Numerical interpretation of pressurized corroded cast iron pipe tests

Chunshun Zhang, Suranji Rathnayaka, Benjamin Shannon, Jian Ji, Jayantha Kodikara

www.elsevier.com/locate/ijmecsci

PII: S0020-7403(17)30575-1
DOI: http://dx.doi.org/10.1016/j.ijmecsci.2017.04.015
Reference: MS3662

To appear in: *International Journal of Mechanical Sciences*

Received date: 8 March 2017
Revised date: 5 April 2017
Accepted date: 18 April 2017

Cite this article as: Chunshun Zhang, Suranji Rathnayaka, Benjamin Shannon, Jian Ji and Jayantha Kodikara, Numerical interpretation of pressurized corroded cast iron pipe tests, *International Journal of Mechanical Sciences* http://dx.doi.org/10.1016/j.ijmecsci.2017.04.015

Numerical interpretation of pressurized corroded cast iron pipe tests

Chunshun Zhang, Suranji Rathnayaka, Benjamin Shannon, Jian Ji*, Jayantha Kodikara

Department of Civil Engineering, Monash University, Clayton, VIC, 3800, Australia

Abstract

Pitting/patch corrosion is a major and common cause of leaks and (or) bursts in cast iron (CI) pipes that consist of over 50% of global pipelines. The determination of the remaining life of a CI pipe is a major challenge facing water utilities requiring an estimate of the impact of pitting corrosion on the degradation of structural pipe capacity. This paper uses an efficient finite element analysis (FEA) to model the behaviour of large diameter CI pipes with natural or simulated corrosion pits and patches. The test results were obtained through laboratory pressure testing. Laser scanning was used to develop three dimensional geometric models of pipe specimens for direct use in the numerical modelling. The CI material was simulated by a non-linear hyperbolic elastic model (termed MHM-CI) recently developed by the authors for CI pipe modelling. The numerical results showed that the proposed FEAs with the MHM-CI model are reasonably capable to predict the measured responses with increasing water pressure, importantly at the critical pipe corrosion patches, such as hoop strains, initiation of leak and burst failures. The initiation of fracture was explained by material failure purely by tension, which can form a crack that could lead to water leakage. Final burst possibility was modelled by using a simplified fracture mechanics approach to determine the critical crack length for spontaneous fast fracture as in a burst. Our numerical findings suggest that the proposed simplified numerical approach may be used to determine whether a corroded cast iron pipe would leak before break provided that the corrosion condition of the pipe and the relevant material properties are available. However, the window of time for leak before break would require further testing since this would be governed by sub critical fracture growth subject to repetitive external and internal pipe loadings.