Temporal force fluctuations experienced by walls subject to granular flows

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ABSTRACT

Dense granular flows down an incline and impacting a wall-like obstacle have been studied in detail in the past recent years (see [1] and references therein). Steady and transient flow conditions were investigated with the help of discrete simulations and laboratory tests coupled with some analytical solutions. In particular, the crucial role of the co-existence between a quasi-static dead zone (roughly triangular), made of grains trapped upstream of the wall, and a more inertial zone made of grains flowing above the dead zone was evidenced.

Until now, the research effort has been mainly focused on the time-averaged force experienced by the wall with only little attention paid to the instantaneous time signals that systematically shows large fluctuations. The time evolution of the force chains network formed inside the dead zone trapped between the obstacle, the flow bottom and the flowing grains above might be at the origin of those large fluctuations.

We have designed discrete numerical simulations of a periodic granular system mimicking the interaction between the free-surface flow and the wall in order to better understand the temporal force fluctuations on the wall. A small-scale gravity-free sample of grains is trapped between one bottom wall and one rough upper wall shearing the sample at constant speed under a given confinement pressure. A sidewall is placed normal to the shear velocity and partially blocks the grains entrained by the upper wall. A dead zone is formed upstream of the sidewall and once a steady state is reached, the mean force is systematically studied by varying the following parameters: the velocity of the upper wall, the confinement pressure exerted by the upper wall, the length of the sample and the height of the sidewall. The particular situation corresponding to a lid-driven cavity when the sidewall spans the whole sample height has been also investigated.

Different regimes were evidenced depending on the length of the sample relative to its height, the macroscopic inertial number and the sidewall height relative to the sample thickness. In light of previous works in granular materials in other granular systems (see [2] and references therein), we have analysed the temporal force fluctuations. Firstly, we discuss how the force distributions and power spectra are influenced by the macroscopic inertial number which drives the granular flow regime. Secondly, we focus on the range of inertial number the fluctuations can be correlated to the intermittent state of the strong network of force chains formed inside the dead zone.

REFERENCES

[1] T. Faug, P. Caccamo, and B. Chanut, "Equation for the force experienced by a wall overflowed by a granular avalanche: Experimental verification" *Phys. Rev E,* **84**, 051301 (2011).

[2] J. Geng, and R.P. Behringer, "Slow drag in two-dimensional granular media" *Phys. Rev. E*, **71**, 011302 (2005).