

Experimental and computational evaluations of parallel spillway outlets

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Fluid Mechanics

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Abstract

Experiments and computational simulations have been performed as part of a larger project to instil trust in computational methods for design of hydraulics flows in spillways. Presented in this licenciate is one manuscript and two conference papers. The first conference paper details experiments done at Älvkarleby of a multiple outlet spillway model with an inlet channel specifically designed to contain interesting hydraulic features. The results indicate that simulations agree well with experiments. In the second conference paper acoustic doppler velocimetry measurements (ADV) were done and compared to simulations of a racetrack flume with a fish passageway at Älvkarleby. The results showed agreement but due to inlet conditions of the experiment some discrepancies were noticed. The manuscript presents experiments of a wider range of flow in the experimental flume of the first conference paper, with additional ADV measurements. Preliminary conclusions are that discrepancies can be due to inlet conditions. A short summary of further work is included.

List of publications

Appended Papers

- Paper A :** **Numerical modelling of flow in parallel spillways,**
Mikael Hedberg Gunnar Hellström Patrik Andreasson Anders Andersson
Kristian Angele Robin Andersson
Published in the Proceedings of the 8th IAHR International Symposium
on Hydraulic Structures ISHS2020
<https://doi.org/10.14264/uql.2020.606>
- Paper B :** **Experimental and computational evaluation of fish passageway
with porous media boundary,**
Mikael Hedberg Gunnar Hellström Nils Solheim
for the Proceedings of the 40th IAHR World Congress 21-25 August
2023 Vienna, Austria
Accepted
- Paper C :** **MEASUREMENTS AND SIMULATIONS OF THE FLOW
DISTRIBUTION IN A DOWN-SCALED MULTIPLE OUT-
LET SPILLWAY WITH COMPLEX CHANNEL,**
Mikael Hedberg Gunnar Hellström Patrik Andreasson Anders Andersson
Robin Andersson
Manuscript

Additional publications of interest

- Paper D :** **Modified Guide Walls for Incremental Increase of Spillway
Capacity**
Nils Solheim Mikael Hedberg Hanne N. Lunde Elena Pummer Leif Lia
for the Proceedings of the 40th IAHR World Congress 21-25 August
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Part I

Summary

Chapter 1

Introduction

The work presented herein was performed under the umbrella of the spillway 99 project. Establishing trust in Computational Fluid Dynamics, henceforth abbreviated as CFD, with regard to its use in design of hydraulics of open waterways and spillways is the main goal of the project and to that end, experiments are performed to create validation cases for CFD codes. The experimental setup can be seen in figure 1. Paper A shows testing of the experimental setup and early simulation attempts which show some agreement. Paper B revolves around some tangential work performed at a different experimental setup in Älvkarleby. Acoustic doppler velocimetry, henceforth abbreviated as ADV was used to map velocities in an experimental fish passageway. This was compared to simulations done of the same experiment with results indicating that the simulations performed adequately. In paper C detailed experimental work is presented alongside simulations based on those made in paper A. The ADV data in paper C indicates that proximity to the outlets dictates how well simulations and experimental data coincides. As above the outlet crest ADV and simulations agree well, while below the crest simulation and experiment diverges. The distribution of the water flow across the three outlets show results within the margins of error for the lower cases tested. For the higher case of 200 l/s the differences between the experiment and the simulations are more exaggerated, while the differences are still small there is still a not insignificant discrepancy between the experiment and the simulations.

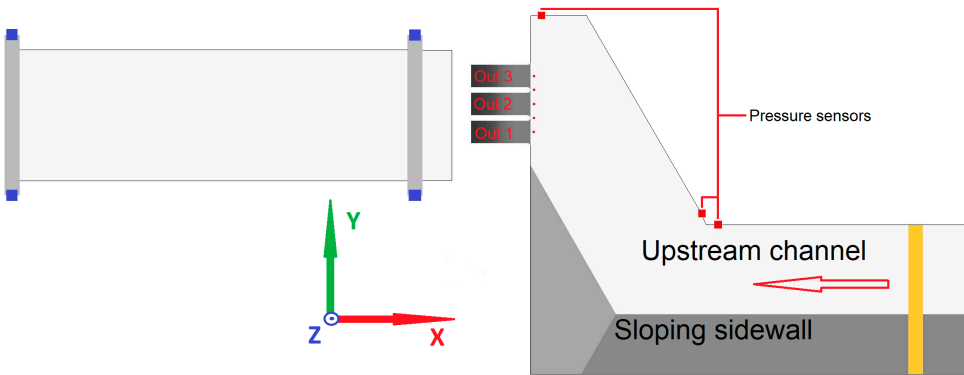


Figure 1: Setup of the experiment, pressure sensors shown for measurement of water level. Honeycomb inlet marked in yellow. Outlet ADV positions marked with red dots.

Chapter 2

Future work

New experiments have been performed in the channel with a modified geometry, the modifications include a raised floor. Raising it from 40 cm below the beginning of the outlets to 10 cm below the beginning of the outlets. Accompanying the raised floor additional modifications in the channel has also been added, one of these modifications is a change of the corner of the channel. In the first experiments it had an angle greater than 90 degrees, with the modification the corner is moved further downstream and also change to be a 90 degree corner. This change brings an alteration to the flow leading to the outlets as it restricts the angle of the incoming flow. The last alteration is for the abutments and pillars of the outlet. They were changed from rounded pillars to rectangles with rounded corners. This change was made to evaluate the impact of the structures around the spillway outlets. Previous work included measuring of the inlet profile with ADV. Due to reflections of the floor, previous measurements could not include large parts of the channel. With the remodelling raising the floor, a design choice was made to allow water to pass under the raised floor. This allowed the ADV to measure closer to the floor without interference. Using this newly measured inlet profile as an inlet condition for simulations will reveal the importance of inlet conditions for spillway simulations. Along with the new possible inlet conditions, different turbulence models will be explored for this case of fluid dynamics. Further work is intended to be performed with input from relevant industrial partners.

Part II

Papers

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