Advanced Condition Assessment & Pipe Failure Prediction

Optimal management of water infrastructure

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Progress on Activity 1

Monitoring and modelling of pressure transients for pipe failure analysis

Objectives

In Activity 1, we try to answer the question how, where and when pipes fail in a network. Therefore, prediction of pipe failure is central considering internal/external factors. Water pressure including pressure transients is an important internal factor that can contribute to pipe failure. As part of the development of pipe failure prediction models, it is important to examine the likely transient development in local networks. Furthermore, any calibration of failure models developed would require likely transient pressures on top of static pressure for rational analyses. To facilitate this, static and transient hydraulic model of selected network is to be developed and be calibrated with field monitoring of transient events. The specific objectives of this component of Activity 1 research can be listed as:

- identify a section of network for the analysis, which has been reported to have experienced pressure transient events;
- undertake EPS (Extended Period Simulation) to obtain appropriate boundary conditions for the pressure transient modelling for the identified network section;
- develop the pressure transient model and select locations for monitoring;
- monitor selected locations in the pipe network for pressure transients; and
- calibrate the pressure transient model and undertake modelling of pressure transient development under various field scenarios.

After calibrating the hydraulic model, the failure prediction models developed will be used to analyse failures within the network against the pressure data combined with the inspection data to understand the impact of pressure transient on pipes with certain condition. Therefore, it is expected that (calibrated) failure prediction models developed may be used more reliably with the improved condition assessment and corrosion prediction that will be undertaken in Activity 2 and 3 respectively.

Model development

Two separate models have been developed for EPS and pressure transient simulation. EPANET software is used for EPS and model calibration was undertaken by using data from the SCADA (Supervisory Control and Data Acquisition) system of the respective water utility.

No skeletonization has been made to the original model as this can modify a likely transient wave. Analysis needs to be carried out for a few minutes only as the magnitude of the transient wave damps out with time as a result of the pipe friction, demands, pipe junctions and loops. Appropriate boundary conditions (e.g., reservoir levels etc.) are obtained from the calibrated EPS model to initiate transient simulation. A dynamic friction model is used to introduce changes in head losses as the flow changes with time during transient events. The pressure sensitive demand is used in the model, since the demand at a particular point needs to be updated with the change of pressure during the simulation. Most up-to-date information about pumps, valves and system demand was obtained through GIS data bases from the respective water utility.

Field monitoring

Field monitoring of pressure transients has been started with a Radcom high speed pressure transient data logger which has the capacity of recording 20 readings per second. The purpose of pressure monitoring is to capture transient events if any occur during the normal operational conditions and to obtain possible magnitude of pressures.

Preliminary results

Extended period model calibration.

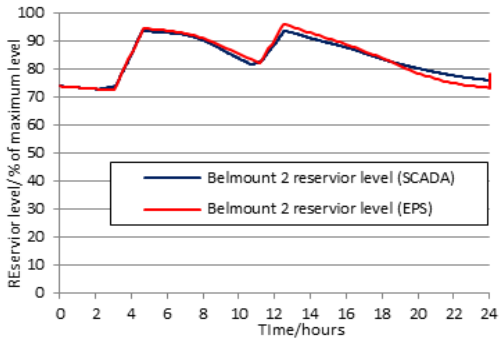

Figure1. Reservoir level calibration

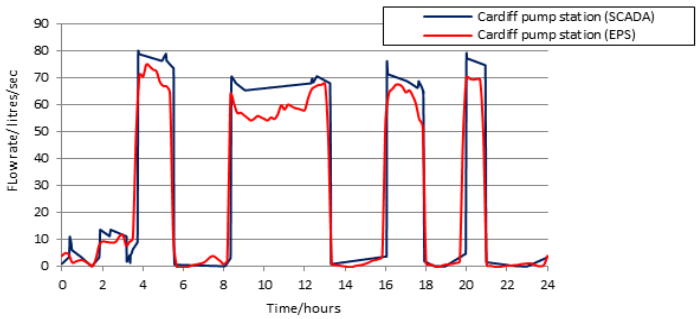

Figure2. Flow rate calibration

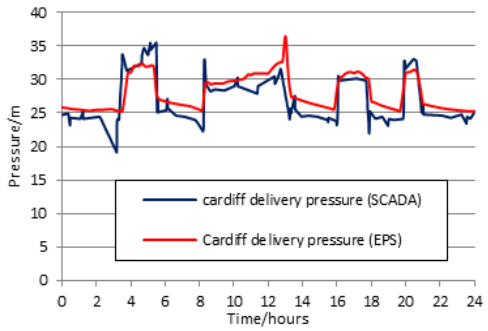

Figure3. Water pressure calibration

Transient Pressure Monitoring

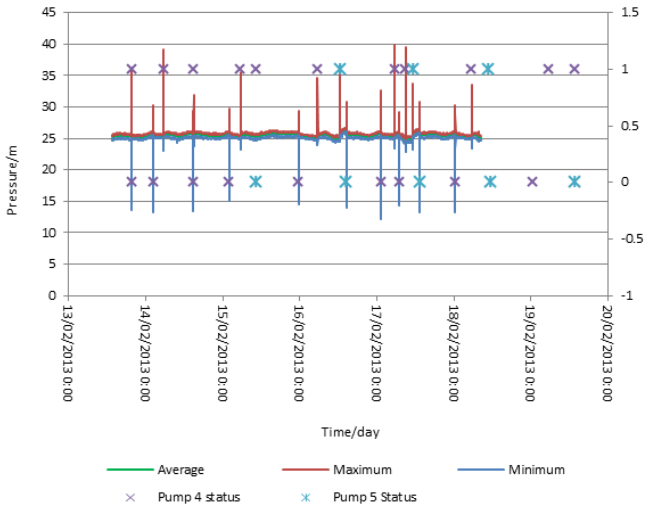

Figure4. Transient pressure monitoring data of Hunter Water network (monitoring location is about 2.5-3km downstream from main pump station).

Concluding remarks

EPS results indicate that the steady-state hydraulic model is consistent with SCADA data. This shows that the surge model developed on the basis of GIS data may be able to accurately represent the actual field conditions as the EPS model is based on the same GIS data. Preliminary results of field monitoring show that there are transients occurring during the pump start up and shutdown. The pressure transient measurements that have been obtained about 3 km downstream from the pump station indicated occurrence of transient events in the order of ±100kPa. More comprehensive monitoring is planned to capture the full extent of transient events across the network, especially closer to the pump stations.

Partners

The partners in this research project include Sydney Water Corporation, UK Water Industry Research Ltd, Water Research Foundation of the USA, Water Corporation (WA), City West Water, Melbourne Water, South Australia Water Corporation, South East Water Ltd and Hunter Water Corporation. Monash University leads the research supported by University of Technology Sydney and the University of Newcastle. Other collaborators include Dr Balvant Rajani from Canada.

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