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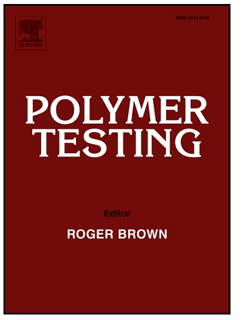

Experimental study of the influence of thickness and ply-stacking sequence on the compression after impact strength of carbon fibre reinforced epoxy laminates

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Material Properties

Experimental study of the influence of thickness and ply-stacking sequence on the compression after impact strength of carbon fibre reinforced epoxy laminates

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Abstract
Composite structures are particularly vulnerable to impact which drastically reduces their residual strength [1-3]. In this work, the influence of laminate thickness, ply-stacking sequence and scaling technique on the impact damage tolerance of CFRP laminates is investigated by means of compression after impact (CAI) tests. Drop-weight impact tests were carried out to determine impact response of the different composite laminates. CAI tests were performed in a non-standard CAI device in order to obtain the compression residual strength. In addition, open-hole compression (OHC) tests were performed for comparative purposes. Ultrasonic C-scanning and cross-sections of CAI samples were examined to assess failure mechanisms of the different configurations.

It was observed that damage tolerance decreases as impact energy increases. In addition, thicker laminates show higher CAI strength due to higher bending stiffness. Furthermore, angle-ply laminates depict better performance in terms of damage tolerance. Finally, the results obtained demonstrate that introducing ply blocking had a negative effect on the damage resistance but, conversely, an improvement of the CAI strength.

Keywords: epoxy composites, impact damage, CAI, residual strength, stacking sequence, ply clustering.

1. Introduction

Fibre reinforced composite materials have become relevant in aerospace, automotive, wind energy, marine and civil engineering applications due to their high specific stiffness and strength, corrosion resistance and fatigue performance [3], [4-6]. One of the major factors limiting the design of structures made from current carbon fibre-epoxy systems is the susceptibility of the material to impact damage in the form of matrix cracking, multiple delaminations and fibre breakage [7-9]. Fibre failure (intra-laminar failure) affects mainly tensile strength, while delamination (interlaminar damage) decreases mainly compression. When compressive stress is applied, the interaction between the delaminations and fibre damage can have a considerable detrimental effect on the performance [7], [10-12]. Low velocity impact damage is especially dangerous because of its difficult detectability, and it is potentially a source of mechanical weakness that can propagate and cause considerable overall strength reduction. Compression After Impact (CAI) testing is of great interest within the aeronautical industry, since the residual compressive strength of the damaged component is the property that decreases the most [9], [13-15].