The EWI Strategic Technology Committee for Oil & Gas: Research Progress for 2017

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Introduction

The EWI Strategic Technology Committee for Oil & Gas (STC) was formed in 2013 to bring together companies interested in furthering research and addressing technical needs related to materials and welding with the goal of enhancing the safety, reliability, and integrity of infrastructure for the energy industry. Members of the STC range from major oil and gas companies to steel makers; engineering procurement, construction, and installation companies (EPCIs); fabricators; and welding consumable suppliers. Member companies are located in North America, Europe, and Asia.

Major projects completed or in process since 2013 include:

- Characterization of weld properties for arctic service
- Assessment of potential welding approaches for casing materials
- Integrity aspects for unintended subsea pipeline/flowline blowdowns
- Improved fracture toughness correlations for advanced high-strength steels and forgings
- Weldability of grade 70 and 80 plate steels for offshore structures
- Assessment of Inconel girth-weld strength mismatch effects
- Engineering critical assessment (ECA) guidance for subsea and offshore systems
- Comparison of nondestructive evaluation (NDE) methods for dissimilar metal welds (DMWs)

The results of these projects have provided the industry with valuable insight into optimized welding approaches and selection of materials to ensure adequate in-service performance, and updated guidance on performing engineering integrity assessments for offshore infrastructure.

Current Work on Lower Temperature Steel Toughness

The STC has been working on fracture toughness below the design temperature for steel. This began in 2016 with an assessment of the behavior of X70 pipe suitable for deepwater offshore service. One way that pipe systems can reach temperatures below their design temperature is sudden release of their internal pressure during blowdown.

EWI tested the fracture toughness ductile to brittle transition of the X70 pipe using three testing methods: Charpy testing that uses impact testing of notched bars in bending, crack tip opening displacement (CTOD) with single edge notched specimens in bending (SENB), and CTOD with single edge notched specimens in tension (SENT). Results from the two CTOD test types are shown in Figure 1. Results differ both in their fracture resistance, recorded as CTOD in mm, but also in their behavior around the crack tip. Three types of behavior are shown with different symbols in Figure 1: delta c with no visible ductile damage around the crack, delta u with some ductile damage advancing the crack and delta m with enough ductility that the peak load is reached smoothly before the crack advances to failure.

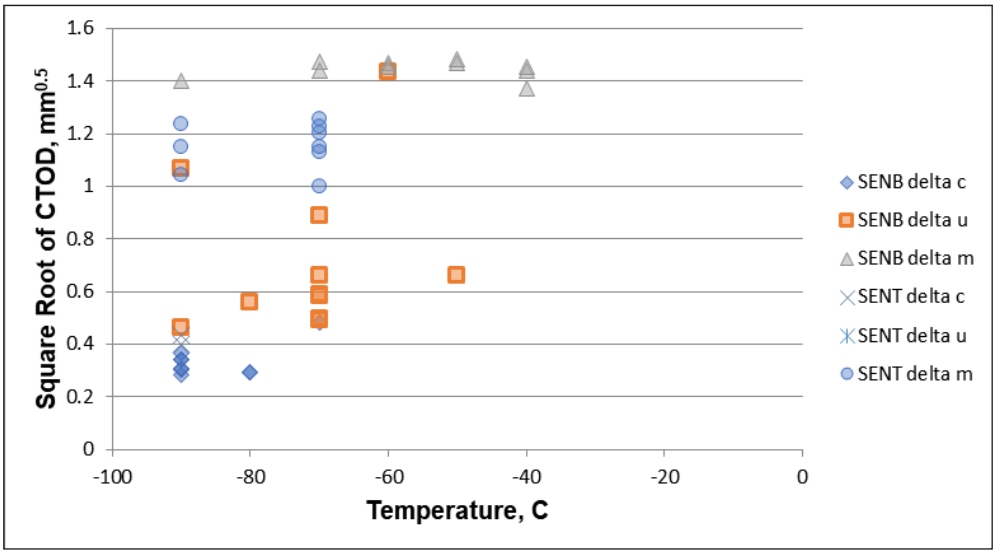

Figure 1: CTOD toughness transitions in tension and bending

The behavior observed showed a larger variation of CTOD SENB than expected in the transition region for homogeneous materials. There was also an indication that the minimum toughness from the SENT tests was higher than the minimumtoughness for the SENT tests.

The 2017 effort is directed at performing similar testing on girth weld metal. The welds have been made with ER80S-D2 and the pulsed gas metal arc welding process.

Additional Research

The STC is conducting two additional projects. The first focusses on a side-by-side comparison of radiographic testing (RT) and automated phased-array ultrasonic testing (PA-AUT) methods in three specially made pipe girth dissimilar metal welds (DMW) with seeded defects. Each coupon contains approximately 18-20 defects of various types and in various locations. The outcome of this project will be a direct comparison of detection sensitivity between RT and PA-AUT for various flaw types and locations. This will provide the industry with an independent evaluation of the suitability of RT and PA-AUT for DMWs as well as guidance on when each method is most appropriate for use on subsea infrastructure.

The STC is also conducting a second project to create guidelines for engineering critical assessment (ECA): the analysis that determines what inspection results are acceptable prior to the start of fabrication. The guidance document that will be produced will identify what inputs and data are needed to perform an ECA, including appropriate formats for these data. The document will also outline different ECA approaches and how to effectively implement results.

Future Work

In 2018, the EWI STC plans to extend its work on NDE for DMWs to include further advances in phased-array ultrasonic testing. New equipment at EWI that uses both full-matrix capture and total focusing method (FMC-TFM) has shown interesting potential for improved sizing of imperfections. Improved sizing of small imperfections can make pipelines and other industry structures easier to fabricate and accept since inaccurately sized imperfections will no longer need to be removed and repaired. In addition, the FMC-TFM technique may be less sensitive to ultrasonic beam scatter, undesirable beam reflections, and the problematic signal attenuation that occurs with conventional UT methods.

The EWI STC is also considering new projects, focusing on the assessment of conditions leading to copper contamination in pipeline girth welds and the evaluation of weldability characteristics of low manganese steel for sour service pipeline applications.

The next EWI STC meeting will be held in March 2018 to discuss and direct research and define the activities for the next year. If you'd like to learn more about the STC and its research, please click here or contact Bill Mohr at 614.688.5182 or bmohr@ewi.org.

Bill Mohr, Principal Engineer - Structural Integrity, is responsible for initiating, conducting, and reporting research and contract work. He is an expert in the areas of fitness-for-service assessment, design, and fatigue of welded structures. Bill has authored more than 50 technical papers in addition to numerous reports of sponsored projects, failure analyses, and fitness-for-service assessments.