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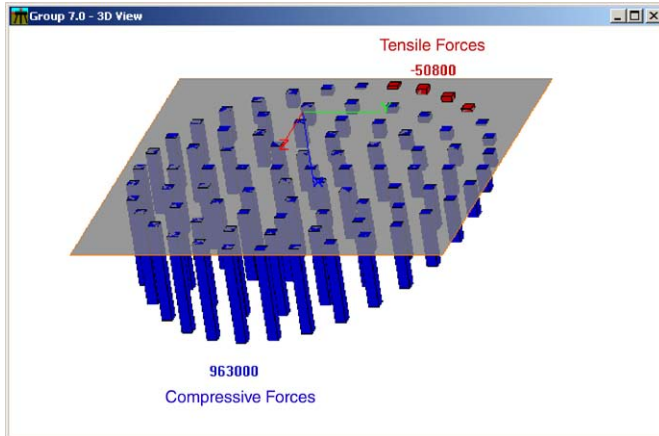
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GROUP v7.0

A Program for the Analysis of Piles in a Group

GENERAL DESCRIPTION

GROUP has been well accepted as a valuable design tool for analyzing the behavior of piles in a group subjected to both axial and lateral loadings. The program computes the distribution of loads (combination of vertical, lateral, and overturning moment in up to three orthogonal axes) from the pile cap to piles arranged in a group. The piles may be installed vertically or on a batter and their heads may be fixed, pinned, or elastically restrained by the pile cap. The pile cap may settle, translate, and/or rotate and is assumed to act as a rigid body.



New visualization of 3D Model in GROUP v7.0 displaying distribution of axial forces at pile cap

The program will generate internally the nonlinear response of the soil, in the form of $t-z$ and $q-w$ curves for axial loading, in the form of $p-y$ curves for lateral loading, and in the form of $t-r$ curves for torsional loading. A solution requires iteration to accommodate the nonlinear response of each pile in the group model. Program *GROUP* solves the nonlinear response of each pile under combined loadings and assures compatibility of geometry and equilibrium of forces between the applied external loads and the reactions of each pile head.

The $p-y$, $t-z$, $q-w$ and $t-r$ curves may be generated internally, employing recommendations in technical literature, or may be entered manually by the user. The pile-head forces and movements are introduced into equations that

Program GROUP allows the input of groups of straight or batter piles, layered soil profiles, various cross-sections of pile sub-groups, and several loading arrangements

yield the behavior of the pile group in a global coordinate system. The program can internally compute the deflection, bending moment, shear, and soil resistance as a function of depth for each pile.

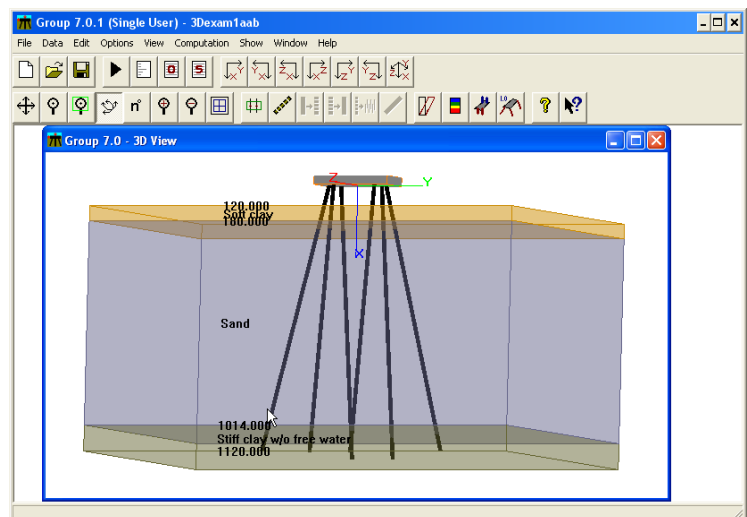
For closely-spaced piles, the pile-soil-pile interaction (group effect) can be taken into account by introducing reduction factors for the $p-y$ curves used for each single pile. As an option, the user may ask the program to automatically generate suggestions of p -multipliers for the internal reduction of the soil resistance in closely-spaced piles.

GROUP v7.0 now allows the user to select a new option for computing the required unit side friction at the top and bottom of each soil layer along with a unit tip resistance. The new version employs commonly-accepted equations to compute internally the estimated unit side friction and unit tip resistance based on the soil properties that are specified by the user for each soil layer.

The new version still allows the user to input external nonlinear curves of axial load versus settlement for each pile in the group. Those external curves can be obtained by the user based on load tests or using the Ensoft programs *APILE* and/or *SHAFT*.

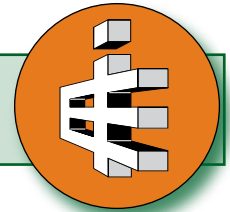
LIST OF FEATURES

- Three boundary conditions are available for pile-head connections to the rigid cap: pinned, fixed, or elastically restrained.
- $p-y$ curves may be input by the user or may be automatically generated by the program and printed for review.



GROUP v7.0

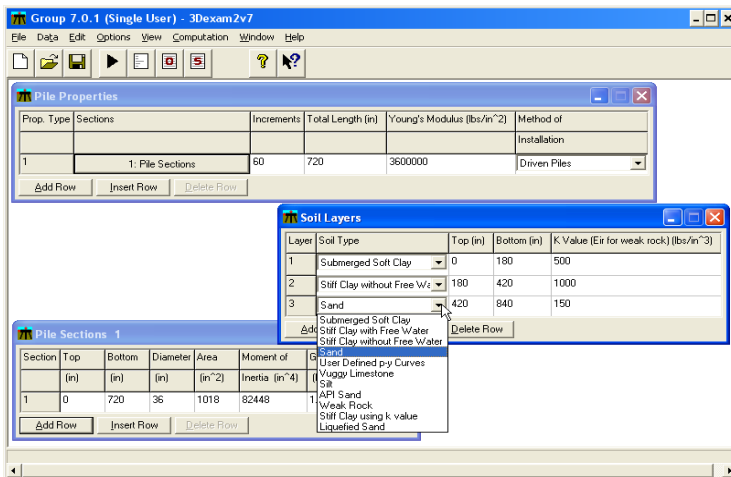
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LIST OF FEATURES (cont.)

- The program can provide data for evaluating the pile-cap stiffness, often used by structural engineers for foundation simulation in their numerical models.
- The graphical observation of output curves features a new interface that allows zooming of areas of particular interest. The user may thus observe the detailed behavioral measurements of any portion of the depth of each pile sub-group.
- The type and number of graphs generated by GROUP v7.0 have been increased over previous versions. More importantly, the program plots the force and displacement on the pile cap, such as the axial force (tension and compression) of each pile on the pile cap, the lateral forces (shear and moment) of each pile on the pile cap, and the displacement of the pile cap in different directions.
- Internal generation of suggested p -multipliers to automatically reduce the soil resistance for closely-spaced piles (group effect), according to the latest technical recommendations.
- The program allows for up to 2000 piles in a group, and each pile can have different EI values in orthogonal directions.
- The program will consider the nonlinear bending stiffness (EI) of each pile during computation. The user can enter nonlinear moment-curvature curves under different axial loads for each pile.
- GROUP v7.0 provides a summary table of output data, which is convenient when the size of the output file becomes very large due to a large number of piles in the numerical model.
- The new version implements a more efficient algorithm to improve significantly the accuracy of the solution of a problem due to iterations because of the non-linearity of soil parameters.
- The p - y criteria for liquefiable sand developed by Rolins, et al. (2003), and p - y criteria for stiff clay with user-specified initial k values, recommended by Brown (2002), were added into GROUP v7.0.

- GROUP allows to consider lateral soil resistance against embedded pile caps and option to specify a reduction factor on the axial capacity of closely-spaced piles.
- Users can now review graphically and in real time the shape of user-specified p - y curves or load-vs-settlement curves as additional help to avoid accidental mistakes.



Sample windows used for data input

SOFTWARE SUPPORT

All users are strongly supported in technical aspects related to the proper usage of our computer software. Free maintenance releases are provided frequently with small improvements and minor fixes. Customized software designs of the program GROUP may also be provided with additional programming fees.

Contoured graphics of total pile moments for foundation models in Group v7.0

