Wang, Y.-Y., Chen, Y., and Salama, M., Enhancing Tensile Strain Capacity Through the Optimization of Weld Profiles, Proceedings of the 10th International Pipeline Conference, 2014, Calgary, Alberta, Canada, Paper no. IPC2014-33589

Abstract

In order to optimize cost and performance of high pressure gas pipelines by reducing the wall thickness, pipeline companies are considering the use of higher grade (X70 or above) steels or a composite pipe of thin steel liner and fiber wrap. The use of high strength steels and thinner pipes can result in challenges when the pipe is installed in areas imposing high strain demand such as discontinuous permafrost regions. For high strength steels, the difficulty of ensuring the strength overmatching of the weld metal and the potential softening of the heat affected zone (HAZ) can result in gross strain concentration in the weld region and thus reduce the strain capacity of the pipeline in the presence of weld defects. Also, a thinner pipe has lower strain capacity than a thicker pipe for the weld defect of the same dimensions. One of the economical and effective ways of mitigating the possibility of gross strain concentration and increasing the strain capacity of a weld region containing weld defects is through the use of appropriate weld profiles. For instance, adding a smooth and wide layer of weld reinforcement (termed weld overbuild) can increase the effective strength of the weld.

The effectiveness of the weld overbuild in improving the tensile strain capacity of girth welds is evaluated using the Level 4a approach of the PRCI-CRES tensile strain models. The crack-driving force is obtained through finite element analysis (FEA) of welds with planar weld and HAZ flaws of various sizes. It was demonstrated that weld overbuild with appropriate dimensions is an effective method to increase the tensile strain capacity (TSC) of girth welds which may have limited TSC without the overbuild. The role of weld profiles in girth weld integrity is discussed from the perspectives of historical evidence and more recent analysis and experimental tests.

Keywords

Pipeline, Strain-based design and assessment (SBDA), Girth weld integrity, Tensile strain capacity