ARTIST PROJECT

AircRaft cost and environmenTal efficIent door STructures

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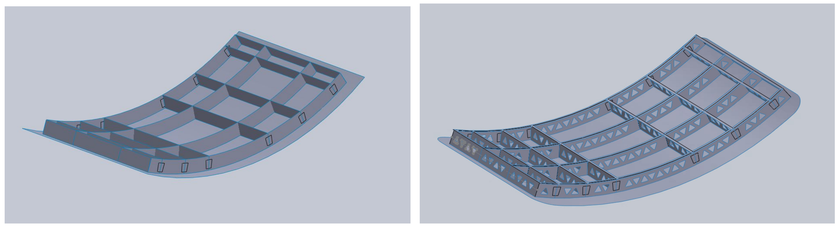
LATECOERE

INTRODUCTION

The goal of this project was to propose the materials, manufacturing processes, and design of a new airplane door structure using lattices to minimize weight without compromising structural integrity or increasing production costs.

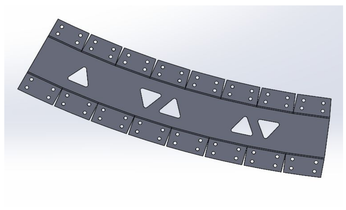


Standard door versus Lattice Proptype

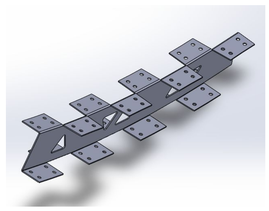
- Standard model utilizes riveted C-channels and plates
- Majority of parts machined from aluminum
- Ribs are not optimized

DESIGN CONCEPT

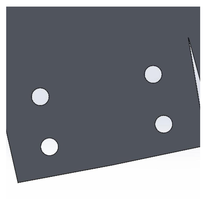
- Lattice elements created subtractively from beams
- Water jet to create lattice structure and cuts for folding
- Sheets folded and connected using blind rivets
- Three unique parts for vertical beam, horizontal beam and skin



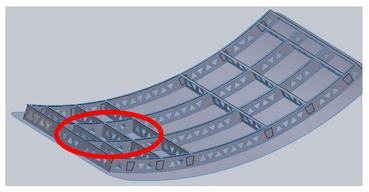
Unfolded Rib Section



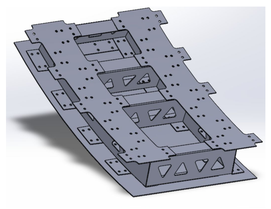
Folded Rib Section



Rivet Holes



Subsection of Model Used



Assembled Subsection of Model

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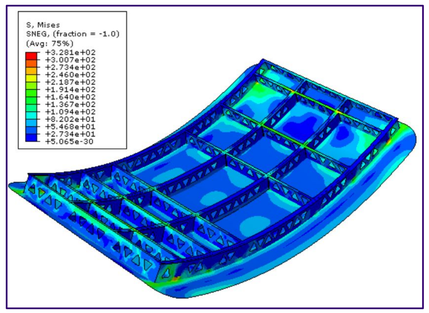
MANUFACTURING AND MATERIALS

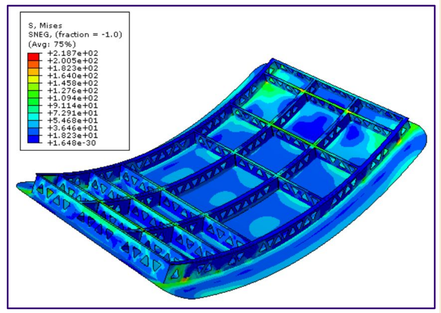
- 7075-T6 aluminum alloy chosen for high stiffness and strength with low weight
- Rivets provide consistent and efficient joints between parts
- Water jetting allows for faster and cheaper manufacturing cycle of lattice structured door beams

FINITE ELEMENT MODELING

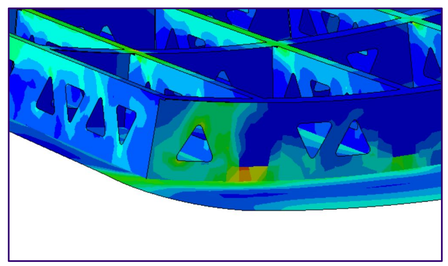
- Parts modeled in SOLIDWORKS
- ABAQUS software used for FEA
- Analysis done in 2D using midplanes of 3D model
- Solved for stress, deformation and buckling

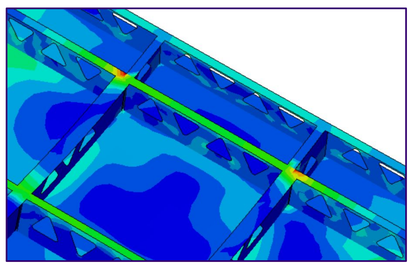


Stress Results 19.8 psi

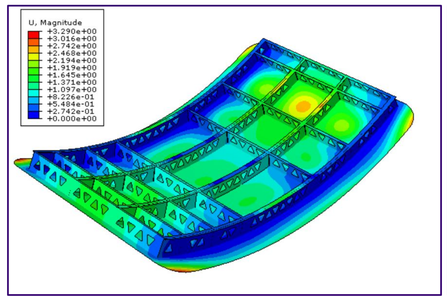


Stress Results 13.2 psi

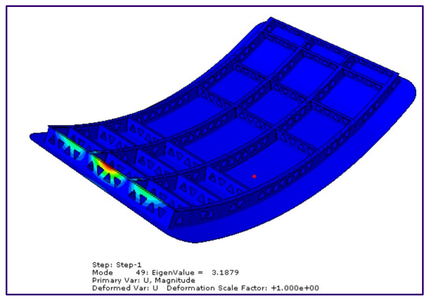




Stress Concentrations



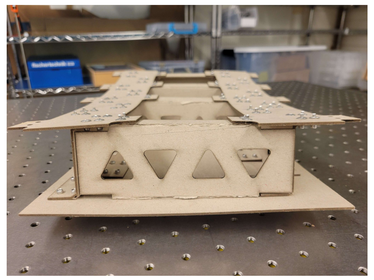
Deformation Results 9.5 psi



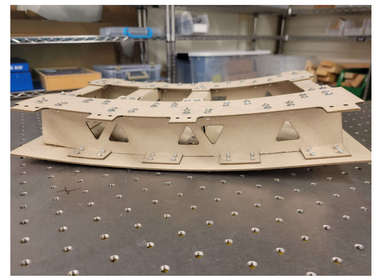
Buckling Results 13.2 psi

PROTOTYPING AND VALIDATION

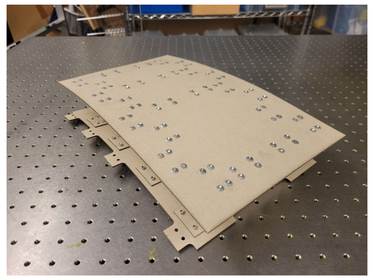
- ½ scale model section created for validation
- Skin and beams fabricated out of 2 ply chipboard
- Ribs and skin connected using aluminum blind rivets
- Cuts were made using the laser cutter in the ME Shop
- Riveting was done using manual rivet guns.



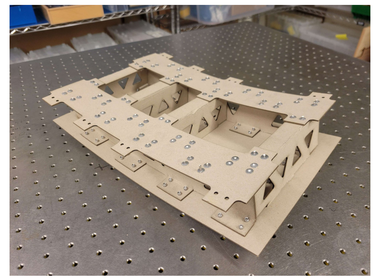
Horizontal Section



Vertical Section



Skin Exterior



Prototype Assembly

- FEA results meet critical stress and deflection design criteria
- Model weight under 50 kg meets expectations, lattice structure saves estimated 3 kg
- Results will be validated by two tests, distributed load on skin, as well as bending test on individual folded beam
- Low stress areas and high buckling eigenvalue indicate room for further optimization through material removal
- Analysis and prototype demonstrate viability of lattice structured door and manufacturing method

Acknowledgements

- Industry mentor Sebastien Devillez
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- Latecoere
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Mechanical Engineering Capstone Exposition
May 29th 2024, Husky Union Building, University of Washington, Seattle