

## Industrial Member Report Summary – Key Findings for Industry

### Effects of Warm Prestress on Residual Stress and Fracture in Uniaxially Loaded Welded Joints

TWI Core Research Programme

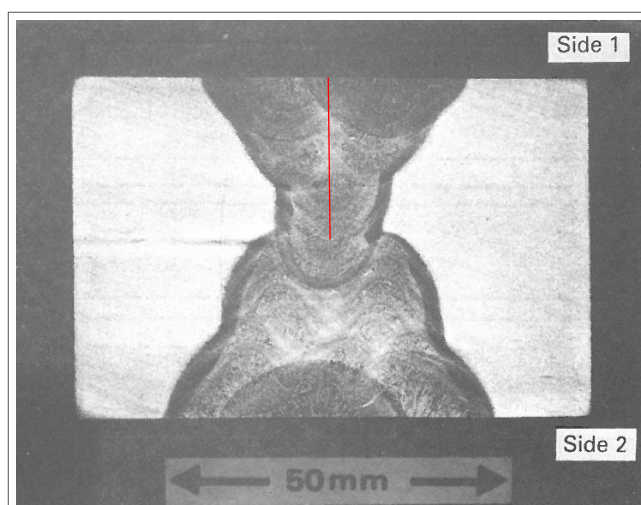
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#### Industrial need

TWI's fracture test database includes details of an extensive programme of wide plate tests on both plain steel plates and welded joints, with and without application of a warm prestress (WPS). The R6 and BS 7910 fracture assessment procedures have developed since the tests were carried out, and the results provide an opportunity to validate various aspects of both procedures: not only the treatment of welding residual stress, but also the enhancement of fracture toughness due to WPS, the effect of weld strength overmatch and the treatment of plastic collapse.

#### Key Findings

- The transverse residual stress data for a butt-welded joint in a ferritic steel weld are reasonably represented by the upper bound curves given in BS 7910 and R6.
- The simple Level 1 model for residual stress relaxation under mechanical loading is a reasonable representation of the maximum value of transverse residual stress data obtained after WPS.
- The model for the enhancement of apparent fracture toughness after a WPS event is consistent with experimental results.
- Refinement of the treatment of residual stress from a simple Level 1 approach to a Level 3 approach allowed an almost threefold reduction in the value of  $K_r$  at failure.
- The initial estimate of  $L_r$  was reduced by a factor of around 1.3 once a revised global limit load solution was used, and the effects of mismatch taken into account.
- To date, all of the results associated with failure of the plate lie outside the default failure assessment line (FAL), so they support the fracture models in BS 7910 and R6.
- The effect of crack tip constraint on the fracture toughness of the weld metal is unknown; however, from the approach given in BS 7910 and R6 it was possible to draw up a series of hypothetical FALs for different levels of crack tip constraint.



Macrosection of weld – crack position in red

#### How to benefit from this work:

- As an Industrial Member of TWI, you have free access to the [full report](#)
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