Numerical Investigation on the Residual Stress Distributions and Crack Propagations in Friction Stir Welded Al 2024 Plates

Z.W. Zhang, Z. Zhang, *H.W. Zhang

State Key Laboratory of Structural Analysis for Industrial Equipment, Department of Engineering Mechanics, Faculty of Vehicle Engineering and Mechanics, Dalian University of Technology, Dalian 116024, China

Sequentially coupled thermo-mechanical model is used for the simulation of friction stir welding. Finite element method and J-integral method are then used for the fracture model in which the residual stress intensity factor can be calculated. According to the superposition approach, the stress intensity factor range and the effective stress ratio are obtained. Then the fatigue crack growth rate can be predicted by NASGRO equation. This method is validated in comparison with the experimental data in published literature. The distribution of the residual stress can affect the calculation of the effective stress ratio. However, the influence decreases as the increase of the stress ratio. With consideration of the residual stress, the fatigue life of the friction stir welded plate can be obviously decreased.

Keywords: friction stir welding, residual stress intensity factor, superposition approach, fatigue crack growth rate, residual stress