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MODELLING OF COMPOSITE SANDWICH STRUCTURES WITH HONEYCOMB CORE SUBJECTED TO HIGH VELOCITY IMPACT

Brenda L. Buitrago*†, Carlos Santiuste*, Sonia Sánchez-Sáez*, Enrique Barbero* and Carlos Navarro*

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

†Department of Industrial Technology
Simón Bolivar University
Valle de Sartenejas, Caracas, Venezuela

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Summary. In this study the behaviour of composite sandwich panels with aluminium honeycomb core subjected to high velocity impact was analysed by a numerical model which was validated by experimental tests.

1 INTRODUCTION

Sandwich structures used for weight-efficient components are commonly applied in aerospace applications. The most usual components of aerospace sandwiches are carbon-fibre skins and honeycomb cores. During service, these structures may encounter high-velocity impacts caused by runway stones, hailstones, debris, etc. Most studies on high-velocity impact behaviour of sandwich structures are based on experimental tests [1]. Since impact phenomena depend on numerous parameters such as material properties or projectile geometry, a numerical model, validated experimentally, is necessary to allow the study of the influence of several parameters without making costly experimental tests.

In this work, a numerical model is used to study the behaviour of sandwich panels made of composite skins with aluminium honeycomb core under high-velocity impact. The model was validated by experimental tests.

2 MATERIAL

The sandwich skins were made from a carbon/epoxy woven laminate (AS4/8552) 2 mm thick with a honeycomb core made from aluminium 20 mm thick.

3 NUMERICAL MODEL

For the analysis of the sandwich panel, a numerical model was implemented in ABAQUS/EXPLICIT,

Figure 1. Only a quarter of the panel was modelled due to the symmetry of the problem. The failure of the skins was evaluated by a criterion implemented in a VUMAT subroutine which includes several failure mechanisms for fibre and matrix [2], also considering delamination failure [3]. To model the loss of composite mechanical properties a degradation procedure and a criterion of element deletion based on strains was included in the subroutine. The honeycomb core was modelled in the zone closest to the impact, reproducing the aluminium hexagonal cells, while the distant zones were modelled by a homogeneous equivalent material. The core model was validated by experimental tests.

4 EXPERIMENTAL VALIDATION

To validate the numerical model, experimental tests were carried out by a gas-gun set-up with spherical projectiles of 1.5 gr and 7.5 mm diameter. The velocity range was between 100 and 550 m/s. Impact and residual velocities were measured by a high-speed video camera.

5 RESULTS

Experimental and numerical results were compared verifying the precision of the model in the prediction of the residual velocity of the projectile. From this information the ballistic limit could be estimated with less than 1% error. The model also predicts the failure shape and the contribution of each component of the sandwich panel to the energy absorption of the projectile. The honeycomb core-energy absorption was estimated to be very small compared with skins ones.

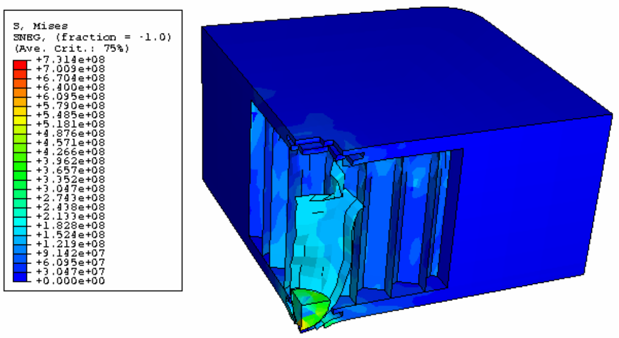

Figure 1: Modelling of the perforation of the sandwich plate

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