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International Conference on Engineering and Ecohydrology for Fish Passage 2015

Jun 23rd, 2:00 PM - 2:15 PM

Session B5: 2D Modelling of Nature-Like Fish Passes

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2D Modelling of nature-like fish passes

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2D Modelling of nature-like fish passes

Tien Dung TRAN, Ludovic CASSAN, Jacques CHORDA, Pascale LAURENS

July, 24th 2015

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2D Modelling of nature-like fish passes

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Context



- Passage of several fish species
- Low head
- Low risk of clogging and silting
- Better attractivity
- Transverse slope

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Objectives

- Design of nature-like fish pass (Block ramps).
- Knowledge of flow : velocity and turbulence.

Methodology

- Experimental measurements of hydrodynamic parameters for several fish passes (block number, slope, bed).
- Validation of a shallow water model, range of validity
- Use of the 2D model for determining hydrodynamic parameters and optimizing the fish pass.
 - Maximal Velocity
 - Resting area
 - Turbulent intensity

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Experimental Set up

Experimental Set up

Tilting Flume (7m * 1m)





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Experimental Set up

Arrangements of blocks



D	q		Fr		${\sf Re}_{D}=V_{g}D/ u$		${\sf Re}_h = V_g h/\nu$	
(<i>mm</i>)	(<i>I/s/m</i>)				(*10 ³)		(*10 ³)	
	min	max	min	max	min	max	min	max
115	10	90	0.36	1.6	50	120	30	140

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Experimental Set up

Experimental measurements

Velocity



Acoustic Doppler Velocimeter (3 components, 50 Hz)

Waterdepth



Shallow water modelling

- Geometry = experimental channel
- Shallow water assumptions (hydrostatic pressure)
- k- ϵ model for turbulence
- Telemac 2D



Water surface colorized by the depth averaged velocity



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Series of experiments

	bed	h (mm)	Vg (m/s)		distance from bed (cm)	Experimental	Telemac2D	
Configuration C, S, Q							Ks Strickler	
13 %, 3%, 30l/s	Rough	89.9	0.52	0.56	5	Exp_1		
13 %, 5%, 50l/s	Smooth	80.9	0.97	1.08	5	Exp_2		
16 %, 1%, 20l/s	Rough	99	0.34	0.34	3	Exp_3	30	Tel_3
16 %, 2%, 40l/s	Smooth	124.1	0.57	0.48	3	Exp_4	60	Tel_4
16 %, 3%, 50l/s	Smooth	128.6	0.65	0.58	3	Exp_5	60	Tel_5
16 %, 5%, 50l/s	Rough	109.9	0.76	0.73	3	Exp_6	30	Tle_6
16 %, 5%, 50l/s	Smooth	100.4	0.83	0.73	3	Exp_7	60	Tel_7
16 %, 3%, 50l/s	Smooth	128.6	0.65	0.58	5	Exp_8		
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Validation of Shallow Water model

Velocity and Water depth results



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Velocity



Turbulent Kinetic Energy



Range of validity

Stage-discharge relationship (q, h) $C_d = f(F)$, C=6,9,13,18,23 %



Resting zone

$$a = V_{limit} / V_g$$





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2D Modelling of nature-like fish passes

Conclusion

- Validation of 2D model F < 0.7
- Maximal velocity (*V_g*), and Froude number influence (vertical contraction)
- Turbulent properties
- Useful to complement the experimental results. Relationship discharge, velocity, TKE and geometrical configurations.
- Help to evaluate passability and to interpret future studies on fish behavior.

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Conclusion

Further study : 3D model



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