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Abstract

Buried defects, such as lack-of-sidewall fusion defects, are some of the most commonly occurring defects in mechanized girth welds. Although some of the existing ECA (Engineering Critical Assessment) procedures permit the assessment of the significance of buried defects, their application is limited to the nominally elastic applied stress range. The assessment of buried defects is more complex than that of surface-breaking defects. There is much more experimental data on the behavior of surface-breaking defects than buried defects. One simplistic approach is to treat buried defects as surface-breaking defects under a generally accepted assumption that buried defects are less detrimental than surface-breaking defects of the same size. This paper focuses on the behavior of girth welds containing buried defects subjected to high longitudinal strains. The high longitudinal strains in onshore pipelines may be caused by soil movement such as seismic activity, slope instability, frost heave, mine subsidence, etc. For offshore pipelines, the highest longitudinal strains typically occur during pipe laying operations. The paper describes a strain design methodology based on a crack driving force method that has been previously applied to obtain tensile strain limits of surface-breaking defects. The focus of this paper is the application of the crack driving force methodology to examine the factors affecting the strain limits of girth welds containing buried defects. By using crack driving force relations in conjunction with a constraint-sensitive fracture mechanics approach, tensile strain limits are derived as a function of material grade, defect size, toughness, and pipe wall thickness. The paper concludes with the comparison of strain limits between buried and surface-breaking defects.

Keywords

Pipeline, Strain-based design, Strain limit, Girth weld, ECA, Fitness-for-service, Defect acceptance criteria, Buried defect, Finite element analysis