Energy Storage in Glass Composites

Clint Berggren[1], William Rae[1] , Griffin Voss[1], Stephanie Wear[1], Gavin Wright[1]
Latécoère
[1]Department of Mechanical Engineering

INTRODUCTION

In the event of an emergency, aircraft doors produced by Latécoère implement a pneumatic cylinder to assist passengers and crew in their operation. However, these cylinders are difficult to maintain, expensive, heavy, and prone to leakage.

Problem Statement

Our objective is to investigate a way to both store elastic energy and provide actuation via composite material, in order to assist airline passengers with opening fuselage doors in case of emergency.

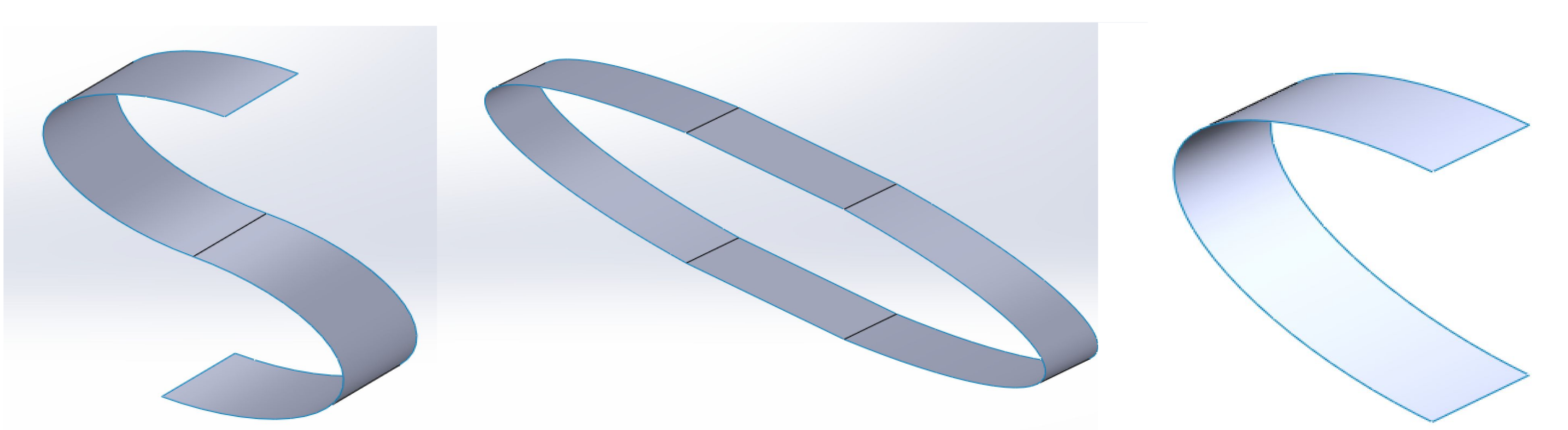

Figure 1: Initial S, O, and C shaped designs

CORE FUNCTIONS

- The springs must reach specific force requirements at multiple stages of compression.
- The springs must fit within a specified spatial envelope with minimal deviation.
- The springs must show a 25-year life expectancy.
- The springs must adhere to aviation standards and environmental requirements.

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DESIGN AND DEVELOPMENT

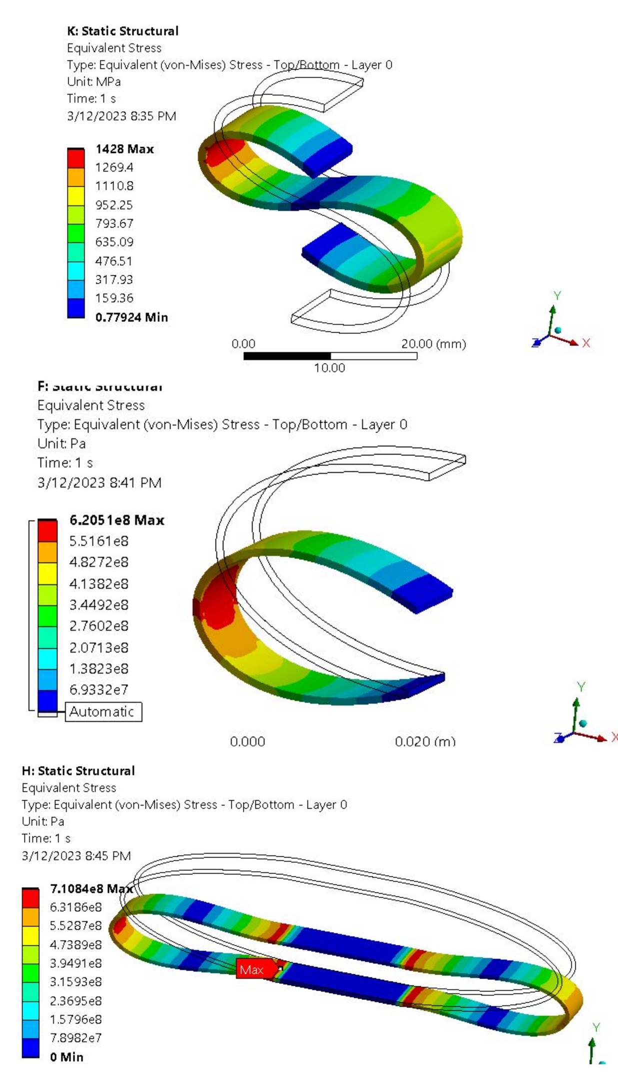


Figure 3: Shape Comparisons

FEA Study #1 (*Figure 3*)

- Parameters of interest: Shape
- Conditions: Vertical displacement of 64%
- Outcome: S is too rigid, O cannot nest effectively, springs deliver small forces (<1% of required load)

FEA Study #2 (*Figure 4*)

- Parameters of interest: Elliptic Ratio, # of plies, Arc vs Ellipse
- Conditions: Vertical displacement of 64%
- Outcome: Excess plies and thinner profile create larger forces and increased failure rates. Arc delivers more force than ellipse

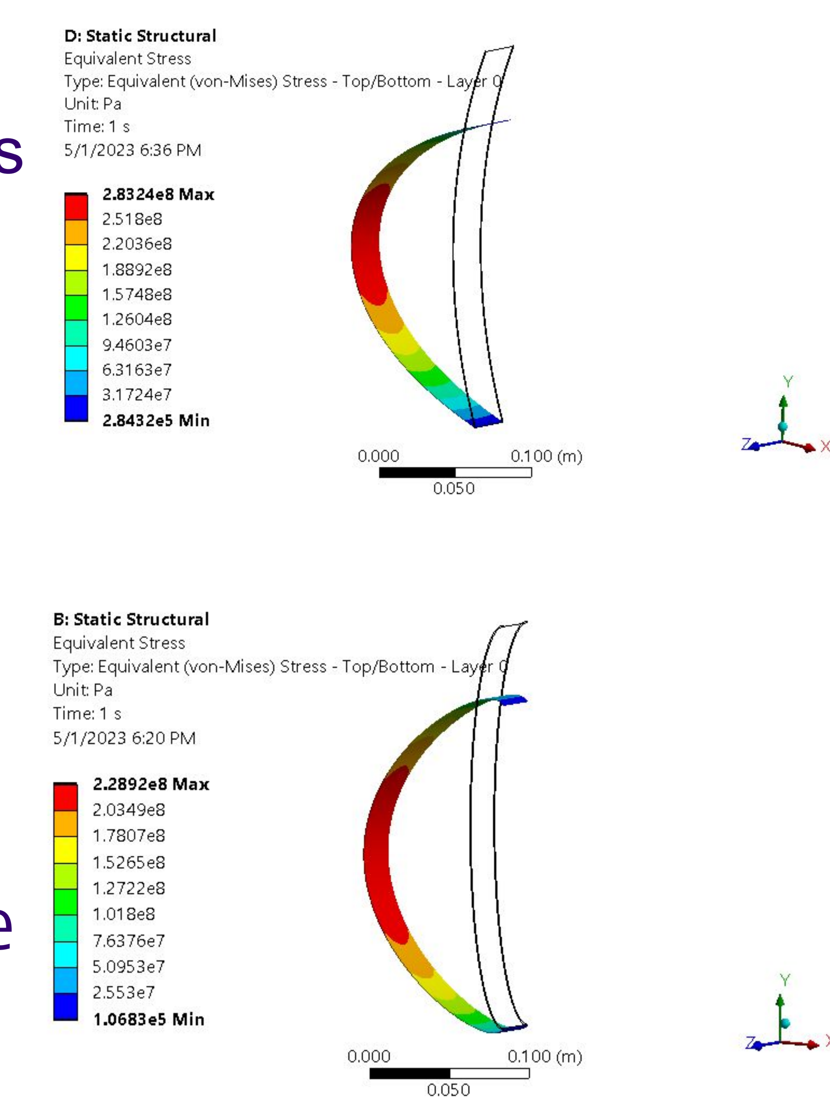
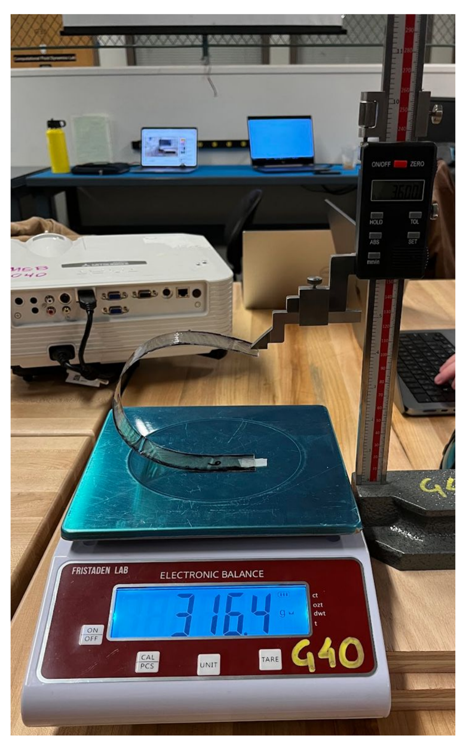


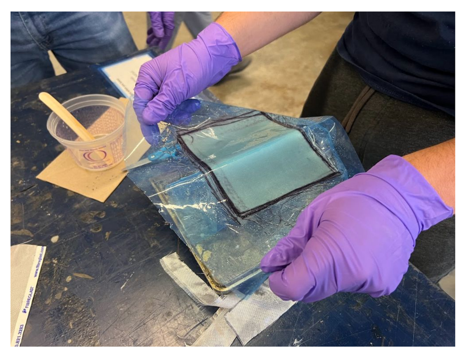
Figure 4: Ply count and Shape Optimization

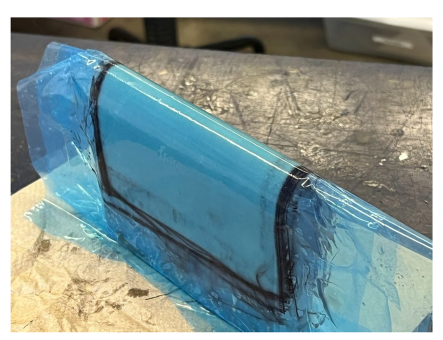
Other Design Considerations for Testing

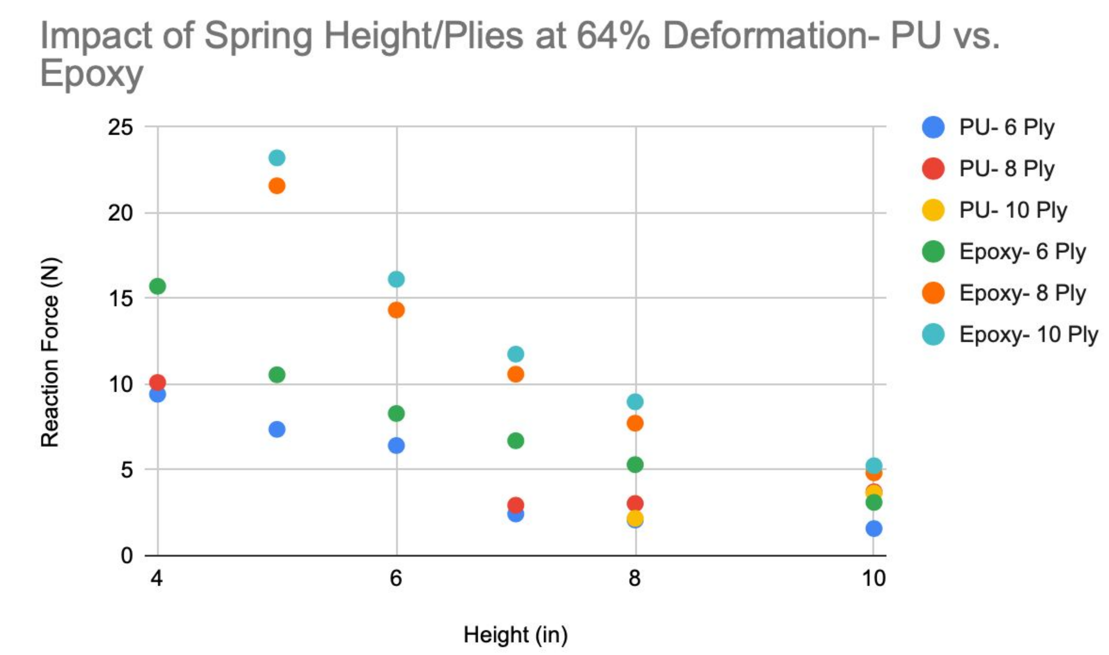
- Materials: Polyurethane vs Epoxy
- Length of Spring: How length affects load capacity and failure
- Other Shapes: Arm bending with rigid body

RESULTS/VALIDATION









Polyurethane/Epoxy Testing Results:

- Results: Epoxy specimens provide greater force, decreasing length of spring provides greater force, with flat specimens outperforming pre-curved molded specimens

CONCLUSION & FUTURE WORK

- Reaching 64% displacement is possible without failure, but tens or hundreds of specimens are needed to reach 9kN.
- Polyurethane does not cause forces as high as the Epoxy samples
- In progress:
    - Epoxy arm bending tests
    - Instron material testing data analysis
    - Creep testing

Acknowledgements
We appreciate the help and support of:
- Prof. Aniruddh Vashisth (supervisor)
- Sebastien Devillez and Latécoère (sponsors)