Discrete to continuum fields in bidisperse segregating granular mixtures

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(Received 6 March 2017)

Many flows in the industry or natural environment consist of shallow, rapidly moving and often segregating granular flows; examples include avalanches, landslides, debris flows and pyroclastic flows as well as industrial flows including rotating drum mixers, kilns and crushers. For applications ranging from rockslide hazard map construction to the flow of sinter and pellets into a ten storey iron-ore blast furnace it is vital to accurately predict the dynamics of dry granular flows. Segregation created by either size or density differences in the particles which comprise a granular material can have a massive influence on its bulk dynamics. This presentation focuses on advancements, both in continuum modelling and simulations, in this respect.

Continuum methods are able to simulate the bulk behaviour of flows such as those described above, but have to make averaging approximations reducing the degrees of freedom of a huge number of particles to a handful of averaged parameters. Once these averaged parameters have been tuned via experimental or historical data, these models can be surprisingly accurate; but, a model tuned for one flow configuration often has poor prediction power for another setup.

On the other hand, discrete particle methods are a very powerful computational tool that allows the simulation of individual particles, by solving Newton's laws of motion for each particle. With the recent increase in computational power it is now possible to simulate flows containing a few million particles; however, for 1mm particles this would represent a flow of approximately 1 litre which is many orders of magnitude smaller than the flows typically found in industry or nature.

This talk will review recent work on modelling bi-dispersed (by size and density) dry granular flows in rotating drums. We will investigate progress on this problem via the continuum modelling approach (both numerical and analytical solutions will be presented), particle simulations and discussing how both can be combined to reveal deeper insight into these complex flows. We conclude by briefly discussing future challenges facing the field.

† Will present at the conference