LABORATOIRE DE CONSTRUCTIONS HYDRAULIQUES

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Sustainable reservoir management using turbidity current venting through bottom outlets (2013-2017)

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Introduction

Sedimentation is a worldwide major problem affecting the performance of a dam and shortening its life. The main result of this process is the loss of storage capacity in reservoirs. This loss reaches 0.5-1% of the global reservoirs' capacity annually.

Figure 1: Reservoir sedimentation observed in Tourtemagne dam in Switzerland

Different factors affect the sedimentation rate. However, in Alpine reservoirs, sedimentation is mainly due to the presence of turbidity currents (Figure 2).

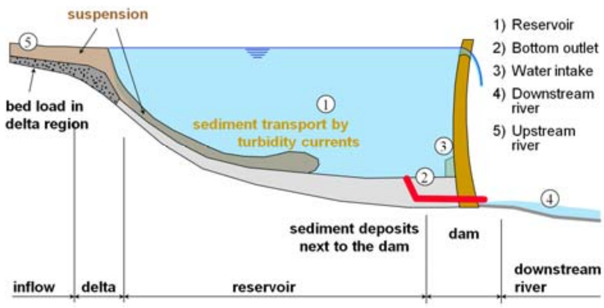

Figure 2: Progression of a turbidity current in a reservoir (prepared by De Cesare, 1998)

The latter are formed during a flood event and are characterized by a higher density than the ambient water in the reservoir. The high density is caused by the presence of sediments and leads to the plunging of the current to the bottom of the reservoir. Once it reaches the bottom, the current flows along the thalweg until it reaches the dam where -in case it is not vented- gets blocked and the entrained sediments deposit.

Figure 3: Rhone river plunging in lake Geneva forming a turbidity current

In order to solve this problem, venting of sediments entrained by turbidity currents through bottom outlets should be ideally performed during a flood event. The optimization of this process is still far from being accomplished as studies concerning the venting still present several gaps.

Objective

The main goal of this project is to optimize the venting efficiency of turbidity currents in a reservoir. This efficiency is defined as the ratio of the mass of vented sediments to the mass of the sediments present in the inflowing turbidity current.

Research procedure

The project includes both experimental and numerical approaches. Tests will be first performed on a physical model (Figure 4) in LCH by varying parameters relevant to the venting process, namely:

- The slope of the channel
- Outlet opening time
- Outlet discharge
- Outlet elevation (above the bottom)

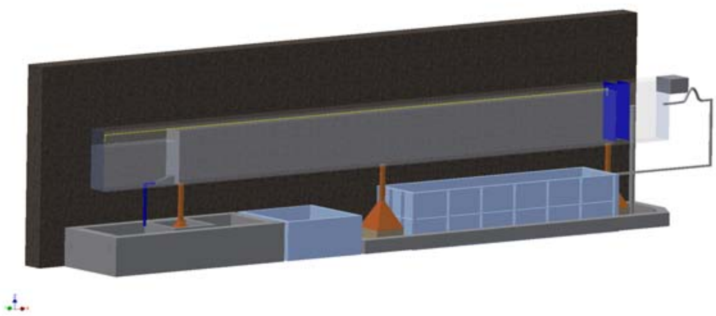

Figure 4: Overview of the physical model (under construction)

Simultaneously, a numerical model will be conceived and validated based on the experimental results. Numerical simulations will be performed using ANSYS CFX to test different theoretical scenarios and case studies. Numerous applications of the research results are possible. It offers the chance to answer questions that hydropower dam operators face at every flood event.