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# International Junior Researcher and Engineer Workshop on Hydraulic Structures Session 6

Boris Rodriguez

Josh Mortensen

Riley Olsen

Nathan Christensen

Mitch Dabling

*See next page for additional authors*

## Presenter Information

Boris Rodriguez, Josh Mortensen, Riley Olsen, Nathan Christensen, Mitch Dabling, and Gonzalo Duró

# International Junior Researcher and Engineer Workshop on Hydraulic Structures

18 - 20 June 2012, Logan, UT, USA

# SESSION REPORT

**SESSION 6**

**Chairman**: Boris Rodriguez

**Rapporteur**: Josh Mortensen

***Advocatus diaboli***: Riley Olsen

**Speakers**: Nathan Christensen, Mitch Dabling, and Gonzalo Duro

***ROUND TABLE***

**Moderator**: Bryan Heiner

**Rapporteur**: Josh Mortensen

**Session Chairman**: Boris Rodriguez

**Session Speakers**: Nathan Christensen, Mitch Dabling, and Gonzalo Duro

**External Expert**: Greg Paxson

**Other Participants**: Dave Campbell, Blake Tullis, Sebastien Erpicum, Riley Olsen, Robert Janssen

*1st Presentation*

**Title**: ARCED LABYIRINTH WEIR FLOW CHARACTERISTICS

**Author(s)**: Nathan Christensen and Blake Tullis

**Speaker(s)**: Nathan Christensen

**Brief description of author(s) approach:**

The main objective of this research was to expand previous research of labyrinth weirs to arced labyrinths. Arced labyrinths are often mentioned and may be more hydraulically efficient due to the cycles being more aligned with the streamlines of the flow. However, not a lot of current information is available. Physical model simulations were used to help calculate the Cd coefficients of arced labyrinths of various geometries and develop an equation that can be used for these types of weirs.

**Questions and answers:**

Q: Why is there a ^2 in your Cd equation instead of a more traditional ^.5?
A: It showed the best fit to our data

Q: Will you expect problems with cavitation in prototype weirs with non-aerated nappes?
A: Yes, it is a concern, that's why we looked at different sidewall angles.

Q: How did you look at aeration and instabilities?
A: Nappe breakers were investigated, which decreased efficiency within certain ranges but eliminated instabilities of the nappe.

Q: Did you look at project costs in comparisons to efficiency?
A: No work was done w/ costs.

Q: Was velocity head included in measurements?
A: Yes, measurement location taken well upstream where zero velocity could be assumed.

Q: Why do curves trail off for the geometry with an angle of 6 degrees
A: This may be an extrapolation past data established in previous work by Crookston.

**Rapporteur's appreciation:**

As someone with very little knowledge on labyrinth weirs, it was enlightening to see that information was being added upon and expanded to arced labyrinths in a way that can be widely used. There was much discussion about how the data will be applied and consolidated into a useable equation. We look forward to seeing the published version of this work.

*2nd Presentation*

**Title**: NOTCHED AND STAGED LABYRINTH WEIR HYDRAULICS

**Author(s)**: Mitch Dabling and Brian Crookston

**Speaker(s)**: Mitch Dabling

**Brief description of author(s) approach:**

The presentation focused on labyrinths that are notched in the apex and sidewalls to match the outflow hydrograph. Again, physical models were used of labyrinth weirs with these characteristics. A standard weir equation was used to calculate Cd values. These values were similar among different configurations of weirs if $Ht/P > 0.5$.

Results were compared to a common design technique and found that Cd values can be used as a rough conservative estimate for design even though they're very specific to various configurations of notched labyrinths.

**Questions and answers:**

Q: Is it a realistic assumption to aerate the nappe in the physical model?
A: Yes, assuming that prototype scale nappes are generally aerated naturally, and its more conservative.

Q: Please clarify nomenclature of notched apexes on figures in slides?
A: Clarified

Q: Was data from the high Cd used in the curve fitting?
A: Yes.

Q: Can an existing labyrinth spillway be modified to be a staged weir?
A: Not sure.
R: Brian Crookston added that it would depend on other factors not researched here, including costs, etc.

At the roundtable discussion there was discussion on the sidewall effects from velocities as well as location of the total head measurement. Modifications of existing labyrinths to include notches was also discussed which indicated that modifications would depend on costs and exposing critical elements of the weir.

**Rapporteur's appreciation:**

Again, I have learned much regarding labyrinth weirs and the many different configurations they can take. The research very interesting and well presented. The roundtable discussions were especially interesting with both researchers and designers around the table. These discussions produced great suggestions on taking results from the laboratory to the field in a way that is more effective and realistic.

*3rd Presentation*

**Title**: CFD APPLIED TO THE SIMULATIONS OF A HYDROCOMBINED POWER STATION IN SPILLWAY MODE

**Author(s)**: Gonzalo Duro and Mariano de Dios

**Speaker(s)**: Gonzalo Duro

**Brief description of author(s) approach:**

The presentation focused on a comparison of CFD modelling to physical model results of a dam spillway with hydropower. Turbulence parameters were investigated as well as dynamic pressures. Dominant pressure frequencies were found along with the Strouhal numbers. It was concluded that there was good comparison between both numeric and physical approaches and that CFD can be used as a cost-effective tool in similar situations.

**Questions and answers:**

Q: Which Re numbers were used in the simulations?
A: Re was not calculated.

Q: Which turbulent characteristic length was used?
A: Recommendations for similar work on spillways were followed.
R: During the roundtable discussion it was clarified that the use of 7-10 percent of spillway crest height was used for the characteristic length, which is consistent with proper modelling guidelines.

Q: Did you look at conservation of mass between the different mesh blocks?
A: Yes, this was checked at the block connections and it was validated.

**Rapporteur's appreciation:**

This presentation was a good example of comparing numeric and physical approaches. This is a frequent issue that we face in our hydraulics lab and it was good to see more available information. Calculations of turbulence characteristics and the use of spectral analysis were especially interesting to me because of similar analyses used in my research. This provided further opportunities for discussion and sharing resources during the roundtable discussion and throughout the remainder of the conference.