Three-dimensional Numerical Modelling of Dynamic Saturated Soil and Pore Fluid Interaction
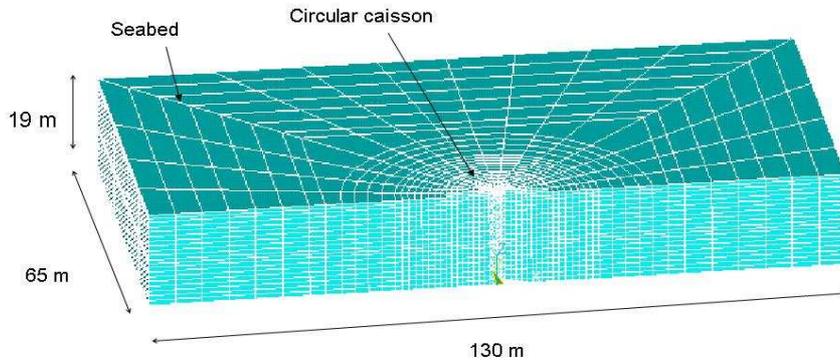
Problem

As it is commonly known, soil is a multi-phase material that contains not only soil grains, but also air and pore fluid. When subjected dynamic loading, these different phases inside the soil will interact to each other. These interactions can subsequently lead to various characteristic behaviours of soil such as liquefaction, cyclic mobility and dilation. These pore fluid-soil interaction induced phenomena not only are complicated in mechanism but also sometimes bring disastrous results i.e. building collapse during earthquake, failure of offshore equipments under wave loading.

Method

Aiming at a better understanding of the coupled interaction between saturated soil skeletons and pore fluid as well as, which is more important, looking for a feasible way to predict and avoid the disastrous damage caused by these coupled interaction phenomena, a three-dimensional (3D) finite element methods program DYNE3WAC was developed, basing on the same numerical scheme as the 2D version DYNE2WAC.

Results

In order to verify and validate the program, a series of tests for both static and dynamic problems were conducted to verify the program. The numerical results were compared with the analytical solutions, and in all of the tests the numerical results agree well with the analytical results.

Additionally, to overcome the memory limit for global matrix storage, an out of core solution method was adopted for the Unix/Linux version by including the MA42 package into this program. The performed tests showed that, by adopting the out of core method, the memory required for the storage of the global matrix can be greatly reduced.

The verified program was successfully applied to two types of analyses. The first type concerned with the wave-induced response around the structures, a circular suction caisson and a breakwater, founded on the seabed. The other is concerned with the earthquake-induced liquefaction.

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Products Used
Intel Fortran compiler

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