Arching and clogging in three-dimensional silo

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ABSTRACT

Discharge of silos and the flow of granular material through orifices are important questions of everyday life and technological processes. Arching in dry granular material is a long established concept, however it remains still an open question how three-dimensional orifices clog.

The primary question we would like to answer is whether the dome is a complete three-dimensional structure or it is rather an assembly of two-dimensional arches?

We investigate by means of Discrete Element Method simulations and experimental data how the outflow creates a stress field leading to arch formation and clogging. On the one hand we present geometric and density-based methods to determine the concave surface of the dome, on the other hand we show the analysis of the force network between particles. Using these methods we conclude that the clogged state of a three-dimensional hopper is basically composed of a complex structure of two-dimensional arches built on top of each other stabilized from the side by small forces.

We present the results for spherical and for elongated particles too. For the latter the dome like structures display large variations, involve vertical walls consisting of horizontally placed stable stackings of particles.

REFERENCES

[1] Ashour, A., et al. "Outflow and clogging of shape-anisotropic grains in hoppers with small apertures." *Soft Matter* 13.2 (2017): 402-414.