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Abstract

Tensile rupture is one of the limit states in strain-based design of pipelines. The tensile strain capacity of a pipeline is controlled by the strain capacity of the girth welds. Factors affecting the tensile strain capacity of girth welds are numerous. A few dominant factors are material's strain hardening capacity, toughness (including transition temperature and tearing resistance), and the existence of weld defects. The girth weld tensile strain capacities of an X70 and an X100 linepipe were studied in this work. Extensive material property characterization was performed, including a variety of small scale testing, such as tensile, Charpy, and standard CTOD toughness. The same welds were tested in mini-wide plate configuration under tension at room temperature and cold temperatures as low as -27°C. The miniwide plate specimens were extensively analyzed numerically. Attempts were made to correlate small scale tests results and the tensile strain capacity measured from the mini-wide plates. The correlation used a set of closed form equations that were developed previously on the basis of the crack driving force approach and the concept of apparent toughness. Reasonably good correlation was observed for both X70 and X100 girth welds. When measured by safety factors on the predicted strain limits (safety factor ≡ measured strain limit / predicted strain limit), the coefficient of variation was in the range of 0.20-0.25. Certain limitations in using small-scale specimen test results to predict large scale tensile strain limits were also observed.

Keywords

Strain-based design, Tensile strain limits, Girth welds, ECA, Fracture mechanics, Pipeline