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2D numerical modelling of granular flows and comparison to laboratory experiments

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The Discrete Element Method (DEM) is increasingly used to simulate avalanches of granular materials owing to their apparent physical similarity with a flow of idealized particles. DEM application to avalanches of granular materials however requires to determine the correct geometric and rheological parameters for and between the particles as well as for the basal surface. The use of spherical (circular in 2D) particles enhance particle rolling and yields too large run-out values. The solution usually adopted for correcting this effect is to introduce a local damping which acts like a drag force and artificially slows down the particle velocities.

The aim of our study is to test the ability of the DEM to simulate well-controlled unsteady channelized granular flows, considering the measured physical properties of the particles and of the basal surface (particle shape, friction and restitution coefficients) which naturally dissipate energy. We first performed a parametrical analysis on a simple 2D model in order to estimate the influence of the shape, the number of particles and the contact parameters on the dynamic of the flow and on the deposit geometry. This study pointed out the prominent role of the particle shape and of the friction and restitution coefficients of the basal surface on the energy dissipation.

We then simulated three laboratory experiments carried out by Savage and Hutter (1991) and Hutter al. (1995) on the motion of several cohesionless granular materials released from rest down a rough incline. As the granular flow is well channelized, the 2D modelling of the flow can be applied. The three physical experiments are performed using two granular materials (nearly spherical glass beads and lens-like shaped plastic particles) with different volumes and bed linings (drawing paper and sandpaper). Using the geometrical data and the values of the mechanical parameters provided by the authors, we obtained a remarkable agreement between the observed and simulated deposit shapes for the three experiments. Also, the computed mass evolution with time is very consistent with the experimental snapshots in all cases. These results highlight the capability of the DEM technique for modelling avalanche of granular material, if the particle shape and the coefficient of restitution are properly considered.

Savage S.B., Hutter K., The dynamics of avalanches of granular materials from initiation to runout. Part I: Analysis, Acta mechanica, Vol. 86, pp. 201-223, 1991.

Hutter K., Koch T., Plüss C., Savage S.B., The dynamics of avalanches of granular materials from initiation to runout. Part II: Experiments, Acta mechanica, Vol. 109, pp. 127-165, 1995.