ABSTRACT

Submerged arc welding is a fusion welding process which is characterized by its high deposition, deep penetration, high productivity and smooth finish especially for down-hand position welding. It is generally used in fabrication of large structures, which involves the formation of residual stresses and distortion. The purpose of the present work is to study the thermo-mechanical behaviour and weldment characterization of the submerged arc welded joints and development of suitable mitigation technique for controlling the weld induced residual stresses and angular deformation. For this purpose, numerical analysis and numerous experimental investigation of submerged arc welded mild steel plates were carried out in this present study. 3-D transient, nonlinear, elasto-plastic finite element models were developed to estimate the thermal history, the residual stresses and distortion of the welded plates. To eliminate the time for edge preparation, welding were carried out for square butt joint with top and bottom reinforcement. A comparative study between single and double sided fillet joints was carried out. Effect of tacking sequences and welding sequences were studied for the development of sustainable mitigation techniques. Angular distortion in large structures also estimated by using an equivalent technic, which eliminated huge computation time and resources. Results obtained from the numerical analysis were compared with the experimental one. Estimation of correct heat source parameters is quite a challenging task. A new volumetric heat source model was developed which can be used in the simulations of fusion welding. Thermal profiles as well as weld bead dimensions were estimated by the application of the new heat source. Effect of weld parameters, joint geometry on weld bead geometry as well as mechanical property was studied. The addition of surface active elements enhances the weld penetration, effect of the same was studied. Single and multi-response optimizations were carried out to determine the best parameter combination.

Keywords: Transient thermal analysis, structural analysis, 3-D finite element analysis, residual stresses, angular deformation, inherent strain, plastic strain, elastic strain, large structure, heat source, welding sequence, tacking sequence, surface active element, included angle, welding process parameter, optimization.