



Industrial Member Report Summary – Key Findings for Industry

Examination of Residual Stress State in a Girth Welded Pipe Spool Subject to High Plastic Deformation

TWI Core Research Programme

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Industrial need

Welding residual stresses can have a profound influence on the fracture and fatigue behaviour of welded joints. Consequently, structural integrity assessment procedures typically include compendia of residual stress distributions for a range of joint types, plus methods for incorporating the effects of residual stress into analyses. They also include advice on circumstances in which residual stresses can be relieved, for example through the use of post-weld heat-treatment or mechanical stress relief.

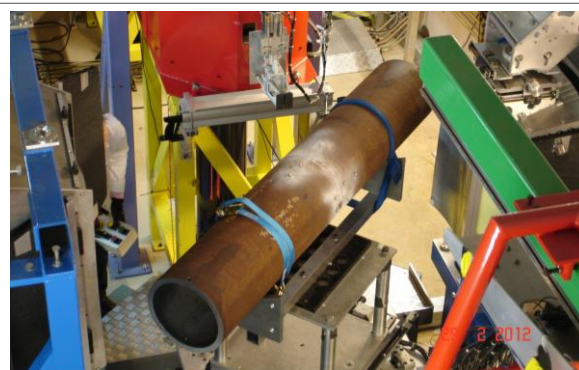
Residual stresses are modified by high applied strains, as experienced in, for example, pipe reeling operations. Understanding this redistribution will allow greater accuracy in fitness for service assessments, potentially improving safety and reducing overdesign.

Key Findings

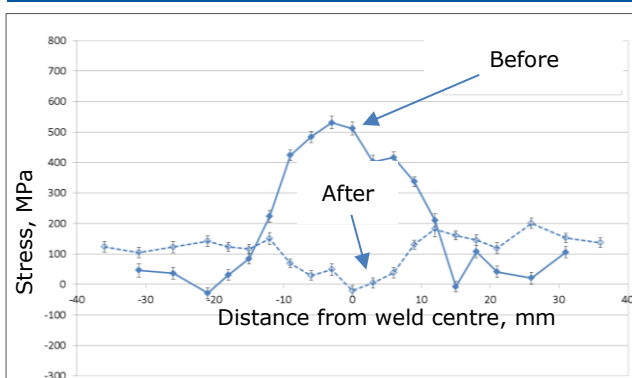
- Narrow gap welded pipe spools exhibited significantly lower axial residual stresses in the as welded condition than conventionally welded pipes.
- The distribution and the peak value of hoop residual stresses in the girth welded pipe spool were of the order of and exceeding the yield strength of the parent material. This distribution is in line with the profiles available in the codes and standards.
- After the application of 3% remote strain, the hoop component of the residual stress reduced significantly and yield magnitude residual stress in the weld vanished, whereas the far-field hoop residual stresses increased from negative values to values in the order of 100 - 200MPa.
- In general, both the radial and axial residual stresses decreased. When the distributions after straining are examined, it can be seen that radial and axial residual stresses were negative and followed a stable trend rather than fluctuating in the vicinity of the heat-affected zone or in the far-field.

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Measurement of axial residual strains in the as-welded pipe spool



Residual stress in hoop direction 3mm below the OD surface, before and after straining