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Jamming in Hopper Flow[1] SEPEHR SADIGHPOUR, Duke University, PAUL MORT, Proctor & Gamble, R.P. BEHRINGER, Duke University — It known that the flow rate, $\dot{m}$, of sand from a hopper is independent of the amount of material in the hopper due to stress screening. This is the basis for the Beverloo equation which relates $\dot{m}$ to an effective fluidized region near the outlet. We use the screening idea to characterize the probability of jamming for flow from a hopper. We focus on the probability $P_s(t) = 1 - P_j(t)$ that flow has continued without a jam, a 'survival' probability. Screening suggests that in time dt, the jamming probability is $dP_j = dt/T$, where T is a constant characteristic time. Simple analysis gives $P_s(t) = \exp(-t/T)$ where t is the time since the start of flow. We can also write $P_s(M) = \exp[-M/(\dot{m}T)]$, where M is the mass that has flowed out. We have carried out experiments in a quasi-2D hopper to test this idea. Our sand grains are photoelastic disks confined between two Plexiglas sheets. We obtain two types of data, first, data for $s_(t)$ and second, photoelastic images showing the force structures within the hopper during flow. We find that P_s is well described by an exponential. Ongoing work seeks to relate T to the properties of the material near the outlet.

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