Summer 2018

Design, Fabrication, and Testing of Lightweight and Durable Components from Composites

James Jeffrey
Montana Tech

Dario Prieto
Montana Tech of the University of Montana

Ronda Coguill
CAMP

Follow this and additional works at: https://digitalcommons.mtech.edu/urp_aug_2018

Recommended Citation
Jeffrey, James; Prieto, Dario; and Coguill, Ronda, "Design, Fabrication, and Testing of Lightweight and Durable Components from Composites" (2018). 2018 Undergraduate Research. 9.
https://digitalcommons.mtech.edu/urp_aug_2018/9

This Book is brought to you for free and open access by the Other Undergraduate Research at Digital Commons @ Montana Tech. It has been accepted for inclusion in 2018 Undergraduate Research by an authorized administrator of Digital Commons @ Montana Tech. For more information, please contact sjuskiewicz@mtech.edu.
Background

With a constant push towards lighter, stronger and more fuel-efficient vehicles, the use of composite materials is a proven way to achieve this goal. Composite material manufacturing is widely used in large scale manufacturing, but is a challenge for small scale operations, such as MT Tech. The idea is to construct a one piece composite seat for the MT Tech Baja team that meets the requirements of the Baja SAE Collegiate Design Series.

Initial Research

Initial research was focused on requirements from BAJA SAE rules and regulations, material selection and manufacturing processes for composite parts. The goal was a useful, lightweight part that would supplement the MT Tech Baja design and withstand the rigors of competition.

Methods

- Designing a 3D model in SolidWorks.
- Selection of the woven material and resin that make up the composite material.
- After the initial design, different manufacturing processes will be explored to find the appropriate method.
- The first prototype will be tested and data collected. Using this data, the model, manufacturing process and material will be optimized.

Design

Initial Design

- SolidWorks was used to create the 3D model of the seat.
- Measurements were taken from the Baja team drivers and the seat was oversized to add padding for the driver.

Final Design

- The final model of the seat was a more simplified version than the original model.
- This was due to the difficulty of manufacturing the various curves and the added padding. The complex curves added no value.
- The model was overbuilt in dimensions with the intent of hand finishing the curves to allow a proper fit.

Manufacturing

- The initial prototype mold was constructed out of foam and finished with a hard surface.
- This surface was then prepped for a wet layup with vacuum assisted curing.
- The layup consisted of several layers of carbon fabric saturated with epoxy resin. The seat was then placed in a vacuum bag to help cure the material.

Results

Material Testing

- Testing was done at the Center for Advanced Materials Processing (CAMP) at MT Tech.
- A woven carbon fabric with an epoxy resin was used due to availability, cost and proven composite use.
- Test samples of unidirectional carbon fiber in 0 and 90 degree orientations were used to determine resin and fiber properties.

From the above data, we can calculate the Modulus, Max Stress and Max Load.

<table>
<thead>
<tr>
<th>Sample</th>
<th>90-1</th>
<th>90-2</th>
<th>90-3</th>
<th>0-4</th>
<th>0-5</th>
<th>0-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus</td>
<td>724960.1</td>
<td>650386</td>
<td>690658.6</td>
<td>16322679</td>
<td>16300513</td>
<td>15587882</td>
</tr>
<tr>
<td>Max Stress (lb)</td>
<td>1956.8</td>
<td>2425.4</td>
<td>1859.3</td>
<td>9946.7</td>
<td>10271.7</td>
<td>10478.6</td>
</tr>
<tr>
<td>Max Load (ksi)</td>
<td>257.3</td>
<td>313.1</td>
<td>234.3</td>
<td>291.8</td>
<td>300.1</td>
<td>299.4</td>
</tr>
</tbody>
</table>

This proves that our manufacturing process with our material is consistent.

Acknowledgements

This work was supported by Montana Tech’s Summer Undergraduate Research Fellowship (SURF). I’d like to thank Flathead Valley Community College (FVCC) for the use of equipment, Paige Payne, Jesse McAulry and the Center for Advanced Materials Processing (CAMP).