AN EXPERIMENTAL STUDY OF SEDIMENT ACCUMULATION, EROSION AND TRANSPORT PROCESSES IN COMBINED SEWER PIPES

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Abstract

The analysis of the sediment accumulation, erosion and transport processes in combined sewers is a key issue within urban drainage systems. Sewer sediments represent the main source of pollution in sewer systems to the receiving environment. To better understand these processes, an experimental campaign was design and carried out in a Flume Test Facility, in which wastewater flow conditions could be provided. New techniques and methodologies were developed in this facility to increase the accuracy in the measurement of the accumulation and transport of in-sewer sediments, such as the Structure from Motion (SfM), as well as to analyse their physicochemical properties. As a result, a large dataset was obtained to develop advanced strategies for the design, operation and maintenance of combined sewer systems.

Keywords: combined sewer pipes, sewer sediments, bed load transport, biodegradability, photogrammetry.

Methods

A large number of experimental campaigns were conducted to understand the accumulation, erosion and transport of sediments in combined sewer pipes. For this purpose, a Flume Test Facility was set up in the wastewater treatment plant (WWTP) of A Coruña (Spain). This facility allows different sewer pipe geometries to be tested under **close-to-real conditions** by supplying wastewater from the WWTP.

New methodologies were implemented to characterize sediments deposited in pipes:

- Structure from Motion **(SfM)**. To obtain the sediment bed morphology.
- Analysis of the chemical oxygen demand **(COD)** and the oxygen uptake rate **(OUR)** from sediment samples. To determine the sediment biodegradability and its influence on sediment transport.

Figure 1: Flume Test Facility at WWTP of A Coruña.

Figure 2: Bed deposit mesh from SFM reconstruction.

Results

Accumulation tests:

- Linear increases in the sediment heights were obtained during the first 7-10 d.
- Accumulation rates ranged [0.8-6.2] mm/d.
- Volatile fraction, COD and OUR values decreased as the accumulation time raised.

Erosion and transport tests:

- Bed forms were observed in some of the erosion tests and could be measured with the SfM technique.
- Erosion tests performed with freshly deposited sediments showed a lower bedload transport threshold than those performed with consolidated bed deposits.
- Capacity bedload transport formulas based on organic sediment tests were consistent with the results if the eroded depth was higher than 5 mm.

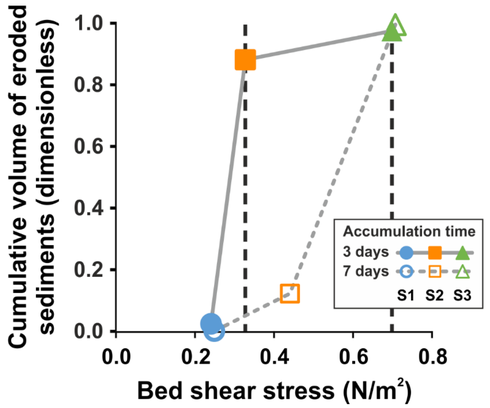

Figure 3: Influence of the accumulation time in bed erosion.

Conclusions

- The accumulation time during dry weather flow conditions was a meaningful parameter due to its relationship with the degradation of the organic matter. The biodegradation of the bed sediments provided an increase in bed erosion resistance and cohesion, and reduced the scouring capacity.
- The formation of ripples influenced the bed shear stress.
- The application of bedload transport capacity formulas in sewer pipes showed a high uncertainty due to: (i) the relationship between biodegradability and bed shear stress and, (ii) the limited availability of sediment, which is influenced by the existence of non-erodible fixed beds.

Bibliography

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