ID contributo: **85** Tipo: **Presentazione orale**

Metal Z-Pin Reinforcement for Improved Tensile Strength in Thin Stepped Composite Joints

mercoledì 3 settembre 2025 12:15 (15 minuti)

Co-cured composite joints are highly prone to debonding and delamination due to the low through-thickness strength of layered composites and the high peel and shear stresses arising at the edges of the bonded interface. Several toughening strategies have been proposed to improve their fracture toughness. Among them, z-pinning, which consists of inserting thin fibrous or metal rods through the thickness of the uncured material, resists delamination growth by forming a crack bridging zone in the wake of the crack front. Compared to conventional z-pins, staple-like (i.e., U-shaped) pins may provide additional load transfer paths between the adherends and further reduce stress concentrations at joint edges. Thus, this study assesses the effect of conventional and U-shaped z-pins on the ultimate tensile strength and the damage response of stepped-lap joints.
To this purpose, single-step lap joints with a cross-ply sequence were reinforced using stainless-steel z-pins inserted near the overlap edges and then tested under tensile loads. Experimental results reveal that the onset and growth of delamination at the joint interface govern the ultimate failure of unpinned and pinned joints. In order to further investigate the z-pin toughening mechanisms, an FE model of unpinned and pinned joints was developed using cohesive damage laws to account for both joint and pin-laminate debonding. Numerical results show good agreement with experimental observations in terms of ultimate strength, force-strain curves, and debonding-crack growth. The proposed model correctly predicts the beneficial effect of through-thickness z-pins on the static strength of the joints and their damage tolerance, demonstrating that z-pins do not delay the occurrence of delamination but resist its propagation by reducing the energy available at the crack front.

Autori principali: Dr. LOI, Gabriela (Università degli Studi di Cagliari); Prof. AYMERICH, Francesco (Università degli Studi di Cagliari)

Coautore: Sig. MARONGIU, Gianluca (Università degli Studi di Cagliari); Dr. EL MOHTADI, Rayane (Università degli Studi di Cagliari)

Relatore: Dr. LOI, Gabriela (Università degli Studi di Cagliari)

Classifica Sessioni: Compositi

Classificazione della track: Materiali Compositi