Hydraulic Behaviour of a Gully Under Surcharge Conditions

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9 UDM BELGRADE
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Surcharge Events

Introduction

Objectives

Experimental Setup

Mesh Generation

Numerical Simulations

Results

Conclusions

1- Surcharge event in sewer system of Auckland, New Zeland, 2009

2- Montreal, Quebec, Canada, 30/05/2012

1- http://joelcayford.blogspot.pt/2009/10/isnt-aislings-death-stormwater-wake-up.html
2- http://youtu.be/l5rZOFW0I1s

Objectives

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- Behaviour;
- Comparison;
- Validation.

Experimental Setup

- Channel

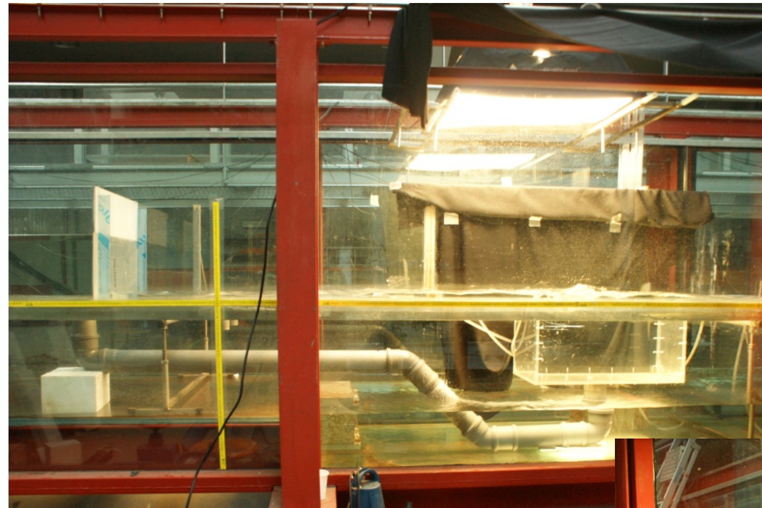
  50 cm width
  1% slope

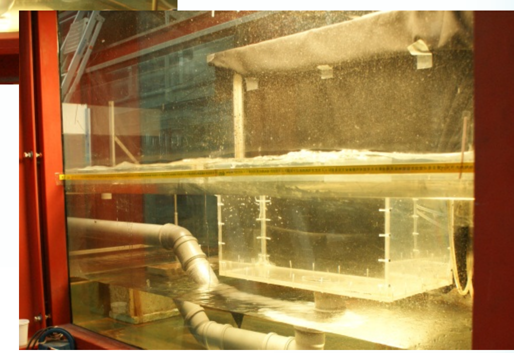
- Gully

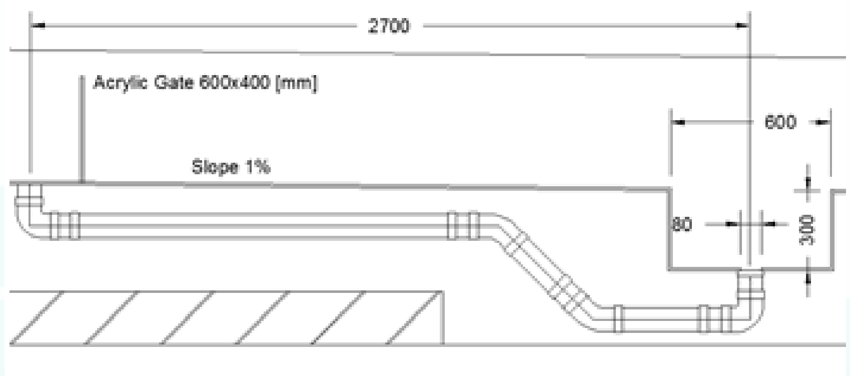
  60 cm length
  30 cm width
  30 cm height

- Pipe

  8 cm diameter



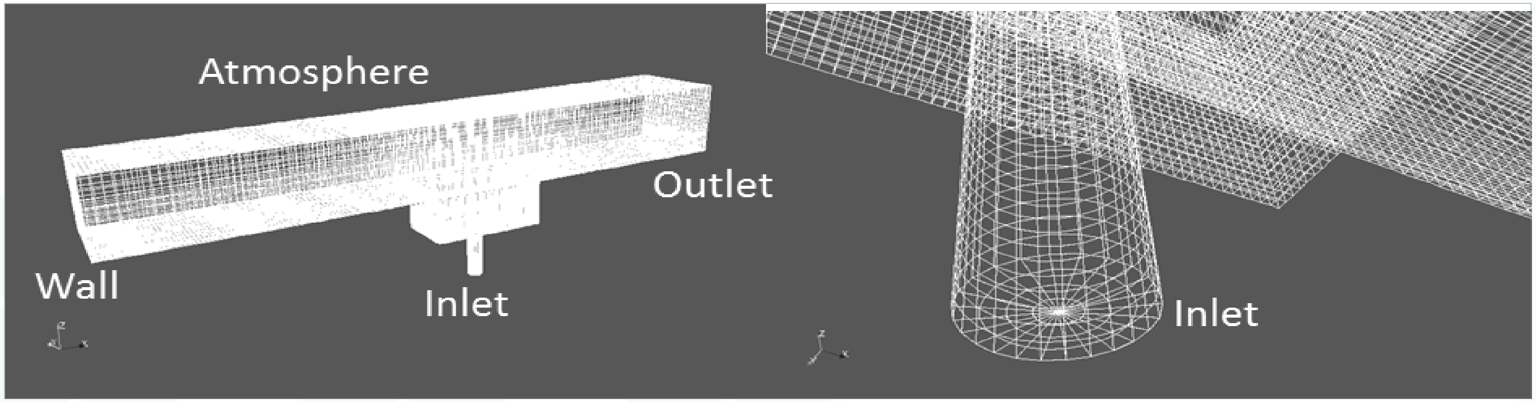




1 - Gully with Simple Inlet (GSI)

- Regular and Non-Uniform
- Ranging spaces 1 to 4 cm
- Created with *blockMesh* utility in OpenFOAM

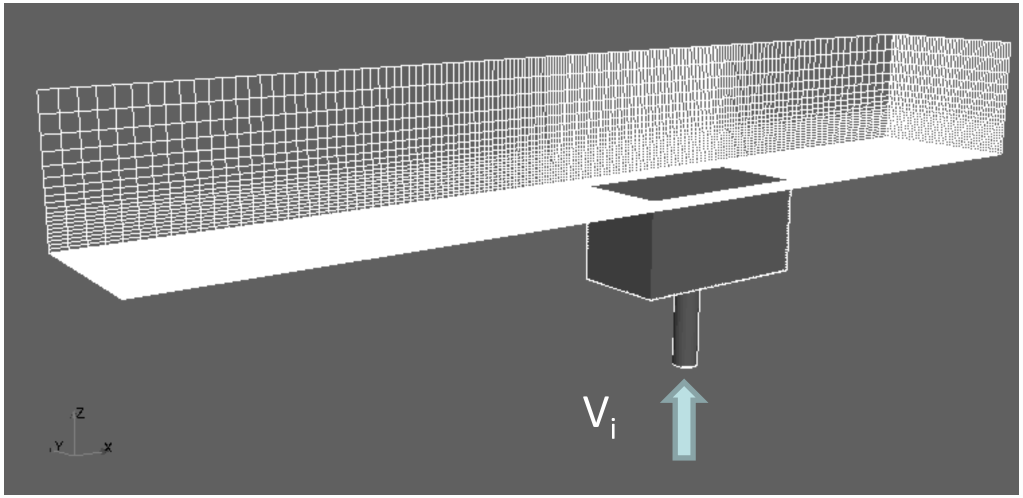
Boundary conditions



(Adapted from Martins,R.)

1 - Gully with Simple Inlet (GSI)

Inicial Conditions



	Q (m^3/s)	D (m)	V_i (m/s)
Q6	0.006	0.08	1.194

OpenFOAM simulations

Introduction
Objectives
Experimental Setup
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- OpenFOAM version 1.7.1
- Solver interFOAM
- PISO algoritm

Turbulence Approach

LES

$$\bar{U}(x,t) = \int_{\Omega} U(x',t)G(x,x',\Delta)dx$$

$$G_1(x,x',\Delta) = \left\{ \begin{array}{cc} 1/\Delta^3 & |x-x'| \leqslant \Delta/2 \\ 0 & |x-x'| > \Delta/2 \end{array} \right\}$$

$$G_2(x,x',\Delta) = \left(\frac{\gamma}{\pi\Delta^2}\right)^{3/2} exp\left(-\gamma\frac{|x-x'|^2}{\Delta^2}\right)$$

$$G_3(x,x',\Delta) = \prod_{i=1}^{3} \frac{sin[(x_i - x_i')/\Delta]}{(x_i - x_i')}$$

RANS

$$\phi(x,t) = \bar{\phi}(x,t) + \phi'(x,t)$$

$$\nabla(\rho\bar{U}) = 0$$

$$\frac{\partial\rho\bar{U}}{\partial t} + \nabla(\rho\bar{U}\bar{U}) = g - \nabla\bar{p} + \nabla(\nu\nabla\bar{U}) + \overline{U'U'}$$

$$\overline{U'U'} = \nu_t(\nabla U + (\nabla U)^T) + \frac{2}{3}kI$$

$$k = \frac{1}{2}\overline{U'U'}$$

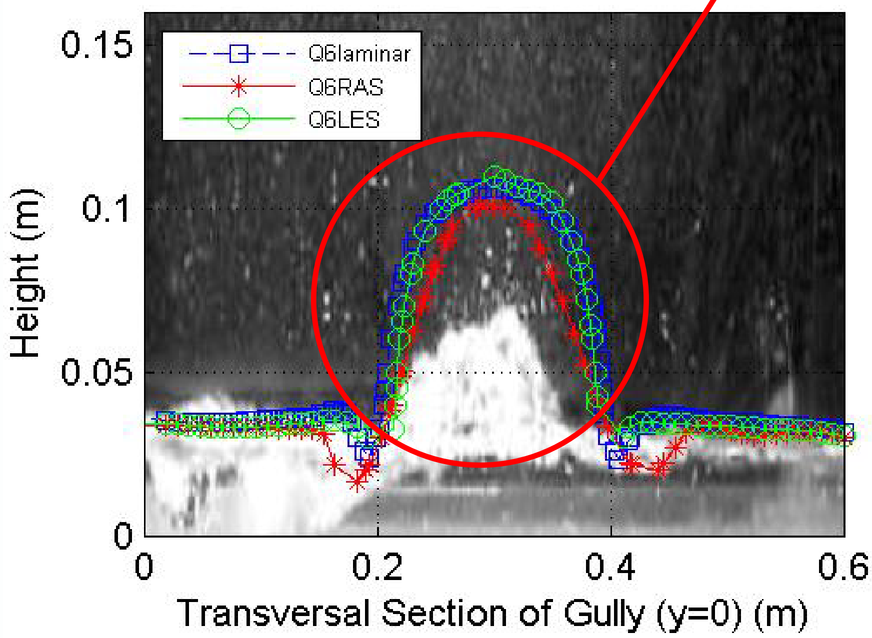
$$\nu_t = C_\mu\frac{k^2}{\varepsilon}$$

$$\varepsilon = \nu\overline{U'U' : \nabla U'}$$

Tests performed

Flow with 6 liters/second

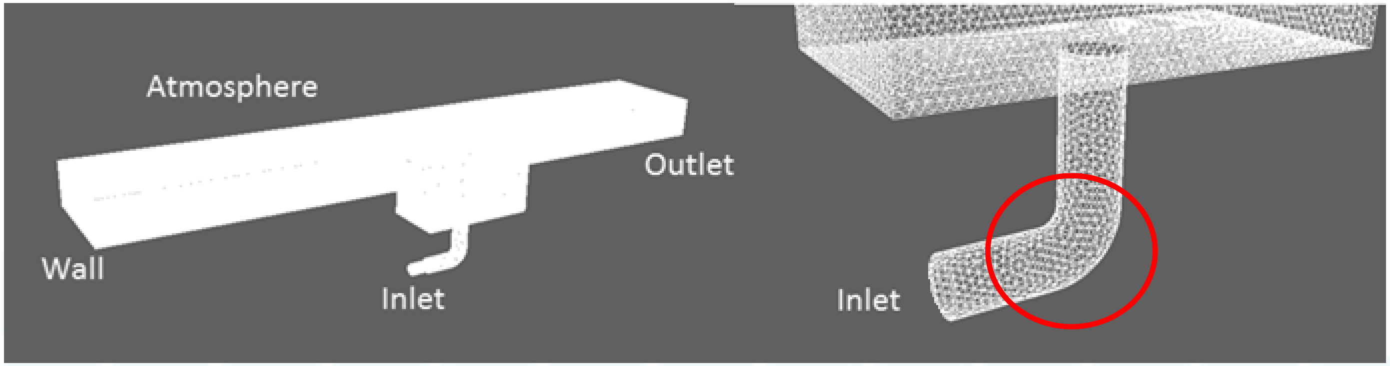
Distant of the experimental results



2 - Gully with Inlet Curve (GIC)

- Non-Regular and Non-Uniform (Thetraedrical cells)
- Ranging spaces 1 to 1.5 cm
- Created with *SALOME-Platform*
- Influence of the curve + curve losses

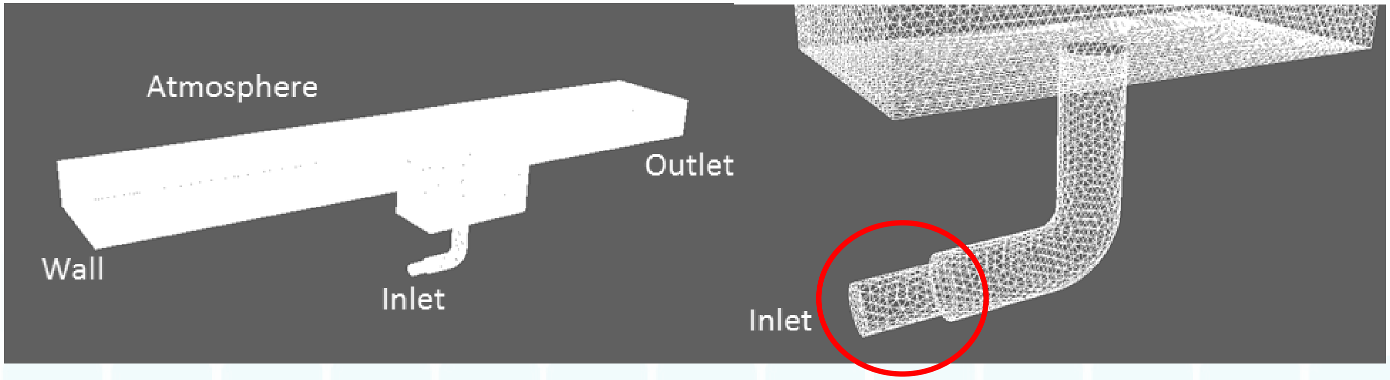
Boundary conditions



3 - Gully with Inlet Curve and Energy Losses (GICEL)

- Non-Regular and Non-Uniform (Thetraedrical cells)
- Ranging spaces 1 to 1.5 cm
- Created with *SALOME-Platform*
- Influence of the curve + curve losses + installation losses

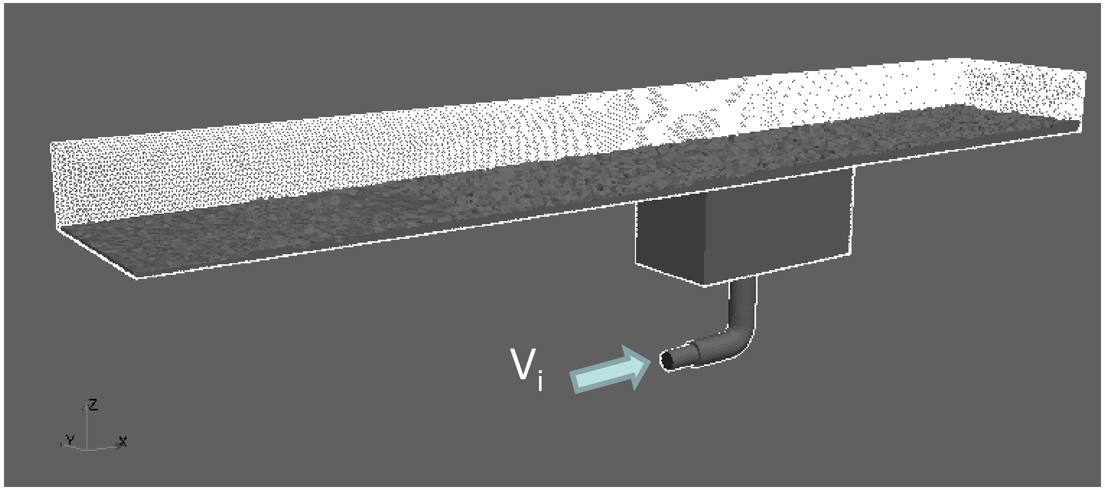
Boundary conditions



(Lencastre,1987)

MESH 3 - Gully with Inlet Curve and Energy Losses (GICEL)

Inicial Conditions

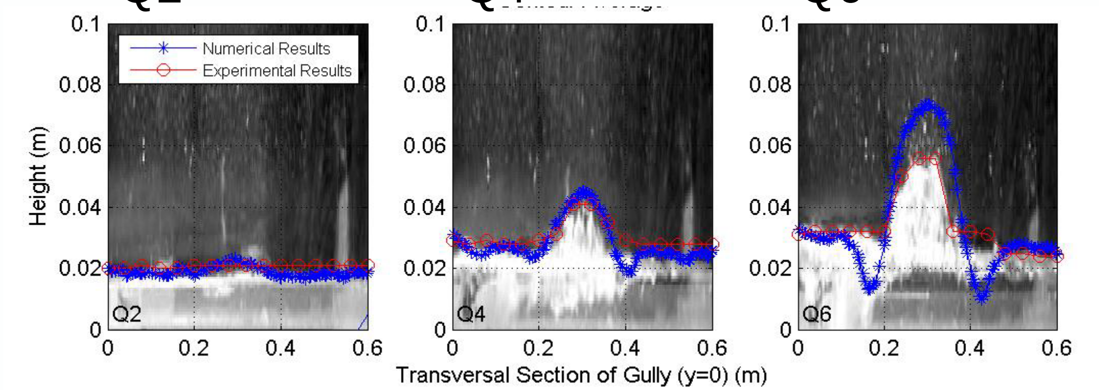


	Q (m^3/s)	D (m)	V_i (m/s)
Q2	0.002	0.06	0.707
Q4	0.004	0.06	1.414
Q6	0.006	0.06	2.122

Tests performed

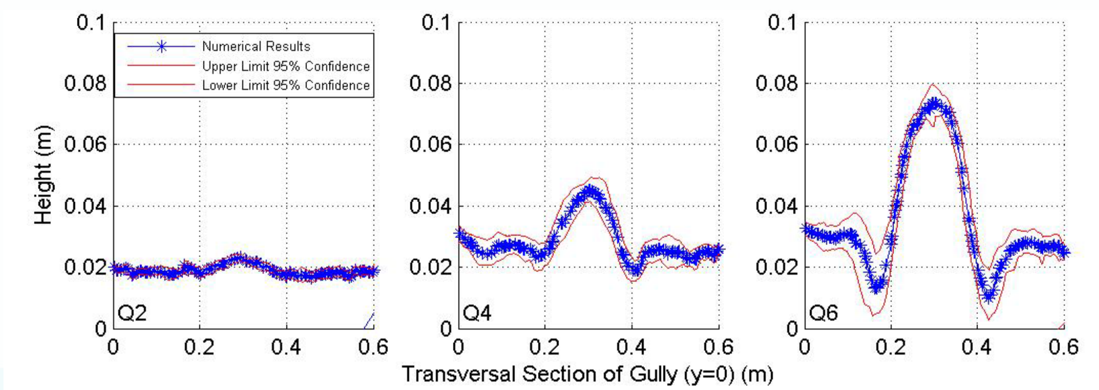
Contour Average

Q2 Q4 Q6



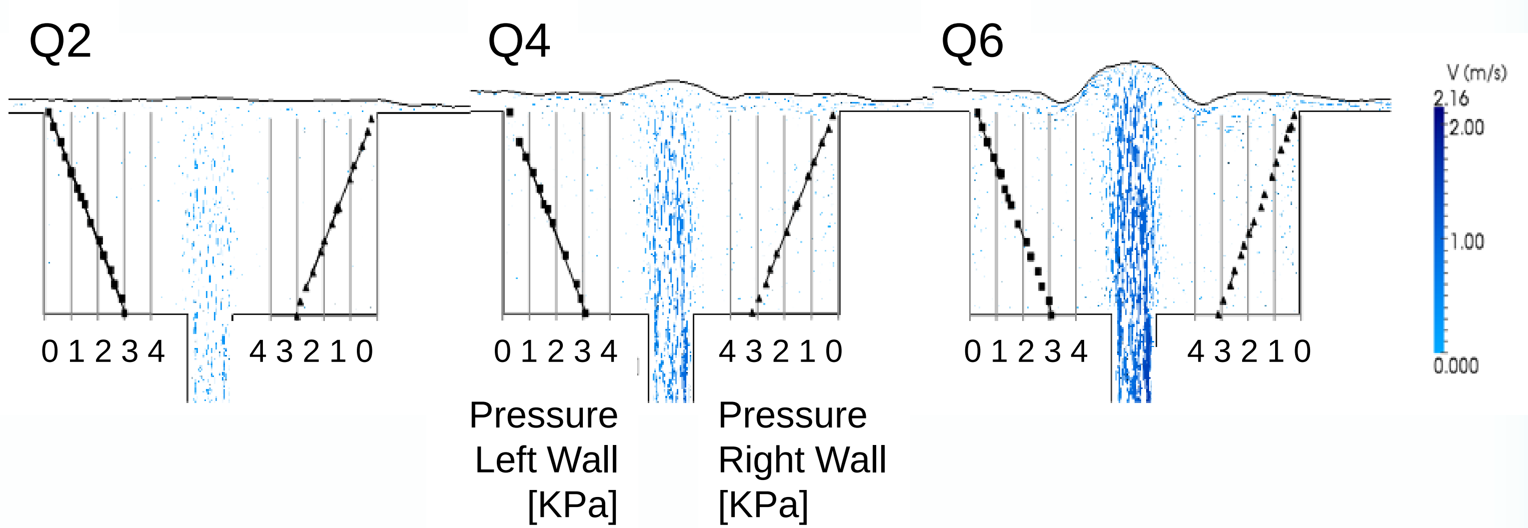
Limits of 95% confidence interval for the average

Q2 Q4 Q6



Tests performed

Pressure at left and right wall



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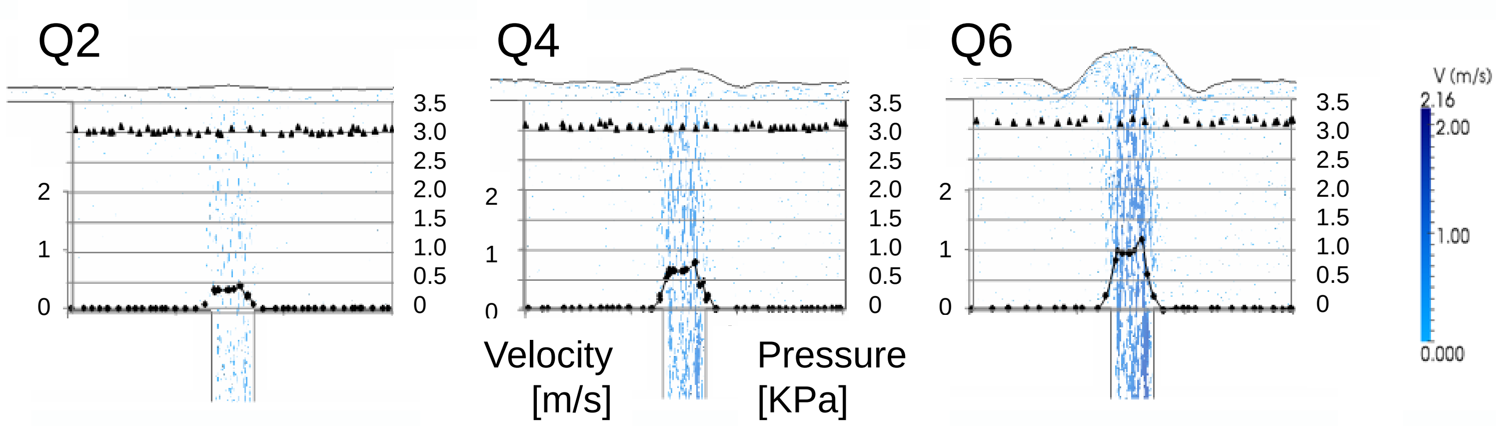
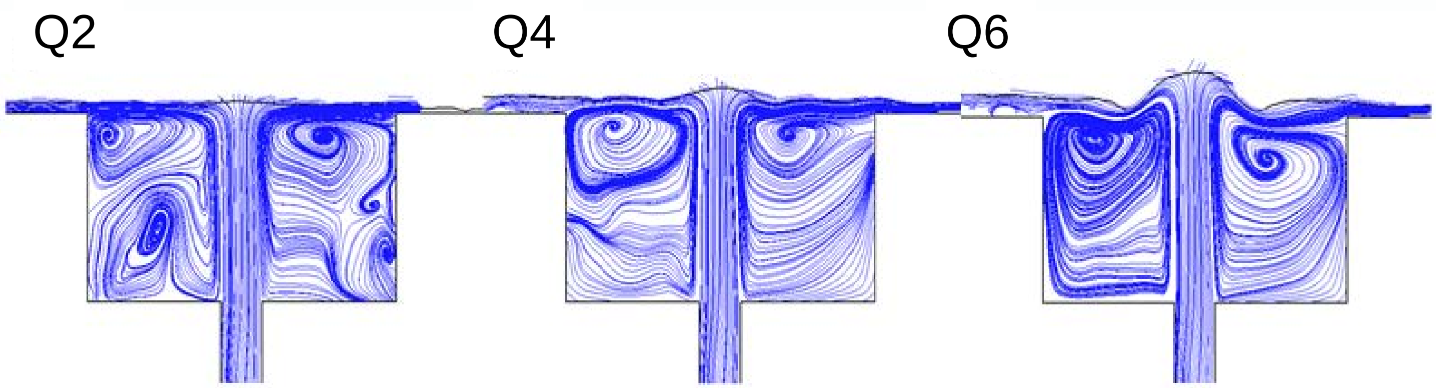
Tests performed

Velocity and pressure at gully bottom



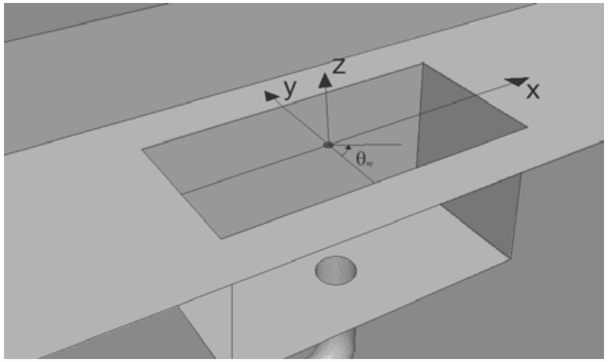
Tests performed

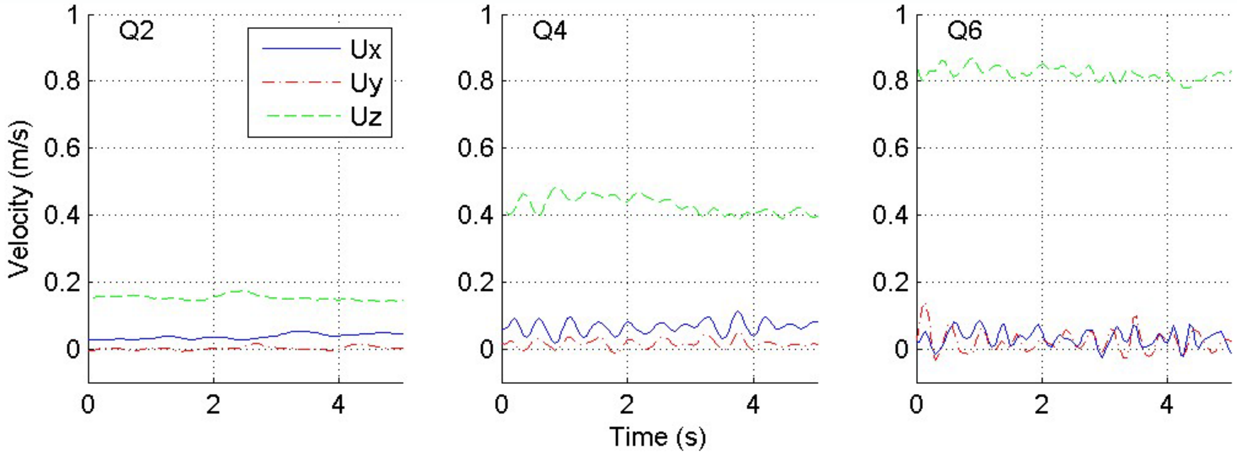
Stream Lines



Tests performed

Velocities in directions x, y and z





Tests performed

Introduction
Objectives
Experimental Setup
Mesh Generation
Numerical Simulations
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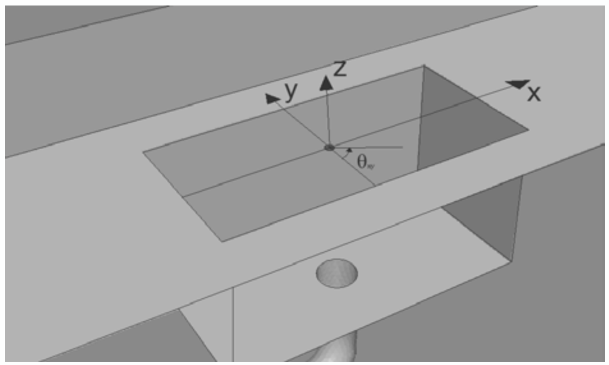
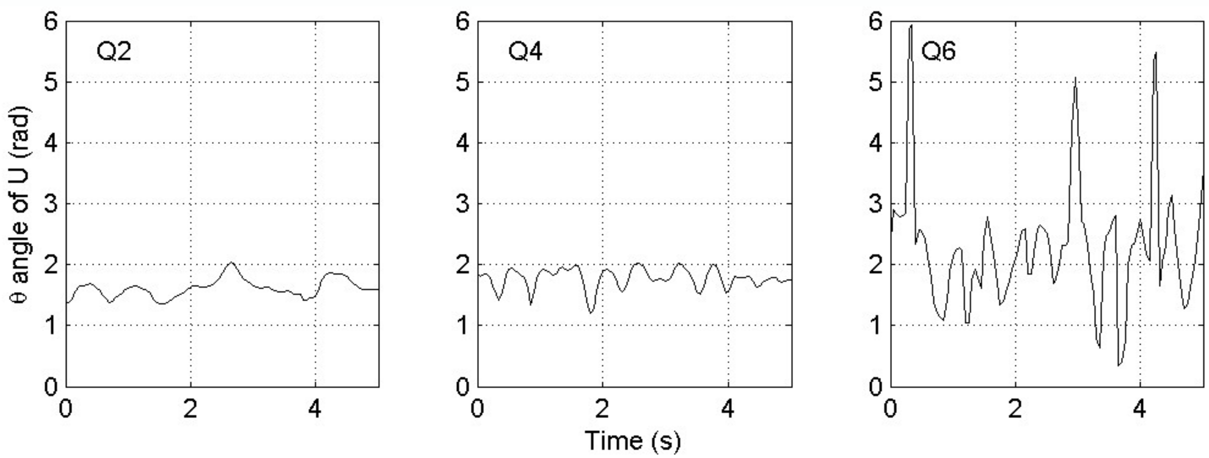
Conclusions

Angular variation of velocity





Tests performed

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Objectives

Experimental Setup

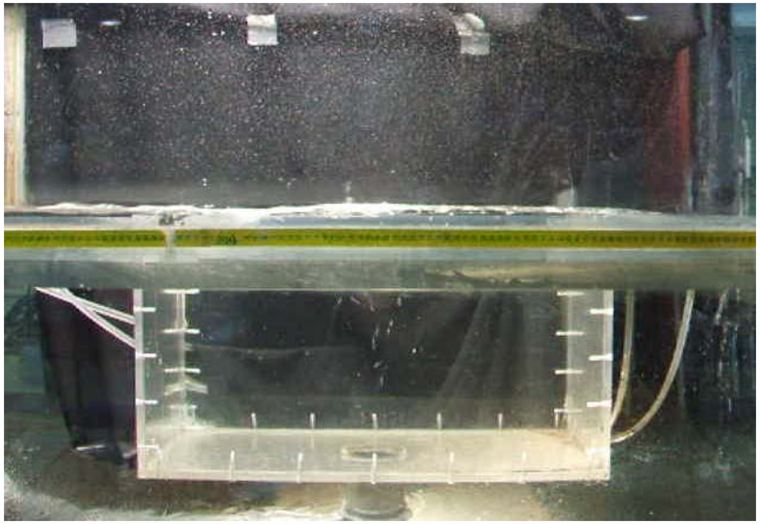
Mesh Generation

Numerical Simulations

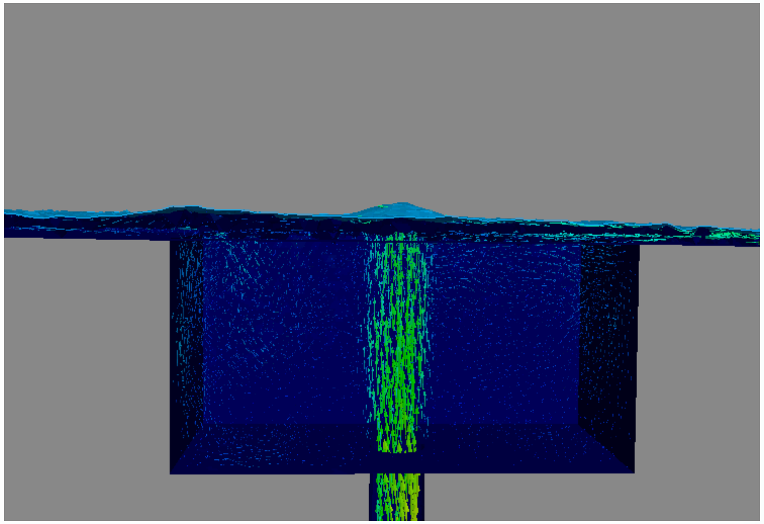
Results

Conclusions

Experimental Q4



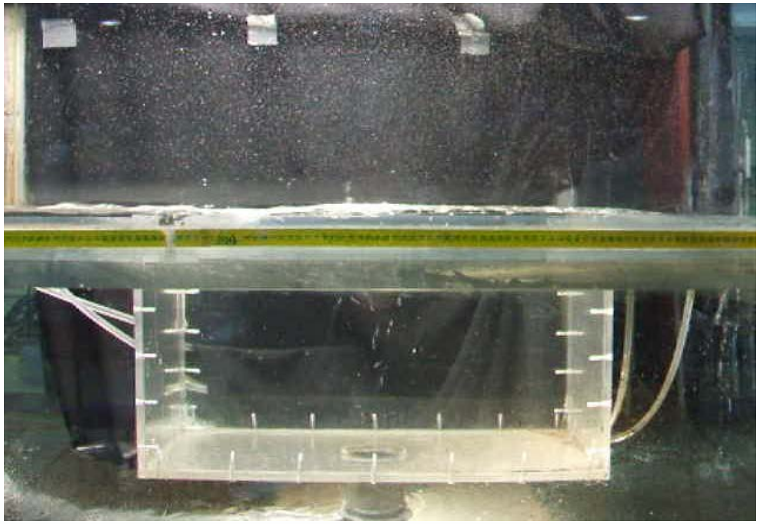
Numerical Q4 (using laminar)

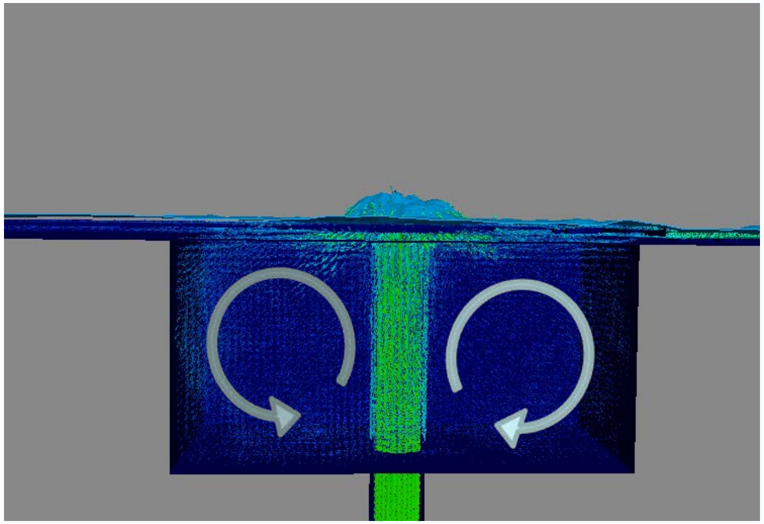


Tests performed

Experimental Q4

Numerical Q4 (using LES)





Further testing, using LES

Conclusions

- Useful tool
- Mesh generation and experimental setup;
- Fully characterized.

Thank you for your attention

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