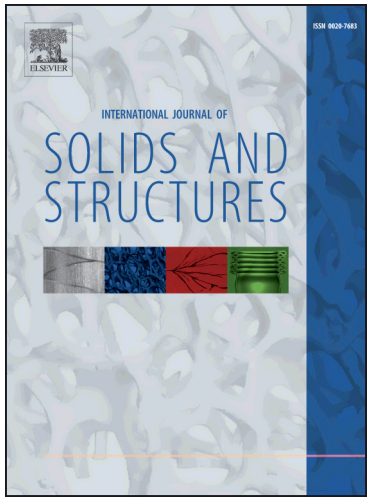

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The influence of constitutive material models on accumulated plastic strain in finite element weld analyses

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Abstract

Recent studies in computational weld mechanics have revealed the importance of the material plasticity model when predicting weld residual stresses. The present work seeks to extend this level of understanding to include the effects of the assumed material annealing behaviour, particularly when modelling multi-pass welds that comprise several thermo-mechanical loading cycles. A series of numerical analyses are performed to examine the variability in predicted residual stress profiles for different material models, using a validated finite element model for a three-pass slot weld in AISI 316LN austenitic steel. The material models consider both the work hardening and annealing assumptions for the chosen material. Model sensitivity is established not only from a weld residual stress perspective, but also from an assessment of the post-weld plastic strain accumulated in the weldment. Predictions are compared with indirect measurements acquired using cross-weld micro-hardness maps taken from benchmark specimens. Sensitivity studies reveal that the choice of annealing behaviour will have a significant impact on plastic flow predictions, which is dependent on the annealing temperature specified. Annealing assumptions will have a varying impact on the weld residual stress predictions, such that the extent of sensitivity is dependent on the plasticity model chosen. In contrast, the choice of plasticity model will have a significant effect on the predicted weld residual stresses, but relatively little effect on predictions of equivalent plastic strain.

Keywords:

Residual stresses, plastic strain, plasticity theory, annealing, finite element analysis

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