Fatigue assessment of cracked pipes with weld misalignment by using stress intensity factors

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Fatigue assessment of cracked pipes with weld misalignment by using stress intensity factors

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Abstract

In this study, fatigue assessment of cracked pipes with weld misalignment is carried out by using fracture mechanics approach. Two types of weld misalignment, viz., centreline offset weld misalignment with equal thickness but unequal diameters, and centreline offset weld misalignment with unequal thickness but aligned inside surface, are considered. A finite element (FE) mesh generator for cracked plain pipes is developed first, and then it is used for the misaligned pipes by incorporating a coordinate transformation method. A small-scale experimental test on the stress concentration curve along the longitudinal direction of misaligned pipes is conducted to ascertain the accuracy of the transformation method. Then, extensive FE analyses are performed to determine the stress intensity magnification factor (M_k) at the crack deepest point and the crack ends of a surface crack in misaligned pipes. A new set of M_k equations for the misaligned pipes are built up using multiple regression analysis, and statistical analyses are carried out to validate the goodness of fit of these equations. The proposed equations can be employed in the fatigue strength calculation and fatigue life prediction based on the fatigue assessment procedure provided by BS 7910:2013.

***Keywords*:** Fatigue assessment; Finite element analysis; Stress intensity magnification factor; Surface crack; Weld misalignment

1. Introduction

Over the past decades, with the rapid development of oil and gas industries, large numbers of offshore pipelines are used for transportation purposes. Hence, the demand for welded pipes and