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Title

On the mechanical response of CFRP composite with embedded optical fibre when subjected to low velocity impact and CAI tests

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Abstract

The influence of embedded optical fibres on the mechanical response of a CFRP composite laminate has been assessed in this paper with a specific focus on their effect when laminates are subjected to low velocity impact and compression after impact (CAI) tests. Although several studies are present in the literature, univocal conclusions based on their results are difficult to be drawn. Indeed, impact and compressive after impact performances depend on a plethora of different parameters in addition to the typical experimental uncertainty. First, the impact behaviour of a specific specimen configuration has been studied in terms of dynamic features, such as the impact force and displacements, and the absorbed energy. Then, the impact damage is assessed through macro-scale non-destructive testing, including ultrasonic and computed tomography. Furthermore, optical microscopy and SEM imaging have been conducted at a micro-scale level for a limited number of specimens. Conclusively, CAI tests have been performed and conclusions on the variation of the compressive strength and stiffness have been presented.

Keywords

Low-velocity Impacts; Optical Fiber Embedding; FBG; CFRP; NDT.

Main text

1. Introduction

Composite materials, Carbon Fibre Reinforced Polymers (CFRP) in particular, are increasingly replacing traditional metallic materials even in primary flight structures, due to their excellent specific mechanical properties, i.e. higher strength-to-weight and stiffness-to-weight ratios, as well as due to their improved resistance to corrosion, their fire-retardant properties and the reduced lifecycle costs. As an example, about 50% of the Airbus A350 XWB and the Boeing 787 Dreamliner is made of composites, thus allowing a more robust design and, consequently, a reduction of both the scheduled and non-routine maintenance burden.

However, if on one hand composite laminates have excellent specific tensile properties, on the other hand the application of out-of-plane and compression loads is often critical. This scenario is well represented by the low-velocity impacts (LVI), which may occur during manufacturing, maintenance and in general during aircraft operation. Such impacts, depending on the structure capability to dissipate the kinetic energy away from the point of impact [1], may induce matrix cracking and delaminations [2], consequently affecting the strength and the stability of the