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Scaling laws for intrusion into granular materials and granular-fluid mixtures

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Session E24: Granular, Porous Media, and Multiphase Flows I
8:00 AM–10:48 AM, Tuesday, March 16, 2021

Sponsoring Unit: DFD
Chair: Nathan Keim, Pennsylvania State University

Abstract: E24.00001 : Scaling laws for intrusion into granular materials and granular-fluid mixtures*

8:00 AM–8:12 AM Live

Abstract

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This talk will summarize our recent work on moderate- and high-speed impacts into (1) dry granular media, (2) dense suspensions and (3) fluid-saturated granular beds. We show experimental, computational, and theoretical results that, for all three material types, reveal important insights regarding the underlying material response. In particular, we focus on the initial stages of impact, and we study how the peak forces and time scales depend on properties of the intruder (e.g., speed, size, mass, and shape) and of the material (e.g., grain size, grain packing fraction, grain stiffness, grain packing fraction, and fluid viscosity). For (1), we find that the peak forces are set by elastic response according to power-law scaling forms which are inconsistent with Poncelet and shock models; for (2), we find that the ubiquitous added-mass model fails to capture several crucial features of the dynamics, likely due to the neglect of large, viscous-like forces; and, for (3), we test and generally confirm Darcy-Reynolds theory, although we observe important discrepancies for high-viscosity fluids.

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