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Triggering mechanism of the wet granular avalanches

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Because of the complexity of the physics that governs granular media, understanding the triggering mechanism of granular avalanches remains a scientific challenge. Such phenomena are controlled by many factors, including the grain size and nature, the geometry of the granular structure, but also the environment conditions such as temperature and moisture which influence is difficult to assess. To this end, we reproduce avalanches at the laboratory scale under well-controlled conditions and focus our study on the moisture parameter.

Recent studies show that the dynamics of a slowly inclined granular bed present three regimes of destabilization[1]: (1) a regime of small independent and localized rearrangements followed by (2) a regime of collective and successive motions of grains, called 'precursors', which appear at quasi-periodic-tilting angles and then (3) the avalanche which occurs at the maximum stability angle. This avalanche angle strongly depends on the relative humidity[2]. The experiments consisted in recording images of the surface of the granular bed, in lateral and top simultaneous views, while slowly and regularly tilting it from the horizontal to the avalanche angle. Image processing was then performed to describe the dynamics of the medium for different experimental conditions.

We did experiments at different relative humidities, between 40% and 95%, on different monodisperse spherical grains: glass beads with diameters 0.875, 0.525 and 0.204 mm, respectively, and polystyrene beads with diameter 0.14 mm. The velocity of the packing inclination was set to 0.17°/s .The two cameras acquired one image per second, to determine the angle of the surface during the inclination and to detect the precursors, respectively. We incline the bed of grains from the horizontal to initiate the first avalanche, and then we continue the inclination to get successive avalanches. The angle of the surface at the avalanche is controlled by the relative humidity, with a trend in agreement with Gomez et al.[2]. We also observed a dependency of the precursor dynamics with the relative humidity which strongly modifies the mechanical properties of the granular pile by making it more cohesive. Other parameters, such as grain size and nature, height of the granular bed and tilt speed, are also investigated.

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[2] I. Gómez-Arriaran, I. Ippolito, R. Chertcoff, M. Odriozola-Maritorena and R. De Schant, Characterization of wet granular avalanches in controlled relative humidity conditions, Powder Technology 279, 24–32 (2015).