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Experimental and Numerical Investigation on the Crashworthiness of a composite fuselage Sub-floor support system

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ABSTRACT

In the present paper, advanced numerical methodologies have been adopted to investigate the structural behaviour of a composite subcomponent for aerospace applications subjected to quasi-static compression and dynamic loads. The analysed structural component, made of laminated carbon fibres reinforced polymers, is part of the floor support system in the cargo area of a commercial aircraft. The inter-laminar and intra-laminar damage onset and propagation has been preliminary monitored under a quasi-static compressive displacement application. Then, the effects on the structural integrity of two impact energy levels have been analysed: 42 J energy has been applied to study the dynamic behaviour in an elastic linear rate while 585 J energy has been considered to assess the crashworthiness behaviour. The adopted numerical model has been validated by comparisons between the numerical results and analytical mass-spring model results and experimental data in terms of stiffness, strain, and ultimate load. The simultaneous assessment of numerical results and experimental data has allowed to provide a comprehensive insight on the damage onset and propagation leading to the structural collapse of the investigated sub-floor support system.

Keywords: Crashworthiness; Finite Element Analysis (FEA); Composites; Progressive Failure Analysis (PFA).

1. Introduction

The use of advanced composite materials for aerospace structural design is progressively increasing although the potential of these material has not yet fully exploited [1,2] due to several reasons such as the use of inadequate design criteria, difficulties in experimental verification (deterioration of the material, environmental factors), expensive manufacturing costs (high equipment cost), and

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