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FEM ANALYSIS OF DYNAMIC FLEXURAL BEHAVIOUR OF COMPOSITE SANDWICH BEAMS WITH FOAM CORE

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Summary. *In this work, the dynamic flexural behaviour of composite sandwich beams, with glass fibre/polyester face-sheets and foam core was analysed by a numerical model. This model was validated through several dynamic flexural tests. The contact force, absorbed energy, and maximum displacement in both face-sheets were analysed.*

1 INTRODUCTION

Sandwich beams with composite faces-sheets and foam core are widely used as lightweight components in automotive, marine and aerospace applications due to high bending stiffness and strength combined with low weight.

Although extensive research has been devoted to the flexural behaviour of composite laminates in general [1], the work on sandwich structures is somewhat limited. In this context, there are numerous works which describe the static flexural behaviour of beams [2], whereas those appertaining to their dynamic flexural behaviour are fewer [3].

The dynamic behaviour of beams depends on a large number of variables, some including: material properties, geometry of the beams and impact features. Thus, as a means of avoiding wide and expensive experimental tests, virtual impact tests can be performed to modify different variables and study their influence.

In this work, sandwich beams with woven laminate faces-sheets of glass fibre/polyester (3 mm of thickness) and PVC foam core (density of 100 kg/m3 and 30 mm of thickness) were studied.

2 NUMERICAL MODEL

A numerical model was developed to analyse the dynamic flexural behaviour of foam core composite sandwich beams, using Abaqus/Explicit code. 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 foam core was modelled as a Crushable Foam material whose hardening curve was determined from a foam uniaxial compression test.

The impact energy was determined by defining an initial velocity to the impactor. As the damage in the face-sheets is located at the region in contact with the impactor, the external ply of the glass/polyester composite is usually damaged, and therefore it was necessary to define the contact between the impactor surface and a node region in the face-sheets that included all the plies.

3 EXPERIMENTS

The experimental tests of this study first entailed a characterisation of the face-sheets and core materials, and second, a dynamic three-point bending test on sandwich beams.

From characterisation tests, mechanical properties of the skins and core were determined. These properties were needed to develop the numerical model.

Dynamic three-point tests were performed in order to validate the finite-element model. A drop-weight tower, instrumented to record the force exerted by the impactor, was used for testing 20 specimens. Sandwich beams were impacted using different energies of between 25 and 75 J. The tests were recorded by a high-speed video camera, measuring the impact velocity, post-ricochet velocity, and the displacement in both face-sheets.

4 RESULTS

Contact force history, upper and down face-sheet displacement and absorbed energy were calculated in order to validate the numerical model by the comparison with experimental tests. The results were quite close (Fig. 1) so that the model was used to gain more information than that provided by experimental tests, such as the plastic-strain history in the foam or stress field and failure criteria in the composite face-sheets.

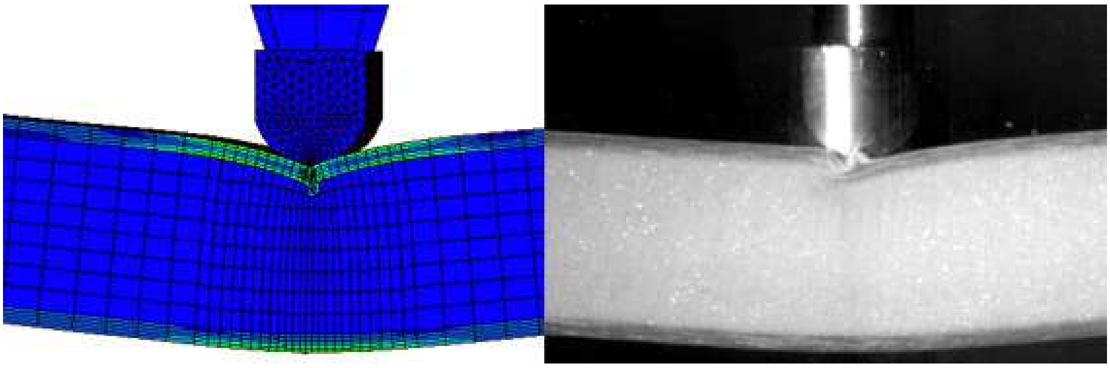

Figure 1.

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