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Design of composite stanchions for the cargo subfloor structure of a civil aircraft

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Abstract

The present work was performed in the frame of a national research program focused on the development of analysis method able to improve the structural response of civil aircraft subject to crash event. In particular, the aim of the program is to demonstrate the energy absorption capability of the lower lobe section of the fuselage aircraft. One of principal substructures, which is able to absorb the impact energy in a crash event, is the cargo subfloor. In this work, the results obtained by an experimental test campaign on cargo subfloor elements are presented. The test case consists in a full scale composite stanchion. The experimental results were used to provide information useful to set the numerical models. Indeed, setting and calibrating the numerical models is an important point in order to have useful tools able to improve the absorption energy capability by means of optimization analyses. The stanchion was tested under static and dynamic load conditions, at different impact energy levels.

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Keywords: Composite structure, Impact analysis, Finite elements analysis, Crashworthiness

1. Introduction

The present work describes the activities performed in order to define the size and the design of the specific parts

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(stanchions) dedicated to the energy absorption during an impact event, in order to obtain a satisfactory behaviour in a typical crash scenario. The results obtained allow to define a numerical methodology able to simulate the impact phenomenon [1,2] occurred on composite subfloor structure of a civil aircraft, based on the corresponding tests performed by CIRA at LISA (Laboratory for Impact testing of Structures in Aerospace field).

In order to design, evaluate, and optimize the crashworthiness behaviour of the airliner cargo fuselage section under crash landing, the evaluation of the energy absorption as well as the measurements of the deceleration time history allow to define the geometry of the absorber elements during the crash phase [3-9].

2. Test case description

The work was focused on experimental and numerical activities related to a component of the cargo subfloor of a civil aircraft made in composite material. In particular, the stanchion elements (figure 1-A) which link the transversal subfloor beam to the frame in order to reduce the bending in the transversal beam, was analysed. Indeed, the stanchion elements represent one of the possible ways to transfer the impact load to the structures.

The stanchion was analysed under both static and dynamic load conditions. In the following, the potted stanchion is named Test Case A. The tests are useful to understand the global response of the structure in terms of failure mode, stress distribution, abortion of energy, etc., and to provide the right recommendation in order to define a reliable numerical model able to simulate accurately both events. A reliable numerical model is the first step to define a numerical procedure finalised to the structural optimization of the component able to upstand to crash event.

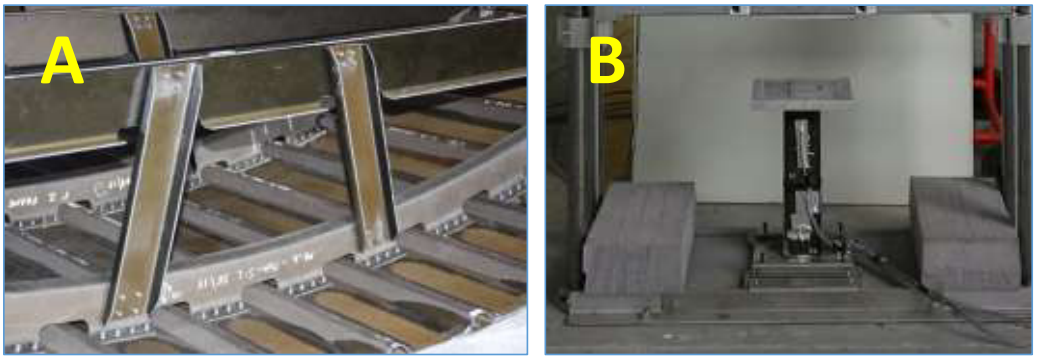

Fig. 1. Test articles in the real configuration (A); Test case A (B); Test Case B (C)

Figure 2 shows the main geometrical parameters of the Test Case A and a schematic representation of testing layout. The stanchions are made in CFRP (Carbon Fibre Reinforced Plastic) material. The mechanical properties at lamina level are reported in Table 1. The stacking sequence is [45,-45,90,-45,45,0,0,0,0,45,-45,90,-45,45].

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