DESIGN AND ANALYSIS OF WOOD VENEER SANDWICH PANELS

D. Bhattacharyya*, S. Banerjee and S. Kavermann
Centre for Advanced Composite Materials (CACM)
School of Engineering, The University of Auckland
Auckland, New Zealand
** E-mail: d.bhattacharyya@auckland.ac.nz*

Cellular materials are extensively used as cores in sandwich structures, particularly for applications in the aerospace and marine industries. With an aim of producing lightweight yet sustainable structural material, a novel corrugated core material has been produced using commercially available 3-ply veneers. The corrugated profiles were manufactured by matched-die forming and roll forming of veneer sheets [1]. Then they were adhesively bonded to produce the multiple-corrugation honeycomb cores. The methods used for manufacturing these core materials allow a range of cell geometry to be produced, providing an opportunity to tailor the cell structure for achieving the desirable performance for the end usage. *Natural sandwich panels* made out of corrugated plywood cores and skins are shown in Fig.1.

When a sandwich panel is subjected to bending, the core carries the major transverse shear stresses, whereas the skins carry the flexural stresses. Because the core is also subjected to compressive stresses, the out-of-plane shear and compressive properties are very important for the core material. In this work, these properties are experimentally measured for validating the numerical and theoretical modelling results. Firstly, a methodology has been developed to maximise the stiffness and strength (both shear and compression) to weight ratios of the corrugated core material. Optimal geometric parameters of the cells are then predicted to achieve the best performance. The whole sandwich panel is then designed to minimise the weight for a certain loading.

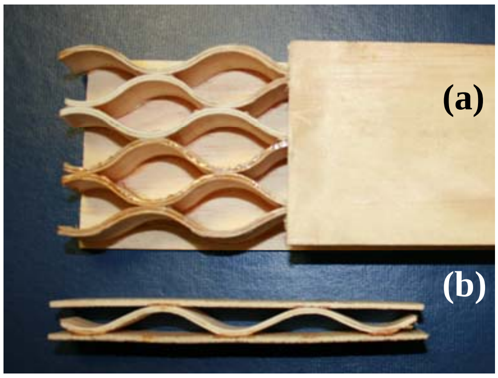

Fig.1 Corrugated cores: (a) single corrugation, (b) multiple-corrugation honeycomb.

Four point bending tests were also performed on the sandwich panels for determining the maximum load carrying capacity of a panel and the corresponding failure mode. As the primary interest was to ensure the shear failure of the core material (the property of the skin material being known) taking place, two different skin thicknesses were attempted: single skin with a thickness equal to that of the cell wall, and double-skin with twice the thickness. When the double skin was used, the core failed in shear, whereas, for the single skin, wrinkling failure was observed along with core indentation. The load vs. central deflection of the panels with double thickness skin is shown in Fig.2. The consistency of the experimental results, especially in the initial, part is remarkable. The cores were also tested for the compressive strengths with skins on both sides, Fig.3.

Failure criteria of the core and panel have been developed based on the failure mechanisms and the properties of veneer. Though plenty of research is available about the hexagonal cores and sandwich panels, [e.g. 2-4], practically no results are available on the multiple-corrugation honeycombs. For the analysis purpose, a suitable unit cell has been chosen here based on the periodicity and symmetry of the structure. Stress analysis are performed both using the finite element approach (ABAQUS) and theoretical formulation. The failure maps are generated, which indicate the minimum weight of a panel for a certain prescribed loading, and the corresponding geometrical parameters of the panel, leading to the best performance.

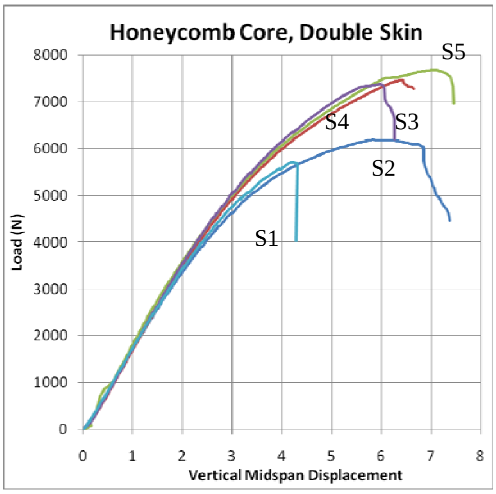

Fig.2 Plot of load vs central deflection of sandwich panels obtained from four point bending tests of five specimens (as indicated).

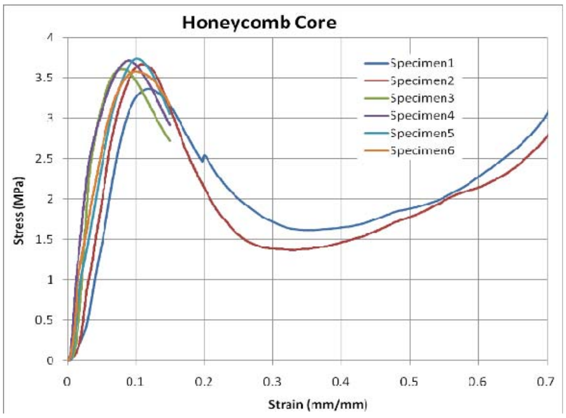

Fig.3 Compression test results of multiple-corrugation honeycombs.

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References

1. Srinivasan N, Bhattacharyya D and Jayaraman K. (2008). Profile production in multi-veneer sheets by continuous roll forming. *Holzforschung* (2008); 62:453-460.
2. Gibson LJ and Ashby MF. Cellular Solids: Structure and Properties. Cambridge Univ. Press, Cambridge (1997).
3. Zenkert D. An Introduction to Sandwich Construction. EMAS: London (1995).
4. Banerjee S, Battley M and Bhattacharyya D. Shear strength optimisation of reinforced honeycomb core materials. *Mech. Adv. Mat. Structures*. (in press)