Design optimisation and virtual prototyping of supporting frame of the Formula Student Vehicle

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Aim of the Project

The Aim of the project is to research, design and optimise a supporting frame for a Formula Student car using Topology Optimisation.

Objectives:

- Research Relevant Information
- Generate a Solid Model
- Run Relevant Simulations
- Generate Topology Optimisation Model
- Export Model and Verify with repeated Simulations
- Prepare for Additive Manufacturing

Background

Photo: Formula Student Logo

Formula Student is a multi-college competition, that challenges groups of students to design, manufacture, race and fund scaled down Formula One-like car, and then compete against each other. The winners are decided by scoring the teams on their Design, Budgeting and Lap times. The role this project takes on is, by using computer generated Topology Optimisation, the mass, weight and overall material usage and therefore cost will be limited, improving all three categories that the team is ranked on.

Initially, SolidWorks was used to generate a featureless box that will contain our chassis design. Ansys was then used to run simulations on this box design, and using Topology Optimisation, any unnecessary mass was removed. The model was then Validated through more Simulations and Prepared for Additive Manufacture.

Simulations Ran

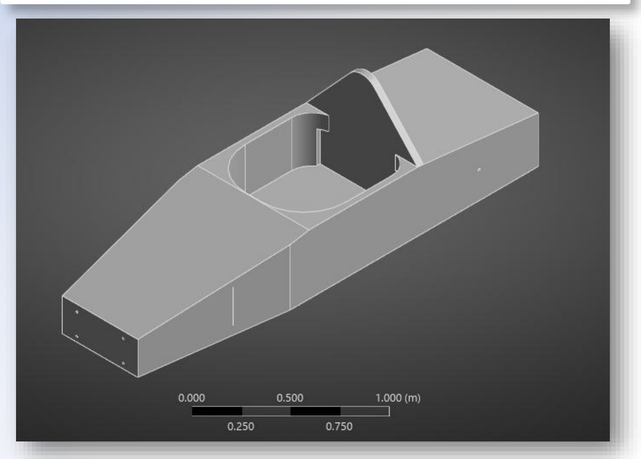

Figure 1: Original Box Model

Ansys Simulations that were used were Impact, at 3000N, to simulate crashes. Torsion, applying 1500N in opposite directions on each side to simulate twist in the chassis, and Acceleration, accelerating at 25m/s^2 to simulate the deformation by acceleration. The Topology Optimization then took the results of these simulations as inputs, and generated a Least Material Condition at the specified retain percentage (15%) that will still satisfy the simulations ran on it.

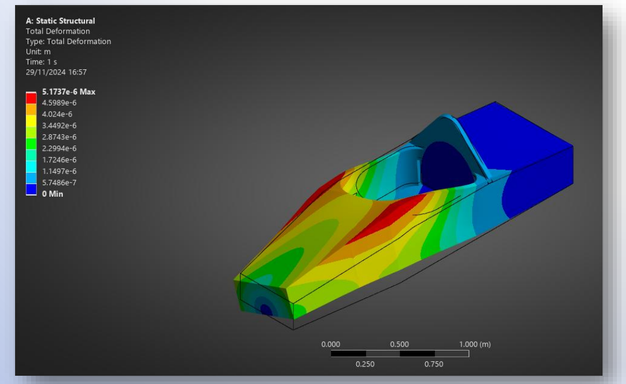

Figure 2: Original Torsion Simulation

Topology Optimization

After conducting the Topology Optimisation, the model then was required to be Exported, then smoothed out and prepared for new Verification Simulations to be ran and ensure it is able to withstand the forces it will experience in real world testing.

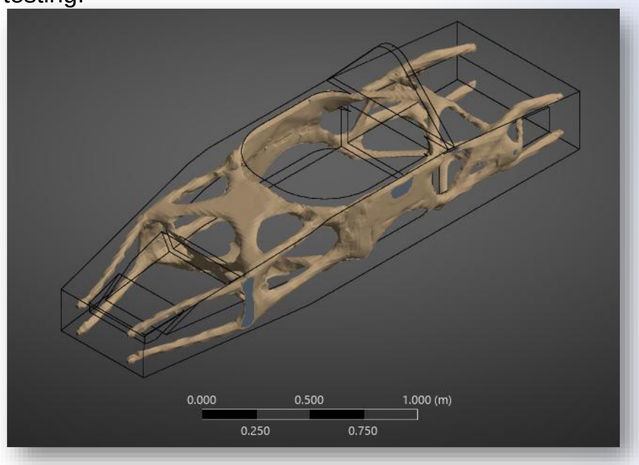

Figure 3: Successful Topology Optimisation

Once the model generated from the Topology Optimisation was successfully exported, all of the previous tests were then run once more, doubling the forces applied, with an impact of 6000N, Torsion of 3000N on each side, and an Acceleration of 50m/s^2 to ensure that the model can withstand double the design loads.

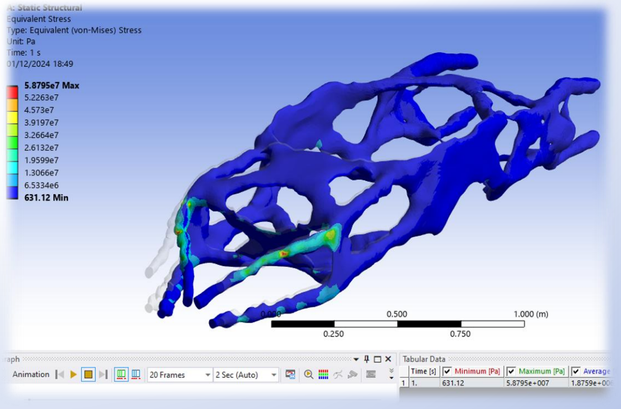

*Figure 4: Validated Impact Simulation (**6000N**)*

Conclusion

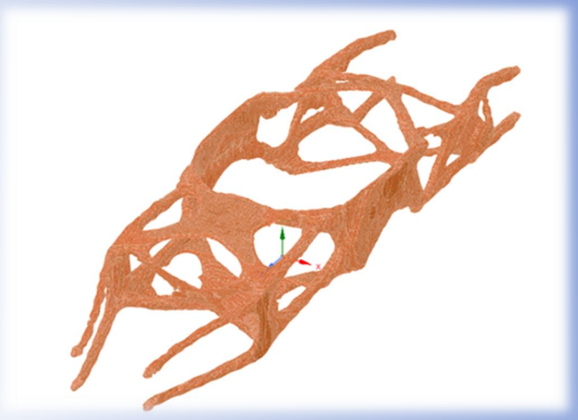

Figure 5: Final STL Model ready for Use

- A fully optimised design of the Formula Student Chassis was successfully modelled
- The model was exported as a smooth, merged STL file in preparation for Additive Manufacture
- The Design was validated to withstand twice the design stress
- The Topology Optimisation reduced the mass of the model to 15% of the original mass
- The optimised design will improve the weight, speed and handling of the car, while maintaining a high degree of safety
- The optimised design will also score well for Design in the Formula Student Rankings and reduce material cost

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