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Fatigue crack initiation point evaluation in load-carrying cruciform welded joints based on strain energy density approach

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Abstract

This paper presents fatigue failure crack initial points and the fatigue failure mode transition relationship between the weld toe and root of load-carrying cruciform welded joints on the basis of LEFM and Williams' notch stress intensity theory. The notch stress intensity factors (NSIFs) of different failure locations were calculated quantitatively. The averaged strain energy density (SED) in a control volume near the notches is used to unify the scalar quantity and rectify inconsistencies of NSIFs units for the weld toe and root. The failure mode transition relations of different geometrical parametric models (such as main plate thickness, attachment plate thickness, weld length, and penetration size) were compared and analyzed based on the SED values from weld toe and root locations, and the effect of unequal main plate thickness ratio in a cruciform joint on failure mode was also investigated. The results show that SED approach can be used to accurately predict the transition region of equal base plate thickness. The weld length and penetration size are related to significant changes in the fatigue failure location of cruciform joints. The SED approach effectively reflects failure characteristics and can be used to assess fatigue failure behaviors for load-carrying cruciform welded joints.

Keywords: Fatigue crack initiation point; Load-carrying Cruciform welded joints; Notch stress intensity factors; Strain energy density.

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