Mechanism of air entry during collapse of saturated and unsaturated columns of transparent granular soil

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The granular column collapse experiment, which consists of the rapid removal of lateral support to a column of granular material, is an important benchmark case for the physical and numerical study of transitional mass flows. While other researchers have focussed on the link between the aspect ratio of the column to mobility of the flow, these experiments are also an important platform to evaluate frameworks for triggering of slope failures.

Critical state soil mechanics centers around the theory that initially dense soils will dilate, and initially loose soils will contract upon shearing. If the soil is sheared at a rate which exceeds the rate which fluids can be expelled or drawn into the pore space between particles, the shearing is considered to be occurring at constant volume and termed “undrained”. This state is associated with a rise in pore fluid pressure and a reduction in intergranular normal effective stress. The authors have conducted experiments varying the time scales of the volume change and dissipation processes. In these experiments, a novel transparent soil mixture comprised of quartz and mineral oil was utilized to visualize the saturation regime of soils during the granular column collapse experiment. Particular attention was paid to triggering mechanisms and the transition between the metastable state and avalanche regimes. The transparent material allowed visual confirmation of the volume change during shearing and important insights were gained into the role of the unsaturated soil condition in temporary strength. These observations have implications beyond the column collapse experiment, including the initiation of debris flow experiments as well as analysis of triggering mechanisms of unstable slopes in the field.
