Front formation in bidispersed shallow chute flows

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Predicting the behaviour of hazardous natural granular flows (e.g. snow slab avalanches, debris-flows and pyroclastic flows) is vital for an accurate assessment of the risks posed by such events. This behaviour is strongly affected by the segregation that occurs in the dense flow regions of these flows [1]. Segregation causes the larger particles to rise to the surface, from where they are transported to the front. In many natural flows, these bouldery fronts experience a much greater frictional force, leading to the formation of a bulbous flow front, see figure 1.

Continuum methods are able to simulate the flow and segregation behaviour of such flows, but have to make averaging approximations to reduce the degrees of freedom from a huge number of particles to a handful of bulk/continuum fields. We use the model of [3] to predict the flow profile of these flows, based on the height, velocity and particle size segregation and show that the solutions converge to a simple travelling wave solution, which makes the computation of the long-time profile very inexpensive.

This talk will focus on the simple case of size-bidispersed dry granular flows over inclined planes. We will investigate this problem via both continuum modelling and particle simulations. Small-scale periodic particle simulations are used to determine the material parameters of the continuum model [2]. We validate the simple 1D continuum level simulations against computationally expensive 3D particle simulations. The agreement is surprisingly accurate, especially considering that the continuum level simulations only cost minutes instead of months of computation time. We conclude by discussing how combining both the continuum and discrete approaches can be used to reveal deeper insight.

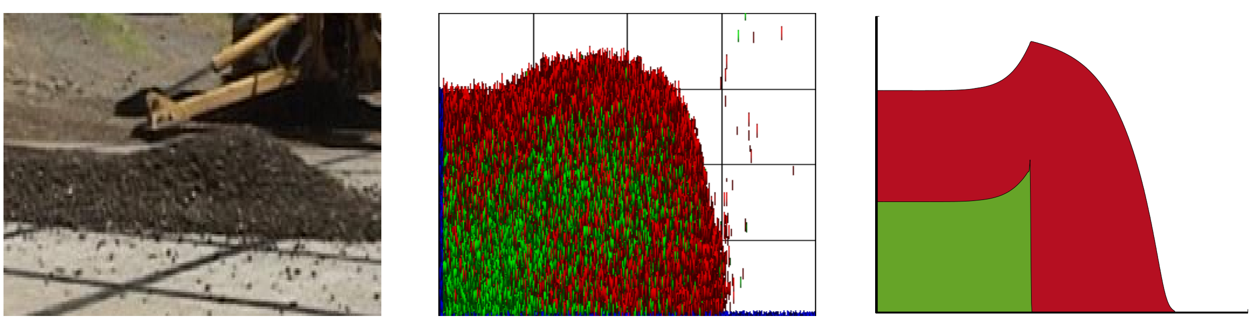

Figure 1: Examples of the bulky head in shallow chute flows. Experiments at the USGS debris-flow flume (*left*), discrete particle simulations (*middle*) and continuum level simulations (*right*). The x-axis is scaled by 1/100 in the middle and right pictures.

References

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