Assessing Flowability of Cohesive Powders from a Small Sample Quantity

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1. Introduction

- Industrial processes involving powder blending, transfer, storage, feeding, compaction and fluidisation all require reliable powder flow.
- There are a number of cases which involve dealing with small amounts of loosely compacted powders e.g. dosing of small quantities of powders in capsules and dispersion for dry powder inhalers and dry particle sizing.
- Most of the common flowability test methods require a relatively large amount of powder and measure the flow behaviour at relatively high compaction stresses.
- Hassanpour and Ghadiri [1] introduced a testing method by ball indentation which can be performed on small amounts of loosely compacted powders.


2. Background & Objectives

- In the ball indentation method, the hardness of the powder bed is measured.
- Flowability is defined by the ratio of pre-consolidation stress to yield stress of a powder bed.
- Hardness is related to yield stress through a material dependent constant, constraint factor.
- For solid materials the constraint factor is well defined based on material properties, however, for particulate systems the definition would be different due to the distinct behaviour of particles.
- In the present work we investigate effects of single particle properties of powders on the constraint factor.
- The constraint factor is evaluated by analysing the internal stress field around the indentation zone. Furthermore constraint factor can be determined by comparing the results of other test methods such as shear tests and uniaxial compression.

3. Project Plan

4. Experiments

- Glass Beads with different sizes (45-63, 75-90 and 90-125 µm), were silanised with commercially available mono-layer coating called Sigmacote which has a functional group of heptane.

5. Simulations

6. Conclusions

- A new flowability measurement method based on ball indentation has been proposed, by which relatively small amounts of loosely compacted powders can be tested.
- Experiments reveal that the hardness and unconfined yield stress are related by a material dependent constant known as constraint factor.
- DEM simulation of the indentation process provides an insight of internal structure and stresses around the indentation zone. The constraint factor can be determined based on single particle and bulk properties by performing sensitivity analyses.
- Simulations reveal that the hardness is constant for a range of penetration depth.

7. Future Work

- Calibration of simulations with experimental data.
- Evaluation of constraint factor by stress analysis around the indentation zone.
- Sensitivity analysis to investigate effects of single particle properties on the constraint factor:
  - Size
  - Shape
  - Friction
  - Adhesion
  - Stiffness
- Analyse the effect of shape using overlapping spheres in the DEM.
- Stiffness of each face matched to real particles.
- Dark blue spheres indicate stiffer particles.

[Image of table and diagram]