

Granular materials are of substantial importance in many industrial and natural processes, yet their complex behaviors, ranging from pattern formation to the mechanical properties, are still poorly understood. We focus on the shear response of granular systems experimentally. We present the results of an experimental study of pattern formation in horizontally oscillating granular suspensions. Starting from a homogeneous state, the suspension turns into a striped pattern within a specific range of frequencies and amplitudes of oscillation. We observe an initial development of layered structures perpendicular to the vibration direction and a gradual coarsening of the stripes.

Then, we investigate the complex flow properties of slowly sheared granular materials in a split-bottom Couette cell that show novel strain localization features. Nontrivial flow profiles have been observed which are shown to be the consequence of simultaneous formation of shear zones in the bulk and at the boundaries. The result of a fluctuating band model based on a minimization principle can be fitted to the experiments over a large variation of morphology and filling height with one single fit parameter, i.e. the relative friction coefficient between wall and bulk. Finally, we measure the dependence of the response of the granular bed (yield stress and the distribution of avalanches occurring before global yielding) to shear stresses applied by a rheometer, on parameters such as volume fraction, penetration depth of the probe, stress ramp speed and also the geometry of the probe. We find a strong dependence of the yield stress and dynamics of avalanches to volume fraction, penetration depth and geometry of the probe. Also, the experimental results on the distribution of the avalanches are well fitted with a power law function obtained from a theoretical model.