UNIVERSITY OF LIVERPOOL

THE MECHANICAL PROPERTIES OF NOVEL LIGHTWEIGHT STRUCTURES BASED ON CORRUGATED-CORES

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LIST OF PUBLICATIONS

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2. M.R.M.Rejab, W.J.Cantwell. Mechanical behaviour of corrugated-core sandwich panels under compression, 32nd SAMPE EUROPE International Conference 2011 (SEICO 11), Paris, France, March 2011.
3. M.R.M.Rejab, W.J.Cantwell. Fracture modes in compression-loaded corrugated-core sandwich panels, 11th Annual Composites UK Conference, Manchester, UK, May 2011.
4. M.R.M.Rejab, M.M.Issa, W.J.Cantwell. Novel lightweight composites cores for aerospace applications, 33rd SAMPE EUROPE International Conference 2012 (SEICO 12), Paris, France, March 2012.
5. M.R.M.Rejab, W.J.Cantwell. The mechanical behaviour of corrugated-core sandwich panels. Composites Part B: Engineering. 2013;47:267-277.
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ABSTRACT

The aim of this research work is to investigate the mechanical properties of corrugated-core sandwich structures under quasi-static and dynamic loading conditions and to determine the failure mechanisms and energy-absorbing characteristics of the corrugated-cores with different cell wall thickness and filled with a foam core.

Triangular corrugation structures were made from an aluminium alloy (AL), a glass fibre reinforced plastic (GFRP) and a carbon fibre reinforced plastic (CFRP). The composite corrugations were fabricated using a hot press moulding technique and then adhesively bonded to skins based on the same material, to produce a range of lightweight sandwich structures. The role of the number of unit cells, the thickness of the cell walls and the width in determining the mechanical behaviour of the structures was investigated. Buckling of the struts was identified as the initial failure mode in these corrugated systems. Continued loading resulted in plastic deformation in the aluminium system, in contrast, fibre fracture, matrix cracking and localised delamination in the composite systems, as well as debonding between the skins and the core were observed in the composites. The compression strength and modulus were shown to be dependent on the number of unit cells and the cell wall thickness, but independent of specimen width. Subsequent mechanical testing was undertaken using an Arcan rig capable of generating a range of loading conditions between pure shear and pure compression. The failure strength in the aluminium system was accurately represented using a two dimensional quadratic failure criterion. In contrast, due to the initation of delamination within the composite struts, the composite corrugated-cores were accurately predicted using a modified failure criterion.

Low velocity compression loading was subsequently performed on the sandwich structures, where the dynamic strength enhancement factor was shown to increase for all the corrugation systems. This was attributed to both a material strain-rate sensitivity and inertial stabilisation effects. The failure mechanisms in the sandwich structures were found to be similar under both quasi-static and dynamic loading conditions, where damage initiated due to buckling of the struts. To simulate the mechanical response of the corrugation systems, FE models have been developed using the Abaqus finite element package. The FE results were compared to measured responses, and good agreement was achieved. The failure modes predicted by the FE models show reasonably good agreement with the experimental observations.

Finally, foam filling the composite corrugation systems significantly improved the specific strength as well as specific energy-absorbing characteristics of the structures. The compression properties of the corrugated structures have been compared to those of other core materials, where the evidence suggests that these systems compare favourably with other cellular core materials.

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