Residual Stress in a Composite Welded CT Specimen

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Advanced gas-cooled reactor nuclear power plants operate at high temperatures (above 450 °C). Structural components and welded joints in the reactor primary coolant system and steam raising plant at these power stations are exposed to conditions where creep deformation and damage mechanisms prevail. These degradation mechanisms are exacerbated by tensile residual stresses, and thus should be accounted for both in the acquisition of test data and in structural integrity and life assessment procedures. Creep crack growth tests have been conducted on compact tension (CT) test specimens extracted from structural weldments made from a high Mn stainless steel (Esshete 1250). Make-up pieces were electron beam welded to the extracted coupons to ensure that the test specimens satisfied standard CT dimensional requirements. Unexpectedly high creep crack growth rates have been observed in laboratory tests using these CT specimen for acquiring life assessment data. It is suspected that the high growth rates are owing to the presence of welding residual stresses remaining in the test specimens. The authors have measured the full residual stress tensor (based on strain measurements in 8 directions) along the line of crack growth in one of the composite welded test specimens using the L3 stress-scanning diffractometer at the NRC Canadian Neutron Beam Centre. The measured results show the presence of tensile residual stresses in the test specimen sufficient to influence creep crack growth behaviour as well as significant shear stresses along the measurement line.

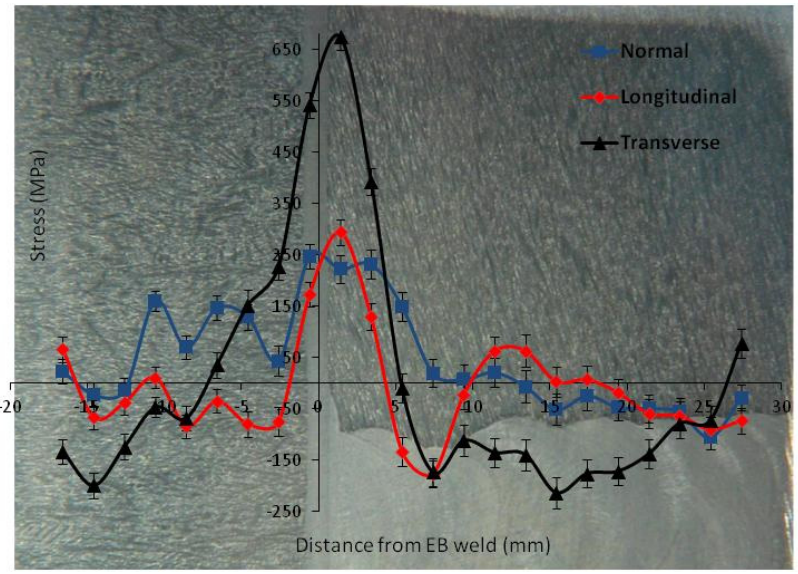

Fig. 1 Variation of longitudinal, normal and transverse stresses along the measurement line. Negative distances correspond to the parent metal and positive distances correspond to the HAZ of the MMA weld.