Simulation of Multi-Pass Welds Using ABAQUS 2D Weld GUI and Comparison with Experimental Results

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Abstract

The modelling of welds is desirable to predict the distortion of components during manufacture, the position and magnitude of peak residual stresses and to predict metallurgical effects in specific regions. Welds are a complex modelling problem requiring both thermal and structural solutions. This has lead to the development of several weld-specific simulation packages and codes for finite element analysis packages.

This paper describes the application of the newly developed Abaqus 2D Weld Modeller to simulate the residual stress field in ferritic weld test specimens. The specimens were manufactured for an ongoing research programme in conjunction with The University of Manchester and Serco Assurance. The specimens modelled were autogenously welded plates, an eight-pass groove welded plate and a seven-pass ring weld disk.

The 2D weld GUI simplified the creation of these models, particularly with its automated selection of surfaces to apply heat transfer equations to and the model change requirements for weld bead deposition.

The results are similar to both measured and previously modelled stress distributions. Simulations have been performed using a number of tools including Abaqus and VFT. Measurements have been made by The University of Manchester using neutron diffraction. The results are broadly similar, but there are noticeable differences in the fusion zone/weld bead area due to the lack of phase transformation modelling. Phase transformation introduces compressive stress in the fusion zone due to the crystallographic expansion as the steel grains transform from face-centred cubic to body-centred cubic. This compressive region also creates a balancing tensile stress region in the heat-affected zone.

Keywords: Residual Stress, Welding.

Introduction

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