6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

COMPUTING FEATURES OF WAVE PROPAGATION INTO A WET GRANULAR MEDIUM

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Key Words: *Discrete Element Method (DEM), Marker And Cell Method (Mac), Granular Materials, P-Waves, S-Waves.*

Understanding the micro-mechanism of wave propagation in wet granular media such as soils is the first step toward predicting and then minimizing earthquake damage.

Granular materials are complex multi-*particle ensembles* that interact and move under Newton's laws. In order to understand and predict their macroscopic physical behavior, the interactions at the level of individual grains must be analyzed. Such an analysis was carried out using the Discrete Element Method (DEM). Hertz's theory was applied to calculate the normal elastic contact of spherical particles, and the Mindlin-Deresiewicz theory provided a solution for a tangential direction.

In the case of saturated soil, the pore spaces are completely filled with water. The water motion was described by Navier-Stokes equations for a non-compressible viscous fluid and modeled by the Marker And Cell (MAC) method, which method works well for time and space transient flows. This is important in the case of small pore spaces in which a laminar flow can easily transform into a turbulent flow because of the smallness of streamlined bodies. The coupling of two methods is organized by special boundary conditions. No-slip and no-penetration conditions were applied to MAC cells located around each particle. The drag and buoyancy forces acting on the particles were determined by integrating viscous stress and pressure fluid tensors. The external boundary conditions were taken up from the natural condition of soil samples encountered in granular materials. The simulations took into account the pressure of the upper soil layers applied to the top of the sample, and non-reflection (or periodic) conditions were applied to the others side.

A crossing of the p-waves (pressure primary waves) and the s-waves (shear secondary waves) was studied on a virtual sample. Simulations of the particle trajectories, speed, energy dissipation associated with thepore pressure and flow velocity are presented.

The simulations were carried out with a virtual laboratory named SiGran, developed at Hydro-Québec's research institute (IREQ). The code is bulk-parallel and can be run on GPU devices. SiGran has been tested on many real and theoretical problems. In this study, numerical results are compared to published experimental [1] ones for elliptical particles subjected to oscillations.

REFERENCES

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