Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 167 (2016) 64 – 70

Procedia Engineering

www.elsevier.com/locate/procedia

Comitato Organizzatore del Convegno Internazionale DRaF 2016, c/o Dipartimento di Ing. Chimica, dei Materiali e della Prod.ne Ind.le

Multifunctional Polypropylene Core For Aerospace Sandwich Composite Panels

A. Riccio[a]*, A. Raimondo[a], A. Sellitto[a], V. Acanfora[a], M. Zarrelli[b]

[a]*Department of Industrial and Information Engineering, Second University of Naples, via Roma n 29, 81031 Aversa (CE), Italy*
[b]*Institute for Polymers Composites and Biomaterials, Italian National Research Council, piazzale Enrico Fermi, 80055 Portici (NA) Italy*

Abstract

The sandwich composite panels, due to their highly specific mechanical properties, are widely used in many engineering fields (such as the aeronautical, railways and automotive).
In this work, a numerical study is presented on the impact behavior of several sandwich composite panels configurations with polypropylene core, usually adopted for aerospace applications, with the aim to assess their mechanical properties and to make a selection of the best configurations taking into account their multifunctional characteristics.
The existing limits in current aeronautical sandwich panels have been assessed and techniques/solutions able to improve (even through the utilization of micro and nano fillers) the multifunctional and structural properties have been explored. Indeed, resistance to fire and resistance to impact events have been selected as the main characteristics of interest for the presented study.
Low-speed impact tests (according to the ASTM standards) on sandwich composite panels with polypropylene core have been simulated by means of the commercial FEM software "Abaqus".
Low velocity impacts can switch complex damage mechanisms (such as delaminations or large indentations) in composite panels. These damage mechanisms are of major concern from a structural point of view because they can suddenly reduce the loading carrying capability without being visible in programmed visual inspections.
As a result of the performed simulations, the low velocity impact induced damage, in terms of delamination and indentation, has been evaluated for several sandwich panels with varying polypropylene core material composition. The outputs have been compared providing a first estimation of the capability to resist to impact event provided by several polypropylene core configurations. The resistance to impact events have been associated to the fire resistance capability of the analyzed material core configurations proving a comprehensive insight on the multifunctional behavior of sandwich composite panels with polypropylene core.

Peer-review under responsibility of the Organizing Committee of DRaF2016

* Corresponding author. Tel.: +39 081 5010504; fax: +39 081 5010204.
*E-mail address:*aniello.riccio@unina2.it

Peer-review under responsibility of the Organizing Committee of DRaF2016
doi:10.1016/j.proeng.2016.11.670

Keywords: Composite plates, Modal analysis, Identification, Properties, Finite elements

1. Introduction

The use of composite sandwich structures keeps growing in several industrial fields such as aerospace and marine industries because of their high specific bending stiffness and strength [1]. The core, which is typically a low strength, lightweight material, provides separation between the face-sheets in order to significantly improve the whole flexural stiffness. However, sandwich structures are known to have limited tolerance to impact damage by foreign objects [2-6]. A multitude of damage mechanisms could occur over a range of impact energies, thereby affecting their subsequent residual in-plane compression properties [7-9].

In order to ensure the specific mechanical and multifunctional properties of the sandwich panels, as required in their operating environment, it is possible to follow two different strategies: increase the skin thickness and mechanical properties or adding nano and micro fillers to the core to improve the core mechanical properties.

The first technique, mainly used for panels with thermoplastic core, often implies an increase of weight and manufacturing costs if compared to the second technique. Additionally, due to the characteristics of their thermosetting cores, the panels produced with the additive process result in a greater environmental impact.

The aim of this work is to numerical investigate the impact behavior of sandwich panels with different configurations of nano and micro fillers for polypropylene cores and to make a selection of the best configurations taking also into account the fire resistance capability. Numerical impact simulations have been performed at different energy levels (3J, 5J and 10J) using the FEM software "Abaqus". The numerical results obtained for the different core configurations have been compared in terms of induced indentation and delamination in order to have a first estimation of the impact resistance. In Section 2 the numerical model adopted for the simulations is described while in Section 3 numerical results are presented and discussed.

2. Model description

The sandwich panel model used for the numerical analysis fulfils the ASTM D7136 standard. The panel consist of a polypropylene core with two exterior composite skins, each made of four ply oriented according to the stacking sequence [0/90]s. Two cohesive surfaces have been placed between core and skins in order to simulate the inter-laminar damage. Delamination between adjacent plies in the composite laminate have not been considered in the present work. A hemispherical impactor with 8 mm radius and 3.6 kg mass has been considered to simulate the impact phenomenon. The geometrical description of the model and the material properties of the composite lamina are respectively shown in Fig. 1, Table 1 and Table 2.

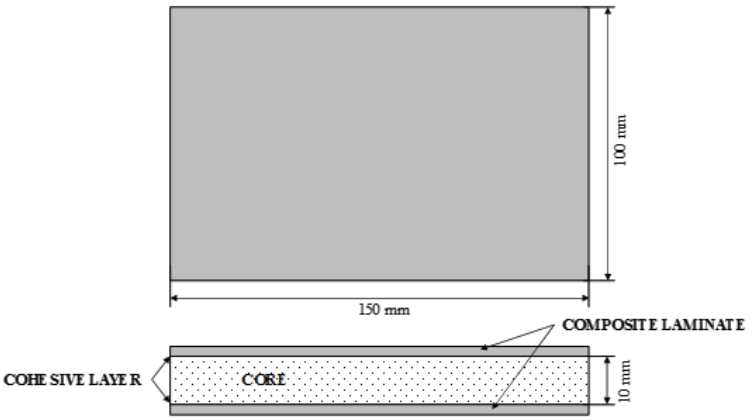

Fig. 1. Geometrical Description.