Structure and Distribution of Forces in Shear Bands of Wet and Dry Cohesive Materials - PARTICLES 2015

Sudeshna Roy*, Abhinendra Singh*, Stefan Luding* and Thomas Weinhart*

* Multiscale Mechanics Group (MSM)
MESA+ Institute of Nanotechnology
PO Box 217, 7500 AE Enschede, The Netherlands
e-mail: s.roy@utwente.nl

ABSTRACT

The aim of our study is to understand the microscopic origin of the force network and statistics of the inter-particle forces inside a shear band. We study the rheology of cohesive granular materials in the quasistatic regime using the Discrete Element Method (DEM) in a split bottom shear cell. We compare the forces and their distribution, originating from different types of cohesive models for dry and wet cohesive granular materials. Cohesion can have various origins, such van der Waals type or liquid-bridge with short-range (non-contact) forces. Cohesion can also be strongly enhanced by elasto-plastic impacts for soft particles.

Previous studies on dry cohesive materials with elasto-plastic contacts include cohesive force acting between particles only when they are in contact. Inside the shear band, the mean normal contact force is independent of cohesion whereas the forces in compressive and tensile directions of the local shear rate do depend strongly on cohesion [1], being symmetrically larger and smaller respectively.

In our present study, we consider wet granular materials with some little interstitial liquid between the particles in the pendular regime [2, 3], which causes short-range attractive forces between non-overlapping particles also. In presence of these short-range interactions, inside the shear band, the mean normal force decreases with increasing liquid bridge rupture distance between the particles i.e. with change in liquid bridge volume. However, it is invariant to the change in magnitude of the interaction force e.g. with change in surface tension of the liquid. Nevertheless, when we explicitly analyse only the contact forces, the mean normal force is independent of the liquid bridge volume. The liquid bridge properties like the bridge volume and the surface tension are varied and we study their effects on distribution of forces separately for contacts with overlap and non-overlapping short-range interactions. By this way we can analyse the force distribution for the cohesion induced by capillary bridges for different liquids in wet granular materials in industries.

REFERENCES

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