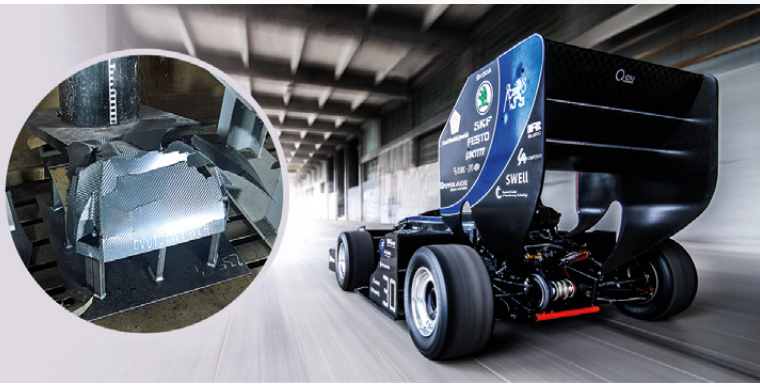
Fast and Safe – University Students Test Their Race Car with ESI Virtual Performance Solution



Crash box of the M-B SLR

Challenge

When a group of students at the Czech Technical University in Prague (ČVUT) began working on a "Formula Student Vehicle" project, they immediately opted for Carbon Fiber Reinforced Polymer (CFRP) to build the crash absorber so they could "go fast and be safe" on the track. However, they had to abide by a strict timespan for design and manufacturing and stay within a tight budget, allowing no room for error.

Benefits

The students were able to avoid physical crash tests of their CFRP race car thanks to ESI Virtual Performance Solution (VPS), using only virtual coupon tests of the CFRP material to validate the material model. This enabled them to move swiftly to the design optimization of the crash absorber structure.

The capability of VPS to complete multiple simulations on a single core model allowed the team to thoroughly examine various geometries of the absorber at any given time. The End to End solution supported the project goals, which were met entirely within the allotted time and budget.

Story

In the automotive industry, especially motor sports, crash absorbers made of Carbon Fiber Reinforced Polymer (CFRP) are widely used because they have the best energy dissipation capacity to weight ratio amongst engineering materials. The team at ČVUT knew this well, but they also knew the challenge of designing and manufacturing these structures efficiently.

"Using ESI Virtual Performance Solution to investigate the performance of a composite crash absorber completely virtually enabled us to complete the structure's design efficiently. Within a couple of days, the students learned how to use the software effectively and were capable of carrying out complex chained analyses".

Michal Vašíček
Project Consultant
Czech Technical University in Prague (ČVUT)

ČVUT is one of the largest technical universities in Europe, comprised of eight faculties, including Civil Engineering, Mechanical Engineering, Nuclear Science, Physical Engineering, and Information Technology. As part of its education and training program for final year students, the Faculty of Mechanical Engineering encourages students to participate in the international competition for "Formula Student Vehicle". The main challenge is to work with complex design structures and advanced materials. From the start, it was clear to the project consultant, Michal Vašíček, that Virtual Prototyping would be necessary to meet their time and financial constraints.

The team adopted ESI Virtual Performance Solution (VPS) as their main tool throughout the project. They started by building simple models to characterize their chosen CFRP material and progressed to macro models of components, to validate their simulation results against lab tests, before tackling the design and optimization of the complete structure. Components were designed in a Computer Aided Design (CAD) system and then imported into VPS to incorporate the physics of materials and crash conditions in the model.

The material characterization was comprehensive using a wide range of virtual coupon tests (tension, compression, in-plane shear, double cantilever beam, and end notched flexure). Having obtained a full set of mechanical and fracture properties of their materials, the students then built a simple, dynamic tube crushing experiment for validation. With confidence in their results and simulation methodology, the students began examining various geometries of the complete crash absorber and worked on finding an optimal layup of the laminate, balancing weight reduction and performance targets.

VPS enabled the students to evaluate the design of the CFRP crash box through extensive analysis of its behavior in stiffness, strength and crashworthiness. Being able to carry out these simulations, while using one single core model for all performance load cases, made their task significantly easier. The students completed their goals in minimal time and stayed within their budget. More importantly, they were confident that they could indeed "go fast and be safe" on race day, not to mention being able to add a bullet point to their resumes: "success in using ESI Virtual Performance Solution for a prototype car design".

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