Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

A Theory of Stochastic Plasticity in Dense Granular Flow KEN KAMRIN, MARTIN BAZANT, MIT — There have been many attempts to derive continuum models for dense granular flow, but a general theory is still lacking, which can describe different flow conditions, such as gravity-driven silo drainage and forced shear cells. Here, we start with Mohr-Coulomb plasticity for quasi-2d granular materials to calculate stresses and slip planes, but we propose a simple "stochastic flow rule" to replace the principle of co-axiality in classical plasticity. This formulation takes into account two crucial features of granular materials – discreteness and randomness at the scale of a continuum element – via diffusing "spots" which cause chain-like cooperative particle displacements, as in recent simulations of silo drainage. We postulate that spots perform random walks along slip lines, biased by body forces (gravity) and local fluidization (switch from static to dynamic friction). Stochastic plasticity allows a natural description of dense granular flows in silos and shear cells within a single theory, rooted in classical mechanics.

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Date submitted: 07 Dec 2005 Electronic form version 1.4