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Physical modelling of debris flows in a small scale

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The objective of this study is to analyse the horizontal impact forces of debris flows, which are very important for mitigation measurements and buildings in their sphere of influence. Currently it is not possible to develop debris-flow impact estimations models (entirely based on theoretical considerations) with sufficient accuracy and computable in periods common for design offices. Therefore debris-flow experiments in a small scale are performed.
The first step was to design and construct a debris-flow flume. The flume model is about 7 meters long and has a flow cross section of 0.5 m. The maximum slope of the flume remains 30 % due to space limitations within the laboratory. The release mechanism was made to simulate a dam-break triggering situation. The used material is equal to a typical debris-flow grain size composition of coarse and fine materials.
As a second step the flume was adapted to assure a flowing mass, scaled in a Froude range between 1 and 2. Since the slope of the flume remained constant, the basal roughness was the only free boundary to be adapted in order to observe the desired Froude range. First experiments showed that the flow behaviour was also influenced by the water content and the distribution of the material within the starting box. Additionally to the measurements of the velocities and the flow heights, using ultrasonic sensors combined with laser measurement instruments, a visual analysis of the different flow behaviours was conducted by video cameras. All the measured data are interpreted with MatLab©.
First experiments showed a similar Froude number of each trial. With this Froude number, the maximum grain size diameter, the measured flow velocity and flow height it was possible to obtain the scale for geometric similarity and kinematic similarity of the model.
First results of the coarse material mixture with a total volume of 0.3 m3 showed a flow height of about 0.1 m with a Froude number of 1. Based on a 1:20 scale, the observed flow height and flow velocity in the flume model correspond to a natural debris-flow with a velocity of 4 m/s and a flow height of 2.0 m.
In a next step, a mixture of fine and coarse material will be released to simulate viscous debris-flow behaviour. Further, installations of measuring devices will be realised to quantify impact forces of different material mixtures. Furthermore it is planned to numerically simulate the debris-flow event with discrete element methods.