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Study of Dense Granular Shear Flow in 3D with Discrete Element Method FUPING ZHOU, DENIZ ERTAS, OLEH BARAN, ExxonMobil Research and Engineering — The steady-state behavior of dense granular shear flow in the simple shear geometry is studied numerically with the 3D Discrete Element Method. Spheres of diameter d and density ρ_g are confined in the z- direction between two parallel rough walls, with periodic boundary conditions in both the x- and y- directions. The bottom wall is held stationary and the top wall is moved with constant velocity in the x- direction, while maintaining a constant normal load per area, p. Beyond a thin boundary layer near the walls, the strain rate $\dot{\gamma}$ becomes independent of position and the medium achieves a uniform macrostate with no spatial gradients, allowing exploration of constitutive relations and collision kinetics with good statistics. The perturbative effect of adding interstitial fluid at low Reynolds number and low fluid density is also considered by incorporating lubrication forces into the simulation. The dimensionless shear rate, $I \equiv \dot{\gamma} d \sqrt{\rho_g/p}$, controls the bulk density in the flow, with and without interstitial fluid, whereas the effective traction coefficient, i.e., the ratio of shear force to normal force at the wall, increases with increasing viscosity of the fluid due to increased dissipation. The sensitivities of the results to particle stiffness, fluid density and the surface roughness of the spheres are also studied. The results are insensitive to stiffness as long as the spheres are sufficiently stiff compared to p.

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