

## Flow Dynamics of Dense Granular Materials Subjected to Vertical Vibration

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Results are presented from a numerical study examining the flow dynamics of dense granular materials in a narrow gap between two concentric cylindrical buckets subjected to sinusoidal oscillation in the vertical direction  $z = A \sin(\omega t)$ , where the parameter  $\Gamma = A\omega^2/g$  exceeds a critical value  $\Gamma_c$ , above which the system becomes fluidized. Using a recently developed expression for the stress tensor of dense granular materials, a set of conservation equations were derived for the particle and fluid phases interacting via an interfacial drag force. Numerical integration of the equations for the granular material in buckets revealed that above  $\Gamma_c$ , granular materials may exhibit liquid-like behavior and convection can occur creating a heap similar to that previously observed experimentally.

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