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HAL Id: hal-02936639
https://hal.inrae.fr/hal-02936639v1

Submitted on 3 Sep 2020 (v1), last revised 11 Sep 2020 (v2)

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Keywords: static granular column; slip threshold; DEM; Coarse graining

Abstract.

The mechanical equilibrium of an ensiled grain column depends on mechanical and geometrical parameters related to the grains on the one hand and to the configuration of the silo on the other hand, but also to the implementation conditions (flow rate, height of fall…). The observed equilibrium at the silo scale is the result of the local equilibria achieved at the particle scale, a scale at which we observe a strong dependence on the history of the intergranular contact establishment. The microstructural analysis of such a system allows to better understand and control the storage of materials (powders, cements, waste) in long-term conditions (silo, bag) or in shorter-term conditions (conveying, maritime and road transport).

In order to understand the slope of the stress profiles, experiments and Discrete Element Method (DEM) simulations are compared to investigate the structure of an ensiled granular medium poured in a cell by a single point source and different flow rates (parameters which allow to control the kinetic energy of the grains). A population of glass beads of 1 to 2 mm (50/50 in volume) diameter with a small span value is poured in an open glass cell container made of transparent glass walls. A flat steel probe, linked to a load cell of a texture analyser which is used as a force sensor, is used to simulate the bottom of the cell and to measure the applied vertical stress. The filling is provided by a funnel and the flow rate is modulated by the output diameter. A code in c[++], using both DEM and coarse graining method (Weinhart and Luding, 2016), is developed to calculate the force network, stress and compactness fields of a similar ensiled granular medium under gravity. With this code, all the contacts between the particles are obtained by calculating *(i)* the normal and tangential forces, (ii) the moment, and (iii) the mobility of each particle.

Experiments show that the vertical stress profile depends on the pouring rate which confirms the importance of contact history. After each filling conditions, the slipping threshold is not ~~realized~~ obtained for all grains located on the walls of the cell. In order to activate the contacts between walls and grains, a small translation of the bottom wall is achieved ~~required~~. After ~~this descent~~ this motion, a proportion of contacts at slip threshold is established from the bottom until a length which defines the perturbed zone located around the wall translated. The apparent weight of the granular column decreases of the contribution of the weight of this zone. Activation of the contacts seem to amplifiate such a phenomenon. Thus the behavior inside large silo can be reproduced at a tinnier scale defined by the scope of the slip threshold. DEM simulations show that in all tested cases, the compactness is relatively uniform, this contact activation is only lightening~~ed~~ the vertical force network and allows ~~let~~ preferential contact network percolating from a wall to the other opposite one. This observation

is highlighted on the stress fields. The deflection of the vertical stress until the wall is observed without slip threshold, but the more this condition is realized, the more the deflection occurs. The slip threshold wall/grain represents a necessary condition to increase the vertical stress deflection but it is not sufficient.

This study makes it possible to discriminate the different parameters that contribute to regulate the equilibrium of an ensiled granular medium (internal and wall friction coefficients, cell width, pouring modality ...) opening the possibility of a scale-up between configurations of various dimensions.

References

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