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Wide Shear Zones in Slow Granular Flow by Discrete Element Simulations

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While the rheology of rapid granular flows is becoming well established, slow, dense flows are not well characterized. In part, this is due to the strain localization (i.e., shear bands) they often exhibit, which is not easily amenable to continuum descriptions. Recently, a novel experimental system (split-bottom Couette Cell) was developed with potential to give new insight into these flows due to its wide, smooth shear zones. In particular, Depken et al. have proposed a set of testable constitutive relations between the internal stresses and flow field. In particular, they suggest that the bulk, effective friction coefficient between sliding layers of particles is not constant, but has a subtle dependence on the orientation of the layers with respect to the bulk force. We present large-scale Discrete Element Simulations to analyze the bulk flow in both circular and linear split-bottom geometries. We characterize the transition from radial to full 3D flow in the circular geometry and make connection to experimental measurements. Finally, we check the proposed form of the stress tensor and assess the validity of the claim that the effective friction coefficient depends on the shape of the shear zone with respect to gravity.

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