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Design Of Composite Chassis For the Aquila Synergy Race Car

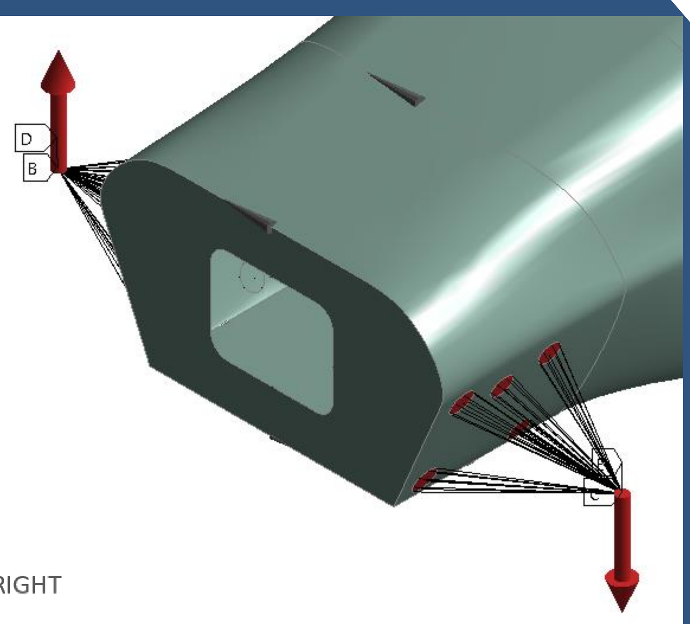
A. P. Knoll, E. N. Paul, F. Torlaschi and K. S. Kristiansen
Department of Materials and Production, Aalborg University, DK

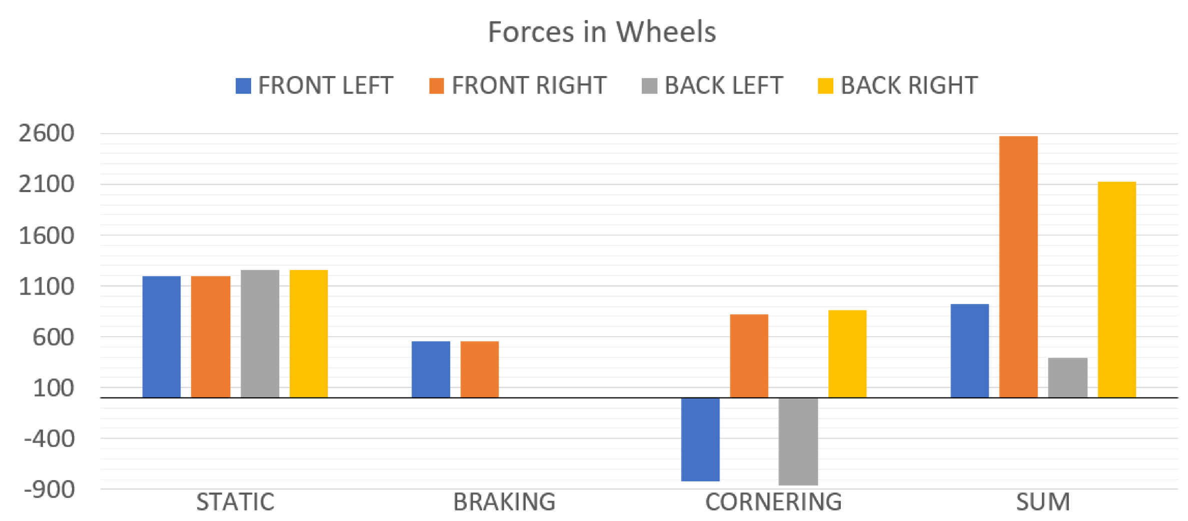
1. Aquila Synergy

The Synergy is an entry level race care for beginners in motorsport. The main objective is to redesign/upgrade of the chassis, changing its material from aluminum to GFRP or CFRP. Emphasis is put on the hardpoints for suspension, manufacturability, and cost.

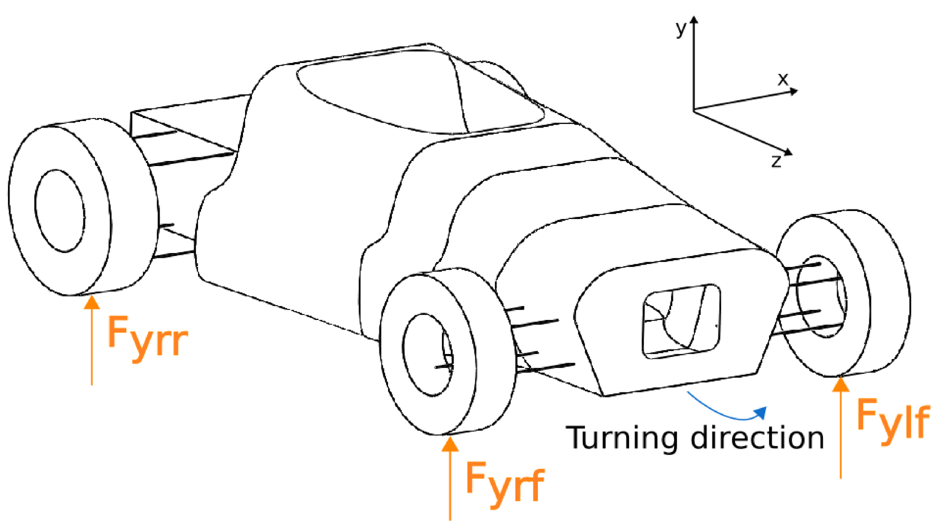
2. Importance of torsional stiffness

Torsional stiffness is often considered as the parameter that reflects the quality of the race car. For this reason it was decided to focus on this load case.

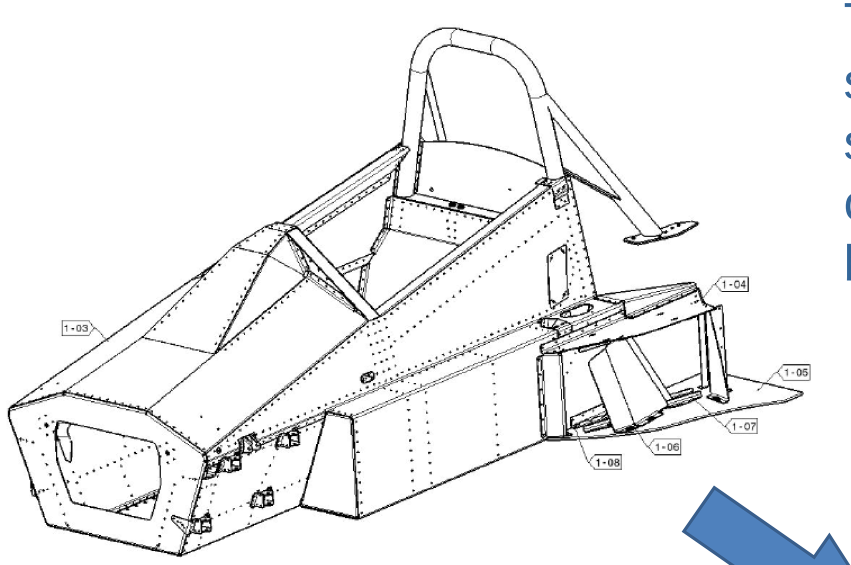




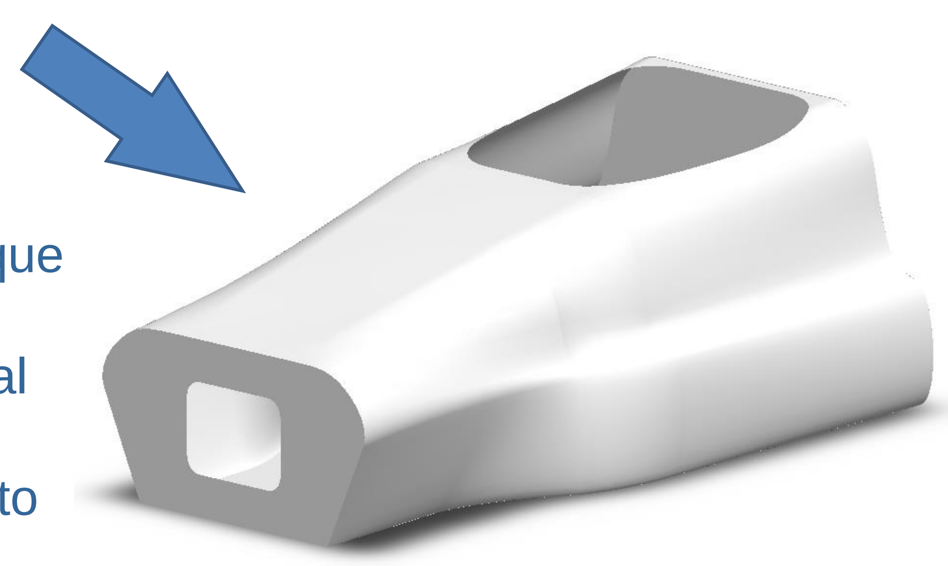
To analyse the torsional stiffness of the monocoque the maximal force from front left wheel F_{yrf} multiplied by a dynamic scaling factor of 3 have been used.



3. Geometry



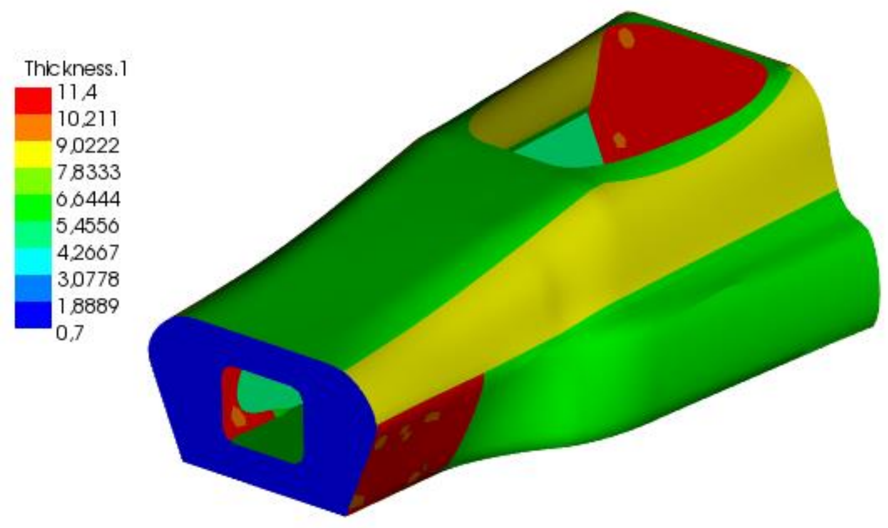
The redesign resulted in a more smooth geometry offering good stress distribution around the cockpit without using front roll bar.



What is more, this monocoque was designed considering: drivers ergonomics, torsional stiffness and weight. Finally manufacturing was taken into account.

4. Layup

The layup has been improved using GFRP because of the large availability and lower prices. All the plies are unidirectional, in particular 0° 90° 45° and -45° were used to find the best configuration, taking into account the weight reduction objective. Each surface need a particular layup and optimization tools were used in order to reach a proper torsional stiffness.



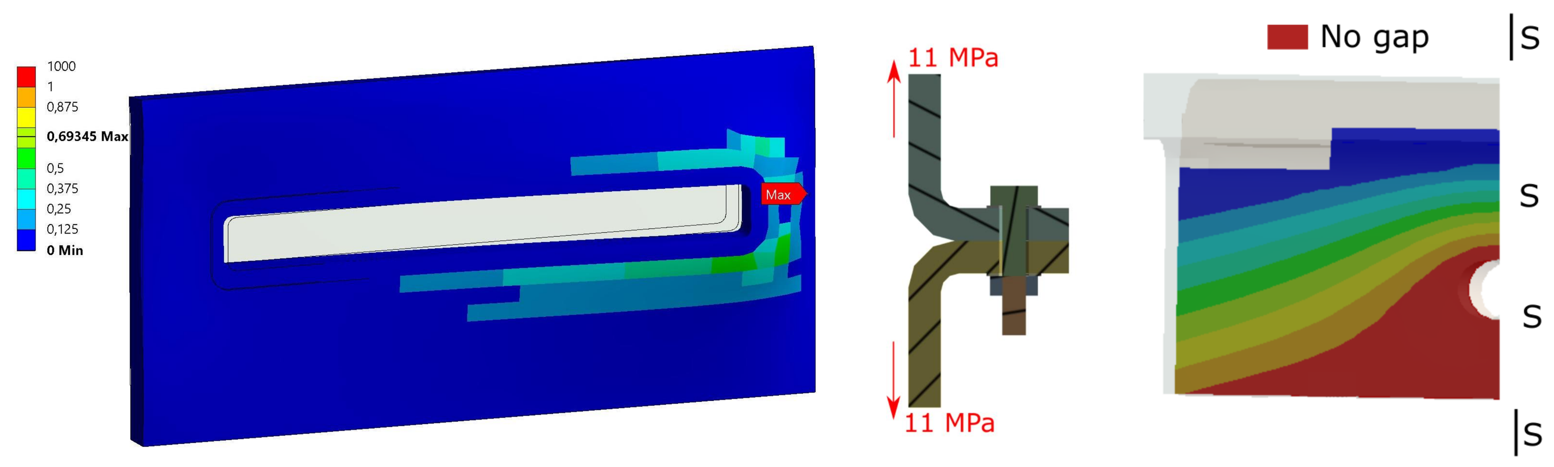
Thickness is not always proportional to weight. Results from ANSYS simulations showed that sandwich structures give higher stiffness to the monocoque. A less dense and thicker core material (PVC) was used to reinforce the weaker parts.

4. Detailed Analyses

A detailed model of: the connection of two halves of the Monocoque and fixation of the suspension are deeply considered. This is done to prevent the failure of the structure. As those sections need to be designed with care in composite structures.

Metal insert fixed in the side wall of the chassis allowed to distribute the load from the suspension over a larger area. This together with increase of thickness of the core material to 20 mm, resulted in reduction of the Tsai-Wu failure coefficient from 2,1 to 0,69.

Bolted joint is used to connect the monocoque parts. It is based on the frictional behaviour and is analysed for the most stressed case. After four iterations, the final configuration appears to work properly as the gap between laminate parts is not present around the bolt hole.



5. Summary

The outcome of the redesign process is a light 35 kg monocoque made of glass fibre reinforced polymer. The torsional stiffness of 8380 Nm/deg which is more that twice of the primary assumed value. Along with cheap solutions and modular design it met most of the goals of the project.

Acknowledgement

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