



Bristol Composites Institute



EPSRC Centre for Doctoral Training in Composites Science, **Engineering and Manufacturing**



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Equivalent elastic properties of morphing sandwich panels with cellular cores and flexible facesheets

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1. Background

Semi-Aeroelastic Hinge

Extended wingspan in flight, folded wingtip when approaching airport gate.

Flare angle helps to alleviate gust load.^[1]

A morphing fairing needed to cover the hinge joint.

3. Homogenization

Cores with zero, negative and positive Poisson's ratios are analysed.

Analytical Approach

Equivalent elastic properties (i.e., E_{11} , E_{22} , v_{12} , G_{12}) of the core evaluated by considering deformation of unit cell walls.^[3]



The objective is to design a fairing with low torsional stiffness and low cross-section warping as the wingtip folds.

2. Overall Design Problem

Morphing sandwich panel with cellular core and elastomeric facesheets for fairing.^[2]

Homogenisation of panel elastic properties to equivalent shell stiffness matrix.



Finite element model with

Shell stiffness matrix evaluated for a panel with isotropic facesheets and equivalent core.

Finite Element Approach





constitutive response

 B_{11} B_{12} B_{16}

 $D_{11} \quad D_{12} \quad D_{16}$

 $D_{22} \quad D_{16}$

 D_{66}

 B_{22}

 A_{11} A_{12} A_{16}

sym

 $A_{22} \quad A_{26}$

Shell deformation modes of a unit cell with multiscale periodic boundary conditions are used to evaluate equivalent shell stiffness matrix.^[4]

4. Preliminary Results



150% Significant error in analytical values Error relative to the FEA centage. values. Future work should explore the



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