UNEXPECTED PROCESSES IN A SEDIMENT RETENTION BASIN

THE "STIGLISBRÜCKE" BASIN ON THE SCHÄCHEN TORRENT DURING THE FLOOD OF AUGUST 2005

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INTRODUCTION

In august 2005, large parts of Switzerland, Austria and South-Bavaria were hit by an intense rainstorm, which caused severe flooding. In Switzerland the most affected areas were the Bernese Oberland and the central part of Switzerland around the Lake of Lucerne. The total loss amount in Switzerland was about 3'000 million Swiss Francs. About 10 % of the damage costs were caused alone by the Schächen torrent, a tributary to the Reuss River in the canton of Uri. The Schächen torrent flows from east to west along the Schächen valley. Near Altdorf, the capital of Uri, it enters the main valley of the Reuss River. Here, an impressive alluvial fan was formed by the Schächen torrent since the last ice age. On the lower part of the alluvial fan, a lined channel was constructed after the flood of 1910 to prevent flooding and sediment deposition on the fan. The channel leads to the fan toe, where the Schächen torrent flows into the Reuss River. The relatively coarse material transported by Schächen torrent forms a deposit in the Reuss River, which leads to regressive aggradation in the lined channel. Several bridges crossing the torrent at the fan toe aggravate the situation. Therefore, after the flood of 1977 a sediment retention basin was built at the fan apex. The maximum capacity of this basin is about 150'000 m^3. At the downstream end of the basin, a slit dam should allow the passage of finer material during smaller floods and, during larger floods, create a backwater and thus retain the material. Horizontal beams in the upper portion of the slit increase the backwater effect. The opening between the lowest beam and the channel bed is 4.5 m wide and 2.25 m high. Discharges up to 50 m^3/s pass this opening without backwater formation.

THE FLOOD OF AUGUST 2005

The flood of august 2005 is characterised by an exceptional duration. A nearly constant peak discharge during almost 10 hours was observed at the gauging station located 1.2 km downstream of the basin. Striking are the pronounced discharge fluctuations between 100 and 150 m^3/s and periods of about one hour during the main phase of the event. The volume of sediments retained in the basin at the end of the event was only about 6'000 m^3. The sediment passing the basin during the flood and the sediments mobilised by erosion on the upper part of the fan filled the lined channel on a length of about 1.4 km. The consequences were extensive inundations and overbank sedimentation of about 250'000 m^3.

PROCESSES IN THE SEDIMENT RETENTION BASIN

Main aim of the present analysis was to identify the causes and processes responsible for the low efficiency of the retaining basin. The study based on all available information, i.e. on the discharge measurements mentioned above, water level traces in the basin, eye-witness ac-

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counts on the course of the event, hydraulic calculations and on a re-examination of the results of the hydraulic model tests performed before the construction of the basin.

The analysis showed that the outlet configuration was the main cause for a cyclic flushing of the basin and thus for the observed discharge fluctuations and the passage of a considerable volume of sediments during the flood. The two wings of the slit dam consist of gravity dams, each founded on the bedrock that is found about 4 m below the alluvial bed. At the upstream end of the slit, a bed sill had been constructed. The bed inside the slit, however, remained unprotected. When a backwater forms the outflow from the basin is pressurised and the flow velocity across the outlet opening increases considerably (Fig. 1a). Thus, when a sufficient high water level is reached, the flow starts scouring the alluvial bed in the slit. The result is a widening of the outlet section and a consequent increase of the outflow from the basin. This causes a lowering of the water level in the basin (Fig. 1b). The sediments deposited in the rear part of the basin during the phase of maximum water level raise are partially re-mobilised and transported across the outlet opening. Due to the decrease of flow velocity at lower water levels, the scour hole in the slit is filled (Fig. 1c). The outlet opening is narrowed again and the discharge decreases such as the water level in the basin rises again and a new cycle starts.

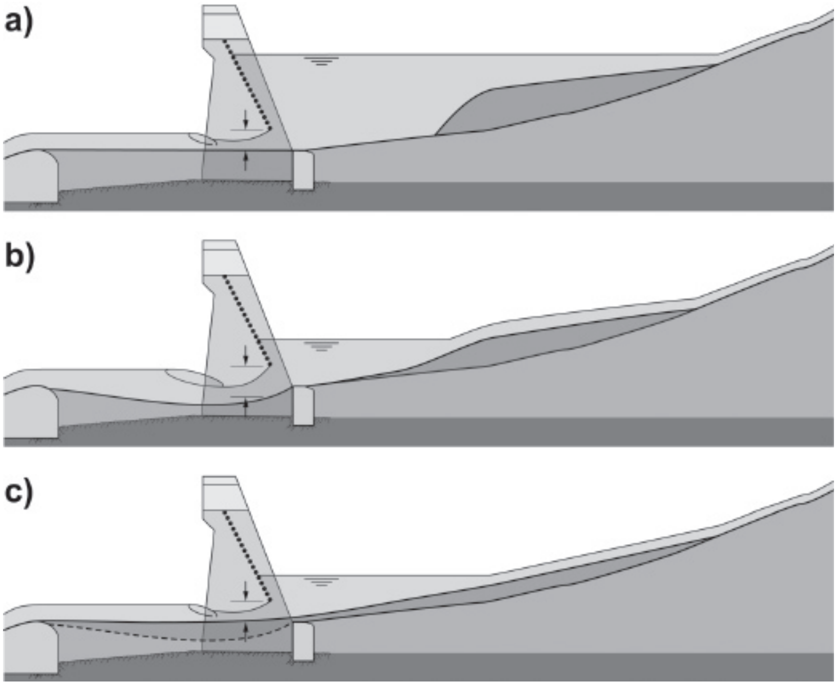

Fig. 1 Cyclic formation of backwater and flushing of the sediment retention basin “Stiglisbrücke” on the Schächen torrent during the flood of august 2005 (schematic representation).

CONCLUSIONS

The case study of the sediment retention basin on the Schächen torrent shows that a dosage of sediments during a flood event by means of a slit dam is hardly possible. During floods coarse sediments or driftwood either blocks the outflow opening and there is a complete retention or the outlet stays open and the retention effect is moderate. In the present case, the additional widening of the outflow opening by scouring caused a cyclic flushing of the basin, thus allowing the passage of a large part of the sediments. Outflow openings of permeable dams have to be fixed to avoid such phenomena. Slit dams have to create a stable backwater in order to grant an efficient retention of sediments during floods.

Keywords: sediment retention basin, slit dam, trap efficiency