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Superelevation measurements of debris flows in a curved flume construction.

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A possible approach to estimate maximum flow velocities is based on the vortex equation by using superelevation marks. Superelevation can be observed in bending channels, where the flow-height of the inner-curvature is lower than the flow-height of the outer-curvature, caused by the centrifugal acceleration of the flow. The objective of this work is to analyze the influence of channel geometry (bend radius and slope) and material properties on the vortex equation when applying to debris flows. In particular, the project aims to compare observed flow velocities from physical modeling in flume experiments with observations from debris-flow field sites.

In a first step experimental investigations are done at the laboratory of the Swiss Federal Institute WSL, Birmensdorf. The flume consists of a flexible plastic half-pipe and is mounted on a wooden plane construction. Two different bend radii (1.0 m and 3.0 m) with a bend angle of 60° are implemented. The total length of the flume, of about 8 m, is further covered with 40 grit silicon carbide sandpaper reflecting a constant basal friction layer. To apply for the complexity of a debris-flow process, four different material mixtures based on four different grain size distributions, were defined. Superelevation is measured by laser devices mounted at two cross sections differing in their bend radii. The maximum flow velocity is measured by high-speed cameras. Additionally, a balance is placed to measure weight over time at the outflow.

80 experiments have been conducted, based on the maximum channel slope of 36 %. Another 38 experiments were performed with a channel slope of 27 %. In total, we accomplished 61 experiments for the 3.0 m bend radius and 57 experiments for the 1.0 m bend radius. Front velocities of the debris-flow experiments range between 0.4 m/s and 2.4 m/s. First analyses show plausible results when comparing observed and back calculated flow velocities.

Beside the experiments, a second step of this project will also be on field investigations, respectively in finding monitoring data of observed superelevation scenarios of debris-flow events.