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Saturated Granular Transitional Flows simulated with the Material Point Method

Philip Alsop and Miguel Angel Cabrera

Universidad de los Andes, Dept. of Civil and Environmental Engineering, Bogota, Colombia (p.j.alsop@gmail.com, ma.cabrera140@uniandes.edu.co)

Modeling of granular transitional flows remains a challenging problem, even with the use of advanced numerical methods like the Material Point Method (MPM). In MPM, a population of Lagrangian material points, representing the continuum body, is allowed to move freely across a stationary Eulerian mesh, which allows for large deformation problems to be solved. However, the generated pressure distribution at the material points can be subject to unrealistic stress oscillations, produced by cell-crossing error, amongst other causes [1,2,3]. Moreover, the influence of the interstitial fluid phase and its interaction with moving grains in saturated granular flows remains an ongoing research topic. This complex coupled interaction may involve drag forces, lubrication forces, or turbulent fluctuations of the fluid flow, none of which the original MPM formulation considers.

In this work, the 2D MPM code developed by Dunatunga [2] (https://github.com/neocpp89/mpm-2d/tree/master/libmpm) is used to simulate the granular column collapse using a non-local μ(I) rheology and its results are compared to the MPM simulations performed with a Mohr-Coulomb model implemented in the Anura3D [4]. Both numerical simulations are compared with quasi-2D experiments of dry glass beads. The resulting final pressure distribution is compared with a geostatic distribution to quantify the error, using the post-processing procedure proposed by Andersen and Andersen [3]. The code is then extended to implement the two-point MPM method proposed by Abe, Soga, and Bandara [5], allowing the simulation of a submerged granular column collapse. We explore the effectiveness of the method with respect to the solid runout, the accuracy of the pressure-profile, and test its limitations involving mixing and separation of the fluid- and solid-phases.

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