Advanced Condition Assessment and Pipe Failure Prediction Project

Optimal management of water infrastructure

Fact Sheet No. 1, April 2012

Urban water distribution systems around the world are becoming older and hence more prone to failure. Those parts of the system comprising large diameter pipes are especially critical since there are high risks and consequences of failure. When a critical pipe fails it is often spectacular and disruptive for the general public, but it also comes with very high capital, social,and environmental costs. Failure of critical water pipes is a global problem. In Australia water utilities spend over $1.4 billion annually on pipe maintenance. Critical pipe failure is a challenge to the cost effective management of water pipe assets.

In August 2011 international water research organisations, Australian water utilities and three Australian universities came together through a collaborative research agreement, and committed overall funding of $16 million (including $4 million cash) over five years to find ways of fixing this problem. 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, Hunter Water Corporation and Water Environment Research Foundation. Monash University leads the research supported by University of Technology Sydney and the University of Newcastle. Other collaborators include Dr Balvant Rajani.

Work has already started on Round 1 of the project which will cover three activities initially:

Activity 1 *How, when and where will pipes fail within the entire network?*
Activity 2 *How do we assess the condition of the pipe cost effectively?*
Activity 3 *How do we calculate pipe deterioration rates accurately with respect to the pipe environment?*

Other participants are expected to join the collaboration in Round 2 and, subject to confirmation of further funding, two more activities will be conducted.

Activity 4 *What is the time-dependent probability of failure along the pipeline?*
Activity 5 *How do we transfer the new knowledge to the industry for optimal pipe management?*

All five activities are due for completion by 2016

Activity 1 How, when and where will pipes fail within the entire network?

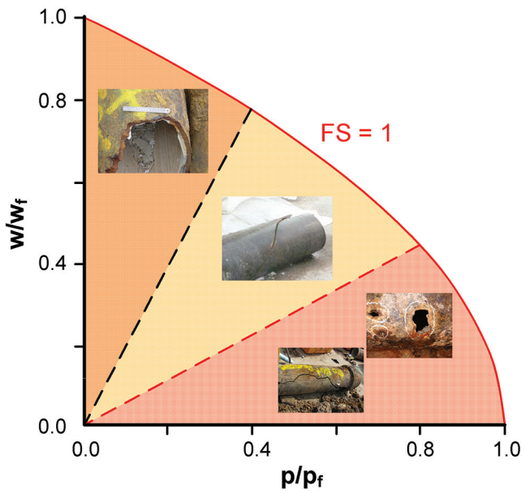
Associate Professor Jayantha Kodikara of Monash University is leading this Activity. Its aim is to establish improved methodologies to predict remaining physical life of critical pipes taking into account the effect of external and internal factors, different material types, and critical locations and factors within the network. This activity will draw from Activities 2 and 3 to establish failure state and to determine the physical remaining life of pipes.

Current work includes:

- Compiling and analysing pipe failure data from participants and related parties and identifying where, how and when pipes fail
- Compilation and measurement of pipe failure properties paying attention to pipe cohorts
- Corrosion pit categorisations and development of associated pipe failure prediction methods
- Instrumentation of field pipes to measure pressure transients and stresses from traffic loading and ground movement
- Use of optical fibres to monitor the performance of new pipelines.

The outcome of Activity 1 will be twofold: (1) Improved methods for estimation of pipe remaining life considering available information including condition assessment data; (2) Development of practical concepts for monitoring of new pipelines using optical fibres and other sensors.

For information on data exchange for Activity 1 contact **jayantha.kodikara@monash.edu**



Schlick diagram showing failure modes of pipes: is it relevant?

Section of Sydney Water test bed in western Sydney

Activity 2 How do we assess the condition of the pipe cost effectively?

Associate Professor Jaime Valls Miro and Professor Gamini Dissanayake of the University of Technology Sydney are co-leading this Activity. The aim of this Activity is to advance knowledge and improve levels of confidence of direct methods for condition assessment using advanced data interpretation techniques which have already been successfully employed in fields such as aerospace, cargo handling, undersea ecology, land vehicles and mining. Sydney Water has provided a decommissioned 600 mm diameter cement-lined cast iron pipe of 1.5 km length in Strathfield for this purpose, but it will support the other two Activities also.

Current work includes:

- Signing agreements with commercial service providers to trial proprietary measurement technologies
- Undertaking initial pipe condition assessment at different sites using magnetic flux leakage and broadband electromagnetic technologies
- Analysing and evaluating raw data from initial trials
- Conducting laboratory experiments on pipes used in trials
- The outcome of Activity 2 will be a method of accurately predicting sensor readings for a given geometric description of a buried large water main, and obtaining the best estimate of the pipe geometry from a set of measurements based on maximum likelihood principles.

For information on data exchange for Activity 2 contact **uts-water-mains@lists.feit.uts.edu.au**

Activity 3 How do we calculate pipe deterioration rates accurately with respect to the pipe environment?

Professor Robert Melchers of the University of Newcastle is leading this Activity. One of the foremost requirements of pipe failure prediction is the accurate estimation of pipe deterioration rates. Most ferrous pipes deteriorate because of various forms of corrosion while asbestos cement pipes degrade through cement leaching. Methods currently available for estimation of pipeline deterioration are purely empirical, insufficiently accurate and limited in application. The purpose of this Activity is to develop calibrated theoretical models to predict significant deterioration in the structural strength of buried pipelines on the basis of established scientific principles.

Current work includes application of 3D imaging techniques, such as photogrammetry, to characterize the surface state around the circumference of selected pipe sections provided by Sydney Water, and determination of the effect of soil conditions (including moisture content, soil type, soil water chemistry) on corrosion rate.

The outcome of Activity 3 will be the development and calibration of a realistic predictive model for pipe corrosion in soil. Associated with this outcome is the collection of data sets for measured pit depths and associated soil conditions, covering a wide range of climatic conditions.

For information on data exchange for Activity 3 contact **Robert.Petersen@newcastle.edu.au**

Example of a corroded pipe (photo courtesy of Hunter Water)

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