Jun 22nd, 11:25 AM - 11:40 AM

Session D1: Experimental Study on Flow Patterns in Vertical Slot Fishways

Verena Höger
Karlsruhe Institute of Technology - Institute for Water and River Basin Management

Martin Henning
Federal Waterways Engineering and Research Institute

Franz Nestmann
Karlsruhe Institute of Technology

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Experimental study on flow patterns in vertical slot fishways

Dipl.-Ing. Verena Höger

A cooperation between the Institute for Water and River Basin Management of KIT and the Federal Waterways Engineering and Research Institute
Introduction
Introduction

- flow pattern 1 (FP1) und flow pattern 2 (FP2)

(Tarrade 2008)

(Tarrade 2008)
Material and methods - Experimental setup

- Physical model at Theodor-Rehbock-Laboratory of the IWG (KIT)
- 9.5 m x 0.79 m flume
- Variable slope
- 6 pools (variable geometry)

Investigated geometric parameters:

- B/L-ratio (0.6 to 0.8)
- angle of slot $\alpha$ (24° to 56°)
- distance from the guide wall to the slot $a$ (3.8 and 7.1 cm)
- slope of the fishway $S$ (2.8% to 5%)
Material and methods - Methodology

- long time exposure of water surface
- exposure time: 4.9 s
- Tracer particles: white rubber sponge ball (15 mm diameter)
- pool: black bottom, white edging

- water depths
- ultrasonic distance sensor
- mesh: ~10 x 10 cm

- Acoustic Doppler Velocimeter (ADV)
- 300 s measuring time per measuring point
- mesh: ~ 5 x 5 x 5 cm
Results - Long time exposure

B/L = 0.75
α = 24°
\( a_{LW} = 0.38 \text{ cm} \)

B/L = 0.75
α = 39°
\( a_{LW} = 0.38 \text{ cm} \)
<table>
<thead>
<tr>
<th>$S = 2.8%$</th>
<th>$B/L = 0.8$</th>
<th>$B/L = 0.75$</th>
<th>$B/L = 0.7$</th>
<th>$B/L = 0.65$</th>
<th>$B/L = 0.6$</th>
</tr>
</thead>
</table>
| $\alpha = 24^\circ$  
$\alpha = 0.71$ | | | | | |
| $\alpha = 24^\circ$  
$\alpha = 0.38$ | | | | | |
| $\alpha = 39^\circ$  
$\alpha = 0.71$ | | | | | |
| $\alpha = 39^\circ$  
$\alpha = 0.38$ | | | | | |
| $\alpha = 56^\circ$  
$\alpha = 0.71$ | | | | | |
| $\alpha = 56^\circ$  
$\alpha = 0.38$ | | | | | |

FP1; Transition; FP2
<table>
<thead>
<tr>
<th>S = 5%</th>
<th>B/L = 0.8</th>
<th>B/L = 0.75</th>
<th>B/L = 0.7</th>
<th>B/L = 0.65</th>
<th>B/L = 0.6</th>
</tr>
</thead>
</table>
| α = 24°  
a = 0.71 | ![Image](image1) | ![Image](image2) | ![Image](image3) | ![Image](image4) | ![Image](image5) |
| α = 24°  
a = 0.38 | ![Image](image6) | ![Image](image7) | ![Image](image8) | ![Image](image9) | ![Image](image10) |
| α = 39°  
a = 0.71 | ![Image](image11) | ![Image](image12) | ![Image](image13) | ![Image](image14) | ![Image](image15) |
| α = 39°  
a = 0.38 | ![Image](image16) | ![Image](image17) | ![Image](image18) | ![Image](image19) | ![Image](image20) |
| α = 56°  
a = 0.71 | ![Image](image21) | ![Image](image22) | ![Image](image23) | ![Image](image24) | ![Image](image25) |
| α = 56°  
a = 0.38 | ![Image](image26) | ![Image](image27) | ![Image](image28) | ![Image](image29) | ![Image](image30) |

FP1; Transition; FP2
Results - Velocities

S = 2.8%, B/L = 0.8, $\alpha = 24^\circ$

S = 2.8%, B/L = 0.8, $\alpha = 56^\circ$
Results - Maximum velocities

S = 2.8%, B/L = 0.8, α = 24°, FP1

$\Delta h = 0.105 \text{ cm}$

$v_{\text{max}} = \sqrt{2g\Delta h} = 1.44 \text{ m/s}$

S = 2.8%, B/L = 0.8, α = 56°, FP2

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>v [m/s]</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.5</td>
<td>16</td>
<td>4.8</td>
<td>1.65</td>
</tr>
<tr>
<td>25.5</td>
<td>21</td>
<td>19.3</td>
<td>1.62</td>
</tr>
</tbody>
</table>

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<tr>
<td>15.5</td>
<td>26</td>
<td>17.5</td>
<td>1.42</td>
</tr>
<tr>
<td>15.5</td>
<td>21</td>
<td>4.8</td>
<td>1.41</td>
</tr>
</tbody>
</table>
Results - TKE

S = 2.8%, B/L = 0.8, α = 24°, FP1

S = 2.8%, B/L = 0.8, α = 56°, FP2

Wang et al. 2010
Conclusions and Outlook

- flow patterns can vary for identical slope and B/L
- more geometrical parameters influence the flow patterns
- angle of slot $\alpha$ is an important parameter
- $v_{\text{max}}$ at FP1 is $\sim 15\%$ larger than at FP2
- maximum velocities are allocated about whole depth
- at FP2: $v_{\text{max}}$ is $\sim \sqrt{2g\Delta h}$
- more, selected variants will be studied by ADV measurements
Thank you for your attention.