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Internal characteristics of refractive–index matched debris flows

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

Debris flows are channelized masses of granular material saturated with water that travel at high speeds downslope. Their destructive character represents a hazard to lives and properties, especially in regions of high relief and runoff. The characteristics that distinguish their heterogeneous, multi-phase, nature are numerous: non-uniform surge formation, particle size ranging from clay to boulders, flow segregation with larger particles concentrating at the flow front and fluid at the tail making the composition and volume of the bulk varying with time and space. These aspects render these events very difficult to characterise and predict, in particular in the area of the deposit spread or runout - zones which are generally of most interest in terms of human risk.

At present, considerable gaps exist in our understanding of the flow dynamics of debris flows, which originates from their complex motion and relatively poor observations available. Flume studies offer the potential to examine in detail the behaviour of model debris flows, however, the opaque nature of these flows is a major obstacle in gaining insight of their internal behaviour. Measurements taken at the sidewalls may be poorly representative leading to incomplete or misleading results. To probe internally to the bulk of the flow, alternative, nonintrusive techniques can be used, enabling, for instance, velocities and solid concentrations within the flowing material to be determined.

We present experimental investigations into polydisperse granular flows of spherical immersed particles down an inclined flume, with specific attention directed to their internal behavior. To this end, the refractive indices of solids and liquid are closely matched allowing the two phases to be distinguished. Measurements are then made internally at a point in the channel via Plane Laser Induced Fluorescence, Particle Tracking Velocimetry, PTV and Particle Image Velocimetry, PIV. The objective is to to increase our understanding of two-phase geophysical flows (e.g. debris flows) by providing velocity profiles and solid concentration obtained away from the flow margins. We also present observations of the final deposit spread or runout.