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Partially saturated granular column collapse

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Debris flows are gravity-driven sub-aerial mass movements containing water, sediments, soil and rocks. These elements lead to characteristics common to dry granular media (e.g. levee formation) and viscous gravity currents (viscous fingering and surge instabilities). The importance of pore fluid in these flows is widely recognised, but there is significant debate over the mechanisms of build up and dissipation of pore fluid pressure within debris flows, and the resultant effect this has on dilation and mobility of the grains. Here we specifically consider the effects of the liquid surface in the flow.

We start with a simple experiment constituting a classical axisymmetric granular column collapse, but with fluid filling the column up to a depth comparable to the depth of grains. Thus, as the column collapses, capillary forces may be generated between the grains that prevent dilation. We explore a parameter space to uncover the effects of fluid viscosity, particle size, column size, aspect ratio, grain shape, saturation level, initial packing fraction and significantly, the effects of fine sediments in suspension which can alter the capillary interaction between wetted macroscopic grains. This work presents an initial scaling analysis and attempts to relate the findings to current debris flow modelling approaches.