149, 187, 19D, 38D	New information obtained / New Models Added (ECH)
	3+28, 3+75, 13+200, 13S+200, 13H+200, 25+220, 26+335, 26S+335, 51+335, 51+535, 51S+535, 51+740, 76+740, 76+800, 115+800, 230+1600	New Models Added (VIB*)
HPSI	-	No new information obtained / No Updating performed
ICE	All Models	New information obtained / Hammer pressures recalculated (OED)



Quality Assurance for Deep Foundations

	32-S, 120-S15, I-19, I30, I-36, I-46, I-62, I-80	New Models Added (OED)
	70, 75, 115, 160, 220, 275	New Models Added (ECH)
	23-28, 216, 216E, 11-23, 223, 416L, 812, 815, 44-30, 44-50, 44-65, 66-65, 66-80, 1412b	New Models Added (VIB*)
IHC	All Models	Updated Hammer and Drive System Information
	S-120, S-150, S-600, S-900 S-1200, S-1800, SC-50, SC-75	New Models Added (ECH)
	FV-50R, FV-60R, FV-450	New Models Added (VIB*)
Junttan	-	No new information obtained / No Updating performed
Kobe	All Models	No new information obtained / No Updating performed
Linkbelt	All Models	No new information obtained / No Updating performed
Menck	MHU800S, MHU2100S	New Models Added (ECH)
Mitsubishi	-	No new information obtained / No Updating performed
MKT	All Models	Hammer pressures recalculated
	V-2B, V-5C, V-20B, V-30, V-35, V-140	New Models added (VIB*)
Raymond	-	No new information obtained / No Updating performed
Uddcomb	-	No new information obtained / No Updating performed
Vulcan	-	No new information obtained / No Updating performed



2003 Hammer Database modifications

Manufacturer	Models	Information obtained and Updates performed
APE	5.4 mT, 7.2 mT, 10-60, D 8-32, D16-32, D25-32	New Models Added
	D 62-22, D 80-23, D 100-13	Hammers were altered so that each is treated consistently and data from the same source is used, due to some inconsistencies in the data release forms. Please note that for hammers D 25-32, D 62-22, D 80-23, and D 100-13 the maximum geometric stroke and hammer weight are not consistent with the rated energy, therefore the rated energy was reduced.
Conmaco	C 50E5, C 65E5, C 200E5, C 300E5	New Models Added
Delmag	D 120-42, 150-42, D19-52, D12-42, D14-42	New Models Added
HPSI	2000	New Model Added
ICE	1412C	New Model Added
	I-12, I-19, I-30, I-36, I-46, I-62, I-80	Hammers were altered to have 4 fuel settings. Fuel settings 2-4 were computed as 90% of the fuel setting one step above it (thus Pfs2=0.9 Pfs3)
	S-hammer series (open end diesel with atomized fuel injection)	A data review indicated that the 2002 pressures were not realistic. The study indicated that using 95% of the pressures used in the pre-2002 releases were more realistic.
	I-12	Corrected the transfer efficiency to be 0.80 instead of 0.93, and recalculated the pressure to be 1350 psi, rather than 1325 psi.
IHC	FV-50R, FB-60R, FV-450	Hammers were removed because of incomplete data.
Kobe	K13, K25, K35, K45	Hammers were altered to have only one fuel setting.
Menck	MHU 1200	New Model Added
MGF	RBH 2400	New Model Added

* please see limitations described in Background Report