

Repute vs 3D FEM/FDM analyses

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One of the main features of Repute is its capability to provide a complete 3D boundary element (BEM) solution of the soil continuum while retaining a computationally efficient code. In principle, a complete 3D analysis of a pile group can be carried out by finite element (FEM) or finite difference (FDM) analyses using commercial codes (eg. Plaxis 3D Foundation and FLAC 3D). However, the complexity and high computational costs involved preclude the routine use of such techniques in pile design.

Main advantages of using Repute instead of 3D FEM or FDM analyses for pile group design include the following:

- **Computational costs**

3D FEM or FDM calculations are extremely computationally demanding, particularly if non-linear soil behaviour is considered. As an example, Comodromos (2004) reports that, using FLAC 3D, the calculation time for an axially loaded 9-pile group is 16 hours on a Pentium IV 1900 MHz with 512MB RAM.

Using a similar PC, the same pile-group is analysed with Repute in only 93 seconds, i.e. 620 times less than with FLAC 3D.

- **Effort in input data storage and preparation**

A larger amount of time is required in the input stages of design for the preparation of a 3D mesh and to input the data with 3D FEM or FDM codes. Moreover, the database files of the input/output data require a large amount of memory disc space (e.g. Comodromos reports that 200 MB of disc space is necessary for one run of the 9-pile group with FLAC 3D).

The amount of input data required by Repute is minimal and is normally carried out in a couple of minutes. The BEM mesh is automatically calculated by Repute in a matter of seconds.

- **Complexity**

3D FEM or FDM codes are rarely utilized in pile-group design because of the complexity in modelling the interaction between soil and piles, particularly when non-linear behaviour is to be considered. Major problems are related to the high mesh dependency (it has been shown that the results are strictly dependent on the geometry and refinement of the mesh) and to the uncertain in assigning stiffness/strength properties to the pile-soil interface elements. Thus, 3D FEM and FDM analyses should only be applied for a limited number of cases, and when the finances and the time are available, by highly experienced engineers.

Repute removes the above drawbacks and successfully predicts the pile response in a simpler and more direct manner. As stated by Poulos et al. (2001), "*It is not necessary to employ complex representations of non-linear soil behaviour in order to obtain reasonable predictions of lateral pile response. Even a simple elastic-plastic or hyperbolic response may often be adequate to capture the main non-linear effects*". The above statement is supported by a large amount of experimental observations on full-scale pile groups.

- **External loads**

3D FEM or FDM codes have been utilized with some success for analyses of pile groups under axial loading. Further research, testing and validation are needed to use this kind of analyses in routine pile-group design, particularly when lateral or torsional loading are applied.

Repute removes the above limitation as it can deal with pile groups under any loading conditions (vertical, horizontal, moment and torsional loading acting in any directions).