School of Nano Science

Ph.D. DEFENSE

Moving objects in dry and wet granular materials

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Abstract:

Granular materials are collections of solid particles with grain sizes greater than 1 micron that can exhibit solid, liquid, or gas-like behavior depending on energies available for the grains in the medium. Because of the inhomogeneity of force transmission via the force chains created by random contact of the grains, the rheology of these materials is more challenging and less explored than that of ordinary fluids. Here, using a costume-made force measurement setup, we report on experimentally measured drag experienced by a solid cylinder penetrating a granular bed of glass beads, including a highly polydisperse sample with grain sizes in the range of 1-100 μm. We consider both cases of lateral and axial intrusion in which the long axis of the cylinder is held horizontally and vertically, respectively, as it moves through the granular medium. We explore different regimes of behavior for the drag force as a function of the penetration depth. In lateral intrusion, where the motion is effectively quasi-two-dimensional, we establish quantitative comparisons with existing theoretical predictions across the whole range of depths. In axial intrusion, we observe peculiar undulations in the force-depth profiles in a wide range of intrusion speeds and for different cylinder diameters. We argue that these undulations reflect the general shear failure in the highly polydisperse sample and can be understood based on the ultimate bearing capacity theory on a semiquantitative level. Finally, we investigate the penetration of vertical cylinders in a water-saturated pack of monodispersed glass beads. We demonstrate that the frictional drag force model is also relevant in this slurry regime provided that the buoyancy effect is also included and the density of the medium is replaced with a reduced effective value.

Saturday, 20 Esfand 1401 (March 11, 2023), 17:00

Classroom A, Farmanieh Building, IPM