FLOOD PROTECTION PROJECT: URNER TALBODEN

TESTING AND OPTIMIZATION OF PROJECT MEASURES WITH A HYDRAULIC MODEL

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At the end of August 2005 humid air masses from the Mediterranean were brought to the foothills of the Alps during several days. The associated rainfall led to devastating floodings at many places. The valley bottom of the Canton Uri was strongly affected by the storm. In the night of the 22 August the Schächen-River overtopped his banks and devastated the nearby industrial zone, the biggest of the canton. The total economic loss caused by the flood event amounted up to 300 million CHF. Subsequent to the flood event a flood protection project was commissioned by the Canton Uri. The Laboratory of Hydraulics, Hydrology and Glaciology (VAW) of the ETH, Zurich has been ordered to inspect the effects of the measures and to optimize the project. Therefore, two hydraulic models have been built with scales of 1:50 and 1:20, respectively and several model tests have been conducted.

INTRODUCTION

The Schächen rises close to the Klausenpass and flows through the Schächen-Valley to the junction into the Reuss in the valley bottom of Uri. The catchment area has a size of some 110 km^2. In the alluvial fan the Schächen is routed in a prismatic, straight lined, fixed torrent channel to its junction where it flows in a slight right hand bend into the Reuss. Several transportation routes of international importance cross the Schächen about 200 m upstream of the junction. A very long period with high discharges characterises the flood event in 2005. The discharge exceeded 100 m^3/s during 12 hours causing an enormous bed load displacement due to distinct bank erosion and channel degradation. The accruing sediment has been transported in the fixed torrent channel up to the junction. Due to the change of slope the sediment has initially been deposed in the junction region. As a result a backward deposition originated. The progressing deposition filled the channel and finally the flow section under the bridges was blocked. This culvert blockage caused enormous overbank flooding of water and bed load.

HYDRAULIC MODEL

Within the flood protection project several protection measures for the Schächen and the valley bottom of Uri have been developed by numerical simulations. The most significant measures are the redesign of the bridges as a 45 m long bridge deck inducing pressurised flow and the construction of a lateral sediment trap, which is linked with the fixed torrent channel via a side weir in the right channel bank. Further measures are the lifting of the banks to increase the hydraulic capacity and another sediment trap at the beginning of the fixed torrent channel. To analyze the measure properties separately and in combination, hydraulic model tests are undertaken at the VAW parallel to the project planning phase. Therefore, a hydraulic model with the scale 1:50 has been built. The model represents the Schächen from the junction (0 m) to the cross section 1100 m and includes additionally 600 m of the Reuss-River to investigate possible backwater effects.

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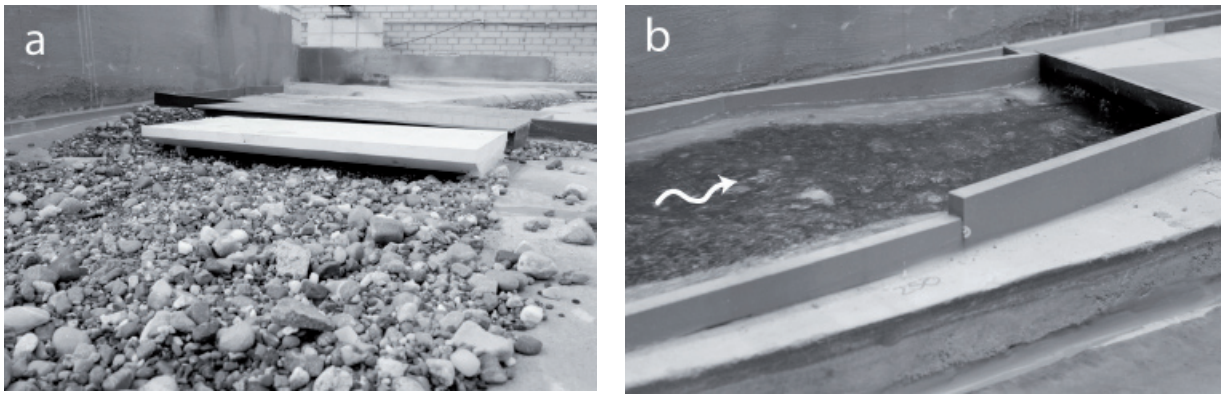
To check the results of the hydraulic model with the prototype various experiments have been conducted. In these calibration runs the flood event of 2005 has been simulated, using the measured flood hydrograph and an assumed time-variation curve of the bed load. The goals of the calibration were threefold: To reproduce (1) the observed hydraulic and morphological processes, (2) their chronological sequence and (3) the bed load quantities. To fulfil these goals the surface roughness and the time-variation curve of the bed load have been systematically varied. After the calibration the attention was focused on the effectiveness of the individual elements of the flood protection project. These have been successively implemented and their performance has been tested for various loads. Simultaneously to this study the pressurised bridge deck has been investigated in a separate hydraulic model with a scale of 1:20. The crucial question of these studies is the following: Is the pressurised flow, induced by the bridge deck, able to avoid the closing of the flow section under the bridge.

CONCLUSIONS

First results of the hydraulic model tests illustrate that the projected protection measures would have controlled the flood event of 2005 without serious damages (Fig. 1). Another finding is that the pressurised flow caused by the redesigned bridge ensures a permanent bridge opening under extreme load. The hydraulic model shows that the two rivers Schächen and Reuss are not able to transport the anticipated quantities of bed load. Additional measures as the sediment traps have to be undertaken to minimize the deposition phenomena in the fixed torrent channel and the connected danger of overbank flooding. The goal of the dimensioning of the measures has to be that the rivers are only confronted with bed load during extreme events. Furthermore, the studies reveal that hydraulic model tests are essential to simulate this highly complex flood event. The local hydraulic and morphologic processes at the redesigned pressurised bridge deck or at the side weir can only be observed in a hydraulic model, however.

Fig. 1: The simulated flood event 2005 in the hydraulic model: (a) existing bridge construction with filled channel and overflowed bed load, (b) pressurised bridge deck and lifted banks ensure permanent bridge opening



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