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# Reliability Assessment of Pressurized Pipes with Inclined Defects

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## 1 Introduction

Ageing and deterioration of pipelines is a significant problem facing pipeline industry. As most of the parameters associated with pipe failures are highly uncertain and change with time, the probabilistic assessment of pipe failure with time-dependent ealiability methods is essential for the management of pipe assets. It has been found that pipe failures are more likely to be fracture type due to the stress concentration near the tips of crack-like defects, which can occur in random directions (Li and Mahmoodian, 2013). This paper presents a time-dependent reliability method to assess the pressurized pipe with inclined defects, in which mixed mode fracture criterion is employed to establish the limit state function.

## 2 Methodology

A time-dependent reliability method, which based on the first passage probability in stochastic process theory, is employed in this paper. The load effect is modelled as a non-stationary Gaussian process and the fracture toughness is used as the barrier level. The probability of failure is considered as the stochastic process of load effect passes upwards the barrier level for the first time. An analytical solution to the mean up-crossing rate of this stochastic process can be found in Li and Melchers (1993).

To illustrate the proposed method for the assessment of pipe fracture failure, the failure probability of a cast iron pipe with inclined defects is calculated. Richard's criterion, which predicts the fracture initiation of a body under mixed mode loading, is employed to establish the limit state function.

## 3 Results

The calculation results of the probability of pipe failure with different defect inclination angles ($\theta$) and auto-correlation coefficients ($\rho$) process between two points in time are shown in Figures 1. The probability of pipe failure increases with the exposure time due to the growth of corrosion pit depth. Also, it can be seen that the probability of failure decreases with increasing inclination angles. Moreover, the auto-correlation coefficients affect pipe fracture failure significantly.

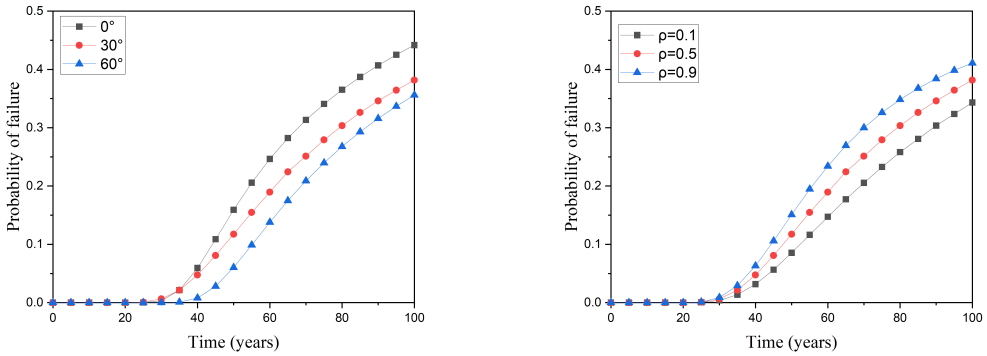


**Figure 1**. Probability of pipe failure: (a) for different inclination angles with $\rho = 0.5$; (b) for different auto-correlation coefficients with $\theta = 30°$.

## 4 Conclusion

From the results of the case study, the probability of pipe failure increases with the pipe ageing. Moreover, the probability of failure is highly sensitive to auto-correlation coefficients and inclination angles. The smaller the inclination angle is, the more possibly the pipe fails. As such, for engineering assessment of pipes with inclined defects, more attention should be paid to the defects with smaller inclination angles. The considerable difference in probability of failure caused by auto-correlation coefficients (*e.g.*, $\rho$) justifies the necessity to use a time-dependent reliability method, based on the concept of first passage probability and the stochastic process theory.

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