ON THE ROLE OF VORTICES IN THE THERMAL AND MECHANICAL PROPERTIES OF SHEARED GRANULAR FLOWS.

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Key words Granular flows, rheology, heat transfer, modelling.

Earthquakes and landslides often involve large deformation of granular soils and fragmented rocks. Predicting their dynamics of such events requires the knowledge of constitutive models describing the mechanical properties of this type of material.

We present here a range of experimental and numerical results aiming to better understand the flow properties of granular materials and enrich existing constitutive models. In particular, we discuss (i) the existence of granular clusters -or granular vortices- within granular flows and (ii) their effects on the material viscosity and on the material ability to transfer the heat produced by mechanical dissipation. This discussion synthesises research results published in [1, 2, 3, 4, 5]

Experiments are based on an original Stadium Shear Device producing steady and continuous shear of a layer of plastic cylinders (1.5 cm in diameter) lying on a glass panel, and that allows us to track the trajectory of individual grains within the flow (figure 1). These results evidence the formation of non-laminar kinematic patterns within the flow: transient clusters of grains form, translate and rotate as a rigid body for a short period of time, and then break appart. Discrete Element Method simulation of granular flow in the plane shear geometry compliment these experimental data, including heat transfer between grains.

The analysis of these results reveals clear scaling laws between the granular vortex size and the granular viscosity on one hand, and between the vortex size and the granular Nusselt number quantifying the heat transfer across the sheared layer on the other hand.

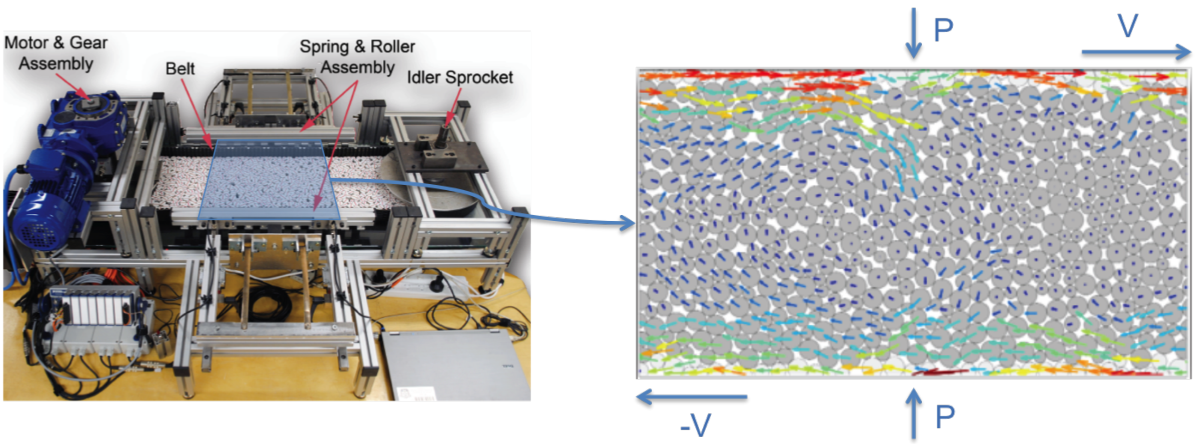

Figure 1. Granular vortices in experimental sheared granular flows. (1) Stadium Shear Device (SSD) where 2D grains are sheared within a belt; (2) Snapshot of the velocity of individual grains in the central section of the SSD showing the formation of granular vortices (V is the belt velocity and P the applied normal stress).

References

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