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Finite-size analysis and the influence of the cross-section shape of the granular column collapses

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The collapse of granular columns, which sheds light on the kinematics, dynamics, and deposition morphology of mass-driven flows, is crucial for understanding complex flows in both natural and engineering systems, such as debris flows and landslides. However, our research shows that a strong size effect and cross-section shape influence exist in this test. Thus, it is essential to better understand these effects. In this study, we explore the influence of both relative column sizes and cross-section shapes on the run-out behavior of collapsed granular columns and analyze their influence on the deposition morphology with the discrete element method (DEM) with Voronoi-based spheropolyhedron particles. We link the size effect that occurs in granular column collapse problems to the finite-size scaling functions and investigate the characteristic correlation length associated with the granular column collapses. The collapsing behavior of granular columns with different cross-section shapes is also studied, and we find that particles tend to accumulate in the direction normal to the edge of the cross-section instead of the vertex of it. The differences in the run-out behavior in different directions when the cross-section is no longer a circle can also be explained by the finite-size analysis we have performed in this study. We believe that such a study is crucial for us to better understand how granular material flows, how it deposits, and how to consider the size effect in the rheology of granular flows.