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Abstract

Curved wide plate (CWP) tests are frequently used to measure the tensile stress and strain capacity of pipeline girth welds. The parameters affecting the CWP measurement include specimen geometry and cooling setups. High-quality data is obtained when valid test conditions are confirmed. Crack mouth opening displacement (CMOD) is often measured in CWP tests. CMOD is a direct indicator of the amount of deformation at the cracked plane. It is an indirect indicator of the crack driving force (CDF) imparted on the crack. For a given test geometry and material, certain relationships can be derived between the measured CMOD and the more conventional representation of crack driving force, such as CTOD (crack tip opening displacement) and J-integral. Such relationships are a key element in fracture toughness testing standards. This kind of relationship is also particularly useful in strain-based design where CWP specimens are used for strain capacity and flaw growth prediction. In this paper finite element (FE) analysis is first used in modeling CWP testing conditions for X100 specimens with girth weld flaws to validate the test conditions. A novel approach called CMOD mapping is then developed to characterize the flaw behavior which, by making a direct use of CMOD test data from the CWP tests, is used to estimate the crack growth in the CWP. Finally, analysis of strain limits using crack driving force (CDF) for the CWP specimens is also given by comparing experimental test data and FE estimation.

Keywords

Pipeline, Tensile strain capacity, Wide plate test, Test procedure