Rheological and Microstructural Properties of Elongated Particles

Nathan Berry* and Sina Haeri†

*† James Weir Fluids Laboratory, Department of Mechanical and Aerospace Engineering
University of Strathclyde
16 Richmond St, Glasgow, UK, G1 1XQ
e-mail: * nathan.berry@strath.ac.uk † sina.haeri@strath.ac.uk

ABSTRACT

In this work, extensive numerical simulations of three dimensional, soft, elongated, monodispersed, non-cohesive particles are performed using a versatile Multi-Sphere Discrete Element Method. The particles are subjected to a homogeneous shear flow and a detailed analysis of their rheological and microstructural properties is undertaken. It is found that the rheological behaviour of these elongated particles is similar to that of spheres , with three clearly identifiable flow regimes namely the quasistatic, inertial and intermediate. However the effect of elongation is important. This is highlighted with the aspect ratio 1.5, which shows a significant dip in shear stress when compared to the other aspect ratios. To understand this dip, a thorough microstructural analysis is performed. A contact mode analysis is utilised, with the results showing that the proportion of contact type is highly dependent on aspect ratio and volume fraction, however it has very low dependence on shear rate. Using Voronoi tessellations, a measure of compactness of the material is defined. This parameter uncovered unusual behaviour with respect to aspect ratio 1.5, with noticeable peaks in compactness across regimes. Despite the interesting results gathered from the aforementioned analysis, further work including a break down of the force networks is performed to conclusively understand the rheological properties observed.

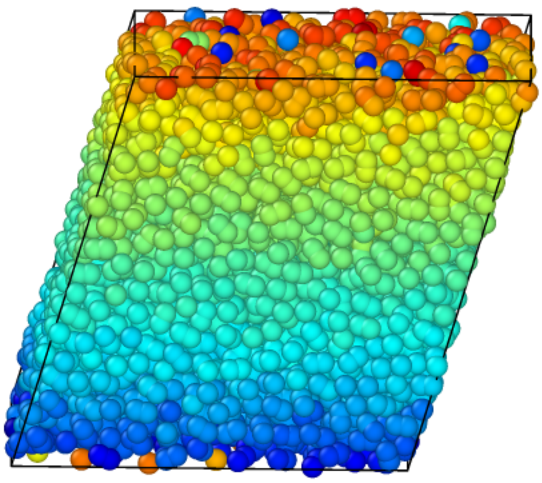

Figure: Snapshot of domain under shearing conditions, with the particles coloured by velocity magnitude (not to scale)