EGU21-15861
https://doi.org/10.5194/egusphere-egu21-15861
EGU General Assembly 2021

Shear banding in elasto-plastic slumping process on a GPU: mechanical and hydromechanical MPM solver

Michel Jaboyedoff, Emmanuel Wyser, and Yury Podladchikov
University of Lausanne, ISTE-FGSE, ISTE, Lausanne, Switzerland (michel.jaboyedoff@unil.ch)

Strain localization plays an important role in the mechanical response of a slumping mass and defines the overall behaviour of such process. We study strain localization with the help of the Material Point Method (MPM), which is well-suited to simulate large deformation problem.

We implemented both mechanical and hydromechanical (i.e., we assume fully saturated conditions of the material) MPM-based solvers within a rate-dependent formulation framework under a GPU architecture. We selected an explicit MPM formulation enriched with the Generalized Interpolation Material Point (GIMP) variant, which fixes a major flaw of MPM, i.e., the cell-crossing error. To avoid spurious oscillation of the pressure field (due to the use of low-order elements) for both solid and liquid phase, we used an element-based averaging technique. This minimizes volumetric locking problems. This numerical framework allows to study high-resolution two-dimensional elasto-plastic (i.e., Mohr-Coulomb plasticity) problems in an affordable amount of time. The solvers were written in a CUDA C environment on a single Nvidia GPU. We report a speed-up factor of 500 compared to a similar MATLAB implementation.

Our results showcase a contribution of pore water pressures over shear banding. In particular, we report a significant influence of the liquid phase over the steady thickness of the shear bands and their location. Pore pressures add a viscous contribution to the elasto-plastic rheological model we choose, i.e., Mohr-Coulomb.

As a future perspective, even high resolution could be achieved considering the extension of the actual implementation toward a multi-GPU solver using MPI.