Wang, Y.-Y., Rudland, D., and Horsley, D., Development of a FAD-Based Girth Weld ECA Procedure: Part I — Theoretical Framework, Proceedings of 4th International Pipeline Conference, Calgary, Alberta, Canada, 2002, Paper No. IPC2002-27171

Abstract

Beginning in the late 1970's and early 1980's, "alternative defect acceptance criteria" were adopted in various codes and standards in the pipeline industry. These criteria relate the tolerable defect sizes with the magnitude of loads and materials' resistance to failure. They allow engineers to assess the suitability of the pipes containing defects for intended service conditions, or fitness-for-service. Assessments based on the fitness-for-service principles are often referred to as Engineering Critical Assessment, or ECA. Although most of these codes are based on fracture mechanics principles, the defect tolerance levels vary significantly from code to code. This paper describes a two-year effort funded by PRCI (Pipeline Research Council International) to develop an ECA procedure specifically tailored to pipeline girth welds. The newly developed procedure is in FAD (failure assessment diagram) format. The key features of this procedure are provided in this paper. Based on prior research and extensive experimental data analysis, a modified Miller plastic collapse solution was selected for its rigorous formulation and good agreement with full-scale test results. The effects of weld strength mismatch on plastic collapse load (limit load) were examined and validated through finite element (FE) analysis. Parametric formulae of mismatch correction factors to the plastic collapse solution were adopted. The stress intensity factor solutions of finite-length surface breaking defects in girth welds were developed and validated. Failure assessment curves (FACs) for girth weld defects were generated. These curves incorporated the effects of material's strain hardening rate and defect size. They are more accurate than some of the generic material and defect independent FACs, yet easy to use.

Keywords

Pipeline, Girth weld, Flaw acceptance criteria, Fitness-for-service, Fracture mechanics