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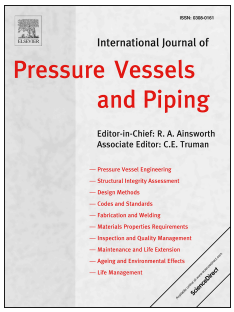

Advances in weld residual stress prediction: A review of the NeT TG4 simulation round robin part 1, thermal analyses

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Advances in weld residual stress prediction: a review of the NeT TG4 simulation round robin part 1, thermal 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) austenitic stainless plate with a central finite length slot filled with three superimposed TIG weld beads. This is a strongly 3-dimensional configuration with many of the characteristics of a repair weld. The round-robin finite element predictions of transient temperatures and the extent and shape of the melted zone are compared with thermocouple measurements made during welding, and with the results of destructive metallography. It is found that the majority of thermal simulations achieve high accuracy at weld mid-length, where quasi-steady state conditions apply, and slightly reduced but still acceptable accuracy at the bead ends, where thermal conditions are much more 3-dimensional. With two exceptions, variability in thermal solutions can be discounted as a cause of variation in subsequent mechanical simulations. The two outlier simulations allow investigation of sensitivity to final pass heat input and bead length.

Keywords

Welding; modeling; Finite element; transient temperature prediction; verification; 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 stainless 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. NeT TG4 was designed as a natural follow-on to TG1, 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 set the following simulation challenge: