Interstitial fluid effects on the dynamics of dense granular flows

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The dynamics of gravity driven dense granular flows are investigated in a rotating cylinder assembly for different flow rates and in presence of interstitial fluids of varying viscosities. Exper- iments are performed in a cylinder half-filled with a model granular material - glass beads of size 1 mm with the remainder filled with an interstitial fluid. All the measurements are carried out at the center of the cylinder where the flow is fully developed. The flow is imaged using a high speed camera, the particle positions are identified very accurately and tracked over long durations to obtain mean and fluctuating properties. One of the liquids is chosen to have the same refractive index as the particles to allow imaging in the bulk away from the end walls. A small amount of fluorescent dye is added and slices of granular flow at different distances from the end walls are visualized using a thin laser sheet.

The mean velocity near the wall shows near-linear behavior across the entire flowing layer for all cases studied. With air as the interstitial fluid, the mean velocity decays exponentially with depth in a small region near the base. Increasing the interstitial viscosity leads to a shrinkage of this region. Qualitatively similar profiles are obtained at different distances from the wall with the magnitude increasing upto a distance of 15 d. The r.m.s. velocity profiles show similar trends. The flowing layer thickness and the dynamic angle of repose near the wall increases monotonically with increasing flow rates and increasing interstitial liquid viscosity. The angles decrease while flowing layer thickness increase with distance from the wall upto a distance of 15 d. The experimental data is compared with the predictions of the models by Khakhar et al. [1] and Jop et al. [2].

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References

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