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Wedge model of force and flow oscillations in plowed granular media PAUL B. UMBANHOWAR, Northwestern University, NICK GRAVISH, DANIEL I. GOLDMAN, Georgia Institute of Technology — We develop a model that captures the changing response of granular media with volume fraction, ϕ, to a partially submerged vertical plate dragged horizontally at low velocity. In experiment, a bifurcation in force and flow occurs at the onset of grain dilatancy, ϕ_c. Below ϕ_c rapid irregular fluctuations in the drag force, F_D, are observed. Above ϕ_c fluctuations in F_D are periodic and increase with ϕ. Velocity field measurements indicate F_D fluctuations are correlated with the creation and destruction of shear bands during drag. Shear bands originate at the base of the plate and extend to the surface forming a nearly triangular wedge of material moving with the plate. Our model assumes that F_D originates in the force required to overcome sliding friction and push the wedge of material up the slope defined by the inclination of the shear band. Combined with the fact that shear bands are weaker (stronger) than the bulk material for $\phi > \phi_c$ ($\phi < \phi_c$) our model quantitatively predicts the observed dependence of F_D fluctuations and flow on time and ϕ for $\phi > \phi_c$ and gives significant insight into the non-periodic fluctuations observed for $\phi < \phi_c$.

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