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Penetration and Blown Air Effect in Granular Media

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Sand is known to oppose an increasing resistance to penetration with depth. This is different from what happens in liquids since granular media, usually non-thermal systems, oppose solid friction to the motion. We report another striking difference between the penetration dynamics observed in granular media and in liquids. When pushing a top-closed shell (e.g. an upside down glass) into a liquid, the trapped air increases the buoyancy and opposes to penetration. It is more difficult to push vertically into liquids a top capped cylinder than an opened one. In contrast, the penetration is considerably eased in dense sand when cylinders are top capped. In this discrete and bi-phasic medium, the trapped air escapes from the shell, fluidizes the porous medium and eases the motion. The initiation of this dynamical effect and its consequences on shell penetration into sand are discussed through simple models.