FORMULA TECHNION 2015

Carbon Composite Wheels

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Background

Weight is one of the factors that most influence car performance; higher weight will affect it adversely. This is especially important in race cars, since high performance is the key design goal. Carbon composites offer good mechanical properties at a reduced weight, compared to metals. Therefore, in order to save weight, carbon composites are used wherever possible.

This project is Formula Technion's first attempt at manufacturing mechanical parts from carbon composites, and the first time that carbon composite wheels have been made in Israel.

The project required research into carbon composites, research into various manufacturing processes and selection of a suitable process, design and analysis of the carbon rim and the aluminum core, and design of an aluminum mold for the carbon composite to be laid on to make the rim.

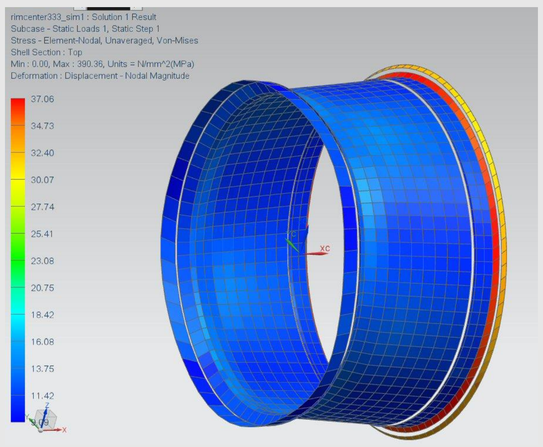
Design goals

Our team was tasked with designing a carbon composite wheel with an aluminum core that would meet the following demands:

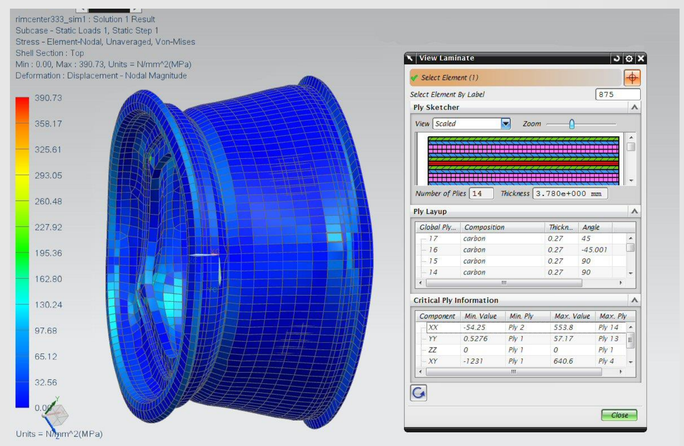
1. The wheel be interchangeable with the wheels previously used on the Formula Technion racing cars. This includes external measurements (width, diameter, bolt pattern etc.) and the space around the wheel hub.
2. The wheel will abide by all the regulations set forth by the Formula SAE Rules Committee.
3. The wheel will have a weight equal to or lower than the weight of the commercially available aluminum wheels that have been used on previous Formula Technion racing cars.
4. Minimum safety factor of 2.

Design process

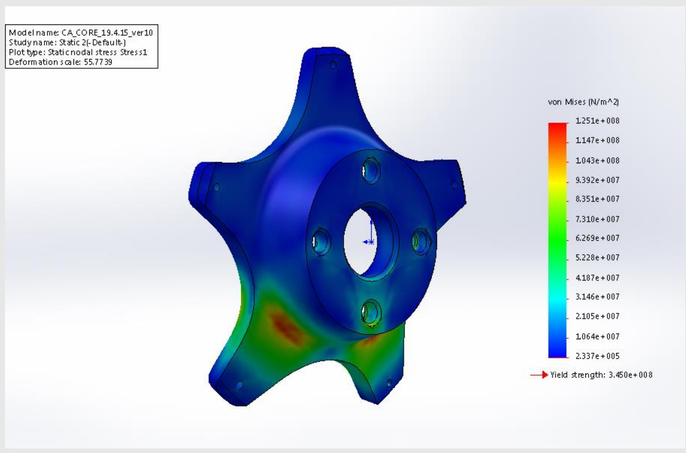
- Using data obtained from previous Formula Technion racing cars, calculations were made to find the forces acting on the rim. Forces were calculated at the car's maximum design speed and assuming 90% of the car's weight (including downforce) is acting on a single wheel - conservative design assumptions.
- A carbon composite rim and aluminum core design was selected over other designs, such as full carbon composite, for reasons of feasibility. The rim and core will be connected using shoulder screws.
- FEA performed using NX composite tools for the carbon composite laminate and Solidworks simulation for the aluminum core.



Composite meshing, performed using NX.



Composite layer modeling, performed using NX.



Core stress analysis, performed using Solidworks.

Carbon composite rim manufacturing process

In order to manufacture the carbon composite rim, molds are required, on which the carbon composite will be laid to create the shape of the rim.

- The rims would be manufactured from pre-preg carbon fiber and would be cured in an autoclave.
- Therefore, the molds must be made of aluminum. This is required because of the high temperatures needed to cure the carbon composite in the selected manufacturing process.

Materials and fasteners used

- Core: Aluminum 2024 T3, CNC machined.
- Rim: Newport 304-1 pre-preg uni-directional carbon fiber ($S_{ut} = 1.99[\mathrm{Gpa}]$).
- Molds: Aluminum 6061, CNC machined.
- Fasteners: ISO 7379 hex socket head shoulder screws, d=6 [mm], M5.

Wheel size specifications

- Wheel diameter: 13 [in].
- Wheel width: 7 [in].
- Bolt pattern: 4x100.
- Offset: 21.5 [mm].

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