IV International Workshop on Modern Trends in Geomechanics
G. Viggiani, D. Salciarini, F. Silvestri, C. Tamagnini, G.M.B. Viggiani
(Eds) Assisi, May 16--18, 2016

FROM PLASTICITY TO VISCOPLASTICITY IN FLOWING GEOMATERIALS: WHAT DO WE LEARN FROM NUMERICAL MODELS?

Bruno Chareyre[1], Donia Marzougui[2], and Julien Chauchat[3]

[1]Univ. Grenoble Alpes, 3SR, F-38000 Grenoble, France and
CNRS, 3SR, F-38000 Grenoble, France
e-mail: bruno.chareyre@3sr-grenoble.fr

[1]Univ. Grenoble Alpes, 3SR, F-38000 Grenoble, France and
CNRS, 3SR, F-38000 Grenoble, France
e-mail: donia.marzougui@3sr-grenoble.fr

[3]Univ. Grenoble Alpes, LEGI, F-38000 Grenoble, France and
CNRS, LEGI, F-38000 Grenoble, France
email: julien.chauchat@grenoble-inp.fr

Keywords: suspension, viscosity, friction, dilatancy, poromechanical coupling

Summary.
The discrete element method has been extended to dense mixtures of non-colloidal particles and viscous fluids in the non-inertial regime [1]. The numerical model includes sphere-sphere contacts using a soft contact approach [2], short range hydrodynamic interactions defined by frame-invariant expressions of forces and torques in the lubrication approximation, and drag forces resulting from the poromechanical coupling computed with the DEM-PFV technique [3].

We examine the dependency of shear stress on shear rate and the interplay between rate dependent dilatancy and hydro-mechanical coupling. The bulk shear stress is decomposed into contact stress and hydrodynamic stress. Both contributions are shown to be increasing functions of a dimensionless shear rate I_v, in agreement with experimental results [4]. Statistics of microstructural variables highlight a complex interplay between solid contacts and hydrodynamic interactions. In contrast with a popular idea, the results suggest that lubrication may not necessarily reduce the contribution of contact forces to the bulk shear stress.

The simulations show that pore pressure feedback can play a key role in sheared mixtures such as debris flow, especially during the triggering phase, when run-out include transitional phases, or when the flow is stopped. It is concluded that debris flow cannot be modeled by assuming solely the rheological properties of an equivalent mixture.

REFERENCES

[1] D. Marzougui, B. Chareyre, and J. Chauchat. Microscopic origins of shear stress in dense fluid–grain mixtures. *Granular Matter*, *17*(3), 297-309, 2015.

[2] V. Smilauer et al., "*Yade Reference Documentation*", in Yade Documentation (V. Šmilauer, ed.), The Yade Project, 1st ed., 2010. http://yade-dem.org/doc/.

[3] E. Catalano, B. Chareyre and E. Barthélémy, Pore-scale modeling of fluid-particles interaction and emerging poromechanical effects, Int. J. Num. Anal. Meth.Geomech., 38(1), 51-71, 2014.

[4] F. Boyer, E Guazzelli, and O. Pouliquen, Unifying suspension and granular rheology, Physical Review Letters, 107(18), 188301, 2011.