Packings and dense flows for a controlled-cohesion granular material

Maxime Nicolas*[1], Sandip Mandal[2], Adrien Gans*[2], Blanche Dalloz[2], and Olivier Pouliquen[2]

[1]Laboratoire IUSTI UMR CNRS 7343 – Aix-Marseille Université - AMU – Technopôle de Château-Gombet, 5 rue Enrico Fermi, 13453 Marseille cedex 13, France

[2]Laboratoire IUSTI UMR CNRS 7343 – Aix-Marseille Université - AMU – France

Abstract

Cohesive granular media are encountered in many industrial processes, examples being cement, pharmaceutical powders, flours, cosmetic powders,.... Whereas progress has been made in our understanding of dry granular media, the flow behavior of powders is less understood despite many existing tests in the industrial community. One difficulty in investigating the fundamental behaviour of powders lies in the precise control of the cohesion force between the particles. Several studies have being carried out using partially wet granular materials as a model system, the cohesion being insured by the capillary bridges between particles. However, a redistribution of the water content occurs during the flow, adding some complexity in the analysis of humid granular flows. In this study, we present a novel method to create a Cohesion Controlled Granular Material (CCGM), based on the coating of particles with polymers (PDMS). We show that the macroscopic cohesion can be precisely controlled in a reproducible manner by the amount of polymers added to the particles. We experimentally investigate how the inter particle force varies with the polymer coating for different particle sizes, and we correlate the coating to the macroscopic cohesion deduced from inclined plane experiments.

In parallel to the experiments, numerical simulations using DEM are conducted. The packing properties under gravity and the granular flows down an inclined plane are studied . The rheology of the cohesive material in terms of a friction coefficient and the volume fraction as a function of the inertial number and of the cohesion number (the ratio of the typical cohesion stress to the confining stress) are deduced from the measured velocity profiles.

Different cohesion models are used (a simple VdW force proportional to the contact area, an elastoplastic model, a new "glue model" with hysteresis between loading and unloading) and the difference between them are discussed.

Keywords: powders rheology, cohesion, packings, dense flows

*Speaker