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Mean force on a wall overflowed by dense granular avalanches: discrete numerical simulations and laboratory experiments

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Considering the destructive power of dense snow avalanches, the design of avalanche defence dams implies a good understanding of the force those flows are able to exert on the structure.
We simulated 2D dry granular flows down a rough inclined plane and overflowing a wall, for a large range of slope inclinations. We performed molecular dynamic simulations using a linear damped spring law between particles with a Coulomb failure criterion. Two kinds of flow regimes were investigated: (i) unsteady and non uniform flows (U.N.U.F) and (ii) steady and uniform flows (S.U.F).
For both regimes, we first characterised flows without any obstacle by measuring the flow depth, the mean velocity and the volume fraction. Similar scalings between U.N.U.F and S.U.F have been observed.
We then introduced a wall normal to the bottom and we measured the mean normal force exerted by the incoming flow. For each slope inclination, the geometrical dimension of the obstacle was kept close to the characteristic dimension of the flow depth. By comparing the mean force with two typical forces linked to the control flow without any obstacle (a hydrostatic force and a dynamic force), a transition appears for both kinds of flows (U.N.U.F and S.U.F) around a specific slope inclination, corresponding to a specific value of the Froude number. This is a transition between the dense regime and the collisional regime. A stagnant zone formed upstream of the obstacle, which strongly depends on the slope inclination, plays an important part in the mean force exerted on the obstacle particularly in the dense regime. Therefore, the length and shape of this stagnant zone, as well as its friction with the bottom, were studied for each slope to quantify the other contributions in the total force. Some small-scale laboratory experiments of dense granular flows down a rough inclined plane impacting an obstacle are currently in process. Preliminary results and comparison with numerical simulations will be also described.