



Concept for improving the parameterisation of dam break wave models including sediment transport

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1 Introduction

The ability to configure a hydraulic model for calculating dam break waves, i.e. peak discharge with a very steep rise, is essential for defining the potential danger inherent in this type of infrastructure. This is even more true in the Alps, where steep slopes and very varying hydraulic conditions exist.

Today, simulation tools allow for better consideration of the topography and highly non-stationary hydraulics of dam failures. However, these models must be calibrated, and the values of certain parameters are sometimes subject to strong assumptions, especially when flow varies sharply. For example, measuring flow properties will enable them to compute the apparent roughness of the bed and changes from a state of low submersion to a state of high submersion.

It should be noted that the description above concerns clear water and that in many cases flood waves include a significant fraction of sediment and floating wood, which further complicates the calculation. This document does not address these last two points.

In order to better calibrate hydraulic models, it is proposed to use bottom outlet opening exercises (a long-planned action in most cases) combined with planned observation of the river downstream to obtain data related to high flows, thereby providing a better understanding of several parameters.

2 Proposal

Across Switzerland, the bottom outlets of at least 20 water-retaining facilities under the direct supervision of the Confederation are (partially) opened each year to verify their functionality and ensure safety. These openings are announced at least one week in advance (in general, several months in advance). It is therefore possible to have a significant number of calibration points with waves and higher flow rates over a few years than is usually the case.

Due to its functions, the SFOE-TS is the official supervisory authority of these bottom outlet operations.

2.1 Work to be done

The proposed measure can be summarised as follows:

- a) Defining time when ready in order to coordinate with the operator that will perform the opening of the bottom outlet gates.
- b) Installation of measuring devices on bridges (if possible, at three locations) during low water flow.
- c) Installation of velocity measuring devices at the same locations.
- d) Implementation of the unified time measurement system.
- e) Wave monitoring (see Figure 1 and Figure 2).
- f) Calculation of hydraulic parameters (like roughness, velocity, flow height and discharge).
- g) Storage of time series in a dedicated database.



Figure 1. On the left before the gate opening, in the middle during the opening of the bottom gate. On the right, the wave passing through, with the sediment load change clearly visible.



Figure 2. The same wave, attenuated downstream and with less sediment load.

2.2 Parameters to be measured and calculated

The parameters to be measured on the day the bottom valve is opened are:

1. the effective slope of the measurement sections ;
2. the topography of the measurement section(s) (wet perimeter) ;
3. the water height during the event ;
4. the timing of the wave passage (to be coordinated between the different points) ;
5. the speed of the wave front and after the passage (will allow operators to better understand the effectiveness of their bottom outlet) ;
6. may be the turbidity ;

It should be noted that the measurement of these parameters can benefit from various new technologies (surface velocity by SfM, height measurement by electrode, etc.).

The necessary parameters are listed above. For different applications (environmental, bedload, etc.), and also for future research by the SFOE, the following measurements could be taken in addition:

- turbidity ;
- sediment transport ;
- temperature ;
- chemistry/conductivity.

Measuring all these parameters by installing a 'station', even a temporary one, will be an asset for student training.

The minimum parameters will make it possible to calculate the velocity, flow rate and dynamics of the free surface and, above all, to determine the apparent roughness of the bed when it changes from a state of low submersion to a state of high submersion of a very rough bed (large stones protruding from the water).

3 Possible follow-ups

Depending on the measurements acquired and new technologies coming onto the market, it will be possible to work on solid transport and, if necessary, on the transport of floating objects.

Once the parameters have been analysed, it will be possible to better constrain the models and consider a coherent and consistent recalculation of submersion waves in the event of a dam breach. It should be noted that this also requires progress to be made on the breach process itself (e.g. the 'progressivity' of the breach, the size of the breach) which depends on the dam structure type.

4 Conclusions

The use of bottom outlet openings to obtain data to better calibrate flood wave models is necessary and to take into consideration scale-effects. Measured data of such parameters are currently lacking.