Steady State Rheology from Homogeneous and Locally Averaged Simple Shear Simulations

H. Shi *, S. Roy, S. Luding and V. Magnanimo

Multi Scale Mechanics (MSM), Engineering Technology (ET), MESA+, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

Email: h.shi-1@utwente.nl,

ABSTRACT

Granular and particulate matter are ubiquitous in our daily life and they display interesting bulk behaviors, from solid- to fluid- to gas-like states, or even all these states together. Bridging the gap between the particulate, microscopic picture towards their continuum description (via the so-called micro-macro transition) is one of today's challenges. A continuum model able to characterize the flow behavior of a granular system is of particular urgency to model and predict the behavior of large scale natural and industrial systems.

We have performed Discrete Element simulations in a periodic stress controlled simple shear setup using MercuryDPM open source software. We have explored different values of inter-particle friction and cohesion for our particles. An improved rheological model is proposed for macroscopic friction, volume fraction, coordination number and granular temperature as a function of inertial number and softness (particle contact deformation) [1]. In addition, the results are compared with locally averaged data from inhomogeneous steady state shear bands in a split bottom ring shear cell [2] as well as homogeneous volume conserved simple shear and pure shear [3], to understand the effects and influences of different boundary conditions.

A set of physical experiments are carried out on fine limestone powders in different shear devices. Once the DEM simulation parameters are calibrated using the shear experiments, the micromechanical-based rheological model can be tuned to describe the specific material and the flow behavior can be predicted for industrial systems, e.g. the discharge from a silo.

REFERENCES

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