On the effects of particle shape on shear flow of non-spherical particles

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ABSTRACT

Shear flow of non-spherical particles is investigated in this paper using Discrete Element Method to identify the effects of particle morphology. In this paper soft, frictional, non-cohesive rod-shape particles with different aspect ratios (A_r = 1.0 - 2.5) are considered. A fabric and an orientation tensor are defined to describe the micro-structure of the particle assembly in detail. It is observed that the mean orientation of rod-shape particles slightly deviates from the flow direction. An attempt has been made to explain this phenomenon by relating it to the formation of force chains. In addition, an unsymmetrical distribution of the long axis of particles is observed on xy-plane where shear is applied in y-direction. The distribution however, remains symmetric on yz-plane. We found that the flow of rod-shape particles – similar to spheroids – falls into three different flow regimes, namely quasi-static, inertial and intermediate, depending on the volume fraction and the applied shear rate ($\dot{\gamma}^*$). Particle coordination number is found to be independent of the shear rate in the quasi-static regime whereas strong dependence of coordination number on shear rate is observed in inertial regime. Furthermore, we found that all the stress data for rod-shape particles collapse onto a single curve upon scaling by powers of distance to the corresponding jamming point. The jamming point is a function of aspect ratio and a linear fit describes this functionality. These findings allow us to conveniently incorporate the shape effects into rheological models currently available for spherical particles.

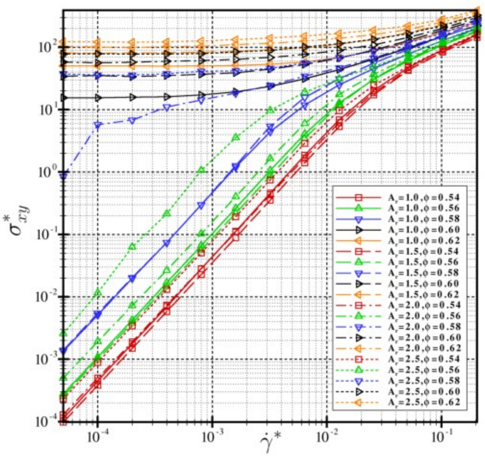

Fig 1. Effects of particle shape on the non-dimensional stress.

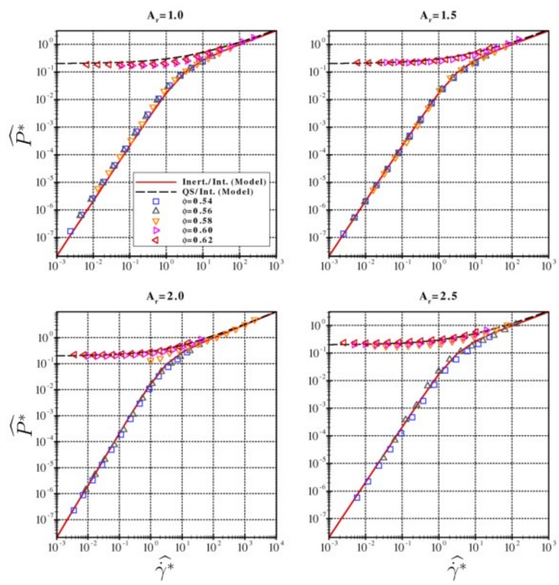

Fig 2. Collapse of pressure data upon scaling by the power of distance to the corresponding jamming point.