Simulation of forming 3D curved sandwich panels

CIMComp EPSRC Future Composites Manufacturing Research Hub

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Summary

The Gordon Murray Design iStream® composite sandwich forming process offers a **step change** in manufacturing cycle time. It produces a complex 3D sandwich panel from composite skins and a hexagonal core by simultaneously forming the skins and crushing the core within a matched tool set. The project aims to develop a generalized predictive explicit Finite Element (FE) model of the process and to use the model to study material and manufacturing parameters in order to further develop the technique. This poster presents interim results.

Aims & Objectives

The **aim** of this research is to develop a numerical tool to accelerate this step change in composite manufacturing. The main **objectives** are (1) to develop an explicit FE model of the iStream® forming process of sandwich panels, (2) to understand the primary factors of producing a defect-free component and (3) to advance the technology by characterising a wide range of process variables. This research fits within the Hub priority areas of both "High rate deposition and rapid processing technologies" and "Design for manufacture via validated simulation".

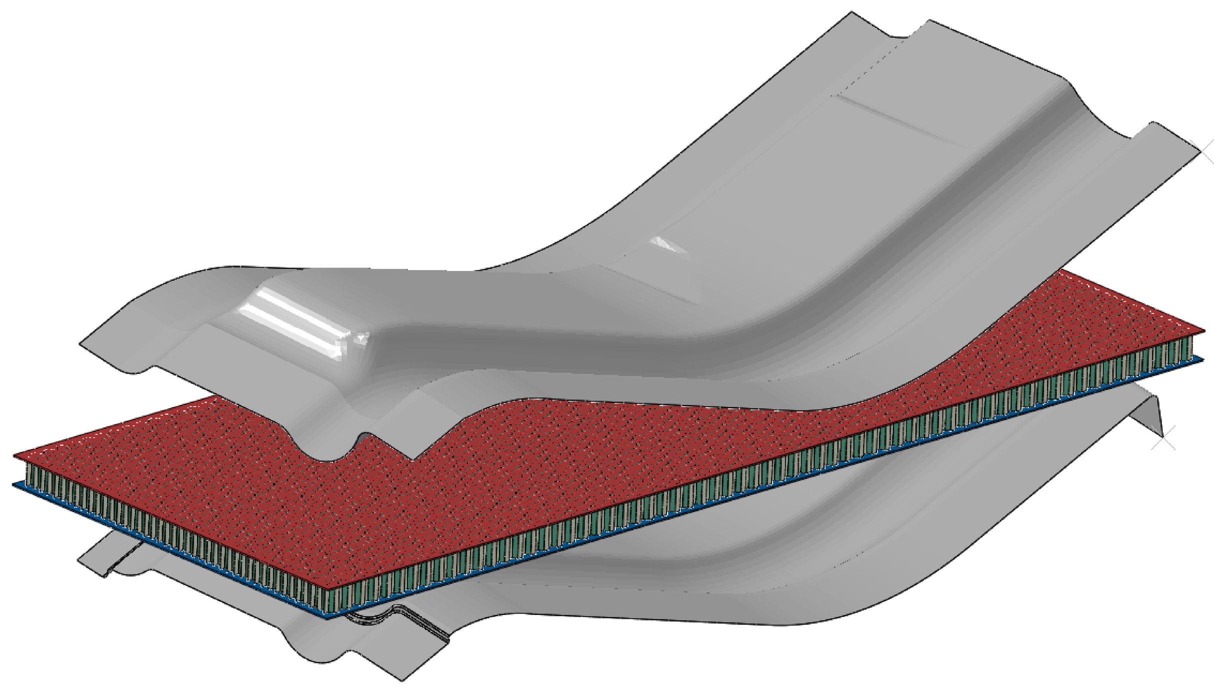

Fig.1. Gordon Murray Design iStream® technical demonstrator component simulation.

Methodology

The hemisphere punch sandwich forming model shown in Fig.2 exploits the fabric forming methodologies developed in [1]-[3] and introduces a new meso-scale deformable core material. The core material has been characterised by a range of novel experimental tests to give a multi-axial constitutive model.

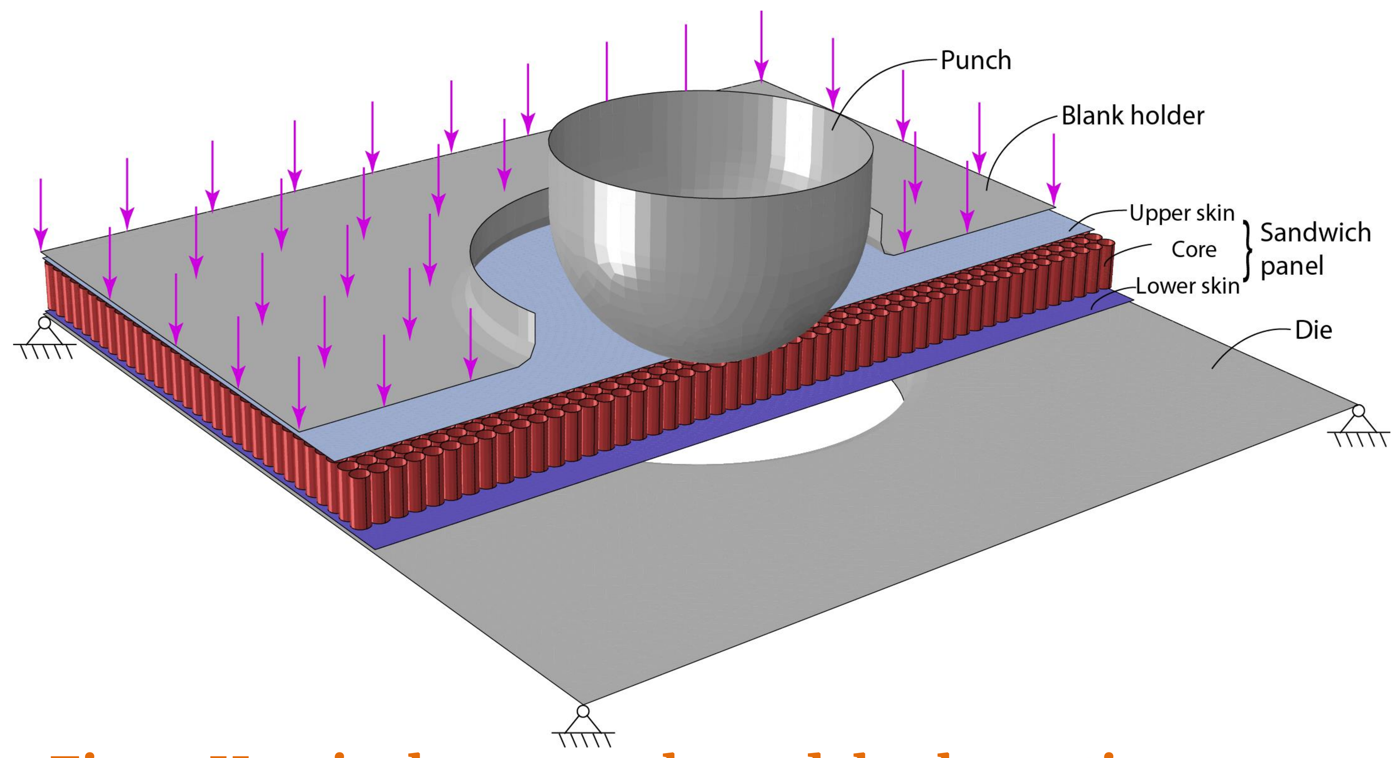

Fig.2. Hemisphere punch model schematic.

Interim Results

Fig. 3. shows the successful completed analysis and demonstrates the in-plane deformation of the core and skin materials draw-in seen in the hemisphere forming study. A cross-section of the formed hemisphere is shown in Fig. 4(a) and in (b) the buckling of the core cell walls that defines the core crushing deformation mechanism is highlighted. In Fig.5. preliminary results from the material parameter studies are shown and demonstrate the future potential of the model for use in process optimisation.

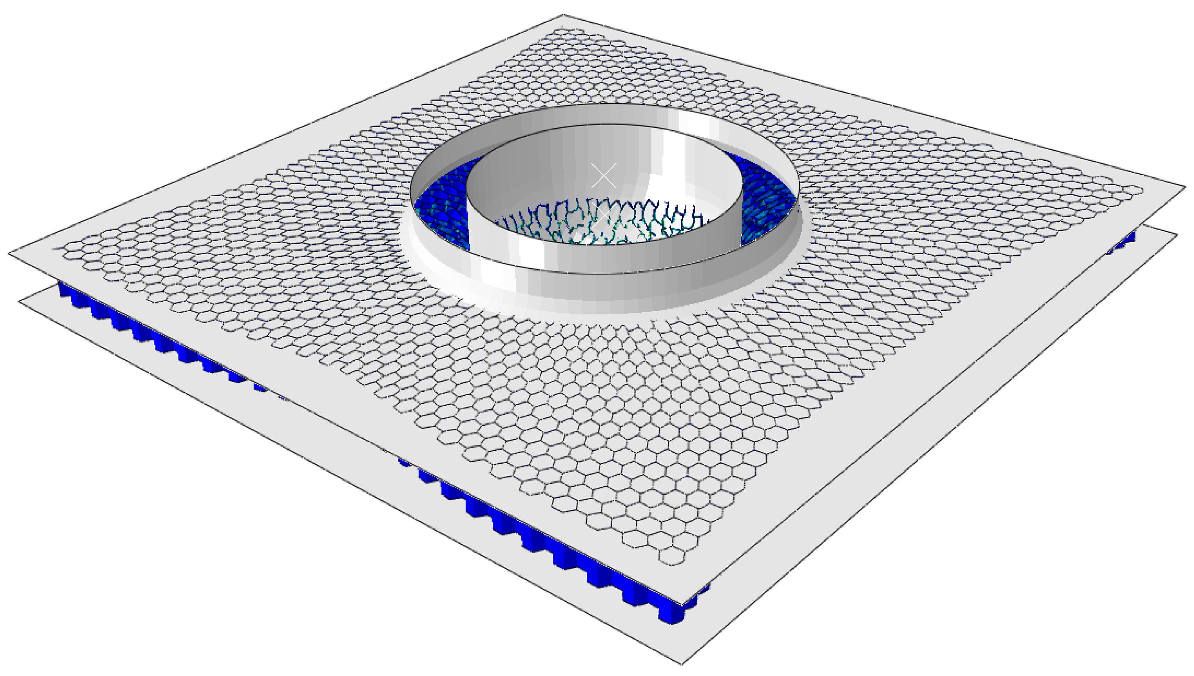

Fig.3. Completed FE run showing fibre and core draw-in.

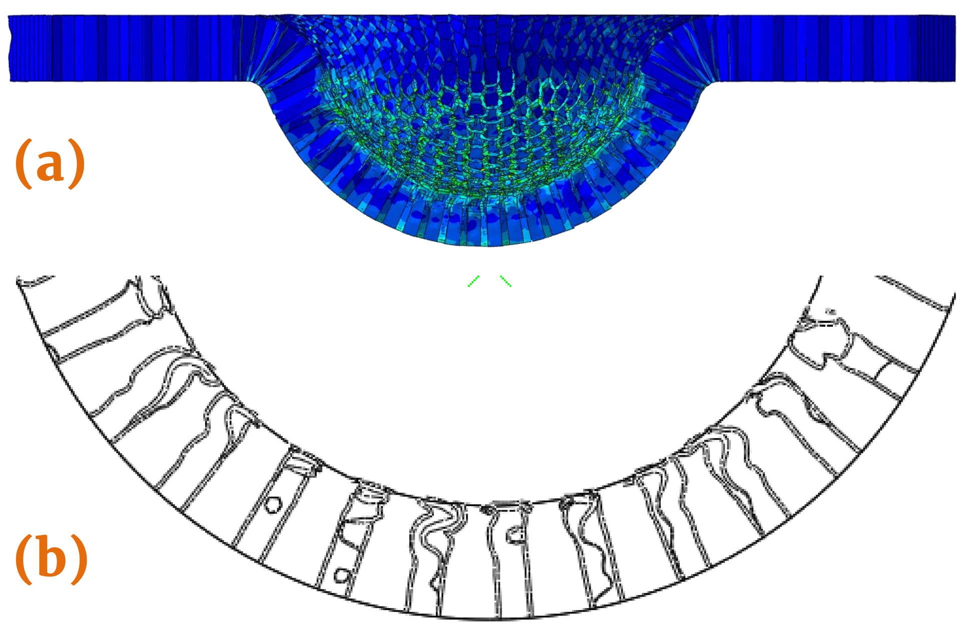

Fig.4. Cross-section of formed hemisphere (a) showing shear angle contours, (b) core deformation.

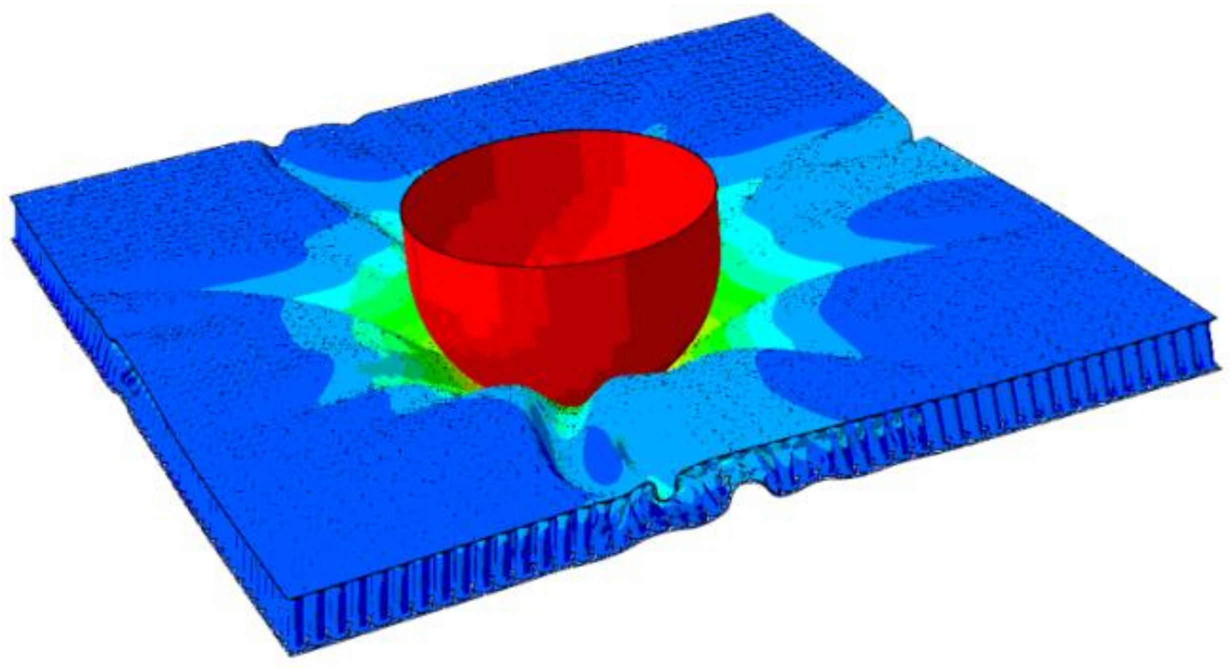

Fig.5. Material parameter study demonstrating forming of in-plane defects.

References

[1] Chen S., McGregor O.P.L., Endruweit A., Elsmore M.T., De Focatiis D.S.A., Harper L.T., Warrior N.A., Double Diaphragm Forming Simulation for Complex Composite Structures, 2017, Composites Part A: Applied Science and Manufacturing, 95,346-358.
[2] Chen S., Harper L.T., Endruweit A., Warrior N.A., Formability Optimisation of Fabric Preforms by Controlling Material Draw-In Through In-Plane Constraints, 2015, Composites Part A: Applied Science and Manufacturing, 76,3927,10-19.
[3] Chen S., Endruweit A., Harper L.T., Warrior N.A., Inter-Ply Stitching Optimisation of Highly Drapeable Multi-Ply Preforms, 2015, Composites Part A: Applied Science and Manufacturing, 71,144-156.

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