A coupled lattice-Boltzmann discrete element modelling of shear flow in saturated dense granular material

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ABSTRACT

The flow of saturated dense granular material is ubiquitous in nature and in industry, such as debris flow and slurry transport. Despite extensive studies of the overall flow behaviour, the specific roles of how particle contacts and hydrodynamic interactions determine the rheology have not been fully understood. In this work, we use high-fidelity simulations of sheared dense suspensions to gain new insights into the fluid and particle micro-scale processes. The employed numerical method couples a lattice-Boltzmann [1] and a discrete element method supplemented with a lubrication force model to resolve the detailed flow field and particle dynamics, respectively. We perform simulations of sheared suspensions at various solid volume fractions and shear rates in a three-dimensional domain with periodic boundaries in two dimensions and sheared parallel solid walls in the remaining dimension. Simulation results are discussed by adopting the micro-scale analysis from [2], i.e. decomposing the bulk stresses into different contributions, viz. stresses arising from particle-particle contacts and hydrodynamic interactions. Thereby, we evaluate the different influences for varying flow conditions. The data generated in such simulations not only contribute to a better understanding of physical processes in suspensions, but also provide a basis for constructing models at coarser levels that do not resolve the flow field and/or particle motion at the individual particle level.

REFERENCES

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