Experimental and numerical investigation of annular granular shear flow

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Shear flows of granular materials represent unique type of flow and deformation in complex systems. When a pack of granular material is subject to shearing the strain field is non-uniform. A shear-zone is developed in the vicinity of the shearing wall in which grains are rapidly flowing. However, the regime of deformation varies exponentially with the distance from the shearing wall. In other words, sheared granular materials display both fluid- and solid-like behaviors across the sheared gap.

We present some experimental results corresponding to shearing granular materials in annular Couette geometry [1]. The schematic view of the apparatus is shown in Fig. 1.

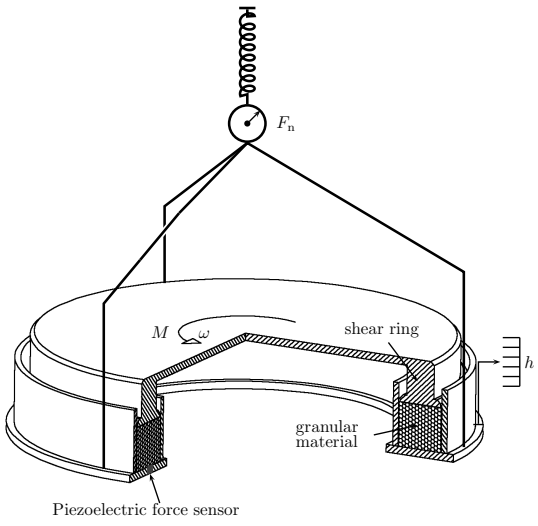

Figure 1: Schematic view of the apparatus for annular shear flow experiments in granular materials.

In addition to experiments, we have performed some particulate dynamics simulations in annular geometry. Results of simulations also indicate the presence of fluid- and solid-like behavior in the system. On the other hand, we are interested in intermittency of stress fluctuations in sheared granular materials, which is quantified using wavelet transform as shown in Fig. 2.

Normal stress fluctuations are measured locally (0.1295 cm^2) using piezoelectric force sensor beneath the granular bed. A typical signal of normalized stress fluctuation corresponding to 2-mm steel spheres is displayed in Fig. 2 with its wavelet transform using Morlet wavelets. We also discuss on intermittency features of monodisperse and bidisperse samples made of 2-mm and 3-mm steel spheres under various conditions set in our experiments.

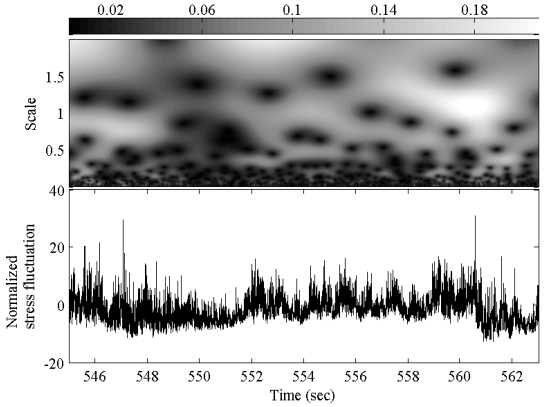

Figure 2: A typical time series of normalized stress fluctuation (bottom) and its wavelet transform (top).

Besides, we present computer simulation results based on hard-sphere model for annular Couette geometry. These results are in agreement with those observed from our experiments.

References

[1] P. Jalali, J. Ritvanen, P. Sarkomaa, Exp. Fluids (2005) Online First.