**Wang, Y.-Y.,** Rudland, D., Denys, R., and Horsley, D., A Preliminary Strain-Based Design Criterion for Pipeline Girth Welds, Proceedings of 4th International Pipeline Conference, Calgary, Alberta, Canada, 2002, Paper No. IPC2002-27169

## Abstract

The strain capacity of girth welds containing surface-breaking welding defects is examined through numerical analysis and experimental verification under a PRCI (Pipeline Research Council International) funded project. Some important insights on the various factors affecting the girth weld strain capacity are generated. The defect size is identified as one of the most important factors in determining strain capacity of a girth weld. Other factors, such as the strain hardening rate of the pipe and weld metals, weld strength mismatch, fracture toughness, and weld cap height, can play a significant role if the defect size is within certain limits. It is discovered that the girth weld response to the remotely applied strain may be characterized by a three-region diagram. For a given set of defect size and weld strength mismatch conditions, the crack driving force may be bounded, unbounded, or gradually changing, with respect to the remotely applied strain. A set of parametric equations is developed that allow the computation of allowable strains with the input of defect depth, defect length, CTOD toughness, and weld strength mismatch. The comparison of the developed strain criteria with full-scale bend tests and tensile-loaded CWPs (curved wide plates) shows the criteria are almost always conservative if lower bound CTOD toughness for a given set of welds is used. However, the criteria can significantly underpredict strain capacity of girth welds with short defects. Although defect length correction factors were added to the strain criteria based on the comparison of axisymmetric finite element (FE) results and full-scale bend test results, a more thorough investigation of the effects of defect length on strain capacity is needed. Future investigation that incorporates the finite length defects is expected to greatly reduce the underprediction. The influence of other factors, such as strain hardening rate, should be further quantified.

**Keywords**

Pipeline, Strain-based design, Girth weld, Toughness, Constraint effects