TRANSIENT PRESSURE SIGNALS FOR LEAK LOCATION IN THE BALMASHANNER BRANCH MAIN AT SCOTTISH WATER

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A continuing and urgent need for novel methods of detecting, locating and sizing leaks led many researchers to investigate transient-based techniques for leak location in water transmission pipelines and distribution systems for the last ten years. Pressure transients that naturally occur in pipe systems propagate back and forth in the pipes and carry information about features of the system. The recognition of these features allows their identification and location, thereby providing a potential tool for leak detection. Different techniques have been investigated based on the time and frequency analysis of transient pressure signals. Most of these have been conceptually developed, existing very few studies of their actual validation with field data.

The current paper focuses on leakage detection and location in life pipe networks by means of the generation of artificial transient events in the systems. The results of a field programme that has been carried out under Work Package 3 (WP3 - Leakage Detection) of the joint European Commission's Fifth Framework 'Growth' Programme via the Thematic Network "Surge-Net" are reported. WP3 was jointly carried out by Scottish Water (SW), Instituto Superior Técnico (IST) and University of Perugia (UoP). The paper summarises the work developed and results obtained under WP3 whose objective is leak detection in pipelines using transient pressures.

Several transient tests were carried out in a Scottish Water real life system with simulated pipe bursts - the Lintrathen East Trunk main network (Dundee, UK).. Field tests reported herein refer only to Balmashanner main, which is one of the branch mains of Lintrathen East Trunk main that supplies the service reservoir in Balmashanner by gravity (Fig. 1). Balmashanner branch main is a 300 mm diameter ductile iron pipe, with 5,936 m length and a "C" Hazen Williams coefficient of 130. The location of a "simulated burst" was located at ca. 3,000 m from the downstream end service reservoir and is simulated with an existing scour valve. A series of transient tests were carried out with a simulated leak in the pipe system for different leak flows.

Collected transient data have been used for testing and validating two transient-based leak detection approaches, i.e. time analysis of the leak reflected wave (Fig. 2) and inverse transient analysis (Fig. 3). Both methods have proven to be successful in the detection and location of leaks of a 'reasonable' size, providing that physical and hydraulic characteristics of the system are known, the transient is generated by a fast-linear maneuver of a valve, and, in the case of ITA, an accurate transient solver is used. ITA was applied in a step-wise manner, starting with a description of leak candidates equally spaced at 10% of the total pipe length and gradually reducing it to 2% and 1% near the potential leak location. Leak location uncertainties depend on the leak size and location, and location where the transient event is generated, being, in general, about 1% of the total pipe length. Both techniques are very promising method for identifying the area of the water supply system with leakage, mainly in long trunk main. ITA seems to be particularly useful important for the diagnosis, monitoring and control of existing systems, not only to estimate leak locations and sizes, but also for a better understanding of the causes of pipe bursts induced by transient events.

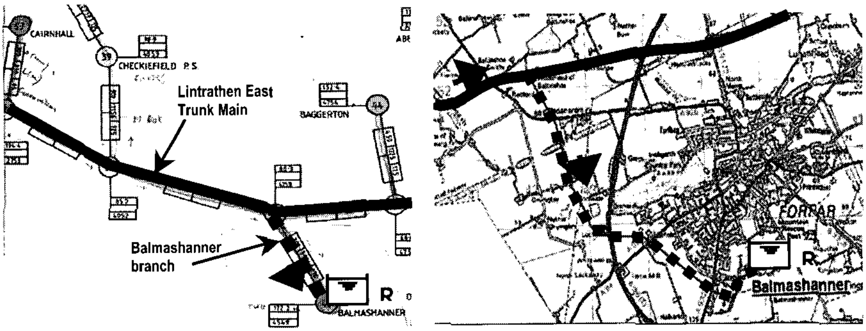

Fig. 1 Balmashanner branch main of Lintrathen East Trunk Main Network (Scottish Water, UK)

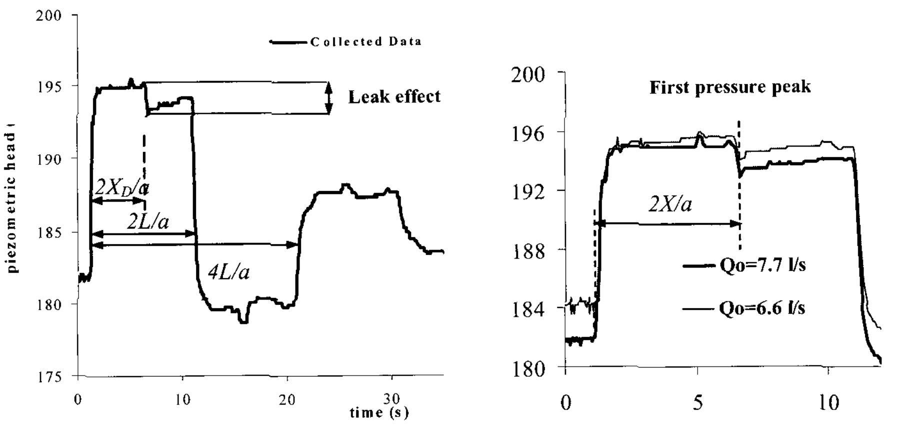

Fig. 2 Leak effect in the piezometric head variation due to a fast downstream valve closure

(a)

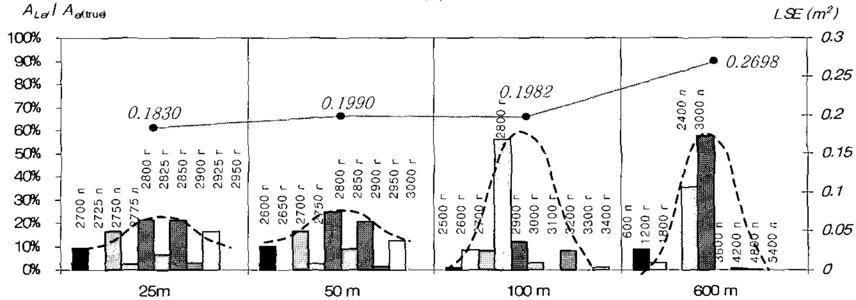

Fig. 3 Leak detection for BALM 7: optimal relative leak sizes and respective LSE.

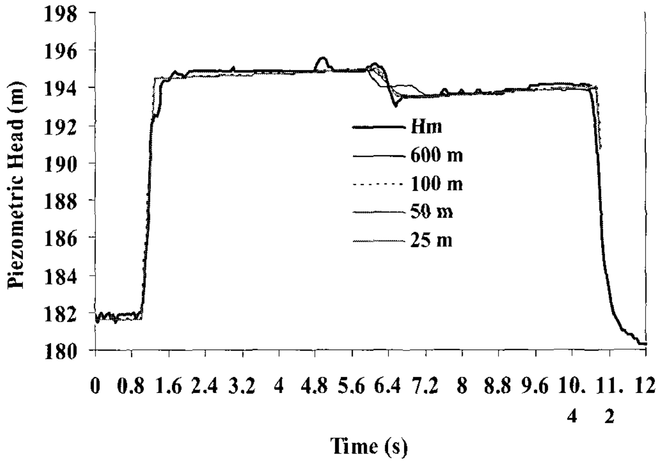

Fig. 4 Leak detection for BALM 7: (a) optimal relative leak sizes and respective LSE; (b) optimal piezometric heads and experimental data