

Abstract Submitted  
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**Dynamics of pull out in a granular material**<sup>1</sup> YUE ZHANG, ROBERT BEHRINGER, Duke Univ — When an object is pulled out from a granular material, some striking phenomena can be observed. To visualize the pull out process in an experiment, we use grains composed of 2D photoelastic disks, from which circular intruders of different sizes are pulled out. We apply forces that are close to the minimum to initiate intruder motion. Then we find that the velocities of intruders depend exponentially on time, and equivalently the accelerations linearly vary with displacement. To better understand this dynamic system, we compute the drag force caused by the granular disks from the acceleration of the intruder. The result shows that the drag force depends linearly on the thickness of disks above the intruder. However, the drag force is much bigger than the weight of particles above the intruder. Additionally, we visualize the force chains formed inside the photoelastic disks and calculate the space-time evolution and curvature of those force chains. It is shown that curvatures obey the same distribution for circular intruders of different sizes.

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