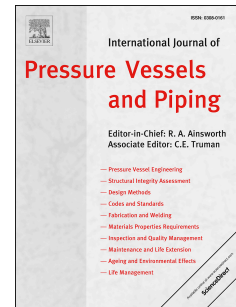


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Advances in weld residual stress prediction: a review of the NeT TG4 simulation round robins part 2, mechanical analyses

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Abstract

The members of the NeT network have undertaken parallel round-robin activities measuring and predicting transient temperatures, fusion boundary development, weld residual stresses and structural distortions in a benchmark specimen manufactured from AISI 316L(N) plate with a central finite length slot filled with three superimposed TIG weld beads. This is a strongly three-dimensional configuration with many of the characteristics of a repair weld. The round robin finite element predictions of residual stresses and distortions are compared with an extensive database of residual stress and distortion measurements made using diverse techniques on multiple TG4 specimens. It is found that high solution accuracies can be achieved.

Keywords

Welding; Weld modeling; Finite element modeling; Verification and validation

Introduction

The mission of the European Network on Neutron Techniques Standardization for Structural Integrity (NeT) is to develop experimental and numerical techniques and standards for the reliable characterisation of residual stresses in structural welds. NeT was first established in 2002, and involves over 35 organisations from Europe and beyond. It operates on a “contribution in kind” basis from industrial, academic, and research facility partners. Each problem examined by the network is tackled by creating a dedicated Task Group (TG), which undertakes measurement and modelling studies and the interpretation of the results.

NeT Task Group 4 (TG4) was launched in 2007, as a follow-on project to the highly successful Task Group 1 (TG1). NeT TG1 [1-18] examined a single weld bead laid onto the surface of an austenitic steel plate. This weld geometry produces a strongly three-dimensional residual stress distribution, with similar characteristics to a weld repair, and proved to be very challenging to simulate accurately. The NeT TG4 specimen was designed as a natural follow-on to the TG1 specimen, with the single weld bead of TG1 replaced by three superimposed weld beads laid into a slot. Hence, it introduces a multi-pass weld and a significant volume of weld metal, while retaining the portability of TG1. The members of NeT were asked to make accurate predictions of the development of material stress-strain properties and the final residual stress field in the weld as well as in the adjacent heat/strain affected zone (noting this material undergoes multiple high temperature thermo-mechanical cycles).

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