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Reynolds Pressure and Relaxation in a Homogeneous Sheared Granular System[1] JIE REN, JOSHUA DIJKSMAN, ROBERT BEHRINGER, Duke University — We describe experiments on the constitutive behavior of a system composed of a disordered collection of frictional disks. We use a novel shear apparatus that avoids the formation of inhomogeneities known as shear bands. We probe the evolution of shear jammed states, occurring for packing fractions $\phi_S \leq \phi \leq \phi_J$, where above ϕ_J there are no stress-free static states, and below ϕ_S, all static states are stress-free. Our linearly sheared, fixed ϕ system exhibits coupling between the shear strain, γ, and the pressure, P, which we characterize by the "Reynolds pressure," and a "Reynolds coefficient," $R(\phi) = (\partial^2 P/\partial\gamma^2)/2$. R depends only on ϕ, and diverges as $R \sim (\phi_c - \phi)^\alpha$, where $\phi_c \simeq \phi_J$, and $\alpha \simeq -3.3$. Moreover, by using asymmetric strain cycles, we find that the observed constitutive relations are limit cycles that are approached logarithmically slowly under cyclic shear. We characterize the relaxation in terms of the pressure asymmetry at cycle n: $\Delta P \simeq -\beta \ln(n/n_0)$. β depends only on the shear cycle amplitude, suggesting an activated process where β plays a temperature-like role.

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