NUMERICAL MODELLING OF LOW-VELOCITY IMPACT ON HONEYCOMB CORED SANDWICH BEAMS WITH COMPOSITE FACE-SHEETS

Inés Ivañez *, Carlos Santiuste * and Sonia Sanchez-Saez *

* Department of Continuum Mechanics and Structural Analysis
Carlos III University of Madrid
Avda. Universidad, 30. 28911 Leganes, Spain
e-mail address: idel@ing.uc3m.es, web page: http://www.uc3m.es/mma

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Summary. In this study, a 3D finite-element model of low-velocity impacts on composite sandwich beams with carbon fibre/epoxy face-sheets and aluminium honeycomb core is presented. The numerical model was validated through a series of dynamic three-point bending tests conducted in a drop-weight tower. The low-velocity impact response of these structures is analysed in terms of contact force, absorbed energy, and maximum displacement in both face-sheets.

1 INTRODUCTION

Composite sandwich structures consist of two composite face-sheets and a lightweight core. This apparently simple combination provides with high bending stiffness-to-weight and strength-to-weight ratios, which are extremely appreciated in several engineering applications, particularly in aerospace and aeronautics industries. However, the composite face-sheets of these structures are susceptible to be damaged by localised low-velocity impacts; thus it is needed to gain knowledge about their response to these events.

Most studies on low-velocity impact of composite sandwich structures are based on experimental tests [1], which are usually expensive; therefore, it is of great interest to develop accurate models to reproduce those impact events. Some authors have developed analytical models of sandwich structures [2]. The analytical approaches are fast and reliable, but they seem to be less flexible than finite-element modelling. Although the FE analysis of composites sandwich structures requires including complex models for the mechanical behaviour of the face-sheets, several variables (materials, geometry, etc.) can be easily modified. Most of the numerical models developed for composite sandwich structures, refer to plates and panels [3] whereas works dealing with beams are lesser.

In this work, low-impact velocity behaviour of sandwich beams with woven laminate faces-sheets of carbon fibre/epoxy (2 mm of thickness) and aluminium honeycomb core (20 mm of thickness) is studied.
2 EXPERIMENTAL TESTS

Low-velocity impact tests were conducted in an instrumented drop-weight tower. A three-point bending device was used to ensure the flexural behaviour of the sandwich beams. The impact energy ranged from 10 to 35 J. The tests were recorded by a high-speed video camera to measure the impact and the post-ricochet velocity of the impactor, and the maximum displacement in the upper and lower face-sheets.

3 NUMERICAL MODEL

A 3D numerical model of the honeycomb core composite sandwich beams was developed with Abaqus/Explicit code. The aluminium honeycomb core was modelled as elastic-plastic material. The face-sheet behaviour was modelled through a user subroutine (VUMAT) which includes Hou failure criteria [4] and a procedure to degrade material properties. The mesh was especially dense towards the impact region.

4 RESULTS AND DISCUSSION

Four parameters were calculated in order to compare the finite-element model to the experimental results: contact force history, upper and lower face-sheets maximum displacement and absorbed energy. Good agreement was obtained between numerical and experimental results (Figure 1) and the numerical model provided with the stress field and failure criteria in the composite face-sheets.

Figure 1: Comparison between numerical and experimental tests

REFERENCES