Ansys + Formula Student Team of TU Berlin

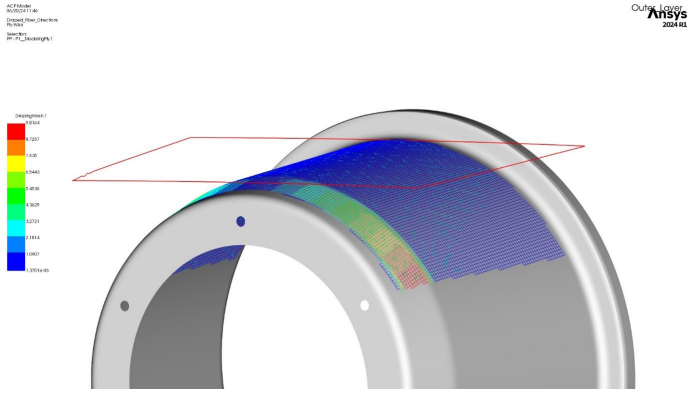
“Ansys was instrumental in our design process. Beyond providing engineering expertise, they granted us access to their powerful simulation clusters. With full access to Ansys and their Learning Hub, FaSTTUBe was able to conduct in-depth analyses of CFRP layups and mechanical investigations. This significantly reduced both costly testing time and vehicle mass, which is especially critical for components like wheels that contribute to rotational and unsprung mass."

— **Jonas Pagel**
Vehicle Dynamics Engineer / Formula Student Team of TU Berlin

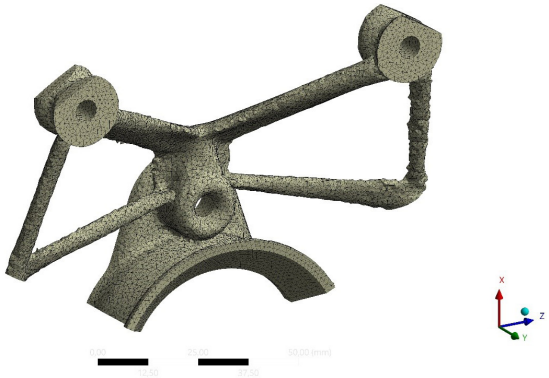
CASE STUDY

Developing a Hybrid CFRP Wheel for Formula Student Using Additive Manufacturing Processes

A reduction in the weight of a racing vehicle can lead to significant improvements in its performance abilities, resulting in enhanced acceleration, handling and responsiveness. Particularly, a reduction in the unsprung corner weight, which is largely comprised of the tires and wheels, can improve the car's ability to maintain contact between the tires and the road surface. To reduce the unsprung corner weight, decreasing the weight of the wheel itself through a concept of a new lightweight part using composite materials with additive manufactured components was a challenge to address.



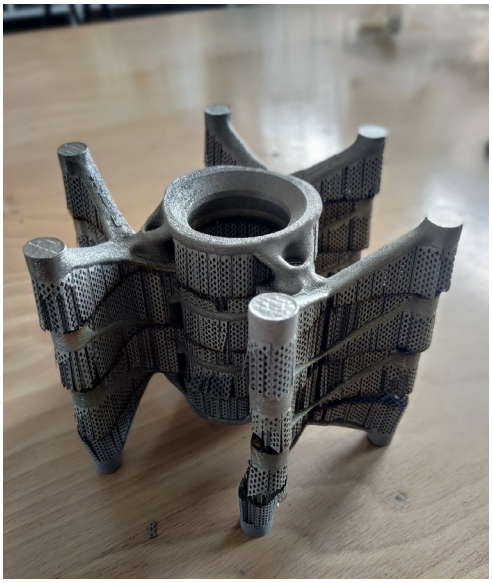
Draped surface ply



Surface model generated by level-set topology optimization

Challenges

The main challenge was to develop a component combining topology optimization as well as carbon-fiber-reinforced plastic (CFRP) layups while maintaining structural integrity and saving weight. As the developed part is supposed to be manufactured, detailed analysis and layup plots of the CFRP wheel have to be generated. To determine the ideal composite, material testing according to respective standards was performed. The bead of the wheel was optimized using parametrized CFRP layup sequences defining thickness and width.



3D printed titanium rim stars, including support structures

Technology Used

- Ansys Mechanical™ software
- Ansys Discovery™ software
- Ansys Composite PrePost (ACP) capability

Engineering Solutions

The generation of draped-ply simulation and parametrized layup optimization was a handy tool in determining and justifying the best layup decisions. Parametrizing the ply width and angle of fibers greatly helped optimize the CFRP wheel in ACP.

For the topology-optimized rim star, comparing materials with different properties helped the team decide on the best solution in terms of weight and stiffness. The rim star compared different materials through topology optimization, showing that a part made from titanium had the largest potential. The optimal combination to minimize compliance while maintaining favorable suspension dynamics was then chosen and manufactured for the FaSTTUBe race cars.

Inflated tires on optimized CFRP rim

/ Benefits

Through the intiuitive user interface and tools of ACP and Mechanical software, the team was able to quickly identify points of action. They could see areas that were of high and low interest in the optimization. As a result, the optimized wheel was considerably lighter than the established benchmarks, reducing the rim weight by 25% and the overall vehicle weight by 1.6 kg while maintaining structural integrity. Future work will validate the developed part on track.

/ Company Description

FaSTTUBe, the Formula Student Team of Technische Universität Berlin, competes in various competitions across Europe, including FSN, FSCZ, FSG, and FSA in 2024. Additionally, they will be the first European team to attend FS China since 2016. Currently ranked 11th in the world, they hold the title of the highest-ranked Emrax-driven Formula Student team globally. This year's car concept focuses on maximizing the potential of the design, incorporating significant weight savings, particularly in the wheel assembly.

Rendering the CFRP rim with final rim star

FaSTTUBe team

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