Geophysical Research Abstracts
Vol. 17, EGU2015-12658-1, 2015
EGU General Assembly 2015

Modelling of a viscoplastic granular column collapse and comparison with experiments

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Landslides and, more generally, large scale granular flows, represent a wide variety of geophysical flows also including mud or debris flow and snow avalanches. In a continuum mechanics context, the accurate simulation of these flows strongly depends on the modelling of their rheology and their boundary conditions, namely the sliding law and processes of erosion. In particular the description of the static and of the flowing states of granular media is still an open issue.

We focus here on the quantitative reproduction of laboratory experiments using a mechanical and numerical model of dry granular flows with the so-called $\mu(I)$ rheology associated to a Drucker-Prager plasticity criterion and a shear rate and pressure dependent viscosity $\eta(\|D\|, p)$. A Coulomb type friction law is considered at the base of the flow.

The modelling is achieved in a finite-element context using the software *FreeFem++*. The simulations are bidimensionnal and well reproduce quantitatively both the dynamical and final shapes of the deposit. The effects of the sidewalls of the experimental channel, neglected in 2D simulations, are investigated by introducing an extra term in the equations varying with the inverse of the width of the channel, providing an enhanced agreement with the experiments.

The numerical results show that the flow is essentially located in a surface layer behind the front, while the whole granular material is flowing near the front where basal sliding occurs. The static/flowing interface changes as a function of space and time, in good agreement with experimental observations.

The resulting dynamic viscosity varies from very small values near the free surface and near the front to $1.5 Pa.s$ within the quasi-static zone. The results show a rather small yet computationnaly expensive difference between a constant viscosity model and a $\mu(I)$ rheology in the case of a rigid bed. This has important implication for application to real geophysical flows. The role of an erodible bed in conjunction with this rheology is also investigated.