Hydraulics of spatial dike breaches

Dikes along rivers prevent flooding of the adjoining environment during high-floods and consequently reduce damage to populated and agricultural areas. However, many dikes were not improved during decades so that overtopping has caused large damages in the past. The dike breach process due to overtopping is still poorly understood despite some recent advances. Therefore, the goal of the present research project is to add to the understanding of plane and spatial dike breaches using two hydraulic models at VAW for conducting this task.

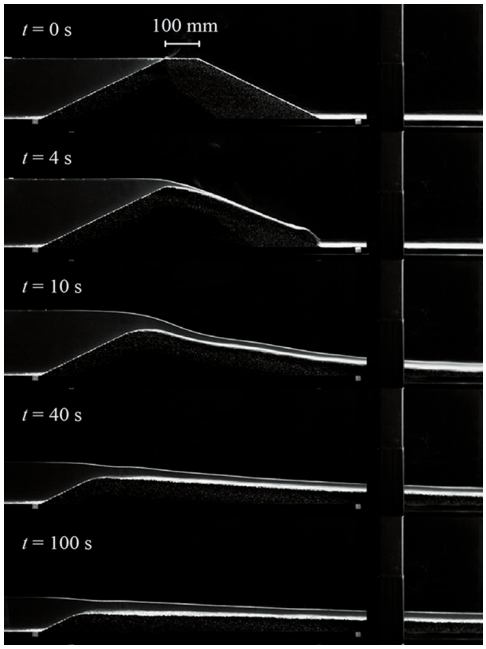

Fig. 1: Temporal progress of plane dike breach

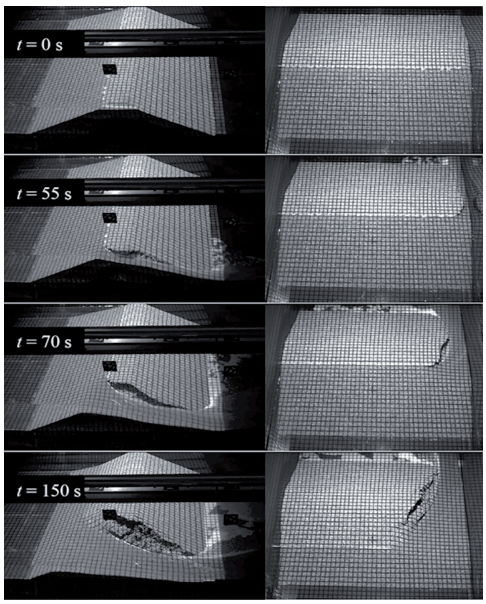

Fig. 2: Temporal progress of spatial dike breach

Plane dike breach

With a width of 0.40m, a discharge capacity of up to 70l/s and allowing for maximum dike heights of 0.40m, the first laboratory set-up is suitable for plane dike erosion tests. The temporal progress of both the water and the sediment surfaces is recorded across the side glass wall using a CCD camera. The temporal and streamwise advances of the plane dike breach processes were investigated by Dr. Lukas Schmocker. The current study concentrates on the effect of selected parameters on the breach process, including the effect of the grain size distribution (Fig. 1), the slopes of both the up- and downstream dike faces, and the effect of the dike crest length, to predict the main erosion features. This research does however not study the tailwater deposition characteristics, which will be investigated with a further future project.

Spatial dike breach

The second set-up is suited for spatial breach-tests, inserting dikes of up to 0.70m height and of up to 1.00m width. The challenge of this project is the simultaneous recording of both the water and the sediment surfaces during a breach test. For reliable data collection, without any perturbation of neither the sediment nor the water surfaces during the breach process, a non-intrusive and continuous approach is applied.

Preliminary tests with the AICON instrumentation have been conducted by Dr. Lukas Schmocker. This method applies videometric mapping of the sediment surface topography below the water flow during a breach test. This method will be extended with measurements of the water surface and surface flow velocities using an adequate tracking algorithm. The temporal progress of bed forms, spatial erosion, water levels and flow velocities will therefore be available at any time of the dike breach process. This also allows for the generalization of 2D results to the 3D problem using accurate hydraulic model data and their detailed analysis. At this stage, no numerical modeling of the problem is envisaged.

Main goals

- Completion of plane dike breach due to dike overtopping
- Improving test set-up and adapt AICON-system to spatial dike breaches
- Investigation of spatial dike failure due to dike overtopping
- Quantifying sediment erosion during breach process and understanding mechanisms of spatial dike breaches

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