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Time-Dependent Reliability Analysis of Corrosion Affected Cast Iron Pipes with Mixed Mode Fracture

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Abstract : A significant portion of current water networks is made of cast iron pipes. Due to aging and deterioration with corrosion being the most predominant mechanism, the failure rate of cast iron pipes is very high. Although considerable research has been carried out in the past few decades, most are on the effect of corrosion on the structural capacity of pipes using strength theory as the failure criterion. This paper presents a reliability-based methodology for the assessment of corrosion affected cast iron pipe cracking failures. A nonlinear limit state function taking into account all three fracture modes is proposed for brittle metal pipes with mixed mode fracture. A stochastic model of the load effect is developed, and time-dependent reliability method is employed to quantify the probability of failure and predict the remaining service life. A case study is carried out using the proposed methodology, followed by sensitivity analysis to investigate the effects of the random variables on the probability of failure. It has been found that the larger the inclination angle or the Mode I fracture toughness is, the smaller the probability of pipe failure is. It has also been found that the multiplying and exponential coefficients k and n in the power law corrosion model and the internal pressure have the most influence on the probability of failure for cast iron pipes. The methodology presented in this paper can assist pipe engineers and asset managers in developing a risk-informed and cost-effective strategy for better management of corrosion-affected pipelines.

Keywords : corrosion, inclined surface cracks, pressurized cast iron pipes, stress intensity
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