Numerical simulation of free surface seepage in saturated soil using Smoothed Particle Hydrodynamics

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ABSTRACT

In this paper we present numerical simulations of free surface seepage in saturated soil using Smoothed Particle Hydrodynamics. The modelling of the water seepage is based on a water-soil mixture theory [1, 2]. Soil skeleton and water are depicted by different groups of particles. The water particles move according to momentum equations while the soil particles are fixed in position. The interactions between these two phases, consisting of drag force and viscous stress induced by the change of volume fraction, are added to the governing equations of the water phase. A nonlinear drag force accounting for the high velocity turbulent flow in soil is applied. The proposed method is capable of analysing problems with spatially different volume fraction.

The proposed method is capable of modelling free surface flow in geomaterial with relatively high permeability, such as gravel and rockfill. In such cases the flow velocities is high therefore the linear darcy's law is not applicable. The free surface flow through a vertical dam is simulated. The numerical results are compared with that from literature. It is demonstrated that the seepage surface and pressure field can be obtained with satisfactory accuracy.

Although the proposed simulations suffer from long computation time in soils with very low permeability and in large scale problems, they serve as preliminary researches to problems with strong water-soil interactions, like seepage failure, landslide, sloshing and bed erosion. If the soils, provided an appropriate constitutive equation, are allowed to move and deform, these phenomena can be modelled in the same SPH framework proposed in this paper.

REFERENCES

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