ABSTRACT

Fracture behaviour of AISI 304LN stainless steel and its weldment has been studied employing *J*-integral approach with and without superimposed cyclic load reversals in order to assess their structural integrity under simulated seismic loading condition and to compare their fracture behaviour in cyclic vis-à-vis monotonic loading. Conventional *J*- integral tests were carried out on specimens having notch in LC and CL configurations. Cyclic *J-R* experiments have been conducted (i) under displacement control with various combinations of R-ratio and incremental plastic displacement, and (ii) under load control (henceforth called *cyclic fracture tests*) for various magnitudes of monotonic peak loads. All cyclic *J-R* and cyclic fracture tests were carried out using specimens with LC orientation. Examinations of fracture surface and crack tip profiles have been made to understand the micro-mechanisms of fracture. In addition, acoustic emission (AE) methods were used synergistically with fracture toughness tests to detect the onset of crack initiation. Characterization of microstructures and mechanical properties like, tensile and hardness values are necessary supplements in this study.

The obtained results and their analyses lead to the following inferences: (a) microstructure of the selected steel reveals predominantly austenite whereas its weldment exhibits austenitic matrix with 12-15% δ-ferrite (b) the strength and hardness of the selected weldment are higher than that of the base metal. The results of fracture studies under monotonic loading conditions showed that (a) average fracture toughness values for LC and CL orientations are similar with J_Q values of 1107 and 1062 kJ/m^2 respectively and (b) fracture toughness values of weldment are almost 50% lower than that of the base metal. The cyclic fracture behaviour of the selected steels leads to the following conclusions: (a) under displacement controlled cyclic *J-R* tests, fracture toughness is found to degrade with (i) decrease in stress ratio from -0.5 to -1.0 and (ii) decrease in plastic displacement from 0.5 mm to 0.1 mm and (b) under load controlled cyclic fracture tests the steels are found to fail in a limited number of load cycles even when the load amplitude is sufficiently below the collapse load estimated from monotonic tests. Examination of the fracture surfaces and crack tip profiles revealed that degradation in initiation fracture toughness and their resistance to crack propagation at R<0 is due to re-sharpening of the crack tip during compressive loading. Synergistic analyses of fracture test and AE results assist to demarcate the region of blunting, crack initiation and crack propagation under both monotonic and cyclic *J-R* tests. In generalization, it can be said that fracture resistance of the selected steels under cyclic loading is considerably lower than that obtained from monotonic *J*-integral experiments and the initiation fracture toughness value obtained from AE parameters provide a conservative estimate.

Keywords: AISI 304LN stainless steel; Weldment; Monotonic *J-R*; Cyclic *J-R*; Displacement control; Load control; Acoustic emission