A Nose Cone for Winning: ARUS Andalucía Racing Team Improves Crashworthiness of Formula SAE Car

Formula SAE is an international competition for engineering students that allows them to practice their passion for motorsport, technology, and engineering. Organized by the Society of Automotive Engineers, the competition challenges students all around the globe to use their skills and available technology to design and build racing cars, both combustion and electrical. The idea is to inspire students to step beyond their academic studies in engineering to create a prototype vehicle that is evaluated in tests ranging from performance to design. The students also have to develop a business plan before taking the race car to the track. This competition is the perfect way to prepare them for future work.

Putting skills into practice: a new challenge for students

When Ana Casares Crespo, a former member of the ARUS Andalucía Racing team from University Seville in Spain, was looking for a final degree project, the team was inspired by the capabilities of Altair's software. The team came up with the idea to improve the crashworthiness of the vehicle nose cone laminate with the help of simulation.
This development project was born and became known as, "crashworthiness improvement of a Formula SAE racecar nose cone through the use of Nomex® fiber in a basalt fiber-based laminate." With more than seven students actively using Altair products to improve various aspects of the vehicle, the decision to incorporate Altair tools was obvious. They wanted to make use of the knowledge they gained from previous studies for structural design of aerodynamic packages. The team conducted static analysis and topological optimization using tools from the Altair HyperWorks™ suite, which helped them create optimized, lighter components.

Impact simulation of new material

The purpose of this project was to investigate the introduction of new material into the laminate of a Formula student racecar nose cone, which is one of the primary pieces of the bodywork. The goal was to improve crashworthiness by solving structural problems in composites under dynamic loadings.

ARUS
ANDALUCIA RACING TEAM

Industry
Academic

Challenge
Improving crashworthiness of a Formula SAE racecar nose cone's laminate

Altair Solution
Structural analysis and topology optimization verifying structural behavior of a new material

Benefits
- Improve crashworthiness
- Improve fracture properties
- Create lighter components

This hybrid composite laminate of basalt fiber and Nomex®, would replace the composite laminate of basalt fiber and epoxy resin that had been used in the last cars built by the ARUS team. First, the students did a preliminary static study of the laminate, which provided a selection criterion for the layout. To obtain the mechanical properties, which were required as an input for the simulation, the students characterized the laminate in the laboratory. With these properties, the students were able to perform impact simulations on the geometry of the nose cone, using Altair Radioss™ as the finite element solver.

As this was a pioneering project in impact simulations, the team had to face a specific challenge. For the first time, the students had to create Altair HyperCrash™ model settings and to find ways to understand which information or data they needed to prepare the model. They performed static analyses using Altair OptiStruct™, and impact simulations using Altair HyperMesh™ and HyperCrash modules for the setting up of the model. The documentation and training material provided by Altair allowed the students to acquire new software skills in a self-learning process and perform the required analyses.

"The collaboration with the Altair academic team and the support we received was outstanding. The Altair solutions are the perfect tools for our project and thanks to the professional feedback of Altair engineers we were able to reach our goal."

Ana Casares, ARUS Andalucía Racing Team

To set up the model step by step, they could draw on documentation like the Radioss study guide, the Radioss theory manual, and several tutorials published by Altair University. When they could not find the solution in the documentation, Altair engineers stepped in and helped the team with support and professional feedback on the settings of the impact simulation model.

Make or break

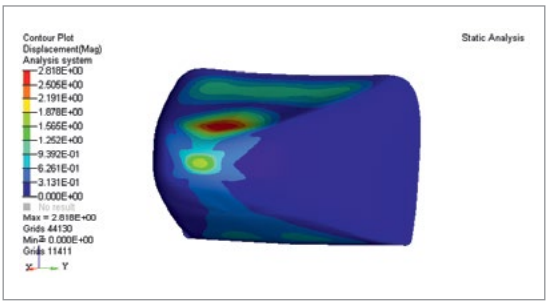
The simulation revealed that adding a layer of the aramid material (Nomex®) into the original laminate changes the fracture shape of the piece. In particular, results showed that the nose cone made of the laminate including aramid would break into homogeneous pieces, while the one made of the original laminate would break into not shape ordered pieces. Regarding energy terms, the simulation showed that the internal energy absorbed by the specimen including the aramid layer was a 18.75 percent higher than the quantity absorbed by the original specimen. While carrying out the characterization of the laminate in the laboratory, the students could also verify the benefits of adding this layer by simulating the structure, as it didn't break up completely during tensile and compression test. For the nose cone on the track this means that the pieces of the broken nose cone will most likely stay together instead of being spread out to the track.

Best-in-class technology and motivation from positive results

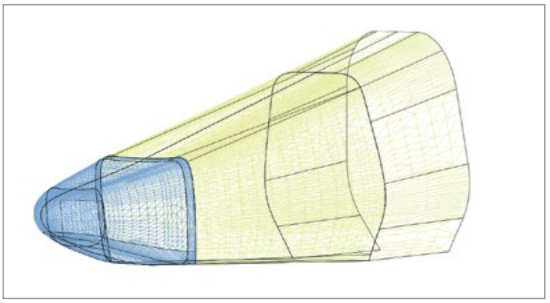
The students benefitted largely from using Altair's meshing software for their composite models as well as having access to a huge quantity of guidance material and personal support from Altair. During the year of the study, the team participated in several Formula SAE competitions including positive results at the Formula Student Germany challenge. The students were proud of the overall outcome which was motivational for continued excellence.

In the coming years, the ARUS team will employ HyperWorks™ to develop their first semi-monocoque chassis, made of carbon fiber composite. For this purpose, they will have to carry out a great quantity of numerical and experimental tests to verify the structural behavior of the piece. Using Altair's advanced technology and best-in-class tools will help them grow and come back even stronger in the next season.

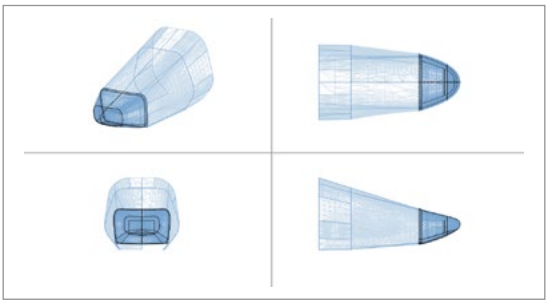
The ARUS Andalucía Racing Team participates with their own cars in several Formula SAE competitions



Displacement (magnitude) results of laminate BBNB (Basal-Basalt-Nomex-Basalt layout).



Geometry of the entire nosecone (yellow+blue). Geometry of study (blue).



Geometry of the entire nosecone (light blue). Geometry of study (blue)

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