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PII: S0167-8442(17)30128-3
DOI: http://dx.doi.org/10.1016/j.tafmec.2017.07.012
Reference: TAFMEC 1917

To appear in: *Theoretical and Applied Fracture Mechanics*

Please cite this article as: R.F. de Souza, C. Ruggieri, Development of a strain based fracture assessment procedure for undermatched pipe girth welds subjected to bending, *Theoretical and Applied Fracture Mechanics* (2017), doi: http://dx.doi.org/10.1016/j.tafmec.2017.07.012

Development of a strain based fracture assessment procedure for undermatched pipe girth welds subjected to bending

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July 12, 2017

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Abstract

Structural integrity assessment of pipeline girth welds subjected to high strain levels which arises from the reel-lay method relies on precise crack driving force estimation procedures. Recent developments in subsea technology favor the use of high strength carbon steel pipelines with an internal corrosion resistant layer to increase protection against corrosive fluids. In contrast to homogeneous structural components, the bimetal configuration may induce the occurrence of weld strength undermatch, with a strong impact on the relationship between remote applied load and crack tip constraint. This work explores the development of a crack driving force estimation procedure based on a strain-based version of the EPRI J estimation scheme coupled with the equivalent stress-strain relationship method (ESSRM) and a weld geometry simplification procedure. The proposed framework takes advantage of the displacement controlled nature of the reeling process. Extensive 3D analyses provide a large set of fracture parameters applicable to the strain-based EPRI methodology followed by parametric analyses conducted to assess the accuracy of the new procedure. Subsequently, a case study is performed to determine the tolerable crack sizes in an idealized pipe installation. The procedure shows an overall good agreement to the benchmark analyses and increased accuracy when compared to the recommended approach proposed by DNV.

Keywords: Strain based analysis, J-integral, weld strength mismatch, girth weld, reeling, steel catenary risers, structural integrity assessment

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