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Testing, modeling and dimensioning of flexible debris flow barriers

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In mountainous regions, debris flows endanger villages and infrastructure and cause considerable damage. Flexible wire-net barriers, derived from rockfall and snowslide protection systems, provide a new alternative for hazard mitigation. However, compared to the well-known loading used for the design of rockfall barriers, there is a lack of knowledge concerning the stopping process of debris flows. The design load problem arises from uncertainty in the description of such two-phase flows (e.g. coarse sediment and a viscous fluid) and the interaction of such flows with flexible, deformable, and porous structures. In this paper, we will present the first results of our full field-scale measurements to evaluate the performance of such debris flow barriers. The Illgraben in Canton Valais, central Swiss Alps, was chosen as a test site for investigating debris flow-flexible barrier interaction because the torrent experiences several natural debris flows per year and the torrent is already extensively monitored. Instrumentation includes laser, ultrasonic, and radar devices for measuring flow height; geophones for measuring front travel time between instrumented cross sections, video cameras for a visual record of the flows, load cells with geophone triggering and a specially constructed force plate to measure basal normal and shear forces. Additional instrumentation was installed to measure forces related to the impact and deformation of a flexible wire net barrier. The torrent channel at the new barrier location is U-shaped valley. The barrier consists of a steel wire ring net (ring diameter ˜ 0.3 m) attached to horizontal steel wire support ropes anchored in both banks. Load cells are installed between anchors and ropes to measure the tension forces caused by the debris flow filling the barrier. Additional energy absorbing elements are integrated into the ropes

to allow large displacements and more flexibility to the entire barrier reducing the peak forces sustained during a debris flow impact. The first debris flow (vol. 19’000 m3) filled and eventually overtopped the barrier. Here we present results on forces measured during the overtopping phase. The field results, combined with complimentary laboratory investigations, are also being used to test a new finite-element simulation code which could be used for optimization of the design of such barriers.