

Morphological clues to wet granular pile stability

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Abstract:

When mixed with a certain amount of water, a pile of dry sand turns into a mouldable material, which allows, for instance, sand castles to be sculpted. The surface tension of the liquid spanning the grains bestows a considerable stiffness to granulate. The geometry of the liquid interfaces in such a random arrangement of grains is of extraordinary complexity and strongly depends on the liquid content. Surprisingly, the mechanical properties of granulates are largely independent of the liquid amount over a wide range. We resolve this puzzle with the help of X-ray micro-tomography and subsequent statistical analysis of the liquid distribution and grain packing geometry. Our results show that the remarkable insensitivity of the mechanical properties to the liquid content is due to the particular organization of the liquid in the pile into open structures. For spherical grains, a simple geometric rule is established, which relates the macroscopic properties to the internal liquid morphologies. We present evidence that this concept is also valid for systems with non-spherical grains. If time allows we will additionally present insights into the energy dissipation processes if such wet granular bead packs are cyclically sheared at constant volume.