Engagement and Impact 2018

The University of Adelaide

ADE09 (ST) - Impact

Overview

Title

(Title of the impact study)

Pipe dream: in-use pipe assessment technology saving time and money

Unit of Assessment

09 - Engineering

Additional FoR codes

(Identify up to two additional two-digit FoRs that relate to the overall content of the impact study.)

Socio-Economic Objective (SEO) Codes

(Choose from the list of two-digit SEO codes that are relevant to the impact study.)

84 - Mineral Resources (excl. Energy Resources)

90 - Commercial Services and Tourism

Australian and New Zealand Standard Industrial Classification (ANZSIC) Codes

(Choose from the list of two-digit ANZSIC codes that are relevant to the impact study.)

28 - Water Supply, Sewerage and Drainage Services

Keywords

(List up to 10 keywords related to the impact described in Part A.)

Pipe condition assessment

Water distribution systems

Wall deterioration

Transients

Sensitivities

Commercially sensitive

No

Culturally sensitive

No

Sensitivities description

(Please describe any sensitivities in relation to the impact study that need to be considered, including any particular instructions for ARC staff or assessors, or for the impact study to be made publicly available after EI 2018.)

Aboriginal and Torres Strait Islander research flag

(Is this impact study associated with Aboriginal and Torres Strait Islander content?
NOTE - institutions may identify impact studies where the impact, associated research and/or approach to impact relates to Aboriginal and Torres Strait Islander peoples, nations, communities, language, place, culture and knowledges and/or is undertaken with Aboriginal and Torres Strait Islander peoples, nations, and/or communities.)

No

Science and Research Priorities

(Does this impact study fall within one or more of the Science and Research Priorities?)

No

Impact

Summary of the impact

(Briefly describe the specific impact in simple, clear English. This will enable the general community to understand the impact of the research.)

Research at The University of Adelaide has led to the development of the p-CAT Pipe Condition Assessment Technology; a non-invasive, non-destructive, reliable and safe method to use while piped water transfer systems remain operational. Development of this technique has had direct economic impacts for several key industry organisations as pipe condition assessments were able to be undertaken without service disruption and enabled targeted responses to damaged pipelines. Where companies previously replaced pipeline unnecessarily, or experienced extended leaks and damages, the p-CAT technology enabled rapid accurate identification of issues in the condition of pipelines for appropriate action, with substantial savings on cost and time, whilst preserving services and minimising disruption.

Beneficiaries

(List up to 10 beneficiaries related to the impact study)

1.Mining companies: BHP Billiton, BHP Mitsubishi Alliance

2.Australian water utilities: SunWater, Gold Coast Water, SA Water, Western Australian Water Corporation, East Gippsland Water, Western Water,

Wingecarribee Shire Council, Australia

Christchurch City Council, Taranaki City Council, Hay Shire Council, New Zealand.

4.Hydramax (USA)

Countries in which the impact occurred

(Search the list of countries and add as many as relate to the location of the impact)

Australia
New Zealand
United States of America

Details of the impact

(Provide a narrative that clearly outlines the research impact. The narrative should explain the relationship between the associated research and the impact. It should also identify the contribution the research has made beyond academia, including:
- who or what has benefitted from the results of the research (this should identify relevant research end-users, or beneficiaries from industry, the community, government, wider public etc.)
- the nature or type of impact and how the research made a social, economic, cultural, and/or environmental impact
- the extent of the impact (with specific references to appropriate evidence, such as cost-benefit-analysis, quantity of

those affected, reported benefits etc.)
- the dates and time period in which the impact occurred.

NOTE - the narrative must describe only impact that has occurred within the reference period, and must not make aspirational claims.)

Research at The University of Adelaide (UA) has led to the development of the p-CAT Pipe Condition Assessment Technology which is a non-invasive, non-destructive, reliable and safe method to use while the piped water transfer system remains operational.

Assessment of the actual performance of underground pipe networks is challenging. Hydraulic transient pressure waves can be used as a tool to extract the wall's structural condition information of a pipeline system. Pressure waves travel at around 1,100 m/s through the water in metallic pipes, and upon encountering a localised feature or structural anomaly, such as a corroded pipe section, some of the energy is reflected back along the pipe. These reflections contain vital information that can help identify and locate a structural anomaly — a process akin to the use of sonar (or radar) waves to detect objects in marine (or aerial) environments. Distributed pipe deterioration can also change the fundamental hydraulic characteristics of a pipe network, such as the wave speed, the damping rate and the system resonant frequencies, which can then also be used as indicators for condition assessment.

Utilities and mining companies face issues relating to limited access into pipes. Currently water engineers and pipeline operators have no comprehensive and simple way of assessing the physical condition of piped distribution systems that are often buried underground. Water utilities in Australia have approximately $160 billion worth of urban water assets and about half of this needs to be replaced over the coming three decades. Every year, despite ~$4b in capital expenditure, an estimated 19,000 breaks in water mains occur, resulting in the loss of 265 GL of potable water (enough water for 1.5 million homes). All developed countries face the same problem due to the ageing of water pipes. For example in the US, more than US$1 trillion will be required between 2011 to 2035 to replace ageing water mains and address projected growth.

The UA research group was the first to apply a new transient-based technique to pipe wall condition assessment; this subsequently led to a new avenue of research and the development of new algorithms for pipe condition assessment as well as new approaches to sense pressure signals in the pipe networks. The resulting technology, p-CAT, allows a rapid screening of pipes providing detailed information about the relative condition of long sections of pipe. Utilities then decide what pipe sections or valves to replace or leave in service, resulting in significant cost savings on unnecessary replacement of pipes.

The high quality pCAT system provides a wealth of information about the pipe networks inspected. Timely analysis is critical to provide quick solutions for customers who are keen to preserve their valuable water assets.

Since the commercialisation of the p-CAT in 2013, Detection Services, an Adelaide company, has turned over about $2.1 million up unto the end of 2016 for the provision of the technology. Detection Services has also employed four PhD graduates and four undergraduate Civil Engineering graduates. (Note: This in not Net Revenue for purposes of Royalty calculations under the Licence agreement as commercialisation costs and expense still need to be deducted). From 2013 to 2016, the technology has been used by more than 24 clients (refer to 'Beneficiaries') throughout the United States, Australia, and New Zealand and major pipe replacements in difficult locations have been averted, such as a key tunnel in Christchurch, New Zealand where p-CAT found a closed valve that was blocking the pipeline and similarly for Western Water in Victoria. Replacement of underground pipe assets is a challenging problem and p-CAT is providing key illumination to clients of what pipe sections need replacing and when. Two specific case studies are outlined below.

In June 2016, Detection Services undertook condition assessment for SunWater. p-CAT analysis determined the remaining wall thicknesses for 37 sub-sections of different deterioration conditions, and identifying and locating a number of anomalies, including a potential service connection unknown to SunWater and a deteriorated section. Another significant finding was the presence of high air content, which likely contributed to the deterioration of the pipeline. Following an initial inspection of the existing assets along the pipeline the work was completed by Detection Services in 2 days without impacting the ongoing operations of the pipeline, or demanding any significant input from the client. The client had significant concerns about this pipeline, but lacked specific evidence; however p-CAT was able to illustrate that only a short section of the pipeline was deteriorated.

In September 2016 a condition assessment for Gold Coast Water analysed a 6.5km long 965mm diameter pipeline from Molendinar Reservoir to South Port using p-CAT. The pipeline was found to be in reasonable condition with approximately 85% of the pipe wall thickness remaining. As a result an $8.8 million pipe replacement expenditure was deferred by many years.

In May 2015, p-CAT condition assessment was conducted for BHP Billiton on the Olympic Dam water supply pipeline, with the purpose of assessing overall pipeline condition and remaining wall thickness plus identification of anomalies such as blockages and air pockets, due to increasing burst problems. Six anomalies were identified and ranked in order of severity to provide BHP Billiton a prioritised list for rehabilitation or repair of the identified anomalies. This pipeline is critical to the Olympic Dam operations; and cannot be offline for any period. p-CAT was able to identify the key sections in this pipeline that needed replacing to bring it back to reliable service.

Associated research

(Briefly describe the research that led to the impact presented for the UoA. The research must meet the definition of research in Section 1.9 of the EI 2018 Submission Guidelines. The description should include details of:
- what was researched
- when the research occurred
- who conducted the research and what is the association with the institution)

From 1995 the Water Research Group of the School of Civil, Environmental and Mining Engineering at UA has undertaken research on pipeline condition assessment techniques and ways of utilising unsteady water flow in pipes for the development of innovative methods to assist industry. The research has demonstrated the potential for using artificially induced small magnitude pressure waves as an aid in assessing pipeline condition and in identifying the location and severity of leaking valves.

Researchers at UA further developed the Inverse Transient Analysis (ITA) technique with Prof James Liggett from Cornell University from 1996 to 2008; with UA directing the first experimental validation of the ITA technique. To do this, several problems needed addressing, including developing global algorithms to search the vast parameter spaces. Damping observed in laboratory experimental measurements was significantly greater than damping predicted by steady state friction assumptions in traditional models, further research was carried out to develop approaches to solve this issue, and models to allow its inclusion in the ITA technique.

In 2006 SA Water investigated the cement mortar lining of pipelines to find ways of non-invasively assessing pipeline condition using small pressure transients. Trials demonstrated small changes in pipe wall thickness could be detected using this technique.

FoR of associated research

(Up to three two-digit FoRs that best describe the associated research)

09 - Engineering

References (up to 10 references, 350 characters per reference)

(This section should include a list of up to 10 of the most relevant research outputs associated with the impact)

1.Gong, Stephens, Arbon, Zecchin, Lambert, and Simpson (2015). "On-site non-invasive condition assessment for cement mortar-lined metallic pipelines by time-domain fluid transient analysis," Struct. Health Monit., v.14, p.426-438.

2.Vítkovský, J.P., Lambert, M.F., Simpson, A.R., and Liggett, J.A. (2007). “Experimental observation and analysis of inverse transients for pipeline leak detection.” Journal of Water Resources Planning and Management, Vol. 133, No. 6, Nov./Dec., 519-530

3.Vítkovský J.P., Simpson A.R. and Lambert M.F. (2001). “Transients for calibration of pipe roughnesses using genetic algorithms.” Journal of Water Resources Planning and Management, 126 (4), pp 262-265.

4.Vitkovsky, J., Stephens, M., Bergant, A., and Lambert, M.F. (2006). “Numerical error in weighting function-based unsteady friction models for pipe transients.” Journal of Hydraulic Engineering, Vol. 132, No. 7, July, 709-721.

5.Stephens, Lambert, and Simpson (2013). "Determining the internal wall condition of a water pipeline in the field using an inverse transient model," J. Hydraulic Eng., v.139, p.310–324.

6.Gong J, Stephens ML, Arbon NS, Zecchin AC, Lambert MF, Simpson AR (2015) On-site non-invasive condition assessment for cement mortar–lined metallic pipelines by time-domain fluid transient analysis, Structural Health Monitoring 14(5):426-438, 01 Jan 2015. LP130100567 (2013 to 2016)

7.Gong, J., Lambert, M.F., Simpson, A.R., Zecchin, A.C. (2014). Detection of localized deterioration distributed along single pipelines by reconstructive MOC analysis, Journal of Hydraulic Engineering, Vol. 140, No. 2, 190 – 198. DP1095270 (2010 to 2012)

8.Gong, J., Zecchin, A. C., Lambert, M. F., & Simpson, A. R. (2012). Signal separation for transient wave reflections in single pipelines using inverse filters. In World Environmental and Water Resources Congress 2012: Crossing Boundaries (pp. 3275-3284). Albuquerque, New Mexico: American Society of Civil Engineers. doi:10.1061/9780784412312.329

9.Patent No. 9097601 USA- Method and System for Assessment of Pipeline Condition by Stephens, M., Lambert, M.F., Simpson, A.R, Kim, Y.I., Vitkovsky, J. Published on 4 August , Patent No. GB2475014 UK , Patent No. 2009281714 Australia , Patent No. 591739 New Zealand, Patent No. HK1157862 Hong Kong.

10.Lee, P.J., Simpson, A.R., Lambert, M.F., Vítkovský, J.P. and Misiunas, D. (2007) Leak Location in Single Pipelines using Transient Reflections, Australian Journal of Water Resources, Vol 11, No. 1, 2007, pp. 53-64.

Additional impact indicator information

Additional impact indicator information

(Provide information about any indicators not captured above that are relevant to the impact study, for example return on investment, jobs created, improvements in quality of life years (QALYs). Additional indicators should be quantitative in nature and include:
- name of indicator (100 characters)
- data for indicator (200 characters)
- brief description of indicator and how it is calculated (300 characters).)

Name

Awards received

Indicator Data

GN Alexander Medal: Authors of Best Paper [10], 2007.
SA Post Graduate Water Prize: Dr Jinzhe Gong, 2013; Dr Mark Stevens, 2007; Dr Xiao-Jian Wang 2002.
Lorenz Straub Award: Dr John Vítkovský, 2001.

Indicator Description

GN Alexander Medal by the Institution of Engineers, Australia to Lee, Simpson, Lambert, Vítkovský, and Misiunas.
SA Post Graduate Water Prize sponsored by Water Research Australia.
Lorenz Straub Award from the University of Minnesota for best hydraulics Ph.D. thesis in the world.

Name

Patent Application Submitted

Indicator Data

T140901 - 17 July 2015

Indicator Description

T140901 - Method and System for Pipeline Condition Analysis –Using Fluid Transient Reflection Translation and Interpretation

Name

Patent Application Submitted

Indicator Data

T140899 –16 July 2015

Indicator Description

T140899 – Pipeline Condition Assessment using Fluid Transient Waves with Dual Pressure Transducers

Name

Patent Application Submitted

Indicator Data

T140900 - 10 July 2015

Indicator Description

T140900 - System and Method for Generation of a Pressure Signal- Side-discharge valve-based signal generator for the generation of persistent fluid transient signals in pressurised pipelines.