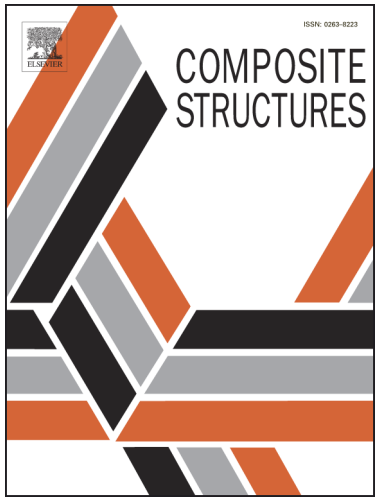

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Static and Fatigue Testing Bolted, Bonded and Hybrid Step Lap Joints of Thick Carbon Fibre/Epoxy Laminates Used on Aircraft Structures

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Abstract:

Fibre reinforced polymer matrix composites are being increasingly used for aircraft structures because of their superior structural performance, such as high strength, high stiffness, long fatigue life, and low density. This study is targeted towards the repair of thicker composite step lap joint configurations. The aim is to compare the static strength and fatigue resistance of a hybrid joint consisting of both bonding and bolting, a purely fastened joint and a purely bonded joint. Parameters such as fastener array, bond strength and the influence of initial defects are investigated.

Static tests results revealed there is minimal change in peak strength achieved by a hybrid joint compared to a bonded joint. Fatigue tests showed that hybrid joints have the greatest durability followed by bolted joints and finally bonded joints. The presence of fasteners in a hybrid joint reduces the peel stress and arrests crack propagation in the bondline. The fasteners also act as an adhesive bond failsafe mechanism preventing sudden catastrophic failure particularly for bondlines containing defects. Failure in the various specimen configurations ranged from bearing failure in the bolted joint cases whilst bonded and hybrid joint configurations showed first ply failure followed by net-tension failure as well as adhesive failure.

Keywords

Adhesive joints; Hybrid joints; Fatigue; Static strength; Damage tolerance

1.0 Introduction

The emergence of composite materials in the construction of aircrafts has resulted in the need for improved damage growth predictions and effective/ efficient repair techniques for damaged structures. The damage mechanisms in composites differ significantly than those in metals and hence further testing and analysis are required to achieve optimal structural efficiency.

The authors previously investigated the effects of joining thin composite laminates together in a double lap joint configuration [1]. Three fundamental joint structures were looked at – mechanically fastening, bonding and the combination of the two called 'hybrid' joints. Results revealed that under static test conditions, there are no significant differences in joint strength between a bonded and hybrid joint; it was during fatigue test cases where hybrid joints showed the greatest durability followed by bonded joints and then fastened joints. This investigation now focuses on the repair of