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LPILE Plus 5.0

A Program for the Analysis of Piles and Drilled Shafts Under Lateral Loads

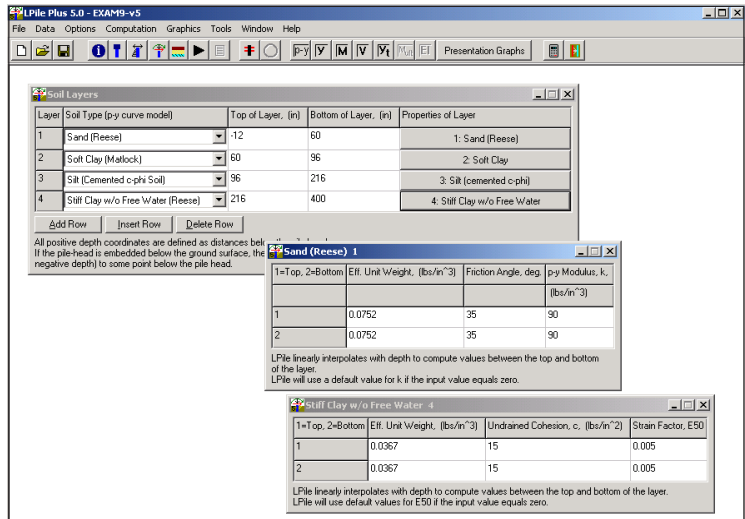
GENERAL DESCRIPTION

LPILE Plus is a special-purpose program based on rational procedures for analyzing a pile under lateral loading. The program computes deflection, shear, bending moment, and soil response with respect to depth in nonlinear soils. Components of the stiffness matrix at the pile head may be computed internally by the program to help the users in their super-structure analysis. Several pile lengths may be automatically checked by the program in order to help the user produce a design with an optimum pile penetration.

Soil behavior is modeled with p - y curves internally generated by the computer program following published recommendations for various types of soils; alternatively, the user can manually introduce other p - y curves. Special procedures are programmed for developing p - y curves for layered soils and for rocks.

Several types of pile-head boundary conditions may be selected, and the properties of the pile can also vary as a function of depth. *LPILE Plus* has capabilities to compute the ultimate-moment capacity of a pile's section and can provide

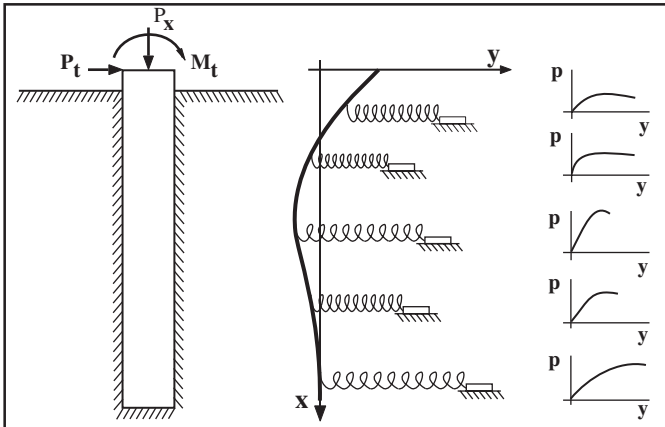
design information for rebar arrangement. The user may optionally ask the program to generate and take into account nonlinear values of flexural stiffness (EI) which are generated internally based on specified pile dimensions, material properties, and cracked/uncracked concrete behavior.



Sample screens for data input

LIST OF FEATURES

- Five sets of boundary conditions are available to model the pile head: free head, pinned head with sway, fixed head with sway, or elastically-restrained with a rotational spring. Depending on boundary conditions, pile-head loading may consist of a lateral load, a bending moment, a specific lateral displacement, or a specific pile-head rotation. The ability to specify both deflection and rotation at the pile head is an useful feature available in *LPILE Plus*.
- The user may optionally ask the program to generate and take into account nonlinear values of flexural stiffness (EI). These



- values are generated internally by the program based on cracked/uncracked concrete behavior and user-specified pile dimensions, and material properties. Version 5 allows the user to define multiple sections with nonlinear bending properties.. This new feature enables the designer to quickly evaluate the benefits for reducing part of the reinforcing steel in the lower sections of a drilled shaft, as is common used in practice.
- Up to ten different load cases may be applied at the pile head in a single analytical run. This is a helpful feature for the quick observation of pile behavior subjected to specific increments of lateral loads, bending moments, lateral displacements, or pile-head rotations.
- A set of distributed lateral loading may be applied anywhere along the length of the pile. Loading may be specified as constant or varying linearly with depth.
- Four values (K_{yy} , $K_{y\theta}$, $K_{\theta y}$, and $K_{\theta\theta}$) of a typical 6x6 matrix for foundation stiffness may be generated by the program for a range of loading. Values are helpful as nonlinear foundation models in superstructure analysis.
- An user-specified curve may be used to model the additional shear resistance provided by the soil at the base of large-diameter drilled shafts and/or short piles.

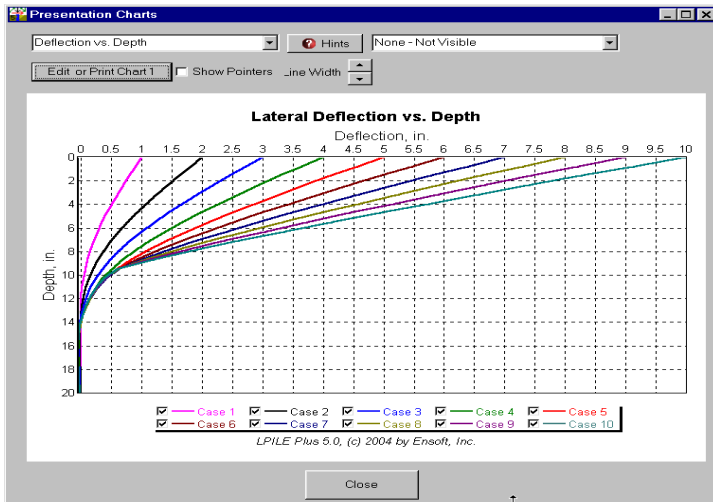
LPILE Plus model of soil response

LPILE Plus 5.0

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LIST OF FEATURES (cont.)

- LPILE Plus has the capability to perform push-over analyses and can study the pile behavior after the development of plastic hinges (yielding).
- Several pile lengths can be automatically checked by the LPILE Plus program in order to help the user produce a design with an optimum pile penetration.



Sample results from push-over analyses

- Soil-resistance (p - y) curves can be internally generated by the program for the following soils: soft clay, stiff clay with or without free water, sand (Reese et al), sand (API), silt (c - ϕ soils), liquefied sand, strong rock, and weak rock. The p - y curves may be printed at any depth for reviews or reference.
- Users may optionally input their own soil-resistance (p - y) curves for certain soil depths.
- Internal modification factors are automatically calculated to model pile batter and sloping ground surfaces.
- A special subroutine effectively incorporates the influence of layered soils.
- User-defined multipliers are provided to increase or reduce the soil resistance (p - y curves) at any points along the length of the pile. This feature is used in seismic conditions to reduce the response of liquefied layers or to account for Group Effects.
- Linear interpolation of bending stiffness is computed for piles with varying cross sections.
- The Graphics menu contains quick observations of results contained in the output file (variations of pile deflection, bending moment, shear and soil resistance with pile depth). The user can customized charts to prepare various engineering plots in high quality for presentation and report.
- Curves of flexural stiffness versus bending moment and/or moment versus curvature are provided to review the

Sample set of curves of bending moment versus depth for different lateral loads

adequacy of the pile's section. In addition, the user may also observe the interaction diagram of the modeled pile section.

- The user may also observe the nonlinear values of the foundation stiffness matrix or the curve of pile-head deflections versus pile length.
- Program LPILE plus Version 5 has the capability of analyzing the behavior of piles subjected to the free-field soil movement in lateral direction.
- Standard Windows operations, such as dialog boxes, speedy buttons, grid cells, clickable buttons, drop-down list of options, and pull-down menu choices are all incorporated in the LPILE Plus program.
- Soil-layer data structures and input screens are improved to help the user enter data conveniently with defaulted values provided. Hints and notes were also introduced on input windows to assist the user for data entry.
- Over 100 error-checking messages have been provided, making it simpler for occasional users to run the program and/or to debug run-time errors of more experienced users.
- Input and output data files are text based and may be directly accessed from within the LPILE Plus program, employing the user's preferred text editor or word processor.
- A well-documented *Technical Manual* is provided with the relevant theoretical equations.

SOFTWARE SUPPORT

All users are strongly supported in technical aspects related to the proper usage of our computer software. Customized software designs of the program *LPILE Plus* may also be provided with additional programming fees.

COMPANY BACKGROUND

ENSOFT, INC. uses modern computational techniques and broad experience to obtain fast and reliable solutions to engineering problems. Thousands of private companies, government agencies, and universities from the United States and 60 other countries have selected software developed by ENSOFT, INC. for various engineering projects.

