Jun 17th, 12:00 AM - Jun 20th, 12:00 AM

International Junior Researcher and Engineer Workshop on Hydraulic Structures Session 2

Francois Rulot

Riley Olsen

Gonzalo Duró

2nd Presentation

Title: Mean Velocity Effects in Biofouled Pipes

Author(s): Maria Trujillo

Speaker(s): Maria Trujillo

Brief description of author(s) approach:

The author presented her research on changes in mean flow velocities in Biofouled pipes. To assess the change in mean flow velocity due to biofilm growth on pipe perimeters, the author attempted at calculating a Darcy-Weisbach head loss coefficient for biofouled pipes. After describing her experimental setup for friction factor assessments and methodology, the author shared her results which showed friction factor variations for various pipe types and flow velocities. Findings indicate that friction factor patterns were not in alignment with Moody's diagram.

Questions and answers:

Q: Are you surprised that your friction factors did not match well with Moddy's diagram?
A: Yes, because my first expectation was that microfilm growth should not have had that big of an impact on friction factor patterns.

Q: Do you have any design recommendations given the variability of your results?
A: The ultimate goal would be to develop a new equation for biofilm friction factors that would be different from the typical equations currently used in practice.

Q: What was the effect of pipe roughness on biofilm growth?
A: Rougher pipes seemed to have less biofilm growth.

Q: What about hydrodynamic vortices formations due to bottom boundary layers? Any effects?
A: 21-day recirculation results indicate there might be some hydrodynamic impacts.

Q: Any optimum velocities to limit microbial growth?
A: Biofilms are there. Higher velocities result in thinner film formations. Nutrient supply will sustain growth. The detachment of biofilms could cause water hammer events and have implications on recirculation.

Q: Is the thickness of these biofilm layers self-limited? Is there any limit?
A: The thickness of the layers is probably limited by the thickness of laminar viscous sub-layers in the pipes.

Rapporteur's appreciation:

I found this presentation and research very interesting. The author did a very good job at presenting her experimental setup and describing her research and results. Roundtable discussions brought up three points worth highlighting: (1) the hazard associated with the release of these biofilms into water distribution systems, (2) the effect the variation in nutrient supply could have on the results (especially since nutrient supply was interrupted and restarted at separate stages of the experiment), and (3) the origin of Moody's diagram and Nikuradse's concept of equivalent sand roughness and how it was developed.

International Junior Researcher and Engineer Workshop on Hydraulic Structures

17 - 20 June 2012, Logan, UT, USA

SESSION REPORT

TECHNICAL SESSION 2

Chairman: Francois Rulot

Rapporteur: Riley Olsen

Advocatus diabolic: Gonzalo Duro

Speakers: Josh Mortensen, Mohanad Khodier

ROUND TABLE

Moderator: Mitch Dabling

Rapporteur: Riley Olsen

Session Chairman: Francois Rulot

Session Speakers: Josh Mortensen, Mohanad Khodier

External Expert: Bruce Savage

Other Participants:

1st Presentation

Title: Measurement of Turbulence in Pressurized Pipe Flow Using PIV

Author(s): Josh Mortensen

Speaker(s): Josh Mortensen

Brief description of author(s) approach:

The main objective of this presentation was to discuss the problem of the invasive muscle species known as zebra and quagga, as well as turbulence effects on these muscles using PIV technology. These muscles are a major problem because they can get into pipe networks and other hydraulic structures and cause biofouling, corrosion, and clogging. A proposed management solution for these muscles involves a "turbulence generator" that can be installed in a pipe. The turbulence generator is anticipated to damage young muscles before they reach full size and are capable of attaching themselves to the surfaces of the hydraulic structure. It was pointed out that the actual turbulence generator used in this study is proprietary, and therefore a detailed description could not be provided. It was also emphasized that because of the slow speed of the camera utilized (7.4 Hz), time spectra could not be used, but rather spatial spectra was used.

Questions and answers:

Q: Does the increased turbulence in the field affect the inflow?
A: No, the addition of flow due to the turbulence generator is minimal. Instead, velocities are increased to create this turbulence. Specific characteristics of the turbulence generator cannot be divulged due to the fact that they are proprietary.

Q: Does the Reynolds Number stay constant between the pipes with the turbulence generator and those without?
A: Reynolds Number was not examined in the models that included the turbulence generator, but it is suspected that the Reynolds Number would increase in the tests with the generator installed.

Q: Did you look at other methods of determining turbulence?
A: Other methods of determining turbulence were not discovered in the literature review performed. The majority of studies found used this method so it was assumed to be acceptable.

Q: What was the frequency of the pictures be taken by the PIV camera?
A: 7.4 Hz.

Q: Was this frequency fast enough for accurate PIV analysis?
A: Had to make sure there were sufficient seeding particles, but it was difficult. This study was based on spatial data rather than time data.

Q: How could it be assumed that targeting only baby muscles would help manage them effectively?
A: The young muscles are not capable of attaching to walls, therefore killing them at this early stage would prevent them from reaching maturity and causing the problems discussed earlier

Rapporteur's appreciation:

I was very interested in this presentation because I have heard quite a bit regarding the invasive quagga and zebra muscles within Utah and Idaho. Most of the information I have seen in the past was from a recreational boating perspective, which emphasizes the transportation of these muscles from one body of water to another by "hitchhiking" on boats. For this reason it was really interesting to see this issue from the engineering and management side and see some work that is actually going on with regards to eliminating these muscles from hydraulic structures.

2nd Presentation

Title: Using PIV System in Fish Passage Through Rehabilitated Culverts

Author(s): Mohanad Khodier, Blake Tullis

Speaker(s): Mohanad Khodier

Brief description of author(s) approach:

This presentation focused primarily on Particle Image Velocimetry (PIV) measurements within rehabilitated culverts. The rehabilitated culverts discussed consisted of a liner that has baffles installed horizontally along the length of the culvert. The purpose of these baffles is to decrease the velocity within the culvert and create slow pools to make passage easier for fish. Through use of the PIV, it was found that a relationship existed between the percentage of fish that successfully passed through the culvert and the shear stress at the tip of the baffles. The max shear stress encountered was effective moved from the walls of the pipe without baffles, to the tips of the baffles for the pipes with baffles installed.

Questions and answers:

Q: What happens when flow rates are small? Does a hydraulic jump form between baffles that effects the fish passage
A: It is really only a question of whether there is enough water for fish to get through the pipe.

Q: What species of fish are being used for this study?
A: Brown trout. The fish that is the main concern regarding fish passage through culverts in Utah is the Bonneville cutthroat trout, but could not get licenses to catch these fish from the state. So instead the brown trout was used because it is a weaker swimmer than the Bonneville cutthroat, and therefore it is assumed that if a brown trout can make it through the culvert a cutthroat would as well. This gives a conservative result.

Q: How is sediment accumulation between the baffles expected to be managed?
A: Possibly through the use of a regular maintenance schedule in which the baffles are cleared of sediment manually

Q: Why was shear stressed used rather than turbulence?
A: Because turbulence gives no indication of fish passage, whereas there is a clearer relationship between shear stress and fish passage.

At the round table, the application of shear stress as an indication of fish passage was discussed in quite detailed questions and suggestions. It was also made clear that only culverts with horizontal baffles were tested in this study, none were examined that featured an incline. Much interest was shown in this topic by participants and future direction of study was discussed.

Rapporteur's appreciation:

This presentation was very interesting to me because I had never considered the problem of fish being able to pass through culverts. Now that it has been discussed, I recognize that it is a very important issue when it comes to biodiversity in our rivers and therefore keeping the river ecosystems and fish population balanced. I am interested to see where this research goes from here, and whether or not a different factor can more accurately relate to fish passage than shear stress.