ETH zürich

Fuse plug spillway at the Hagneck-Channel

The Hagneck-Channel provides a man-made diversion of the Aare River from Aarberg to Lake Biel, Switzerland. Today, the 140 year old channel needs to be improved as the design flood of 1'500 m^3/s cannot be discharged anymore without causing major problems. Further concerns exist regarding seepage, internal erosion and slope failure as the dams were constructed without an impermeable core. Therefore, the dams are currently improved and elevated to assure a discharge capacity of HQ_{100} = 1,500 m^3/s, including a 1.0 m freeboard.

To prevent uncontrolled dam overtopping under extreme flood scenarios, a side spillway is added at the beginning of the improved dam section. The fixed weir sill is located 1.7 m below the crest of the new flood dam to ensure sufficient spillway capacity. To activate the spillway as late as possible, a fuse plug is placed on top of the fixed weir sill. If the fuse plug gets overtopped during an extreme flood event, it should erode fast and completely. The 1.2 m high and 300 m long fuse plug is constructed as an earth embankment and provides a spillway capacity of approximately 300 m^3/s. The surplus water is discharged into a flood plain with a comparatively low damage potential.

Two designs for the fuse plug were studied in collaboration with the Institute for Geotechnical Engineering of ETH Zurich and tested at VAW by means of small and large scale experiments (scale factors of 1:5 and 1:1). Fig. 1 shows the advance of the fuse plug erosion for an embankment design with an impermeable core. The silt core is inclined toward the downstream direction preventing a washout of the fuse plug for discharges smaller than the design discharge. If the fuse plug is overtopped, the core collapses under its own weight as the embankment body below the core gets eroded. The core is covered with a sand filter to prevent piping. Highly erodible gravel forms the major part of the fuse plug embankment. A slope protection consisting of coarse gravel is provided on both the up- and downstream slopes to protect the fuse plug against wind, waves and rainfall. The filter criteria between the four material types are maintained to prevent internal erosion and sediment washout.

Fig.2 shows the erosion process of an embankment consisting of fine sand in a 1:1 scale experiment. The sand prevents seepage and washout of the fuse plug for small discharges. A filter of fine gravel between the embankment body and the slope protection prevents internal erosion of the embankment. Once overtopping starts, the fuse plug erodes gradually and entirely.

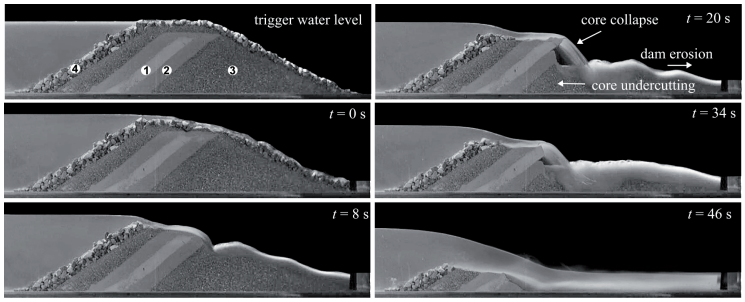

Fig. 1: Advance of fuse plug erosion at different model times *t* (Small scale experiment 1:5):
(1) Impermeable core
(2) filter
(3) embankment body
(4) slope protection

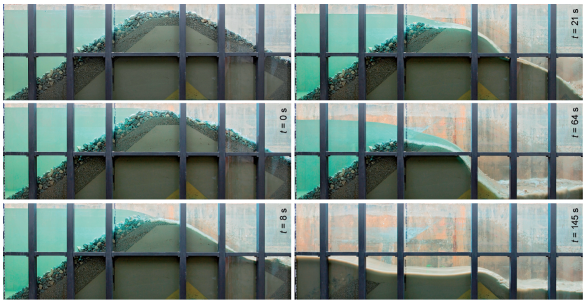

Fig. 2: Fuse plug erosion for an embankment with a body of fine sand in a 1:1 scale experiment.

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