Geometrical and Physical Interpretations of the Properties of Disordered Granular Packings

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ABSTRACT

Disordered granular media composed of non-spherical particles are a recurring feature in natural systems and one of the most important inputs into industrial activities ranging from construction and manufacturing, to food processing and pharmaceuticals.

We utilize discrete particle simulation methods to generate disordered granular packings of superellipsoids [1, 3]. We simulate a range of preparation methods including pouring, particle expansion, and slow settling of grains in a viscous liquid (Fig. 1). These allow us to generate systems ranging from the densest disordered to the loosest mechanically stable packings [2].

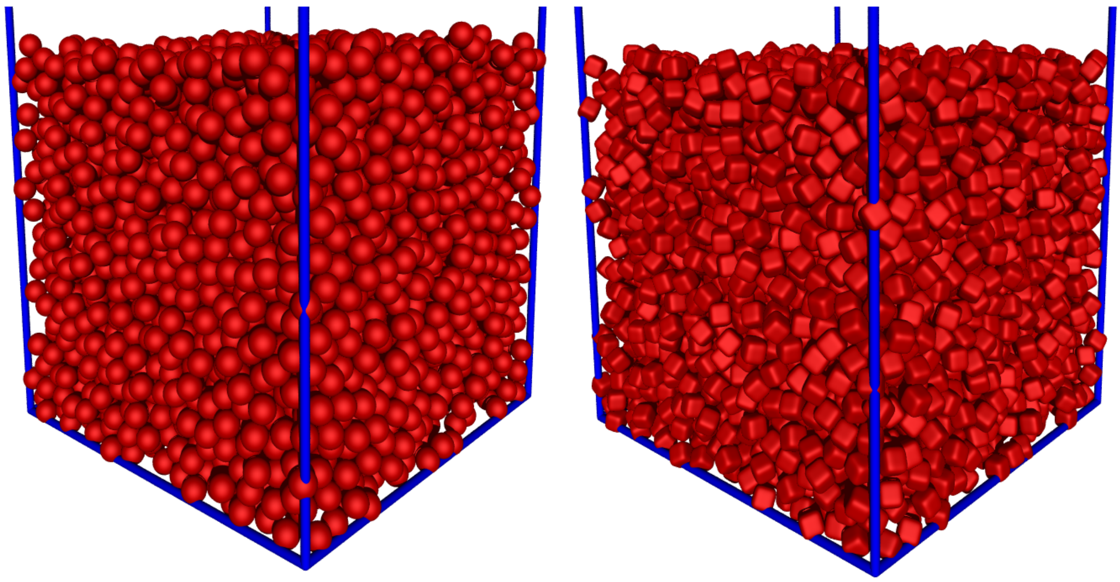

Figure 1: Simulated disordered packings of grains formed by slow sedimentation in a viscous liquid. Packings are shown for spheres (left) and equi-axed superellipsoids with a cubic shape (right).

We utilize a range of order parameters to quantify how features of the individual grain shapes affect the properties of the system in the packed state [1, 2]. By considering a broad range of packings, prepared via multiple preparation methods and composed of a range of grain shapes, we are able to identify the effects of key properties of the particle shape that determine the structure of packed granular media. We find that anisotropy and broken rotational symmetry in the individual particle shapes play key roles in determining the properties of the resulting

granular packings. We are also able to decompose the contribution from the geometric shape of the grain, the inter-grain interaction properties (in particular inter-grain friction) and the preparation method.

References

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[3] G. W. Delaney, T. D. Matteo, and T. Aste. Combining tomographic imaging and DEM simulations to investigate the structure of experimental sphere packings. *Soft Matter*, 6(13):2992–3006, 2010.