Slat Cove Filler Optimization

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The Problem

Airframe noise

- Body
- Wings
- Landing Gear
- Flaps
- Slats
The Problem

Slat noise

- Air circulation
- Flow separation
A Possible Solution...

Slat cove filler (SCF) invention

Wing performance with slat cove filler
Early experimentation

Bench top model

- Worked for very thin sheet metal
- Testing different materials was time consuming
Problems and requirements

• SCF must withstand high aerodynamic loads
• SCF must have low overall weight

This lead to the use of shape memory polymer composite materials
Shape memory polymer composites

This allows for a very malleable material during deployment and retraction, very stiff during the rest of flight.

Caveat: a section in the middle must remain stiff for full deployment: ‘Mid-link’
The project

Goals:
1. Find thickness restrictions for several materials
2. Find an optimal size and location of mid-link
   1. Max strain <2%
   2. Full autonomous deployment
   3. Must retract and stow correctly
3. Use model to validate material tensile test data
4. Test a range of composite materials for max strain
5. Assist in the manufacture of composite test materials
Abaqus Model

- Finite Element Analysis
- SCF is the only deformable body
- Material and dimensions easily changed
Homogeneous stiffness

- Analysis run on several SCF stiffness variants, different thicknesses and different materials. Most of the time there was no deployment.

  - Thin steel
  - Carbon fiber composite
  - High-Kevlar carbon fiber composite
Mid-link size, placement

![Graph showing Mid-Link Size vs. Location](image)

- **Mid-Link Size** vs. **Location**
- **Fully Deploy**
- **No Deployment**
Mid-link size, placement

Maximum strain verses mid-link location for various mid-link sizes

Mean mid-link location (from SCF bottom)

Maximum Stain (%)

Size
- 5
- 4.5
- 4
- 3.5
- 3
- 2.5
- 2
- 1.5
- 1
- No Deployment
Data validation

• SMPC tensile test data was used in Abaqus
• Hyperelastic, Marlow model
• 2-6% difference
High modulus range

• A series of higher modulus SMPC materials were tested in Abaqus.
• Results showed that strain does not change significantly within high-Kevlar modulus range.
Simulation video

Structural Dynamic Optimization of a SMA Slat Cove Filter
Manufacturing

- Applying silver conductive epoxy
- Cutting, epoxying electrodes
Future of the project

- Materials research
- Manufacturing methods
- Available for licensing
Thank you Oregon Space Grant Consortium!

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