Experimental analysis of segregation in granular flows

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Natural granular flows have a widely dispersed grain size distribution. The majority of the numerical models and laboratory investigations of granular flows are developed assuming a single grain size. However, the geophysical massive flows involve several classes of particles and the bulk solid evolves spatially in a non-uniform state [1]. Segregation causes a different spatial distribution of the particles and influences the kinematic of the bulk solid, like the concentration, the run-out, the velocity and the granular temperature. During the flow motion, the largest particles are found at the surface due to the imbalances in the contact forces, and the smallest at the bottom as they percolate due to gravity [2].

To investigate the physical processes responsible of the particles transfer, we conducted a series of laboratory experiments, using two different grain size classes to reproduce the binary mixture. The measured data are required to calibrate the mathematical model and to set the coefficients that describe the percolation and the kinetic sieving mechanism. The experiments to study the free surface flow started considering the dry condition. Two different type of classes of particles flow over a loose deposit in homogenous and steady conditions. We used spherical particles of non-expanded polystyrene with a density of 1035 kg/m$^3$. The small beads are black with a mean diameter of 0.00075 m and the large beads are white with a mean diameter of 0.0014 m. At the end of the flume there is a weir with two openings. The material is manually inserted and flow in the flume, it is then recirculated by an auger and finally conveyed in a hopper, from where it falls down in the chute again. The system works for at least 30 minutes, after reaching the steady condition.

The measurements were taken through a high speed camera in a section lateral to the flume. The flow field was measured with an optical method, that gives the velocity, the concentration and the granular temperature for both the small and the large particles, from the sidewalls.

Analyzing the experimental data, as regards the longitudinal velocity, it is possible to observe that the velocities of the two classes are similar and the large particles flow a bit faster. In contrast, there is a strong segregation in the concentration rates. After the running time, segregation causes the separation of the two classes: the largest classes are in the upper part and the smallest fraction at the bottom.

References