

# Examples of big debris retention basins combining concrete and net-structures

Catherine Berger, PhD<sup>1</sup>; Corinna Wendeler, PhD<sup>2</sup>; Lisa Stieglitz, Dipl. Ing.<sup>1</sup>; Guido Lauber, PhD<sup>1</sup>

## INTRODUCTION

The villages Oberwil and Merligen in Bernese Oberland in Switzerland are both endangered by debris flows from the Hüpach and Grönbach torrents, respectively. The hazard maps for both villages show extensive red zones along the torrents and risk estimations reveal the need for improvement in the hazard and risk situations. Within an integrated risk management approach and as part of prevention measures, different types of technical structures including debris retention basins were studied. At both locations, combinations of concrete structures with ring nets were favored compared to conventional constructions due to lower cost, simplified transport and installation, flexible behavior of a net at debris flow impact and a better fitting into landscape with such a comparatively low-visibility structure. Also the positive experience with the standard flexible net systems (Wendeler et al., 2014) influenced the decision makers to go with this system. Here we report concepts and advantages of both debris retention barriers.

## FIELD SETTINGS

**Hüpach torrent:** The catchment from the Hüpach torrent (2.14 km<sup>2</sup>) extends from 2,104 m a.s.l. to the fan apex at about 910 m a.s.l. and the Hüpach discharges at 778 m a.s.l. into the Simme River. Average channel inclination is about 33 % and limestone and marl are the main geological components. The catchment is mainly covered with meadows, forest and rock / scree and driftwood plays an important role. The village Oberwil is located in the lower part of the fan.

**Grönbach torrent:** The Grönbach catchment covers about 14 km<sup>2</sup> and the highest point is at about 2,051 m a.s.l.. About 60 % of the catchment is covered with forest, followed by meadows and rock / scree. Main geologic formations are limestone and

quaternary sediments in the valley zone. The village Merligen is located on the fan and the torrent is channelized through the village from the fan apex to the outlet into the lake of Thun at 558 m a.s.l..

## DESCRIPTION OF THE RETENTION BASINS

**Hüpach torrent:** In total, 16,000 m<sup>3</sup> debris are retained with two ring net barriers, whereas the major barrier holds back around 13,000 m<sup>3</sup> and a smaller standard barrier type (UX-180-H6 by Geobruigg) has a capacity of around 3,000 m<sup>3</sup>. The major barrier is located about 250 m upstream of the fan apex and has a span width of about 40 m and central height of about 15 m. Ten layers of heavy duty ropes (diameter 95 mm, structural design 1,000 tons per rope) are fixed at the river banks in a concrete bar. A single net with ring diameters of 30 cm is hold straight by the ropes, whereas the lower middle part of the net is installed in two layers. Heavy, strong anchors fix the concrete structure to the river banks. The net at Hüpach is the tallest flexible ring net barrier in Switzerland and even worldwide.

**Grönbach torrent:** The debris retention basin is located near to the mouth of the torrent in the low-gradient area and has a retention volume of around 12,500 m<sup>3</sup>. The damming height is 7.5 m with a width of about 25 m, whereas four guidance walls are arranged in a funnel shape. A ring net barrier (ring diameter 30 cm) is fixed with high tensile spiral ropes (22 mm diameter) between the guidance walls which are anchored to the ground. Access to the retention basin is enabled by a lift gate. The maximum height of the lateral walls is about 10 m above the river bed.

At both torrents, event scenarios for bedload transport and debris flow events were established for hazard assessment and dimensioning of the

structural measures and also included debris flow parameters for different surges (volume, discharge, velocity). In these analyses, historical records, field investigations and estimates were combined with the 2D-modell RAMMS by WSL/SLF for a complementary analysis of flow behavior, flow parameters and flow patterns. Out of these flow parameters the net structures were modeled with the nonlinear finite element tool FARO (Volkwein, 2013). At both torrents, basal openings prevent from clogging by driftwood during smaller flood events. For larger floods and debris flows, drift wood retention capacity is requested due to small discharge capacities of bridges on the fan. For dimensioning of the net-structures, functionality and behavior of smaller constructions during events were adapted to the big retention barriers and the structural analysis considered the correspondent impact forces derived from the event scenarios.

### CONCLUSIONS AND OUTLOOK

Both debris retention basins show a new application of net constructions combined with concrete as protection against debris flows. Main advantages for such big constructions are flexible structures

which absorb forces and minimize the loads produced by debris flow impact and improved draining of the debris mass through the net. Furthermore, lower costs and transports due to reduced concrete usage can be achieved and a lower impact on the visual landscape is possible. The structural measures are part of the integrated risk management and observation of the catchment and torrent channel, emergency plans and land use management are implemented at Hüpach and Grönbach as well in future.

### REFERENCES

- Volkwein A. (2013). Flexible debris flow barriers - design and applications, WSL Research Institute Birmensdorf, Switzerland.
- Wendeler C., Volkwein A., Roth A., Nishimura N. (2014). Successful hazard prevention using flexible multi level barriers, Interpraevent Conference Nara, Japan.
- Wendeler C., Shevlin T. (2011). Load model for design of flexible debris flow barriers.



Figure 1. Flexible ring net barrier at Hüpach (left, line of sight downstream) and retention basin combining concrete guidance walls with ring nets at Grönbach (right, line of sight upstream).

### KEYWORDS

debris flows; protection measures; combination ring net and concrete

1 Emch+Berger AG, Bern, SWITZERLAND, spiez@emchberger.ch  
2 Geobruigg AG, SWITZERLAND