Universal and wide shear zones in granular bulk flow

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Recommended and a Commentary by Sidney Nagel, University of Chicago

When granular materials flows, it invariably does so by forming shear bands. These are narrow regions in the material in which there is localized shear with the material on either side showing little or no distortion. These bands are accompanied by a local density decrease as layers of moving particles dilate in order to be able to move past neighboring layers. Why does granular matter flow in this way whereas other types of soft- and complex- matter (such as foams, for example) can distribute the shear over nearly the entire system?

It has been an underlying assumption that granular shear bands are always narrow – perhaps 10 to 20 bead diameters in width. This is what has been seen in many different experiments. The results of the present paper show that this assumption is false. Using a modified Couette shear cell, Feinstein, van de Meent and van Hecke have shown that they can apparently produce shear bands that are *arbitrarily* wide. They do this by forming the shear band away from any boundary. Thus, there is no location for layering or density oscillations to become pinned.

Moreover, the authors have found that they can measure the velocity profile within the shear band and find that the profile is well fit by an error function. There is no good understanding of why this form of a profile is chosen by the system. Simulations have shown an exponential decay.

Because the shear band is so broad in this system, one may now think that theories of an effective temperature (based on various fluctuation-dissipation or linear-response relations) could be confronted by making a measurement of different fluctuations within the shear band and by measuring the response of the system, within the shear band, to small perturbations. Such measurements have been hampered in the past because previous shear bands were so thin that it was nearly impossible to make high precision measurements at different points with in single band.