HAZARD PREVENTION USING FLEXIBLE MULTI-LEVEL DEBRIS FLOW BARRIERS

PROTECTION AGAINST DEBRIS FLOWS INSTALLING 13 FLEXIBLE BARRIERS IN THE MILIBACH RIVER (CANTON BERNE, SWITZERLAND)

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INTRODUCTION

The villages Hasliberg Reuti and Meiringen were affected by flood and debris flow events resulting from unusually large rainfall in August 2005. Subsequently, a protection concept had been developed, including multiple flexible debris flow barriers. Extensive research was necessary to assure the efficiency of these new technical protective measures. Close co-operation between the scientific team of the WSL, the industrial partner and the cantonal authority during the investigations led to a consistent and technically plausible solution. The multiple barrier system will be realised in 2007.

LABORATORY TESTS

Studying the loading aspects of flexible debris flow barriers and corresponding laboratory tests were performed. We studied the stopping and overtopping process of artificial debris flows with original debris material flowing against barrier systems with different stiffness and mesh size. Tests with debris material from the Milibach River (Hasliberg, Switzerland) were used to quantify the influence of different mesh sizes and the opening between the lowest support rope and the river bed compared to the maximum grain size. The conclusions also take into account numerous laboratory tests using different debris material, e.g. from the Illgraben River (Canton Valais).
The actual test series show that it is possible to study the filling process and the retaining behavior of the barriers dependent on the mesh size. We found that the material was reliably retained a net having a mesh size and opening on the size of d_{90}, i.e. 90 % of the grain is $\leq d_{90}$. Scaling the laboratory tests to prototype scale using Froude similarity indicates that the barriers should have a ring diameter of 0.3 - 0.5 m.

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Fig.1: Laboratory net and full scale field barrier filled by debris flow events.

The opening between the lower support rope and the river bed should be between 0.3 m and 0.5 m to achieve a good initial stopping and subsequent infilling process of the debris flow material. The opening itself is necessary to allow passage of the normal mean high water discharge without filling up the barrier.

FLEXIBLE MULTILEVEL DEBRIS FLOW BARRIERS

Based on the results of the laboratory studies carried out by the WSL, flexible ringnet barriers with a mesh opening of 350 mm have been proposed which are attached to the borders of the stream using wire ropes, special brake elements and anchors.
The same type of ring net barrier has been successfully tested in the Illgraben, Switzerland on a 1:1 scale. It resisted several events filling and overtopping the barrier. A special steel element protects the top support ropes from the effects of abrasion.
Thirteen debris flow barriers installed in series ("multi-level approach") will be placed in the Milibach River in 2007. They are able to retain a debris volume of more than 10'000 m^3 compared to the event 05 where 13'000 m^3 of debris were mobilized in the catchment area. The uppermost barrier was designed as a pre-stopper for the debris flow arriving and should absorb as much energy as possible to slow (down) the debris flow mass. At the end, this barrier might even fail partly (pre-determined breaking point).

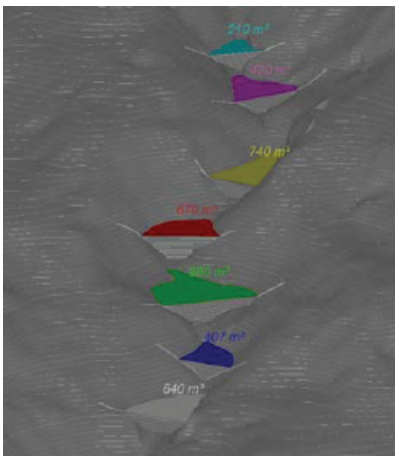

Fig. 2: 3D - view of the planned multi-level debris flow barriers

Using the Finite Element Software FARO which was validated with the Illgraben events in 2005 and 2006, the barriers were dimensioned for the following load cases:

- Granular debris flow
- Muddy debris flow
- Static loading (active earth trust value)
- Snow gliding

Barrier 2 was additionally dimensioned to absorb the energy of an avalanche arriving in this area.
Calculations showed that for snow gliding, the forces in the cables do not reach the activation threshold of the brake elements and therefore do not have to be specially secured in winter.

Keywords: Debris flow, protection concept, multilevel barriers, laboratory tests.