ACOUSTICS2008/1304
Multi-modal acoustic propagation in pipes with arbitrary defects: theory and experiments

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Underground sewer systems are prone to flooding incidents caused by obstructions such as sediment deposits and wall deterioration. An efficient method for identifying and characterising these obstructions involves measuring the amplitudes of the reflected and transmitted acoustic normal modes excited by a point source in the sewer pipe. However, the behaviour of higher order modes in relatively large pipe work is often difficult to predict and interpret. In order to provide a greater physical insight into the measured data and to guide future experimental work, theoretical predictions have been developed and validated. The presented theoretical work is based on a finite element method and a mode matching technique. In this paper the predicted and measured sound fields are analysed for up to four acoustic modes reflected from two different obstacles (axisymmetric and non-axisymmetric) deposited in a 150 mm diameter uPVC pipe.