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# Discrete element modelling of bed load transport

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Discrete element method (DEM) is a numerical method to simulate an assembly of particles, which has been widely used in mechanics (soil, rock) and granular physics. DEM consists in considering undeformable particles and modelling the intergranular interactions with simple laws (e.g. linear elastic and Coulomb friction law). The expression of the equation of motion on each particle considering the nearest neighbor interactions allows then to solve the dynamical behavior of the system explicitely. Since its introduction more than thirty years ago, this type of model has proven its ability to well describe the behavior of granular media in several different situations, from quasi-static system to flow of granular media.

Bedload transport in streams is characterized by particle transport restricted to the interface between fluid flow and immerged granular media, where particles are rolling, sliding or in saltation over the bed. This situation corresponds to the larger particles transported on the bed in stream channels and has a great influence on geomorphology. Physical mechanisms and processes ruling bedload transport and more generally coarse-particle/fluid systems are poorly known. This is partly due to the small attention given to the role of granular interactions. Starting from these considerations, we used DEM to reproduce experiments carried out with spherical glass beads in an experimental steep and narrow flume. This was done in order to focus on granular interactions and to have access to parameters not available in the experiment. DEM open-source code Yade was coupled with a simplified fluid model, taking into account the different hydrodynamical interactions (buoyancy, drag, lift...) experienced by the particles.

Numerical results obtained from the simulation are compared with an experimental data set established previously at the laboratory. It consists in monodisperse and bidisperse mixtures of coarse spherical glass beads entrained by a shallow turbulent and supercritical water flow down a steep channel with a mobile bed. The particle diameters were 4 and 6mm, the channel width 6.5mm (slightly above the coarse particle diameter) and the channel inclination was typically 10%. The water flow rate and the particle rate were kept constant at the upstream entrance and adjusted to obtain bedload transport equilibrium. Flows were filmed from the side by a high-speed camera. Using image processing algorithms made it possible to determine the position, velocity and trajectory of both smaller and coarser particles.

The comparison between numerical and experimental results focused on streamwise velocity, concentration and sediment rate normal profiles. For bidisperse mixture, a particular attention was given to the segregation phenomenon. We observed in both cases a fair agreement between DEM and experiments.