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Small-scale laboratory tests on granular avalanches around an obstacle

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In the framework of the European project DYNAVAL (Interreg Alcotra), experiments have been scheduled in order to improve the existing knowledge about the dynamics of dense snow avalanche flows around an obstacle and the induced forces exerted on it. In particular, small-scale laboratory tests on granular flows are performed at Cemagref. The granular properties and behaviour of flowing snow have been evidenced and studied in recent literature and, until now, the analogy with dry granular materials has been largely used when investigating the influence of obstacles on dense avalanche flows. The experimental device consists of an inclined plane equipped with a reservoir to store the granular material simulating the dense flow and feeding a channel of variable width whose slope can be modified among a large range of values. Flow height, surface velocity and impact forces are measured.

Two main tests, with and without obstacle, are realized. The flow dynamics (velocity, height and eventually density as well) is first characterized by performing reference tests for which the granular material flows down the channel in the absence of obstacle. The temporal evolution of the flow height is detected using a laser technique correlating the deviation of the laser line proportionally to the flow height. The granular PIV method (Particle Image Velocimetry) allows surface velocity measurements. As a second step, an obstacle is set up at the end of the channel and measurements are pursued focusing on the hydrodynamic effects of the obstacle and the forces exerted on the obstacle. Impact forces are measured at high frequency thanks to two force sensors connected to the obstacle.

The current obstacle has been designed to represent the simplest case: a flat structure of height typically close to the incident flow depth, normal to the flow direction and to the bottom, spanning the whole channel width. This geometry is similar to 2D discrete numerical simulations previously reported in steady and transient avalanche regime, and typically encountered when snow avalanches overflow dams. Results, showing two main flow regimes affecting the resulting force on the obstacle, will be presented. The results are consistent with the previous numerical simulations and a simple hydrodynamic model. These experiments will be then used to design more complex tests based on obstacles with a geometry similar to real retarding mounds built at the Taconnaz avalanche path, France.