

Flexible Ring Net Barriers for Debris Flow Protection - Learning from More Than 10 Years of Experience -

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INTRODUCTION

Flexible ring net barriers against debris flow have been installed worldwide during the last 10 years mainly for the purpose of retention and a few for erosion control in the way by reducing the inclination of the river bed. An increasing number of client projects (40 barriers within Switzerland, more than 100 worldwide by 2017) showed the economic benefit of this solution. Special applications to retain big volumes with single barriers have been successfully installed in Switzerland (see **Fig.1**) and Japan.

This article gives examples of different special applications like one big barrier providing big retention capacity, several barriers in line or filled up barriers for erosion control. Advantages and challenges for the use of flexible ring net barriers are discussed on a technical and economic level and needs for maintenance and replacement works are addressed.

EXAMPLES OF INSTALLED AND FILLED UP DEBRIS FLOW BARRIERS

In March 2017, 22 debris flow barriers type UX successfully stopped debris flows in Peru and protected the villages below. Each barrier retained 1,500 m³ – 10,000 m³ of debris material (see **Fig. 1** right).

On July 22nd, 2010, a convective thunderstorm developed in the Spanish Pyrenees over the region of Port-Ainé. Rain intensities of up to 130 mm/h triggered a debris movement and filled 9 debris flow barriers type UX/VX (one is shown in **Fig. 2** left) with an overall retention volume of 20,000 m³. The barriers were left filled for erosion control of the river bed. Some new barriers to provide new retention volume were projected in between.

During 10 years, 3 filled multi-level barriers in the river Merdenson in Switzerland protected the basis of an existing check dam against erosion. By 2017, an overall protection concept for the whole river is being applied and the temporary nets will be removed (see **Fig. 2** right).

OBSERVATIONS ON PRACTICAL USE, CLEANING AND MAINTENANCE

Multiple flexible debris flow barriers proved to retain several 10,000 m³ of debris material, if placed in series one after the other and if they are well designed according to the latest technical standards. The relatively light weight and easy to install material is an economical advantage especially in hardly accessible, steep mountain torrents. After partly or full filling, the nets are usually emptied and parts of them are replaced (for examples brakes, netting).

Observations on overflowed barriers in the last 10 years showed that the material behind the barrier is compacted and drained due to the drainage effect of the ring net. After a few days and with consent of the local safety authorities, debris material may be removed with an excavator as

slightly wet, but well compacted material. For the material, enough space for deposition needs to be considered during the design phase of the barrier.



Fig.1 Giant netting as special application in Hüpbach, Switzerland (left) and one of the successful filled barrier in Peru (2017)



Fig. 2 Filled barrier in Porainé Spain 2010 (left) and 3 filled barriers as erosion control in Merdenson, Switzerland.

For overflow of filled barriers not cleaned up within the next days, observations showed that in specific cases in curves of the river, non-stabilized river banks of the barrier were eroded. Specially designed winglet ropes give the barriers a more U-shaped overflowing section and help to reduce erosion of river banks. Another option is the implementation of a concrete slab in the borders of the river bed and lateral concrete erosion protection downstream of the barrier. Abrasion protection devices on the top part of the barrier reduce erosive effects on the ropes.

CONCLUSIONS

Within the last 10 years, flexible debris flow barriers proved to be a valid protection measure against debris hazards. While easy in installation, and reliable in retaining the debris, issues on potential cleaning, scour problems and repair of the barriers should be included in an early planning stage. For sure regular inspection of the installation is recommended to control the basal opening and the barrier performance itself.

Keywords: Debris flow, flexible ring net barriers, experience, maintenance