Experimental and numerical investigation of deposition in sewer detention tanks

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Summary

1. Presentation of ‘Urban hydraulics’
2. Introduction of this study
3. Experimentation
4. Numerical modelling
5. Conclusion and outlook
Urban hydraulics

- Pluviometry
- Catchment area
- Receiving watercourse
- Grates
- Venturi flume
- Wastewater treatment plant
- Sewer system
Urban hydraulics

Hydraulic works:
Grates, pipes, CSO chambers, detention tanks, Venturi flumes...

Numerical modelling

Experimentation

Hydraulics

Sediment transport

Design

Diagnosis

Instrumentation

Research

Engineering
Summary

1. Presentation of ‘Urban hydraulics’
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3. Physical modelling
4. Numerical modelling
5. Conclusion and outlook
Introduction

- Objective of the whole study: operational tool for the design and the rehabilitation of sewer detention tanks
  - numerical model
  - technical guidelines

- Need for experimental data about trap efficiency and spatial distribution of deposits
Introduction

Rectangular tanks

Physical models:
- Stovin (1997) - Univ. Sheffield
- Dufresne (2008) - INSA Strasbourg
- Kantoush (2008) - EPFL
- Dufresne, Dewals et al. (2009) - ULg
- Camnasio (2010) - Milano, EPFL

Circular tanks

Physical model:
- In project (2011)

Complex geometries

Real-life applications
Introduction

Rectangular tanks

Complex geometries

Circular tanks

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Physical model:

Data for developing and/or optimizing numerical models

Real-life applications

Data for testing numerical models
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Spatial distribution of deposits

- 2.4 mm
- 1,020 kg/m³
- 25 mm/s

Fr = 0.2
h/ΔB = 0.6
Trap efficiency
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Numerical modelling

• **Software:** Ansys Fluent (3D)

• **Flow models:**
  – Isotropic turbulence model: k-ε
  – Wall treatment: standard wall functions
  – Free surface: symmetry plane

• **Particle transport:**
  – Lagrangian particle tracking
  – Specific treatment for deposition on the bed: bed shear stress, bed turbulent kinetic energy
Lagrangian particle tracking

If value < threshold
Then deposition

Bed of the tank

Trajectory of the particle

If value > threshold
Then resuspension
Numerical modelling

<table>
<thead>
<tr>
<th>EXPERIENCES</th>
<th>SIMULATIONS</th>
<th>BSS\textsubscript{critique} = 0.03 Pa</th>
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<tbody>
<tr>
<td>(3) 2.0 L/s</td>
<td>CL = 0.15</td>
<td>CL = 0.5</td>
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<tr>
<td></td>
<td>0.40 m/s</td>
<td>0.40 m/s</td>
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<td></td>
<td>CL = 1</td>
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<tr>
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<td>0.40 m/s</td>
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<td></td>
<td>CL = 2</td>
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Numerical modelling

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<tr>
<td>(49) 1.0 L/s</td>
<td>CL = 0.15</td>
<td>CL = 0.5</td>
</tr>
<tr>
<td></td>
<td>CL = 1</td>
<td>CL = 2</td>
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</tbody>
</table>

- EXPERIENCES: Image showing an experiment with 1.0 L/s flow rate.
- SIMULATIONS: Graphs showing particle distribution for different CL values:
  - CL = 0.15
  - CL = 0.5
  - CL = 1
  - CL = 2
Numerical modelling

![Graphs showing trap efficiency vs. inflow velocity for Asym. flow and Sym. flow, with different obstacle and column configurations.](image-url)
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Conclusion and outlook

• Conclusion:
  – Experimentation => Large dataset of experimental results
  – Numerical modelling => New bed boundary condition
  – Good reproduction of the spatial distribution of deposits
  – Overestimation of the trap efficiency in most cases

• Outlook:
  – Taking into account the anisotropy of turbulence near the bed
  – Threshold values
  – Circular tanks
  – Real-life applications
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