Successful hazard prevention using flexible multi-level barriers

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INTRODUCTION

The villages Hasliberg Reuti and Meiringen were affected by flood and debris flow events resulting from unusually heavy rainfalls in August 2005. The river Milibach rises in the Gummen Region and flows through Hasliberg and merges with the Aare river at Meiringen. The valley of Gummen is made of slope parallel black clay rich in alénien schist. This formation is overlaid by weathered and several meter thick debris layer. Due to these difficult natural conditions conventional preventive stiff measures could not be used there because of foundation problems. This paper will illustrate how a flexible multi-level barrier has been developed to protect the villages from future hazards.

BACKGROUND: EVENT IN 2005

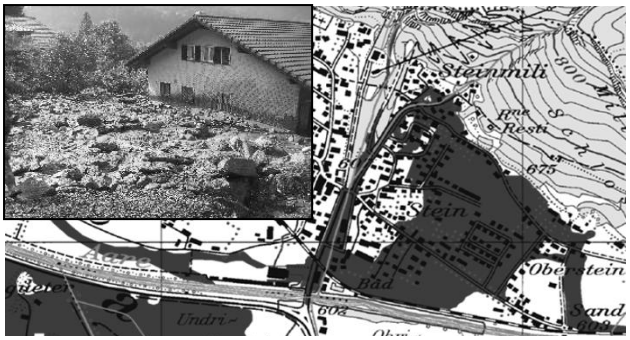

Fig. 1 Deposited debris in the village of Meiringen (dark colored) caused main damages

In August 2005 during heavy rainfalls the settlements of Hasliberg Reuti and Meiringen were flooded. The debris flows initialized at the Gummen catchment area caused the main disaster at infrastructure. Around 13,000m^3 of the weathered schist material in the catchment were mobilized during the intensive rainfall and were transported within 3 surges down the channel. Along its way down further 25,000m^3 were picked up by erosion processes and expand the total volume of the flow up to 40,000m^3.

The marginal shear stress could be approximated out of border deposition after the events to 600 / 1,100 N/m^2 hence these debris flow were muddy flows. The water content of the flows was around 50 %. The density of the flow itself was in the range of 18 - 20 kN/m^3.

METHOD: PROTECTION MEASURE WITH FLEXIBLE NETS

To avoid damages as in 2005 a part of the complete protection measure was to place 13 multilevel flexible barriers in the catchment area. The intention has been to stop the starting debris flow early before it is developing the enormous erosion potential. The advantages of a flexible solution over a fix and stiff protection are lower maintenance work and better usage in unstable ground.

The dimensioning of the flexible ring net barriers was carried out using the software FARO which has initially been developed to simulate the impact of rockfalls. Compared to rockfall, debris flows are characterized by distributed loads instead of a punctual load, longer braking time, smaller

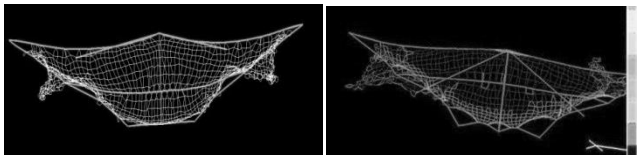

Fig. 2 Simulation of representative barrier for project Gummen using the software FARO

deflection and several surges arriving onto the net. The simulation of debris flows have been validated with measurement of real scale field tests at the Illgraben torrent. For the 13 nets at the Gummen project various load cases have been considered (e.g. granular and muddy debris flows, snow and overload).

Calculations showed that only nets with high resistance are able to withstand the given requirements. Therefore, the used net components are the strongest elements available on the market. The lifetime costs of the nets over the life expectancy of 20 years are 177,000 CHF per year. This value is 7 times lower than the budgeted protection costs calculated by the Canton of Berne.

RESULTS: EVENT 10TH OCTOBER 2011

On 10th October 2011, a big storm occurred at Hasliberg area declared as a 100 year flood. The combination of more than 70cm of snow and a heavy rainfall resulted in flooding of mountain rivers, slope failures and landslides. Around 2,000 m^3 of material got mobilized in the catchment area of Hasliberg by a shallow landslide flowing into the torrent. Flexible net number 2 got filled up to the max. level and flexible net no. 5 filled up to half net height. The nets in between did not fill up because of their higher basal opening, the gap between the lower support rope and the river bed.

Fig. 3 Stopped material behind net number 2 (left) and number 5 (right)

CONCLUSION

The customer, the two villages Hasliberg and Meiringen, as well as the designer of this multi-level protection concept are satisfied with the function of the nets in the 2011 storm because without the barriers the 2,000 m^3 of the 100-year flood would have eroded more material along the channel and could have caused much more damages again to Hasliberg village.

In addition, the complete developed design concept of the dimensioned barriers was proven by this event. No failure of the directly impacted barrier number 2 was happening even when a total volume of around 2,000 m^3 of shallow landslide at once impacted the barrier.

Keywords: Debris flow prevention, multilevel ringnet barriers, shallow landslides