Contribution ID: **89** Type: **Présentation**

Influence of the grain size polydispersity on the collapse of immersed granular columns

Tuesday, July 4, 2023 9:00 AM (50 minutes)

The granular column collapse is a benchmark experiment for studying granular flows. Granular flows are found in varying scales from handling purposes to natural debris flows and can occur in subaerial or submerged environments. Out of convenience, granular flows are commonly studied with a monodisperse distribution of grains; however, the variety of grain sizes, known as polydispersity, is an important feature often found in these flows. Understanding the role of polydispersity remains a challenging task to be addressed experimentally and that requires a series of simplifications when studied numerically. Therefore, our research focuses on exploring the influence that polydispersity has on the collapse of dry and immersed granular columns with two methodologies. We study the collapse of granular columns in dry and immersed conditions with a coupled Finite Element Method (FEM) and Discrete Element Method (DEM) capable of managing high polydispersity levels. Additionally, we do an experimental campaign to study the three-dimensional nature of the process. We define the polydispersity level as the ratio between the biggest and the smallest grain and study systems with a polydispersity level ranging from 1.2 to 20. We show that polydispersity has stronger effects on immersed collapses than in dry collapses. Notably, the collapse sequence and final runout of immersed columns are affected by increasing the level of polydispersity. We reveal that the differences between monodisperse and polydisperse columns arise from differences in the evolution of the pore pressure changes. Moreover, we propose a simplified model that scales the column runout with the spreading front kinetic energy that works for all polydispersity levels, and for dry and immersed collapses. This model scales results from numerical simulations and from the experiments and it may prove useful in comprehending mass movements in areas where the only available data is the mobility and an interpretation of the initial geometry.

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Session Classification: Mardi matin

Track Classification: Présentation orale