Advanced Condition Assessment & Pipe Failure Prediction

Optimal management of water infrastructure

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Progress on Activity 1

Numerical modelling of pressure transients in Hunter Water to predict critical pipe failure

Objectives

Internal and external factors, which contribute to pipe failures, have been studied extensively during this research project. Internal pressure was identified as the most critical loading to cause high stresses in large diameter water pipes. A pressure monitoring program, which was carried out as a part of this project, measured the pressures in two selected sections (section A and B) in the Hunter Water network. This data provides pressure variation in the several selected locations in the network. But this data cannot be used to obtain pressure distribution across the entire network. In order to obtain the pressure distribution across the entire water network pressure transient hydraulic modelling was carried out using the Surge 2000 (KYPIPE) computer program. Prior to performing pressure transient analysis, an Extended Period Simulation (EPS) was carried out to understand the behavior of two sections during steady state operation. Such models, once validated, can be used to obtain the pressures at the locations of previous failures to understand the possible causes of pipe failure.

Methodology

An extended period simulation was carried out using an EPANET program for a selected day. Subsequently, pressure transient hydraulic modelling was performed. No pipe sections were removed from the original network data; instead, continuous pipe segments shorter than a specified length were combined into a single pipe in order to eliminate the possible computational instability issues with Surge 2000 program. Associated such as pressure sensitive demand and dynamic friction options were used to improve the accuracy of the results. Three pump events from main pump station of section A and two pump events and one valve closure event from section B were selected for the model validation. Several models were run to check the sensitivity of unknown parameters. Finally, pressure maps were developed to show the pressure distribution in the entire network during a pressure transient event.

Results

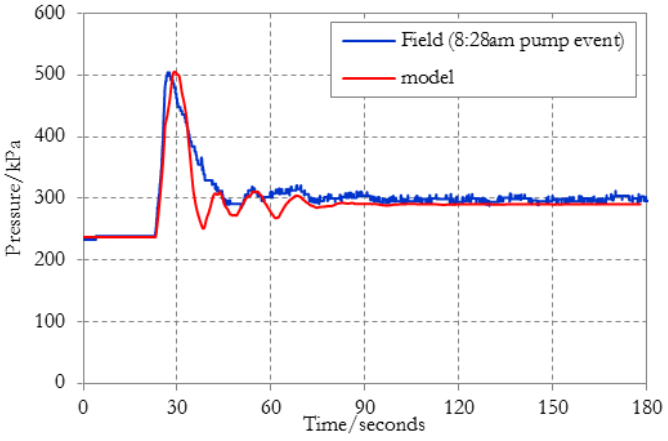

Figure1. Comparison of model and field results (site 1) of 5s pump start-up event at section A.

Industry Partners

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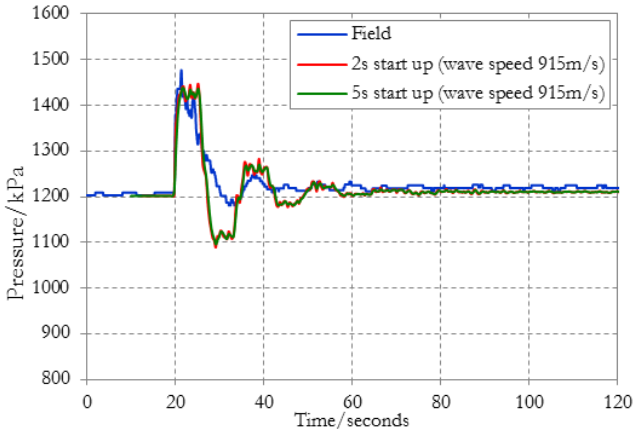

Figure 2. Comparison of model and field results (site 6) of pump start-up event at section B (13/07/2013).

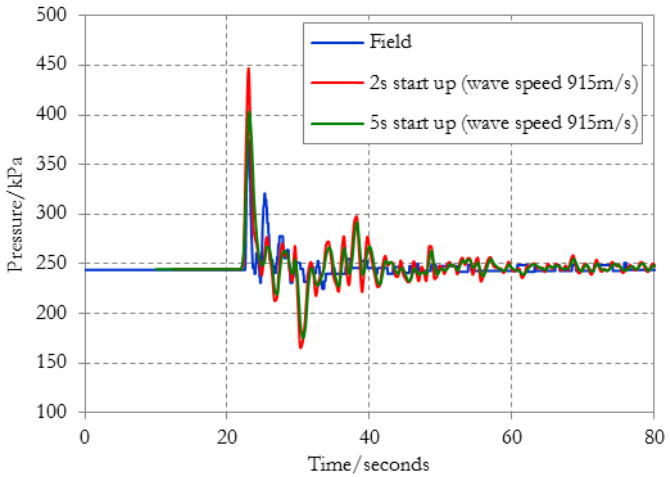

Figure 3. Comparison of model and field results (site 7) of pump start-up event at section B (13/07/2013).

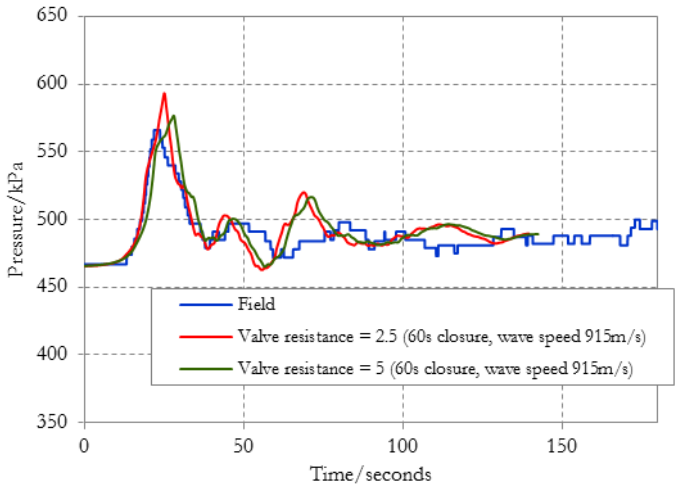

Figure 4. Comparison of model and field results (site 10) of valve closure at reservoir 9 AIV (13/07/2013)

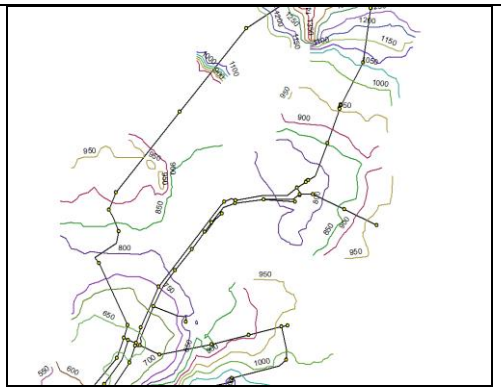

Figure 5. Pressure contour map developed based on maximum pressure in the section B during 5s pump start-up event.

Concluding remarks

Field observed pressure transients were simulated quite accurately by the pressure transient hydraulic model. The computer model simulated the shape and the magnitude of the initial pressure pulse and the rate of initial pressure rise quite accurately. A significant amplification of pressure magnitude was observed when the pressure waves propagated into reticulation pipes. The numerical model was particularly accurate when the observed site is close to the event origin. But when the monitoring location is far away (e.g., 2 to 3 km) from the event origin, the model could not replicate the field observed pressure data with such accuracy. Field data showed considerably higher damping of pressure transient waves in comparison to model results. It is possible that the presence of more energy dissipation mechanisms in the field than are embedded in the model may cause this difference.

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. The authors would like to thank, specifically, Hunter Water Corporation for their valuable support on this work.

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