# A systematic investigation of torrential filter structures by physical scale experiments

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## INTRODUCTION

In the framework of the INTERREG Project „SedAlp“ (Sediment management in Alpine basins: integrating sediment continuum, risk mitigation and hydropower) physical scale model experiments are carried out in the hydraulic laboratory of the Institute of Mountain Risk Engineering at the BOKU University in Vienna in order to optimize torrent protection structures.

Two different types of check dams are investigated. A rake-dam with inclined vertical beams is compared with a beam-dam with horizontal beams. The experiments should evaluate the variation of sediment transport of these structures including the influence of coarse woody debris. Therefore the distance between the steel elements can be adjusted to show their ability to filter sediment. The distances have been varied from 10.5 mm to 15 mm. The physical scale of the experiments is 1:30. All experimental runs are Froude scaled. Both dams are tested in elongated and pear-shaped sediment retention basins in order to investigate the shape effect of the deposition area. The inclination of the basin is 5 %.

## EXPERIMENTS

First the hydraulic effect of the structures is investigated by measuring the flow field and the backwater effects of the protection measures. For a systematic comparison of the two check dams experiments with fluvial bedload transport are made. First a typical hydrograph for an extreme flood (HQ150) with unlimited sediment supply is modelled. Therefore a typical torrential sediment mixture with a wide grain-size distribution is used. The sediment is fed by a conveyor belt according the transport capacity of the upstream reach.

A total sediment volume of 1.05 m³ is needed for each run. Then the deposition is scanned with a 2-D laser-scan device mounted on a rail above the basin in order to analyse the deposition pattern and the deposited volume. Afterwards a flood with a lower reoccurrence period (HQ5) without sediment transport from upstream is modelled to investigate the ability of the protection structure for self-emptying. Then the basin is scanned again to quantify the volume change in the deposition basin.

To investigate the influence of driftwood on the deposition behaviour experiments with logs are made. The hydro- and sedigraphs are the same as described above, but different log diameters and lengths are added upstream the basin. After scanning the surface the driftwood is removed carefully to model the cleaning of a log jam. Then the more frequent flood (HQ5) without sediment and wood from upstream is modelled to show the self-emptying behaviour of the basins. After each experiment the deposition was scanned by a laser-scan device mounted above the basin. With the known geometry of the basin the volume in the deposition basin was calculated by subtracting the elevation models after the HQ150 and HQ5.

For further analyses comparable experiments were grouped to show the effect of the beam distance, shape of the deposition basin and effect of the dam type. The experimental runs for the HQ150 with bedload transport and added driftwood are shown in Figure 1. Compared to the experiments without driftwood slightly higher (on average) deposition volumes were recorded for the narrow beam distance of 10,5 mm. For the wider beam distance (15 mm) the deposition volumes are increased, but show more scatter. The high variability in the deposition behaviour can be attributed to the chaotic and unpredictable clogging behaviour of the wood.

The results have been further analysed concerning the possibility of self-emptying. Again, the beam distance controls the passing volume, but only a minor effect of the shape of the deposition basin was found.

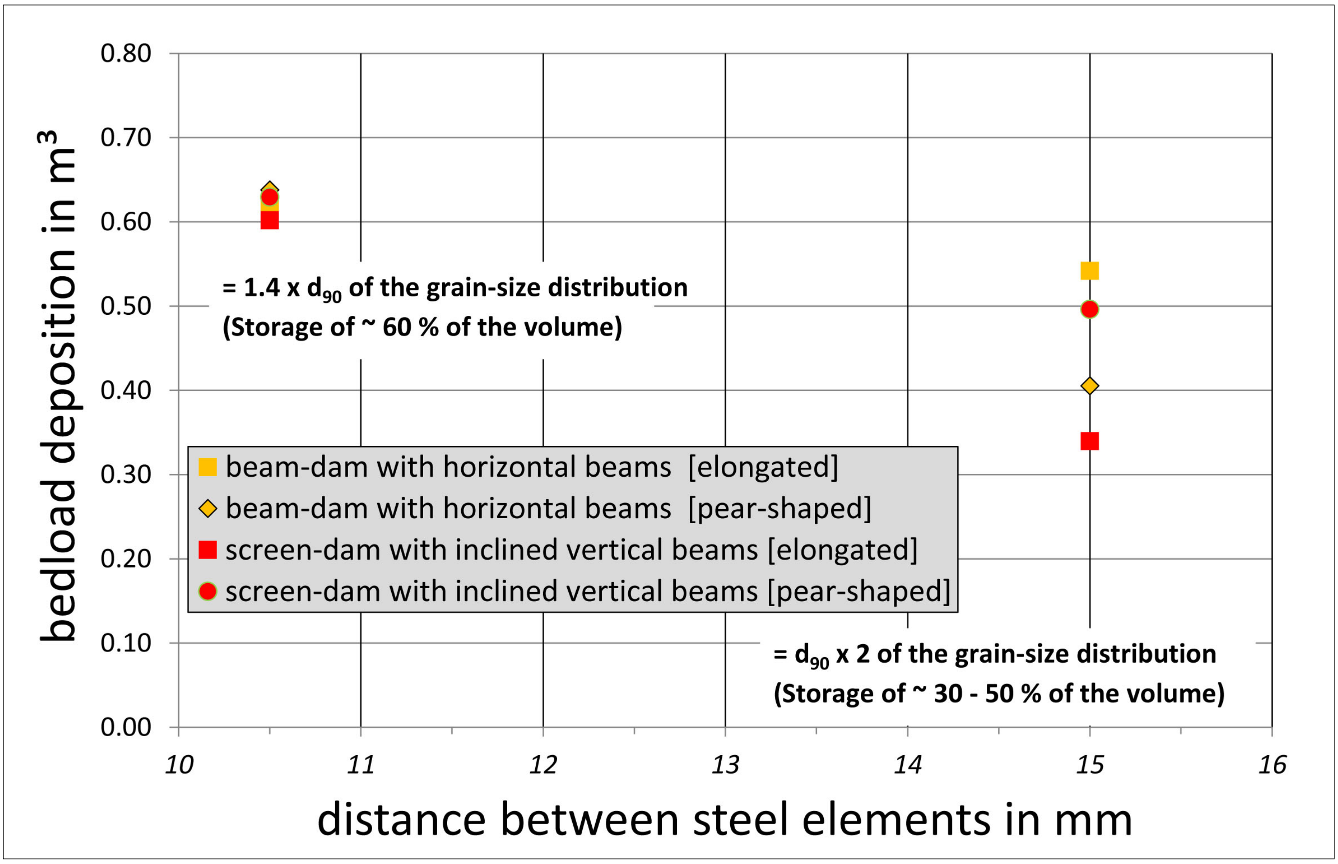


Figure 1. Experiments with bedload and drift wood. The volumes are given for the deposition basin.

## CONCLUSIONS

The actual project showed that the deposition during the experiments was not controlled by filtering-effects at the location of the dam. The deposition always started from upstream, where the transport capacity was reduced due to the milder slope and the widening of the basin. No grain sorting effects could be identified. Finally it can be stated:

1. The deposition volume can be controlled by the beam distance if there is no driftwood.
2. The pear shaped basin resulted in slightly higher deposition than the elongated basin.
3. Driftwood causes clogging of the dam and therefore higher deposition of bedload material.
4. Due to the chaotic behaviour of the log jams, driftwood causes a higher variability in the deposition behaviour.
5. Even if the log-jams are removed, the self-emptying efficiency is limited.

Different rake designs should be investigated to reduce the hydraulic effect of the check dam during small events. This could be reached by rakes with fewer beams in the lower part.

## KEYWORDS

bedload transport, torrent, filter structure, physical scale experiments

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