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SPECIAL ISSUE ON RESIDUAL STRESSES AT REPAIR WELDS

Editorial

The idea for this Special Issue stemmed from a steam leak-before-break incident in 1997 at Hunterston nuclear power station in Scotland, where a creep crack initiated and grew through the pipe wall adjacent to a finite length repair in a stainless steel pipe butt weld [Dunn et al., 1998]. A review of published literature at that time revealed a paucity of knowledge about weld residual stresses associated with repairs. The need to understand the driving force behind this kind of structural degradation has motivated new research and development work in the United Kingdom aimed at characterising weld repair residual stresses by direct measurement and by finite element simulation of the welding process.

The importance of residual stresses at weld repairs for structural integrity has been emphasised by a more recent leak-before-break incident at the V C Summers Nuclear Power Plant in the United States, where 9 Kg of boric acid crystals were found beneath the reactor pressure vessel inlet nozzle transition weld. Axial cracking at a repair weld was caused by stress corrosion in this case. More generally, a recent survey of weld repair technologies currently used by EPRI member utilities in the US has found that 40 percent of all repairs to steam chests, piping and headers resulted in subsequent cracking [Gandy et al., 2001]. For high integrity plant, safety critical applications, or where the economic penalty of failure is unacceptable, it is crucial to understand and quantify the residual stress state associated with weld repairs, whether they are introduced during fabrication or later in life to remedy in-service degradation.

There are nine papers in the Special Issue devoted to the themes of analysis, measurement and assessment of weld repair residual stresses, with three papers in each theme. The first three papers describe advanced applications of three dimensional weld residual stress simulation procedures to finite length weld repairs. The predicted results illustrate the general nature of residual stresses at weld repairs, and in many cases, the results compare favourably with residual measurements. These papers also demonstrate how measurements can be used to critically evaluate and improve predictions. The three papers on the measurement theme describe through-thickness residual stress measurements carried out on mock-up repaired pipes using the deep hole drilling technique [Smith et al., 2000] and neutron diffraction [Withers and Bhadeshia, 2001]. The papers bring together measurements published by the authors at recent conferences and substantial new measured results, thus providing a unique set of reference data. Three papers follow this on the theme of assessment. Soanes et al. describe the development and optimisation of a successful repair and local post-weld heat treatment strategy to remedy extensive cracking in an operating nuclear power station pressure vessel weld. The final two papers provide some guidance on the issue of whether or not the overall integrity of plant is improved by carrying out weld repairs (without stress-relief treatment), from a fatigue crack growth and defect tolerance perspective.

Dunn J., MacGuigan J., McLean R. J., Miles L., and Stevens R. A., 1998, "Investigation and repair of a leak at a high temperature stainless steel butt weld", Proc. Int. Conf. Integrity of High Temperature Welds, pp. 241-258, PEP Ltd., London.

Gandy D. W., Findlan S. J. and Viswanathan R., 2001, "Weld repair of steam turbine casings and piping – an industry survey", ASME J. Pres. Ves. Techn. Vol. 123, pp 157-160

Smith, D.J., Bouchard, P.J. and George, D., 2000, "Measurement and Prediction Of Residual Stresses In Thick Section Steel Welds", Jnl of Strain Analysis, 35, 4, pp 287-305

Withers P.J. and Bhadeshia H.K.D.H., 2001, "Residual stress: Part 1-Measurement Techniques", Materials Science and Technology, 17, pp 355-36