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Frictional piece-wise solution of the runout distance during an axisymmetric granular collapse

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Granular matter received an increasing interest over the last decade. Many scientific investigations were successfully addressed to acknowledge the ubiquitous behavior of granular matter, in particular, the dynamics of granular collapses. Many attempts do not fully integrated a physically-based formulation of the runout yet. Instead, they mostly rely on scaling laws inferred from experimental evidences. We here propose i) a novel experimental device, which ensures no significant influences of removing walls on the collapse dynamics producing reliable experimental data such as the final runout distance, which is further predicted by iii) a friction-based formulation we established and, iv) finally compared to distinct particle simulations with a contact force law based on the Hertz-Mindlin theory.
Our results are in good agreements with past experimental results. In particular, we infer from our observations a dynamical invariance but with a variety of different magnitudes. When comparing our experimental runout distances with the friction-based solution we propose in this work, it confirms a good agreement of the analytical solution with these experimental insights. Since our formulation simply relies on the repose angle and the initial aspect ratio, it confirms the strong influence of both frictional dissipation processes (frictional contac) and initial geometry of the granular column. Gathering these experimental evidences and analytical predictions of the runout from this new formulation also validate the numerical results obtained with our two-dimensional discrete particle model.
These results suggest that i) a friction-based formulation is able to correctly predict the final runout distance even though being simplistic, which implies ii) friction as being governing the collapse and, iii) our 2D distinct particle model is a reliable numerical tool to describe granular dynamics such as the collapse given the good aggreements between the numerical runout obtained, experiments and the analytical solution we established. .