Physical experiments on sediment transport in two merging mountain torrents in Meiringen

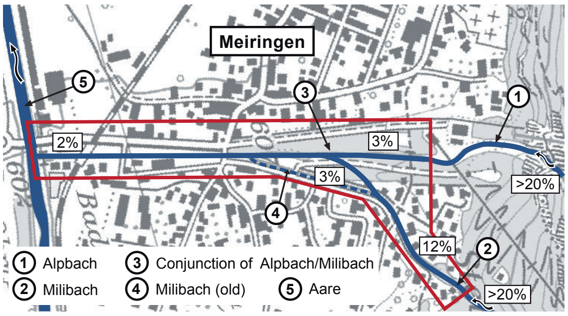

Fig. 1: Model perimeter of the physical scale model Meiringen. The numbers in percentage correspond to the slope.

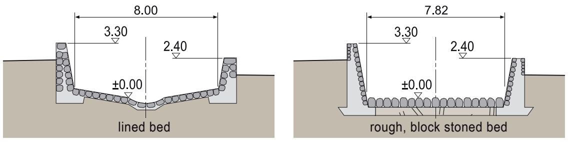

Fig. 2: Alpbach cross sections of the lined bed and the rough, block stoned bed.

In 2005, the village of Meiringen in the Canton of Bern was heavily affected by the floods of the two converging mountain torrents Alpbach and Milibach (Fig. 1). The reason for the overflow was the high sediment input coming from the mountainous catchment area (in total about 35'000 m3) in combination with the low channel transport capacity. Sediments and boulders of diameters larger than 1 m deposited in the channels and blocked the flow section causing water and sediments to overtop the banks.

The flood mitigation project planned thereafter includes the installation of sediment traps in the upper part of the catchment area and the enhancement of the channels' sediment transport capacity in Meiringen. To obtain this, the channels are to be expanded and the bed slope of the Milibach is to be increased by moving its confluence upstream (Fig. 1). The existing lined channel bed of Alpbach is to be changed into a rough block stoned bed in order to increase the ecological value of the channel (Fig. 2).

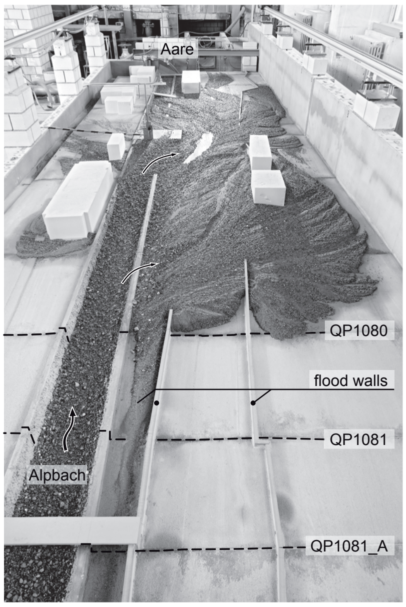

Fig. 3: Deposition beyond the Alpbach channel at the end of the extreme flood event EHQ

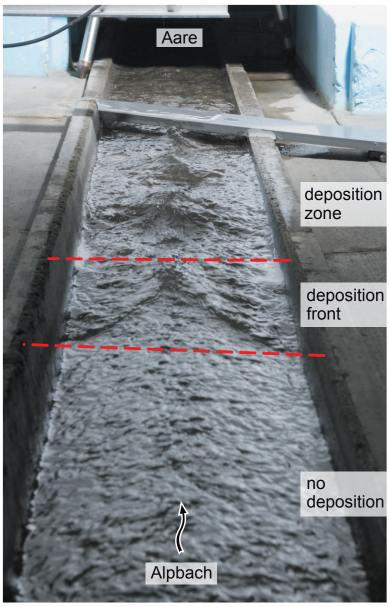

Fig. 4: Hydraulic jump in the lined Alpbach channel at the interface between zones of deposition and no deposition. Standing waves propagate downstream of the hydraulic jump.

Focus of the study was the evaluation of the rough and lined Alpbach channel in terms of flood protection and sediment transport as well as the conjunction of Alpbach and Milibach, the sediment retention basin dam and the effects of the backwater of the river Aare at the Alpbach confluence.

The physical model was built with Froude similitude and a scale of 1:35, leading to a model which is about 10 m wide and 21 m long. Sediment was added by a PC-controlled loading machine which permits to run hydrographs. The outlet basin was situated where the Alpbach meets the river Aare. Its water level could be kept constant by a regulated pump while simulating a flood hydrograph. This allowed the investigation of the effect of backwater into the Alpbach.

The experiments showed that the bed configuration has no strong influence on flood protection. However, as the water level is higher in the rough channel, deposition processes are accelerated in comparison to the lined channel exhibiting higher energy levels. During the design flood HQ100 the depositions are small and do not lead to an overtopping. During the extreme flood EHQ, the depositions block the flow sections and an overflow of water and sediment is the consequence (Fig. 3).

By a design optimization of the sediment retention basin dam, the overtopped sediment volume was reduced by around 15%.

As flow is supercritical during flood events, the Aare backwater provokes a hydraulic jump. This induces a local bed load deposition which grows forward and backward. The high energy level in the lined channel generates stationary waves and antidunes on the depositions (Fig. 4).

Keywords:	Mountain torrents, sediment transport, bed load, supercritical flow, flood risk, flood protection, laboratory experiment, physical hydraulic model test
Commissioned by:	Schwellenkorporation Meiringen

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