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Modelling of Landslides with the Material-Point Method

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As a part of the globalisation, cities are built in mountainous areas in which landslides are common occurrences. If landslides cannot be prevented it is of interest to know the extent of an eventual slide. Landslides are a very complicated and varied physical phenomena depending among other factors on the slope geometry, the soil properties and the environment. Previous research has focused on determining the reliability of slopes and the risk of failure. The idea in the present paper is, however, to examine the dynamic evolution of slides in unstable slopes by means of numerical simulations.

The modelling of landslides is performed with the aid of the Material-Point Method (MPM) which has been developed in the 1990s [1,2]. In the MPM two material descriptions are employed. The soil is described using a Lagrangian description in which the soil is divided into a number of discrete points at which the mass, stresses, strains and other properties are evaluated. However, the kinematic equations are solved on an Eulerian grid, which allows the modelling of complex material behaviour and large displacements of the soil.

Different types of slope failure leading to landslides are modelled. The initial stress distribution in the slopes are determined using a finite-difference scheme. The first test case is a landslide triggered by removing part of the slope. The extent of the slide are determined for different types of soil. The second example is a landslide triggered by the cohesion being removed. This is a typical scenario after heavy rainfall in fine-grained soils. The purpose of the analysis is to provide a further understanding of the dynamical evolution of landslides in different soil-types.

References

[1] Schreyer, H.L., Suslky, D., Chen, Z., 1994. A particle method for history-dependent materials. Computer Methods in Applied Mechanics and Engineering 118, 179-196.

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