Discrete element modelling of granular column collapse tests with industrial applications

Joel Torres-Serra*, Deepak R. Tunuguntla†, Irana F.C. Denissen†, Antonio Rodríguez-Ferran‡ and Enrique Romero‡

* Técnicas Mecánicas Ilerdenses, S.L.
Polígono industrial Camí dels Frares, c. Alcarràs, parc. 66, 25190 Lleida, Spain
e-mail: j.torres@tmipal.com

† Multi Scale Mechanics, Engineering Technology/MESA+
University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

‡ Universitat Politècnica de Catalunya, Campus Nord, c. Jordi Girona, 1-3, 08034 Barcelona, Spain

ABSTRACT

Describing the behaviour of granular materials is a challenging issue for the industry. Our work concerns packaging industries where packing equipment is designed to handle a wide range of powders and bulk solids with varying physical and mechanical properties. While packaging, a variety of material conveying techniques are used ranging from air fluidisation to discharge of material through a hopper. Thereby even a small improvement in their efficiency can lead to significant benefits, both financial and environmental.

Flowability of powders and bulk solids is often experimentally investigated using granular column collapse, as this test provides deep insights into the kinematics of granular flow both at particle and bulk levels [1]. Here, we consider a quasi-two-dimensional set-up with a reservoir containing the granular pile which is instantaneously released onto a channel where run-out takes place.

Instead of experiments, we use discrete particle simulations allowing us to quantitatively link bulk-level observations to particle-level properties of the materials, besides enabling inverse analysis leading to indirect measures of micro-scale parameters. We present a simulation strategy aimed at controlling several particle parameters influencing the run-out:

- Polydispersity in size, using different particle size distributions; and also in shape, comparing the use of spherical and non-spherical particles, namely cylinders and ellipsoids.
- Mechanical properties of the contacts, comprising normal stiffness and dissipation, as well as sliding, rolling and torsion coefficients. Specifically, hygroscopic behaviour of bulk materials is inspected modifying the contact law parameters.

Additionally at the bulk level, air fluidisation of the columns before release is studied through the initial packing state by changing the volume fraction of the piles. Numerical simulations are implemented with the open-source code MercuryDPM [2].

REFERENCES

[1] G. Lube, H.E. Huppert, R.S.J. Sparks and A. Freundt, “Collapses of two-dimensional granular columns”, Physical Review E, 72, 041301 (2005).

[2] T. Weinhart, D.R. Tunuguntla, M.P. van Schrojenstein-Lantman, A.J. van der Horn, I.F.C. Denissen, C.R. Windows-Yule, A.C. de Jong and A.R. Thornton, “MercuryDPM: A Fast and Flexible Particle Solver Part A: Technical Advances”, Proceedings of the 7th International Conference on Discrete Element Methods, 1353-1360 (2017).