Shear Rate Diffusion during Transients in Simple Shear

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ABSTRACT

The transients of a sheared granular medium, before it reaches steady state flow, provide a crucial test for continuum equations of motion. We investigated these transients by Contact Dynamics Simulations for a simple shear geometry with smooth frictional walls. The particles were non-cohesive, frictional hard spheres. The initial configuration was jammed (no shear rate in the bulk). Provided the wall velocity is high enough to induce bulk flow, the shear rate spreads diffusively [1] starting from narrow shear bands at both walls, until it becomes constant throughout the bulk. Not surprisingly, the final bulk shear rate increases monotonously with the wall velocity. However, unexpectedly, the relaxation time increases linearly with the final bulk shear rate, and the local constitutive laws for solid fraction and macroscopic friction coefficient already hold during this transient. These results will be discussed in view of the theory of Kamrin and Koval [2].

REFERENCES

[1] Z. Shojaaee, J. N. Roux, F. Chevoir, D. E. Wolf, *Shear Flow of dense granular materials near smooth walls. I. Shear localization and constitutive laws in the boundary region*, Phys. Rev. E **86**, 011301 (2012).

[2] K. Kamrin and G. Koval, *Nonlocal Constitutive Relation for Steady Granular Flow*, Phys. Rev. Lett. **108**, 178301 (2012).