

THE INFLUENCE OF ANNEALING ON RESIDUAL STRESSES AT WELD STOP/START POSITIONS

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The measurement and finite element modelling of a single pass bead on plate specimen indicate peak stresses which occur at or close to the weld stop/start positions. These welds may be considered analogous to finite length weld repairs which are commonly used as a means of repairing defects found in operating plant. These peak stresses may have a detrimental affect on the creep/fatigue and stress corrosion initiation assessments for non-stress relieved stainless steel welds.

Weld simulations of multi-pass welds have shown that the consideration of annealing affects due to subsequent overlaying material reduces the predicted residual stresses. Note the term annealing used here is defined as the temperature at which the material melts and the finite element code, ABAQUS, assumes that the material loses its hardening memory, i.e. the effect of prior work hardening is removed by setting the plastic strain to zero. Thus for multi-pass welds the peak stresses observed at stop/start positions in underlying material may be relieved by subsequent weld passes.

In order to investigate this behaviour, welded mock-up specimens have been manufactured and residual stress measurements and finite element analyses have been carried out. Type 304 stainless steel plates containing 5-pass and 8-pass groove welds were produced. The fifth weld pass in each specimen contains a ramped weld stop/start and an abrupt weld stop/start, which is then overlaid in the 8 pass weld specimen.

This paper describes the manufacture of the specimens, which includes a record of the temperatures measured in the specimen during welding; the residual stress measurements which have been carried out using neutron diffraction (more are planned using a variety of techniques) and the 3D finite element simulations using the code SYSWELD. The results of the measurements and predictions are compared and the influence of weld overlays on weld stop/start positions is discussed.