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Granular temperature field of monodisperse granular flows

Devis Gollin, Elisabeth Bowman, and Paul Shepley
University of Sheffield, Dept. of Civil and Structural Engineering, Sheffield, United Kingdom (e.bowman@sheffield.ac.uk)

For dry granular flows as well as solid-fluid mixtures such as debris avalanches, the momentum transfer is carried by frictional and collisional stresses. The latter may be described by the granular temperature, which provides a measure of the energy contained within the fluctuating nature of the granular motion. Thus, granular temperature can be used as a valuable means to infer the ability of a granular system to flow. Granular materials are known for the difficulties they pose in obtaining accurate microscale laboratory measurements. This is why many theories, such as the kinetic theory of granular gases, are primarily compared to numerical simulations. However, thanks to recent advancements in optical techniques along with high-speed recording systems, experimentalists are now able to obtain robust measurements of granular temperature. At present, the role of granular temperature in granular flows still entails conjecture. As a consequence, it is extremely important to provide experimental data against which theories and simulations can be judged.

This investigation focuses on dry granular flows of sand and spherical beads performed on a simple inclined chute geometry. Fluctuation velocity, granular temperature and velocity patterns are obtained by means of particle image velocimetry (PIV). Flow behaviour is probed for different spatial (interrogation sizes) and temporal (frame rates) resolutions. Through the variation of these parameters an attempt to demonstrate the consistency of the degree of unsteadiness within the flow is made. In many studies a uniform stationary flow state is usually sought or preferably assumed for the simplicity it provides in the calculations. If one tries to measure microscale fields such as granular temperature, this assumption may be inappropriate. Thus, a proper definition of the flow regime should be made in order to estimate the correct flow properties. In addition, PIV analysis is compared against particle tracking velocimetry (PTV). This alternative technique provides high-accuracy measurements and allows individual flow tracer particles to be tracked. In comparison, PIV provides exhaustive analyses although some limitations exist. The interrogation size plays an important role in determining the achievable spatial resolution of the flow. There is a limit on how large or small this region can be for adequate measurements. A further limitation is encountered when velocity gradients are presents which apt to bias the displacement estimate.

Ultimately, the above techniques and analysis will be applied to 3D polydisperse granular systems. This is extremely valuable to gain a more complete understanding and move towards more realistic flows. The overall aim of this study lies in obtaining a clearer understanding of the micromechanical processes governing granular flows and improving the modelling of debris avalanche hazards.