Impact of Specimen Configuration on Fatigue Properties of Self-Piercing Riveted Aluminum to Carbon Fiber Reinforced Polymer Composite

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Impact of Specimen Configuration on Fatigue Properties of Self-Piercing Riveted Aluminum to Carbon Fiber Reinforced Polymer Composite

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Abstract

In this study, the fatigue properties of SPR joints in CFRP-to-AA6111 aluminum alloy in lap-shear and cross-tension specimens are presented. The test specimens were produced with two distinctive targeted rivet head heights separated by 0.3 mm. The tensile failure load and fatigue life of the lap-shear joints in particular was highly influenced by the flushness of the rivet head against the top sheet of CFRP. The lap-shear SPR joints produced with a proud head height exhibited higher tensile failure load and slightly longer fatigue life than SPR joints produced with a flush head height. In cross-tension joints, the flushness of the rivet had no significant influence on the quasi-static failure load and fatigue life of the SPR joints. Two distinctive failure modes were observed, in quasi-static loading, the lap-shear and cross-tension joints failed due to rivet pullout of the bottom aluminum sheet. In cyclic loading, the lap-shear joints failed due to kinked crack growth in the bottom aluminum sheet, while the cross-tension joints failed due to rivet pulling out of the top CFRP sheet. Finally, an analytical based, structural stress model was used to generate a master curve to predict the fatigue life of the SPR joints for both specimen types. The study shows, the flared rivet diameter as a controlling parameter in evaluating the fatigue life of the SPR joints.