

RESIDUAL STRESS MAPPING IN A PIPE WELD REPAIR USING HIGH ENERGY X-RAY DIFFRACTION

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Weld repairs are introduced into pressure vessels and pipework, either as a result of remedial work to remove and make good initial fabrication defects, or as a consequence of reparation work to eliminate service-induced defects or degradation. Post weld heat treatment of stainless steel welds to relieve residual stress is generally not required by engineering construction codes and standards because of detrimental metallurgical effects. Thus in practice, weld repairs in stainless steel components are frequently returned to service duty in the as-welded state. Such weld repairs can severely compromise the life and structural integrity of industrial plant owing to strong three dimensional residual stress features that can be very different from those in original fabrication welds. Characterising complex residual stress fields in repaired pipework is a challenging undertaking whether by numerical modelling or experimental measurement.

This paper describes the first application of high energy X-ray diffraction (HEXRD) to measure residual strains in the vicinity of a short 'boat-shaped' repair in an Esshete 1250 austenitic stainless steel pipe butt weld. The test pipe was 600 mm long, and 35 mm thick, with a 180 mm outer diameter. Measurements were made at the European Synchrotron Radiation Facility on beam-line ID15A using energies in the range 0 - 300 keV. Both hoop and axial components of residual strain were measured simultaneously at more than 200 points, allowing maps of measured axial and hoop strains to be obtained on radial-hoop planes in the vicinity of the weld repair. The results give a unique insight into the distributions of strain and stress along the (circumferential) welding direction of a short length weld repair. In the HAZ the axial stress and strain maps show a classic global form; that is tension over the repair sector balanced by compression beyond the ends of the repair. The results suggest greatest stress levels concentrated beneath the repair capping pass, with a gradient in the concentration of weld cap residual stress that increases in the direction of welding.

Information

- This abstract is submitted to the ICRS conference
- Permission is granted to post the abstract
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- Oral presentation requested in the following session: Synchrotrons: Macrobeam and High Energy Techniques
- We intend to publish in the ICRS proceedings