SUPER LIGHT WEIGHT COMPOSITE WING DESIGN CONTEST SAMPE 2008

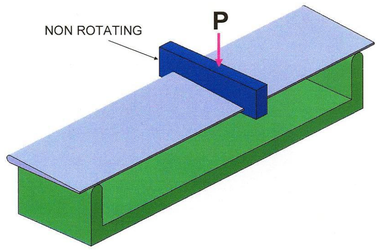
C. Jacob, J. Gangloff, R. McCauley, N. Counts, J. McLaughlin

University of Delaware – Center for Composite Materials – Department of Mechanical Engineering

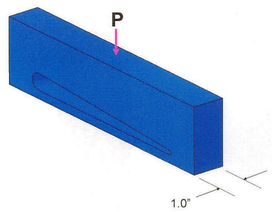
INTRODUCTION

Design Challenge:
"To build an ultra light composite wing with the highest ratio of applied load to wing weight (P/WT) at a maximum 2.5 inch deflection."

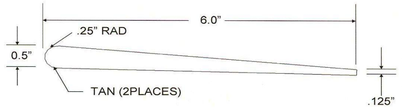
Additional Goals:
- Maintain dimensions of 26" length X 6" width
- Optimize the wing to endure 3-point bending failure with applied load to load collar
- Straight wing with constant surface cross-section



Loading



Load Collar



Maximum Airfoil Geometry

PROCESSING

Vacuum assisted resin transfer molding (VARTM) was used to infuse carbon fiber with an SC-15 resin. An inlet and outlet hose is placed within a sealed bag before attaching a vacuum pump. Atmospheric pressure then forces the resin throughout the wing. Excess resin was drawn into a pressure vessel under a vacuum. Much attention was given to the path of the resin. Carefully placed media allowed the resin to distribute throughout the carbon fiber.

VARTM Layup of Wing Prototype

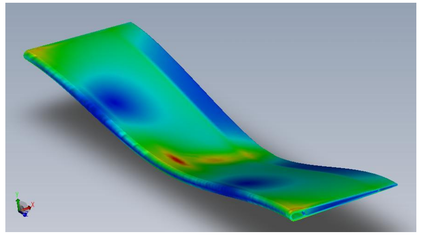
TESTING

Mechanical Testing of Wing Prototype

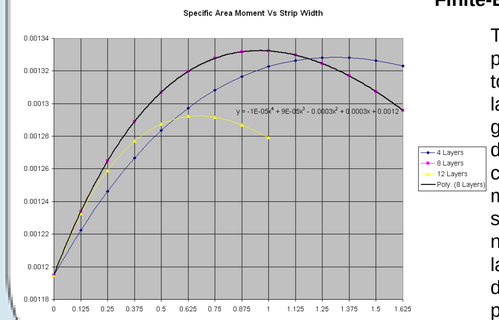
To simulate 3-point bending related to the actual competition, test wings were loaded using an mechanical testing machine. This machine is able to plot the displacement of the head versus the load imposed on the wing. Here the load arm is directly placed on our load collar.

THEORY

SolidWorks © COSMOSXpress was used to calculate the area moment of inertia for different cross sections and the resulting wing mass. This allowed us to optimize the cross sectional geometry and fiber layup. Displayed is the initial finite-element analysis (FEA) of the wing design.



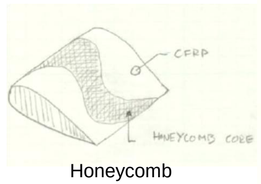
Finite-Element Analysis



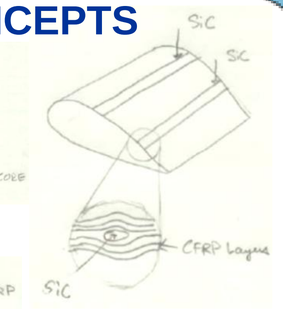
Mathematical Modeling

To assist in the design process, a model was created to optimize the composite layup arrangement with geometrical and material data. Displayed is a chart that compares specific area moment versus carbon fiber strip width for different numbers of carbon fiber layers. Optimization of this data furthered the design process to isolate the best arrangement for the final design.

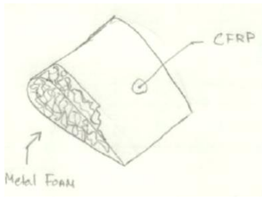
CONCEPTS



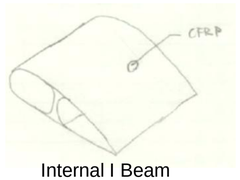
Honeycomb
Reinforced CFRP



SiC Bending Support



Metal Foam
Reinforced CFRP



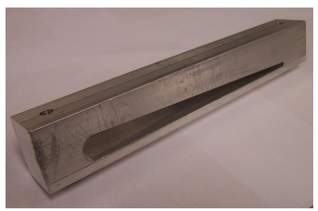
Internal I Beam
Structure

MANUFACTURING

5-axis CNC Mill

A 3D solid model of the wing was created using SolidWorks ® software package. The geometry of the wing foam core could then be imported to a 5-axis CNC mill. The mill then automatically machined the core out of Divinycell.

Testing of the wing under 3-point bending required a loading collar. Our collar was made to the specifications of the one that will be used in the competition. It was fabricated out of stock aluminum with the cross-section of the wing.



Machined Load Collar

CHARACTERIZATION

To obtain a greater understanding of the wing design, conventional testing specimens were manufactured from wing materials adhering to ASTM standards. Using the ASTM standard, the team was able to characterize the carbon / SC-15 composite system for Young's modulus, ultimate yield strength, and ultimate tensile strength. Their properties were then coupled with our mathematical models to optimize our design concepts. In addition, the team was able to observe how different fiber layups failed and determine the best layup pattern for the contest specifications. **Note: material specimens were obtained directly off of previously tested wings.**

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UNIVERSITY OF DELAWARE
CENTER FOR COMPOSITE MATERIALS
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