Wang, B., **Liu, B.,** Wang, Y.-Y., Huising, O., 2020, Estimation of Tensile Strain Capacity of Vintage Girth Welds, Proceedings of the 13th International Pipeline Conference, Paper No. IPC2020-9664, September 28- October 1, 2020, Calgary, AB, Canada.

Abstract

Being able to estimate the tensile strain capacity (TSC) of vintage girth welds is sometimes necessary for the integrity management of vintage pipelines. For instance, assessing girth weld integrity could be a top priority after a confirmed ground movement event. Decisions may also be needed about the disposition of a girth weld when weld anomalies are found. Typical fitness-for-service (FFS) procedures, such as API 1104 Annex A and API 579/ASME FFS-1, generally target materials under nominally elastic conditions and strain demands less than 0.2%. These procedures may produce overly conservative results when the strain demand exceeds 0.2%.

This paper summarizes the development and validation of a TSC estimation tool for vintage girth welds under PRCI funding. The tool development process follows the Level 4a procedures of the PRCI-CRES tensile strain models. Finite element analyses (FEA) were performed to develop a crack-driving force database, considering the salient features of vintage girth welds such as larger weld caps and weld strength mismatch levels. A TSC model was then derived from the crack-driving force database and a representative apparent toughness for vintage girth welds based on an initiation-control limit state. A graphical user interface (GUI) and a user help manual were developed to facilitate the application of the TSC estimation tool. The tool produces TSC estimates based on geometry, material, loading, and flaw characteristics of a girth weld. For inputs that might not have readily available values, recommended values are provided. The tool allows the evaluation of the impact of various input parameters on TSC.

The TSC estimation tool was evaluated against eight purposely designed curved wide-plate (CWP) tests. Accompanying small-scale material characterization tests, including chemical composition, round bar tensile, microhardness, and Charpy impact tests, were performed to provide additional inputs for the evaluation of the tool. The tool is shown to provide reasonably conservative estimates for TSC.

An example problem is presented to demonstrate the application of the tool. Gaps and future work to improve the tool are highlighted at the end of the paper.

Keywords

Engineering assessments, integrity management, properties of girth welds, strain based design, tensile strain capacity, vintage pipelines