Hydraulic study of a combined sewer overflow using 3D modelling
SUMMARY

- Methodology
- CSO background
- 3D model and mesh
- Results
- Conclusions
METHODOLOGY

Simulation results

Mesh + 3D model (modelling strategy)

Identification of the deciding factors (e.g.: upstream or downstream influence)

Topography of the Studied CSO

Available data (in situ sensors)

Analysis of the results (are they plausible, Credible, consistent?)

Comparison with available data if any

Is the analysis conclusive?

No

Yes

CSO diagnosis
Establishment of operating laws
CSO BACKGROUND
CSO BACKGROUND

- Current measurements monitor the flow sent to WWTP
- Sensors are settled in the downstream chamber
- Sensors are height (aerial ultrasonic sensor) and velocity (inflow Doppler sensor) measurements
- Needs to monitor discharge and inlet flows
CSO BACKGROUND

CSO Chamber

Exceptional filling

Occasional filling

Regular filling
3D MODEL AND MESH

- Turbulence model: k-ε RNG
- Inlet condition: mass-flow inlet
- Outlet condition: pressure-outlet or velocity-inlet with a negative velocity (downstream influence)
3D MODEL AND MESH

805 309 cells
RESULTS

- A campaign of 30 calculations is planned (due to the downstream influence)
- The 30 free-surfaces are analysed to:
  - find where to settle an aerial height sensor in order to monitor the inlet flow
  - find where to settle an aerial height sensor in order to monitor the discharged flow
- The 30 velocity fields are analysed to:
  - check the reliability of the current measurements
RESULTS

Example of simulation results

Free-surface for an inlet-discharge of 0.270 m³.s⁻¹ and an imposed outlet discharge of 0.050 m³.s⁻¹
RESULTS

Settlement of a height sensor that allow to monitor the discharge flow

Inlet section of the CSO

0.55 m

2.24 m
RESULTS

f(x) = 1.79x - 0.45
R² = 0.98

Discharge flow (m³.s⁻¹) vs. Water depths (m)

Adrien MOMPLOT
RESULTS

Using both height measurements (the new one and the current one), we can establish a law to monitor the inlet flow.

\[ Q_{\text{inlet}} = 0.925 \times H_{\text{upstream}}^2 + 0.125 \times H_{\text{downstream}}^2 + 1.363 \times H_{\text{upstream}} - 0.201 \times H_{\text{downstream}} - 0.316 \]
RESULTS

- Using the calculations result, we can check the Doppler measurements reliability.
RESULTS

- Doppler velocities are calculated using the following formula:

\[ V_{moyDoppler} = \frac{\sum_{i=1}^{n} \frac{V_i}{d_i^4}}{\sum_{i=1}^{n} \frac{1}{d_i^4}} \]

<table>
<thead>
<tr>
<th>V10cm (m/s)</th>
<th>V20cm (m/s)</th>
<th>V30cm (m/s)</th>
<th>Vitesses Doppler (m/s)</th>
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<td>0,547</td>
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<tr>
<td>32</td>
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<td>1,557</td>
<td>1,302</td>
</tr>
</tbody>
</table>
RESULTS

- The red line represents the ideal case (measurements and calculations are concordant)
- The blue line represents the real case: measurements tend to overestimate slightly the flow
CONCLUSIONS

• Current measurements are validated (both uncertainties and accuracy are acceptable)

• Discharge flow can be monitored with a unique height sensor in the CSO chamber

• Using the current height sensor and the new one defined in the CSO chamber, it is possible to monitor the inlet discharge with reasonable uncertainties and accuracy
Nos partenaires:

ÆGIR

deep

ANSYS FLUENT

PULSALYS

INSALVA
Annexes

Pour le calcul 1

À 10 cm

Pour les calculs 4, 8, 27 et 32

À 10 cm

À 20 cm

À 30 cm

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