Parcel Methods for Cohesive and Interlocking Granular Materials

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ABSTRACT

Cohesive inter-particle forces and particle shape significantly impact the flow of granular materials, often leading to large uncertainties when making flow predictions: while particle shape may alter flow rates by up to 40%, cohesion may even radically change the flow regime. Previously, we have shown that cohesion effects can be successfully captured by Eulerian [1] and Lagrangian parcel-based simulation models [2] in a number of flow situations.

Unfortunately, computer models that aim at capturing interlocking effects (due to particle shape) have not achieved this state. Classical approaches that aim at modelling the true shape and size distribution are doomed to failure in many engineering applications: for systems involving sub-millimeter sized particles they are computationally simply too expensive. My talk aims at a radically different approach, namely to (i) abstract the particle shape as much as possible by using so-called “pods”, and (ii) consider parcels that represent an ensemble of particles. Calibration and validation steps are then used to identify parcel shape, size, and interaction parameters that replicate relevant reference data. We have recently shown [3] that such a strategy is not only able to represent average statistics of experimental data sets, but can even be used to match experiment-to-experiment variability: it is possible to calibrate the simulation model such that it predicts the experimental uncertainty.

In my lecture I will go a step further, and present (i) an explanation of why particle shape is essential to be captured, (ii) detail on the plurality of bifurcations that occur in simple flows of pods, and (iii) how one could use pods to model extreme compaction processes of cohesive interlocking materials.

REFERENCES

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