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

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

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Tran, Tien Dung; Cassan, Ludovic; Chorda, Jacques; and Laurens, Pascale, "Session B5: 2D Modelling of Nature-Like Fish Passes" (2015). *International Conference on Engineering and Ecohydrology for Fish Passage*. 12.
https://scholarworks.umass.edu/fishpassage_conference/2015/June23/12

2D Modelling of nature-like fish passes

IMFT

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July, 24^{th} 2015

Context

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

Objectives

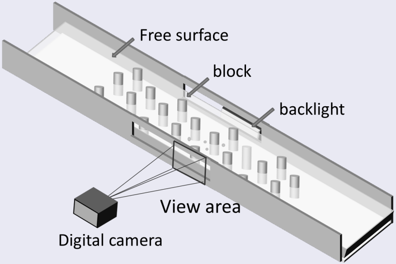
- Design of nature-like fish pass (Block ramps).
- Knowledge of flow : velocity and turbulence.

Methodology

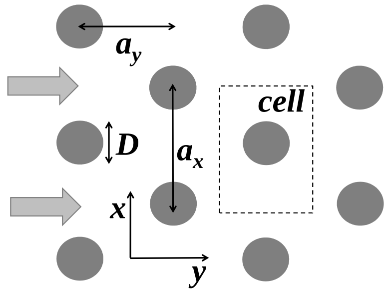
- Experimental measurements of hydrodynamic parameters for several fish passes (block number, slope, bed).
- Validation of a shallow water model, range of validity
- Use of the 2D model for determining hydrodynamic parameters and optimizing the fish pass.
  - Maximal Velocity
  - Resting area
  - Turbulent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

Experimental Set up

Tilting Flume (7m * 1m)



Arrangements of blocks



$$C = \frac{D^2}{a_x a_y}$$

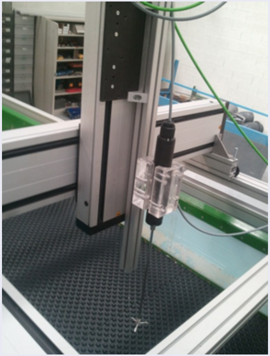
$$\frac{V}{V_g} = 1 - \sqrt{\frac{a_y}{a_x} C}$$

$$F_r = V_g / \sqrt{gh}$$

D (mm)	q $(l/s/m)$		Fr		$Re_D = V_g D/\nu$ $(*10^3)$		$Re_h = V_g h/\nu$ $(*10^3)$	
	min	max	min	max	min	max	min	max
115	10	90	0.36	1.6	50	120	30	140

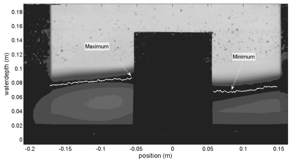
Experimental measurements

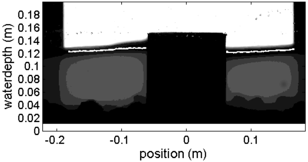
Velocity



Acoustic Doppler Velocimeter (3 components, 50 Hz)

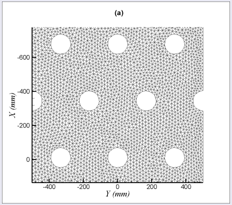
Waterdepth



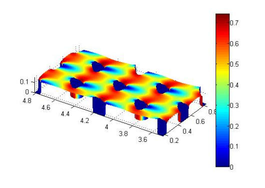


Shallow water modelling

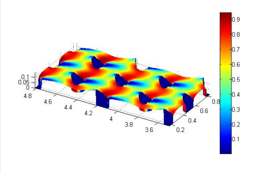
- Geometry = experimental channel
- Shallow water assumptions (hydrostatic pressure)
- k-ϵ model for turbulence
- Telemac 2D



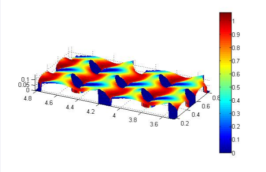
Water surface colorized by the depth averaged velocity



$F_r = 0.58$



$F_r = 0.84$

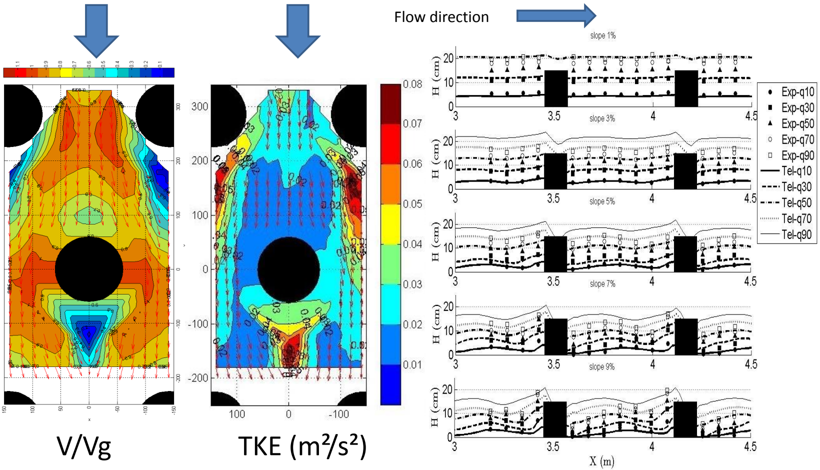


$F_r = 1.08$

Series of experiments

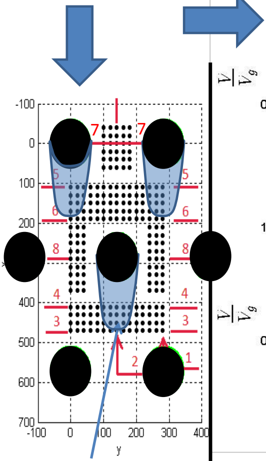
Configuration C, S, Q	bed	h (mm)	Vg (m/s)	F	distance from bed (cm)	Experimental	Telemac2D	
							Ks Strickler	
13 %, 3%, 30l/s	Rough	89.9	0.52	0.56	5	Exp_1		
13 %, 5%, 50l/s	Smooth	80.9	0.97	1.08	5	Exp_2		
16 %, 1%, 20l/s	Rough	99	0.34	0.34	3	Exp_3	30	Tel_3
16 %, 2%, 40l/s	Smooth	124.1	0.57	0.48	3	Exp_4	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		

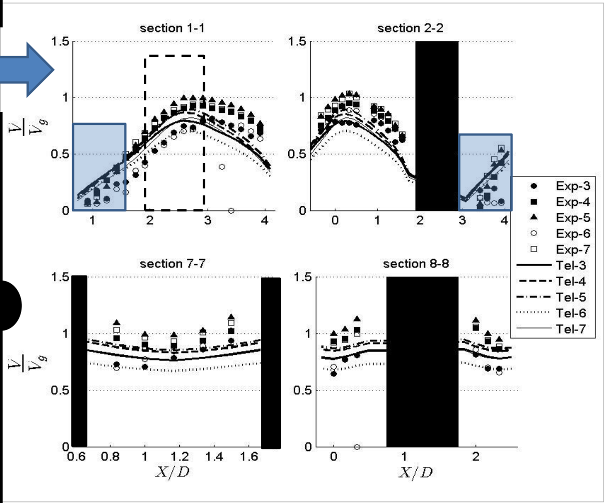
Velocity and Water depth results



Velocity

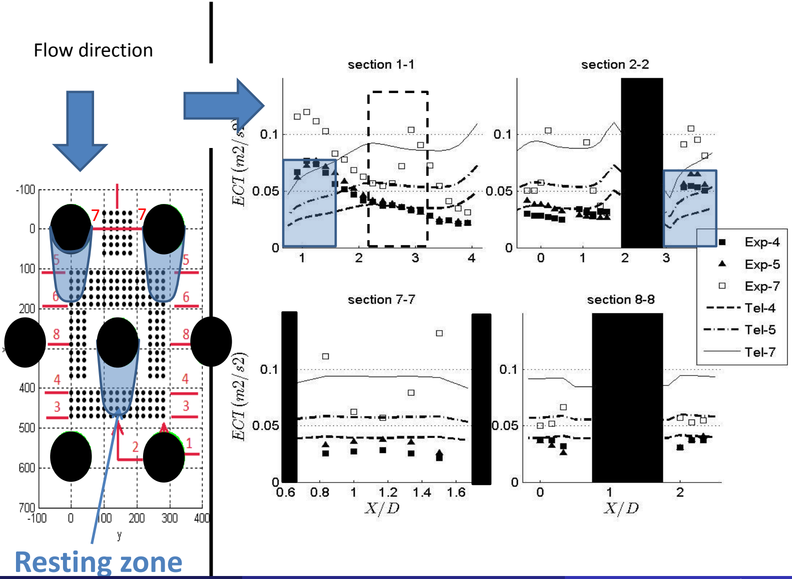
Flow direction





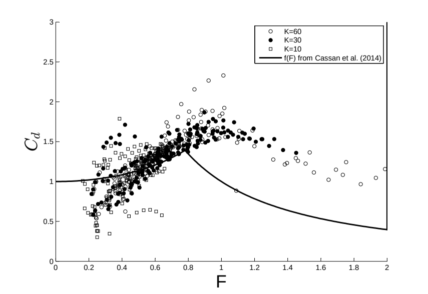
Resting zone

Turbulent Kinetic Energy



Range of validity

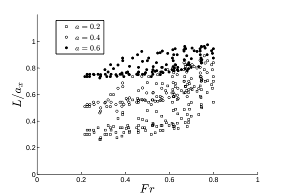
Stage-discharge relationship (q, h)
$C_d = f(F)$, C=6,9,13,18,23 %

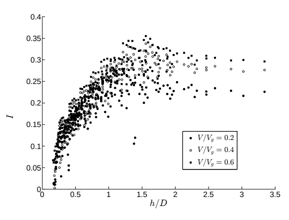


$$q\sqrt{\left(\frac{C_d}{D}\frac{C}{1-\sigma C}+\frac{C_f}{h}\right)} = h\sqrt{2gS}$$

Resting zone

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





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.

Further study : 3D model