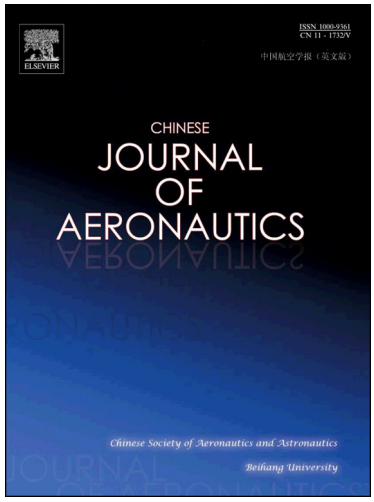

Full Length Article

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Evaluation of tensile properties of a composite-metal joint with a novel metal insert design by experimental and numerical methods

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Abstract

Composite-metal joints with a metal insert are one kind of connecting structure. In this paper, tensile experimental tests were carried out to investigate tensile properties of a composite-metal joint with a novel metal insert design. Finite element models of the joint were established, and strain distribution and tensile strength were analyzed. The numerical results are in good agreement with the experimental results. Results show that the joint failure is dominated by shear properties of the resin layer. Increasing the resin layer thickness in a certain range will improve the tensile strength of the joint, while increasing the radius of the fillet on the ending side of the metal insert will decrease the joint strength. Increasing the resin layer plasticity will improve the joint strength. The effect of the embedded depth of the metal insert can be ignored.

Keywords: composite structure; failure mode; joints; metal insert; tensile properties

1. Introduction[1]

Composite structure joints are mainly divided into two types, namely mechanical joints and bonded joints. Mechanical joints can transfer heavy load and are suitable for concentrated load transmission[1-4], while bonded joints are applicable for distributed load transfer without any hole in adherends[5-9]. Bonded joints have been widely used in engineering structure connection, including connection of composite structures and connection between composite and metal structures[8-11]. For general bonded joints, there is only one adhesive interface, and thus the load transmission efficiency is low. Therefore, a novel composite-metal bonded joint is developed to improve the load transmission efficiency by increasing the bonding area between a composite and a metal insert.

Investigations on unconventional joints between a metal plate and a composite laminate have been performed. Dvorak et al.[5] investigated adhesive tongue-and-groove joints for thick composite laminates and concluded that the joints provide superior strength in bonding a steel plate and a laminate under a tensile load. Melogranaa et al.[6] investigated adhesive tough-and-groove joints between thin composite laminates and steel plates, and found that structural failure is consistent with adhesive failure. The joint strength is 40% higher than that of a conventional single-lap joint with an equivalent overlap length. Riberholt[11] investigated glued bolts in glulam and found glulam glued-in rods can efficiently improve strength and stiffness of a joint. Llopart et al.[12] investigated the influence of imperfect bonding on the strength of specific double-lap joints. They indicated that imperfect bonding has a significant negative effect on structure strength but hardly influences stiffness. Camanho et al.[13] investigated bonded metallic inserts for bolted joints in composite laminates and presented that the introduction of metallic inserts releases

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