Abstract

Tensile strain rupture is an ultimate limit state. A limit state is stated in generic terms of "load" and "resistance" or alternatively termed "demand" and "capacity." The "demand" of tensile rupture limit state is mostly related to displacement-controlled loading, such as that induced by frost heave, landslide, and seismic activities. The "capacity" is most often controlled by girth weld tensile strain limits, as girth welds tend to be the weakest link in pipelines experiencing high tensile strains. The tensile strain limits of girth welds are affected by a large number of factors: tensile and toughness properties of the pipe and weld, weld geometry, stress state, defect size and location. Consequently, closed-form solutions for tensile strain limits of girth welds do not yet exist in codes and standards.

PRCI and TransCanada have funded a number of projects in recent years to develop fracture-mechanics-based procedures aimed at quantitative determination of girth weld tensile strain limits. The results of these projects, along with the reviews and examination of available experiment data by the authors, have culminated in a set of recommended procedures that enable the quantitative determination of the tensile strain capacity of pipelines. The required input parameters, formulae for the computation of tensile strain limits, limits of applicability, and suggested methods of applications are specified in the proposed procedures. This paper covers the technical basis of the procedures. Particular emphasis is placed on the validation of these procedures. The limitations of the procedures and future directions of improvements are suggested. It is believed that these procedures may lay the initial groundwork towards the eventual code implementation of a comprehensive set of tools for quantitative strain-based design of pipelines.

Keywords

Pipeline, Strain-based design, Tensile strain limit, Girth weld, Weld defect acceptance criteria