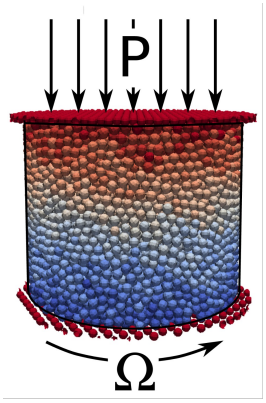
Shear localization in confined 3D granular flow

Riccardo Artoni* and Patrick Richard

LUNAM Université, IFSTTAR Site de Nantes, MAST/GPEM,
Route de Bouaye CS4, 44344 Bouguenais, France.
e-mail : riccardo.artoni@ifsttar.fr

ABSTRACT

We discuss discrete numerical simulations of a confined three dimensional dense granular flow in a torsional shear cell, i.e. a smooth cylinder filled with a granular material, where the bottom plate is rotating (see Figure).



Analysis of the kinematics allows to see that, for the range of variation of the parameters considered, velocity profiles are auto-similar, i.e. they are almost linear with the radial coordinate. Despite this simple dependence on r, analyzing the development of the velocity along the vertical direction, we find that shear can be localized (1) at the bottom or (2) at the top of the shear cell, or that (3) it can be even quite distributed.

Moreover, the depth of the shear zone is not at all constant but depends on system parameters such as wall friction, externally applied pressure, velocity of the rotating boundary.

This surprising behavior is closely related to the presence of the cylindrical wall providing confinement and friction.

We show that while some features can be simply explained by least effort considerations, other features need more complex modeling attempts. In particular, the need for non trivial boundary conditions for wall slip [1,2] and for nonlocal constitutive laws [3] is discussed.

REFERENCES

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