

Morphing fairing for folding wingtip joints

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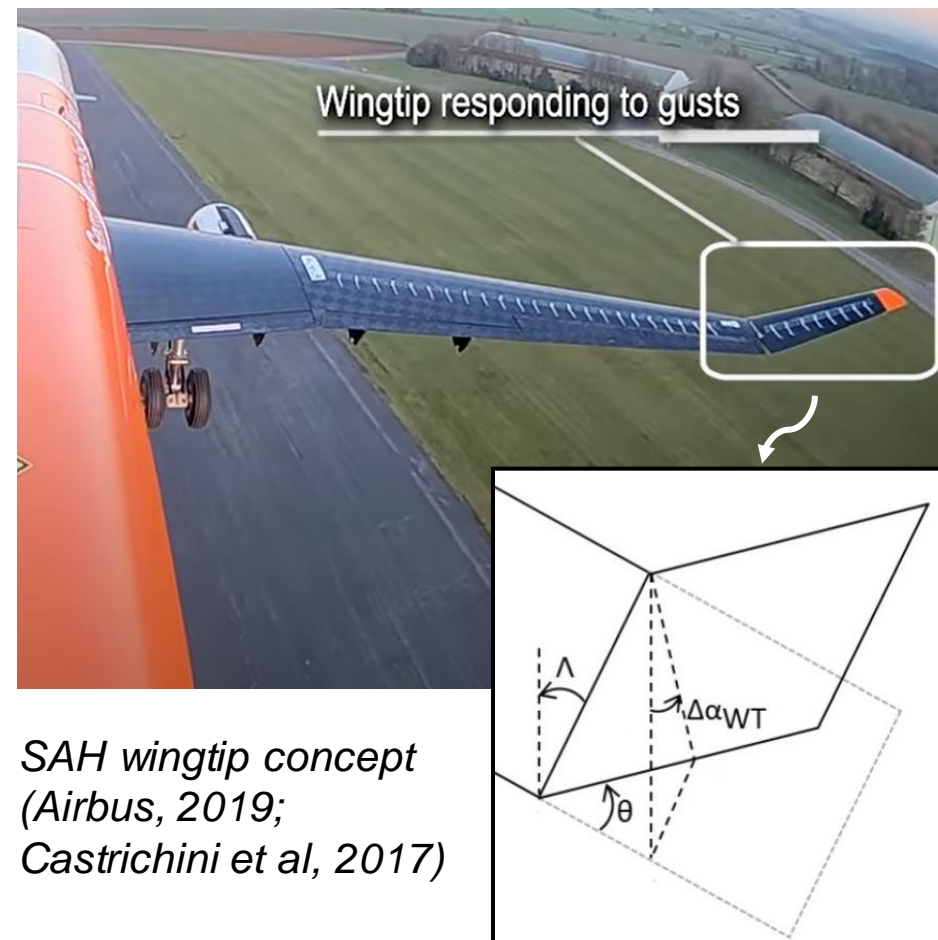
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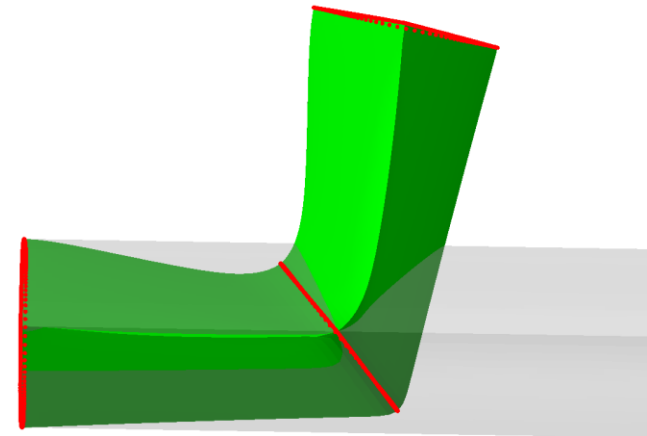
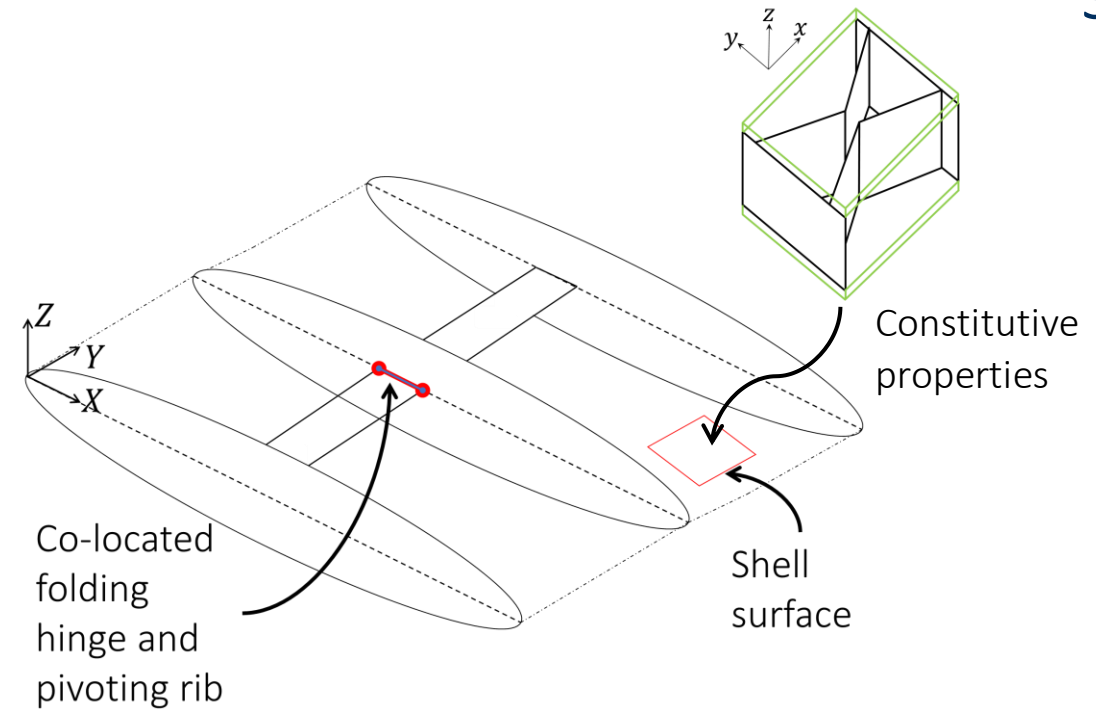
Semi-Aeroelastic Hinge

- Extends the wingspan while folding the wingtip to fit within the airport gate width
- Flare angle (Λ) helps to reduce gust loads which allows lighter wing structure
- Fairing around the joint must be flexible when folding, and carry pressure loads



Fairing

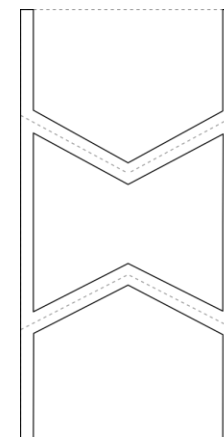
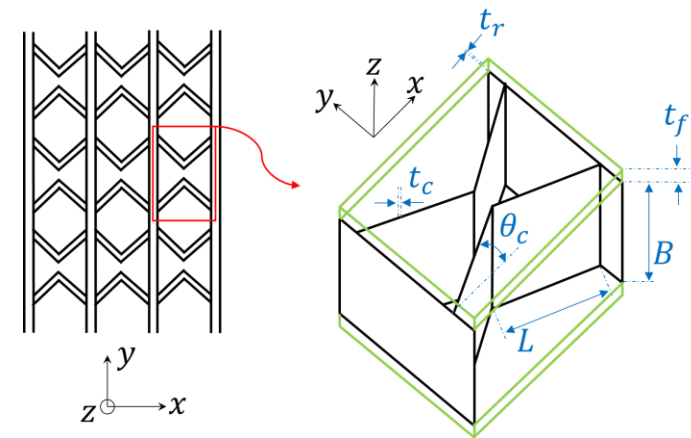
- Two hinges, connecting:
 1. Inboard and outboard beams
 2. Central rib and the joint
 - Independent rotation of the central rib reduces overall strain and stiffness
- A flexible sandwich panel for the fairing modelled as a shell surface



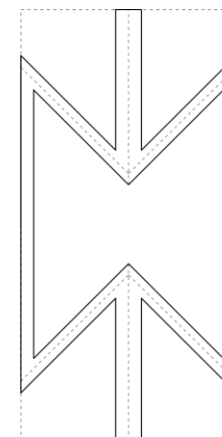
Panel

Equivalent shell stiffness matrix

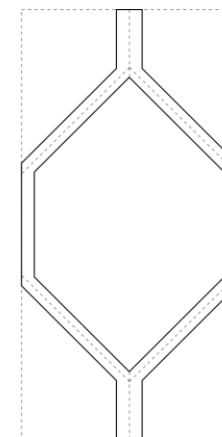
- Analytical homogenisation:
 - Equivalent core stiffness + laminate theory to give the ABD matrix
- FE-based homogenisation:
 - Equivalent ABD matrix, but without the transverse shear matrix
- Future work: Transverse shear effects



Zero
Poisson's
Ratio Core



Negative
Poisson's
Ratio Core



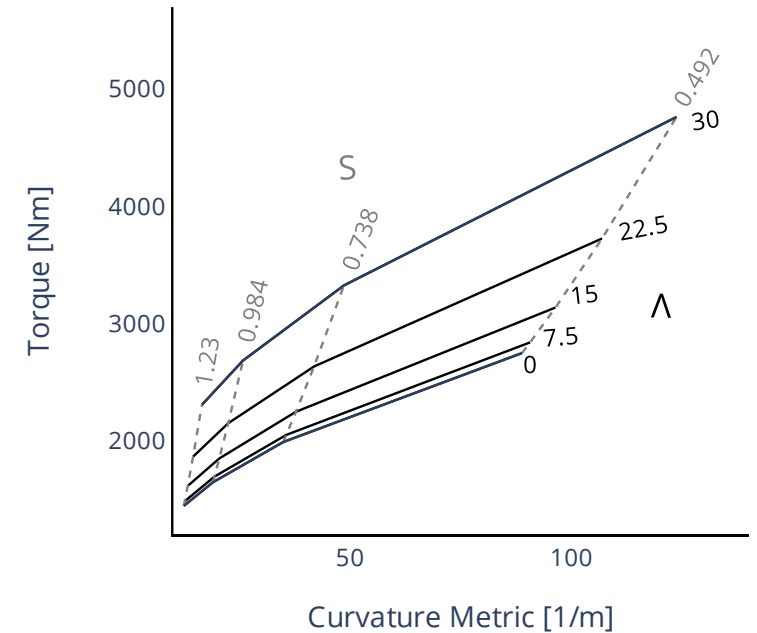
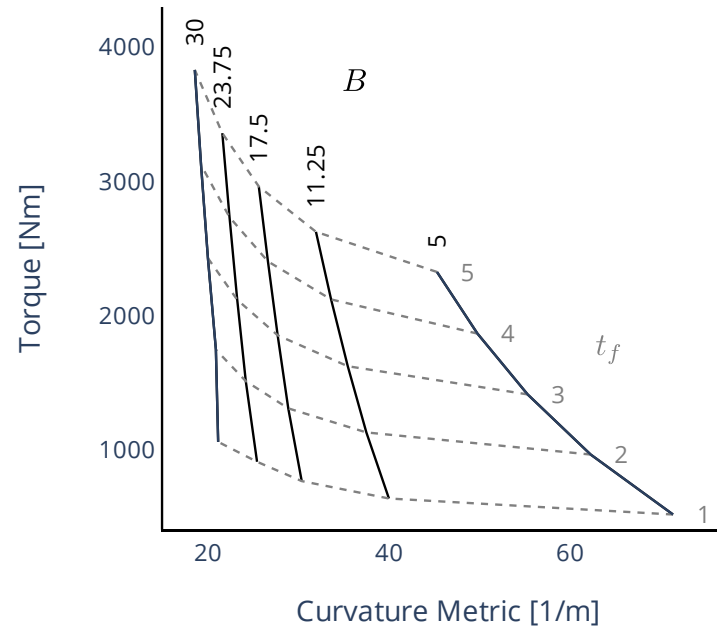
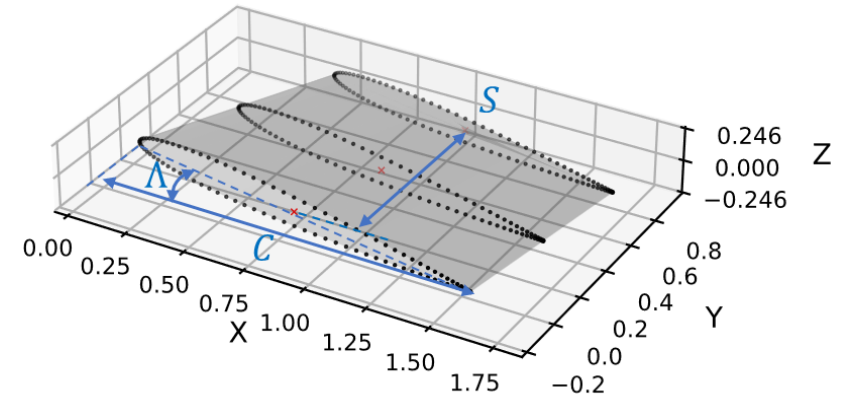
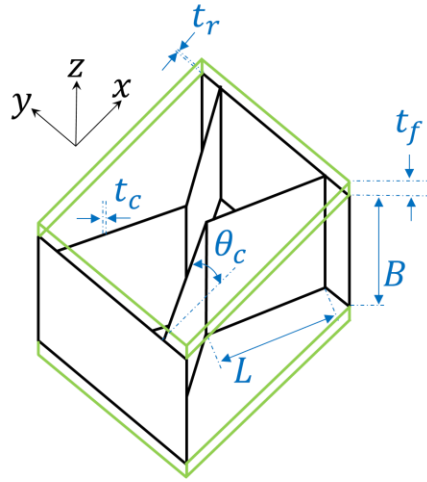
Positive
Poisson's
Ratio

Analysis

Objectives:

- Reduce Torque
- Reduce Curvature (i.e., warping of the cross-section shape)

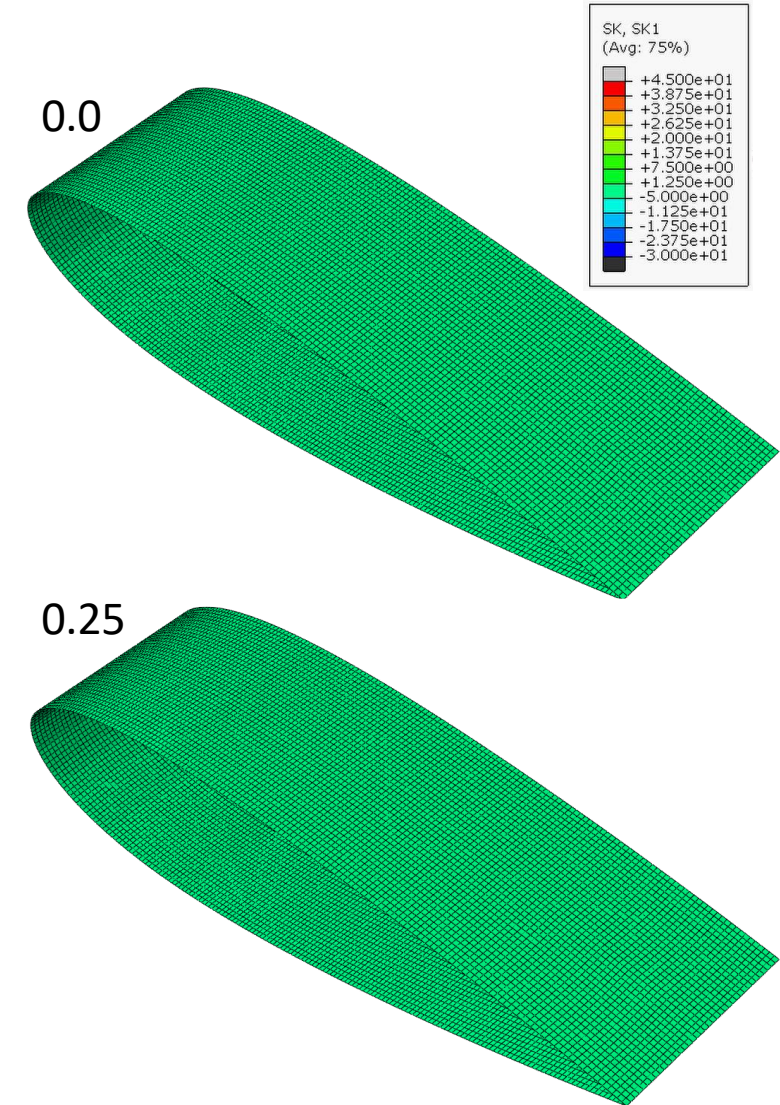
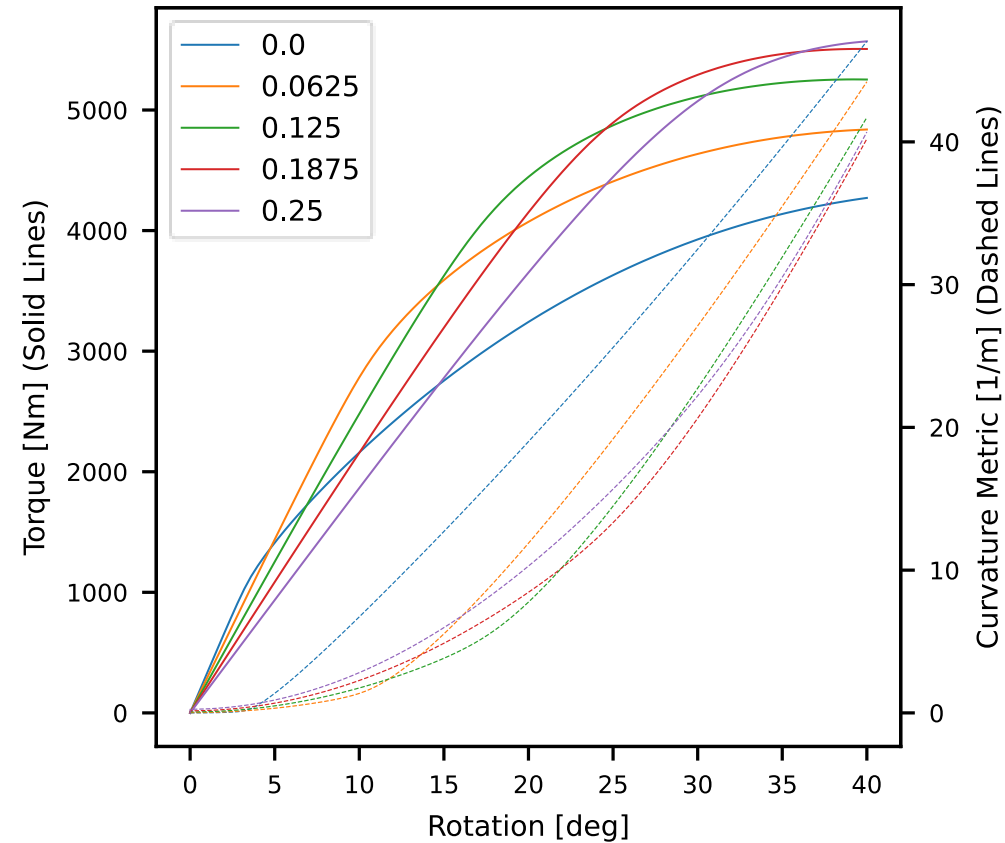
$$C = \sqrt{\frac{\sum V_i \kappa_i^T \kappa_i}{\sum V_i}}$$



Analysis

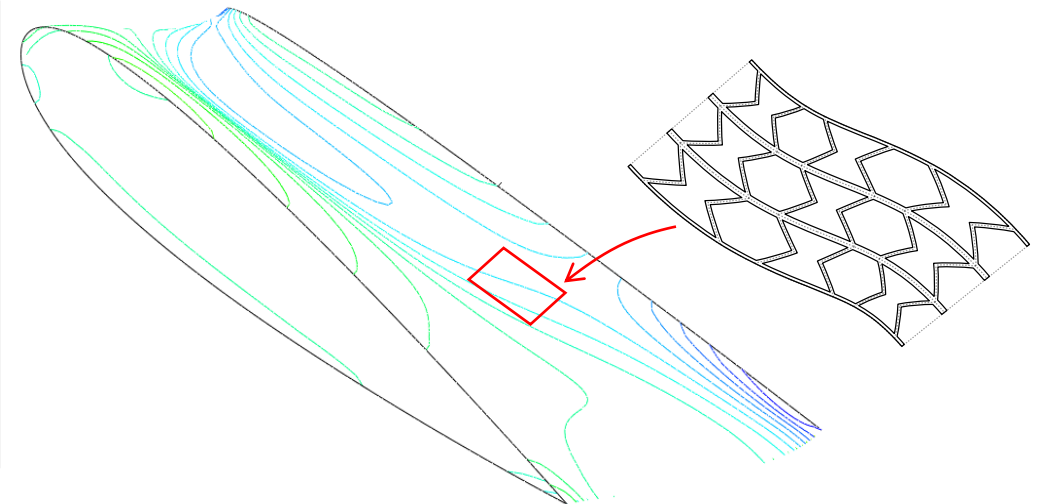
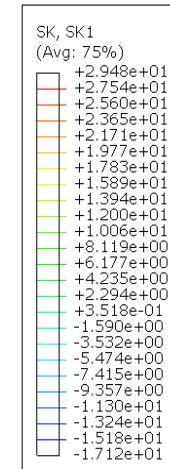
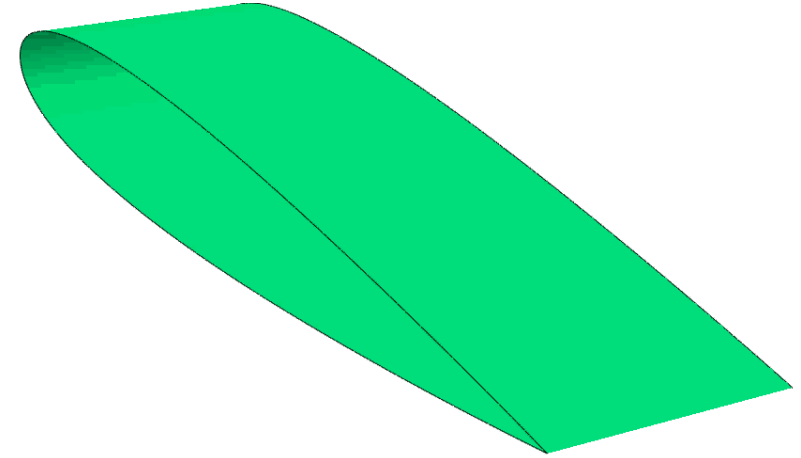
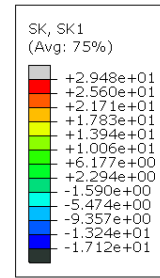
Effects of pre-strain

- Lower initial stiffness
- Longer linear region with late softening



Future work

- Study the effects of transverse shear stiffness of the panel
- Surrogate model based optimisation framework
- Use contour lines of field variables to guide the local orientation of the panel



Questions?

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