

STRESS-CORROSION CRACKING OF WELDED JOINT OF X70 STEEL WITH CONCENTRATOR IN WELD

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Numerical modeling using finite element method showed that stress-corrosion cracking of the welded joint with a V-shaped stress occurs along the weld, without spreading through heat-affected zone and parent metal, which emphasizes high ductility properties of the weld. Maximum deformation is concentrated under the notch, where the fracture focus is formed.

Keywords: stress-corrosion cracking, weld, properties, deformation, fracture

Introduction. Steel X70 has high impact toughness, strength, satisfactory weldability, and resistance to various types of deformation. However, during welding, the mechanical properties of welded joints (WJ), particularly in the heat-affected zone, deteriorate due to the thermal cycle of welding. For example, authors [1] shown that in a near-neutral pH solution the ranking of sensitivity to stress-corrosion cracking (SCC) of welded joints of X70 steel is as follows: weld metal > heat-affected zone > base metal. Other researchers [2, 3] found that in a near-neutral pH environment SCC of a welded joint of X70 steel can initiated from microvoids in heat-affected zone and propagate along the plane of main stress.

The purpose of this work was to investigate the influence of V-notch in the weld on SCC of welded joints [4] of X70 steel in near-neutral pH solution at polarization potential -1.050 V using numerical modelling.

Research results. Slow strain test method [4] and finite-element simulations in ANSYS (Fig. 1) were used for SCC studies of welded joints including WJ with V-notch in near-neutral pH solution at polarization of -1.050 V (relative to saturated silver chloride reference electrode).

Stress-distribution analysis during tensile failure of welded joints revealed:

- for welded joint without notch the maximum deformation is concentrated in the base metal outside the weld, which is due to its higher strength; the rupture center is located in this region. This correlates with the stress-corrosion tests results showing that the welded joint broken through the base metal [4];

- in welded joint with V-notch stress-corrosion cracking occurs along the weld metal itself, with maximum deformation concentrated beneath the notch where the crack initiates. This correlates with SEM analysis of fracture surfaces which confirm rising of part of brittle areas after welded joint broken down.

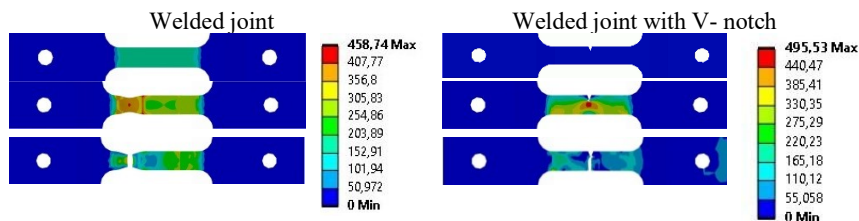


Fig. 1. Stress–intensity distribution in the welded joints during SSRT tests in NS4 solution at polarization potential of -1.050 V.

Conclusion. It was found that SCC of welded joint without stress concentrator in the NS₄ solution at a polarization potential of -1.050 V occurs along the parent metal. Numerical modeling using finite element method showed that the maximum stress during rupture of welded joint without stress concentrator is concentrated in base metal. In the presence of V-notch in the weld center, SCC occurs along the weld, without spreading through heat-affected zone and parent metal, which also emphasizes high ductility properties of welded joint. maximum deformation is concentrated under the notch, where the fracture focus is formed.

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