Lecture Notes in Mechanical Engineering

Volume 3, Issue 14, 2019, Pages 145-152

Remaining Life Estimation of the High Strength Low Alloy Steel Pipelines by Using Response Surface Methodology

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Abstract: This paper presents a probabilistic study to estimate the remaining lifespan of cracked steel pipeline by using the response surface technique. The purpose is to assess the reliability index of the high strength low alloy steel (HSLA) pipelines for a limit state function without closed-form. The implicit objective function is approximated by a polynomial representing a quadratic response surface and the assessment of the failure probability is obtained using Second order reliability method (SORM). The presence of a semi-elliptical crack defect in the longitudinal direction of the pipe steel will intensify the stress field at the crack tip and will decrease the limit state function. Exhaustive and costly tensile and Charpy V notch tests prepared from the longitudinal direction of the parent tube were achieved in order to study the mechanical behavior of API X70 steel grade and integrating the uncertainties of the engineering model parameters through their probabilistic densities. The assessment of the stress intensity factor is conducted by using the finite element methods. The estimation of the reliability index and the probability of failure are carried out by coupling the mechanical model, and the finite element method based on the commercial code ABAQUS. This coupling based on the response surface methodology, could be used as a decision making support for any repair or replacement of the damaged pipeline.

Keywords : Reliability, Elliptical crack, Response surface, Uncertainties