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Powder property influence on the local force profile in a granular column



Agnès DURI, Sandra MANDATO, Bernard CUQ, Thierry RUIZ



ISSUES

In a mixer equipment, the external mechanical stress induces the mobility of the particles that allows their mixing, segregation or association.

The mobility of the particles are greatly affected by the **initial mechanical static state** of the powder bed.

- How to evaluate the mechanical static state of the powder bed before mixing?
- How the physical properties of the particles influence this mechanical static state?



OBJECTIVES

Short-term: characterization of the mechanical static state in ensiled granular media of different physical properties (particle size, restitution coefficient, coefficient of friction, cohesion, angle of repose, compactness, history of the bed formation...).

Long-term: better understanding the contribution of the initial mechanical static state of the powder bed on the mobility of the particles.

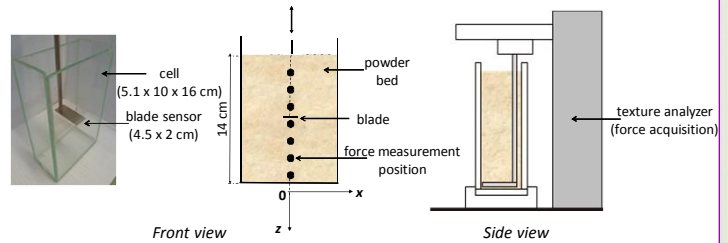
MATERIALS

Powders - 5 wheat-based powders of identical origin but with a different structure.

Sample Name	SEM Image	d ₅₀ (mm)	d ₉₀ -d ₁₀ (mm)	Bed compactness	Angle of repose (°)
Fine semolina		0.210	0.321	0.416	32.2
Semolina		0.298	0.434	0.446	31.4
Fine couscous		0.676	0.645	0.578	12.1
Medium couscous		0.953	0.517	0.573	9.8
Large couscous		1.095	0.406	0.578	7.6

METHOD

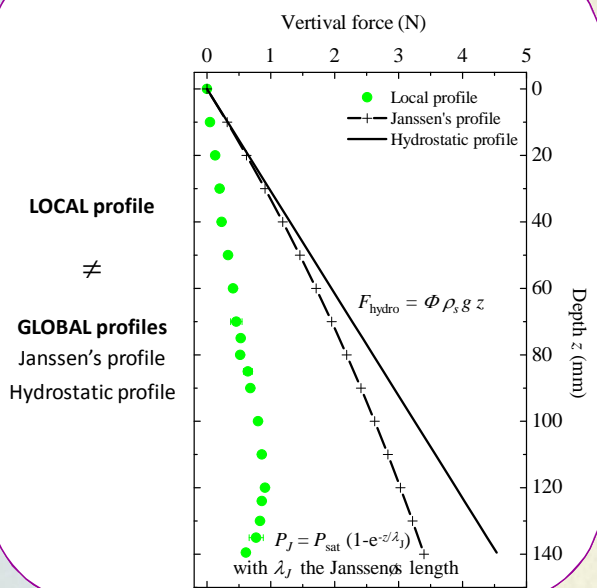
Approach – Transposition from an industrial mixing device (with a 3D blade motion) to a unidirectional mixing device.



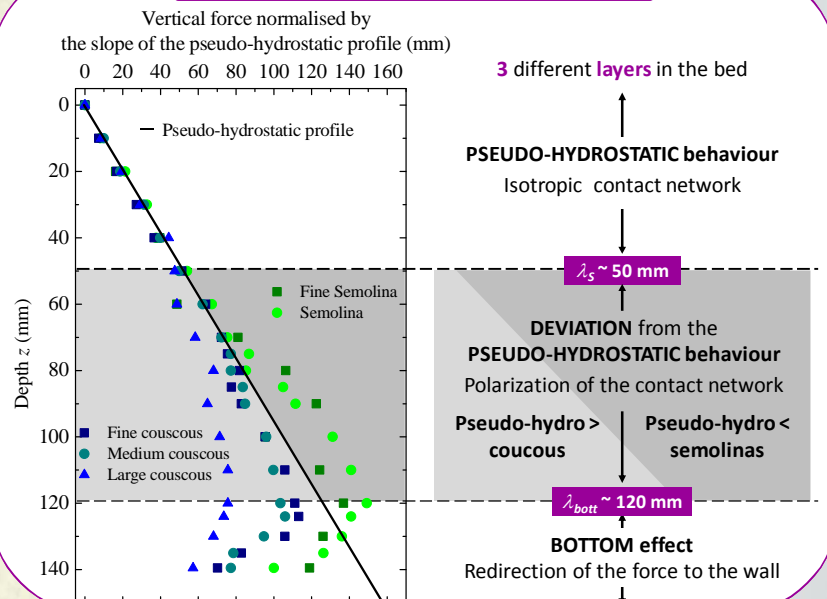
The mechanical static state is achieved by measuring the local vertical force (in triplicate) perceived by the blade (immobile) in different z positions in the powder bed.

RESULTS

Local – Global profiles



Local profiles – Physical properties of the particles



CONCLUSIONS

The study of the mechanical static state indicates:

- An **inhomogeneous lateral repartition** of the mechanical static state of the powder bed.
- A **superficial layer** of about **50 mm** with **low shear level** and **independent** from the physical properties of the particles.
- A **median layer** of about **70 mm** with **higher friction level** for semolina than for couscous.
- A **bottom layer** of about **20 mm** for which the **bottom wall effect** is **independent** from the physical properties of the particles.

PERSPECTIVES

- **PIV analysis** will be performed to **characterize** the **particle motion** under the action of the blade motion in the three zones of the bed.
- **Define sizing criteria** of powder mixers from the **characteristic lengths**.