



Optimization of Formula Racing Frame Based on FEA

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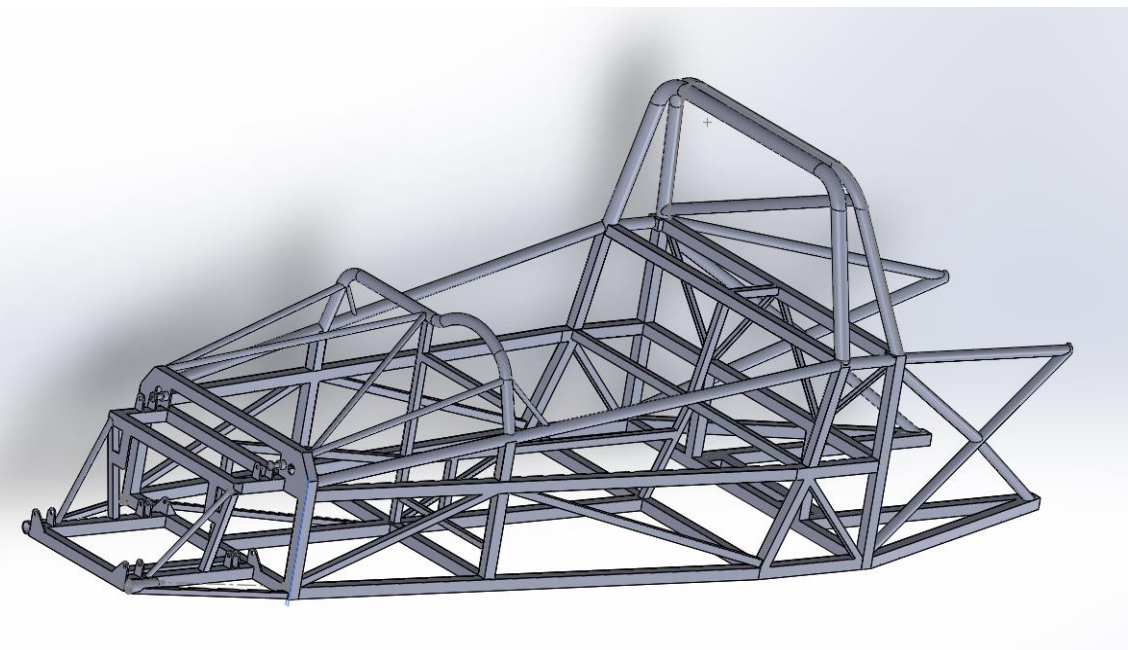
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Introduction

In order to upgrade and optimize the existing racing chassis frame, it was measured, modeled and analyzed. After acquiring the measurement data, a basic model of the vehicle chassis structure is established in SOLIDWORKS for finite element analysis.



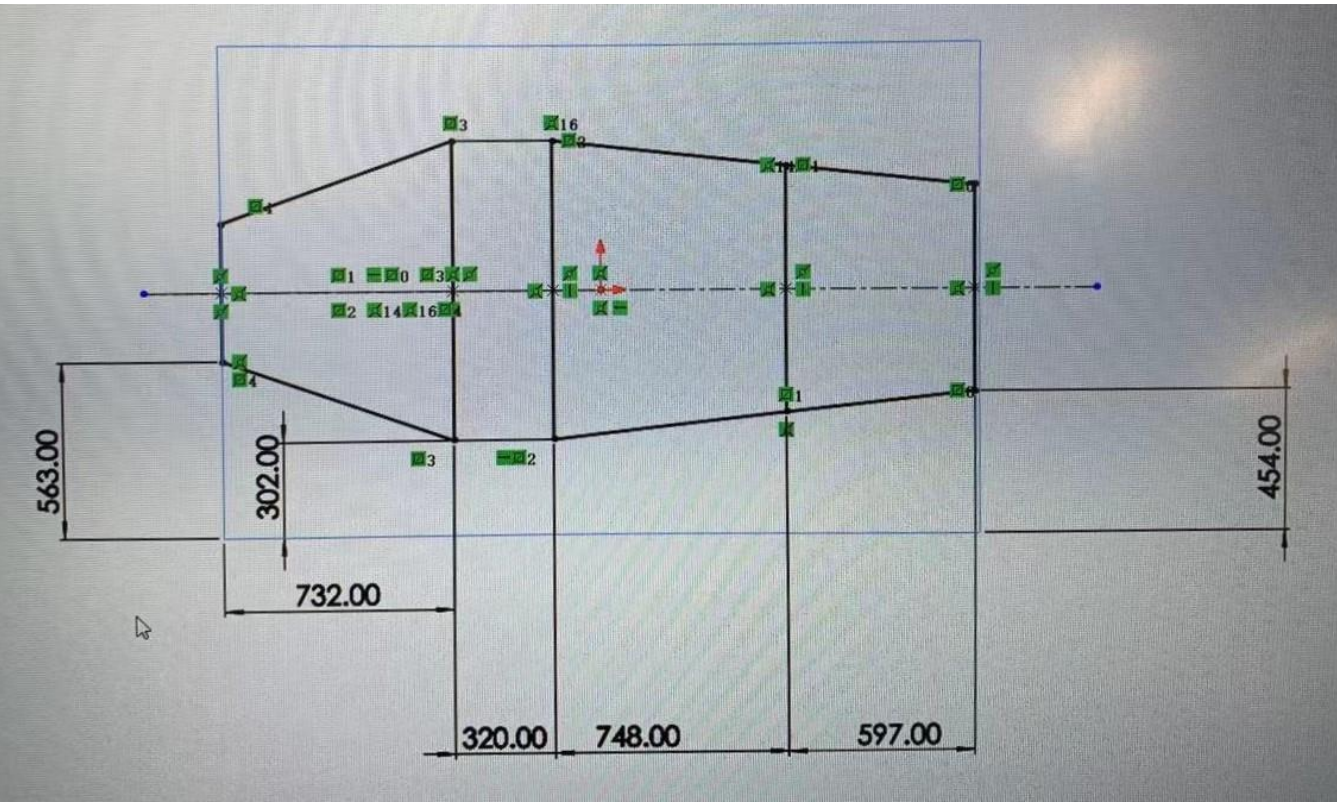
The finite element analysis of the frame is mainly experimented and analyzed from the two aspects of bending stiffness and torsional stiffness. The accuracy of the model and finite element analysis is verified by comparing the results of the finite element analysis with actual tests. After analyzing the results of the finite element analysis, the frame is optimized and upgraded with comprehensive consideration of strength, stiffness, cost and weight.

Project Aims

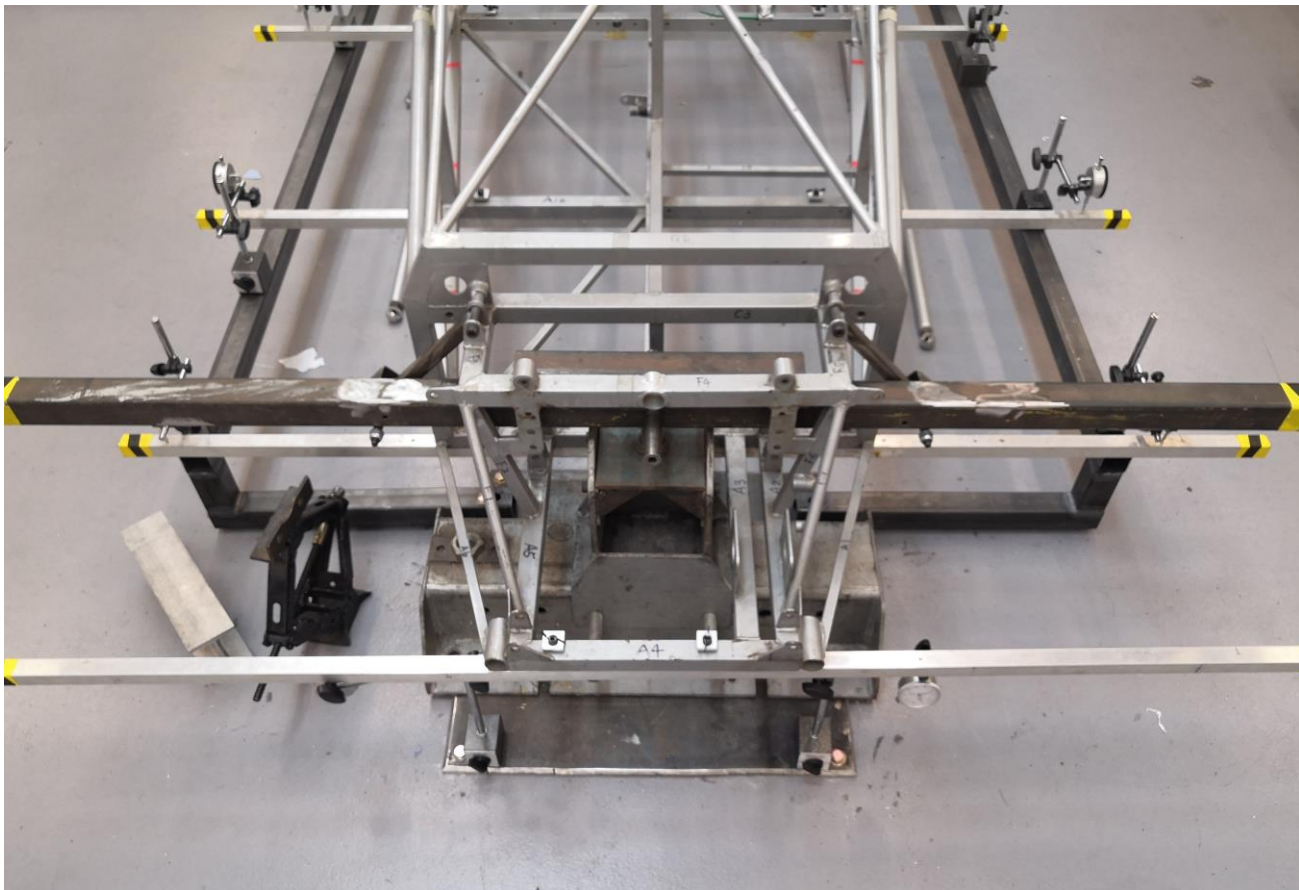
- Higher Stress Limit
- Lager Bending Stiffness
- Bigger Torsional Stiffness
- Lower Cost
- Smaller Weight
- Lower Centre of Gravity

Methodology

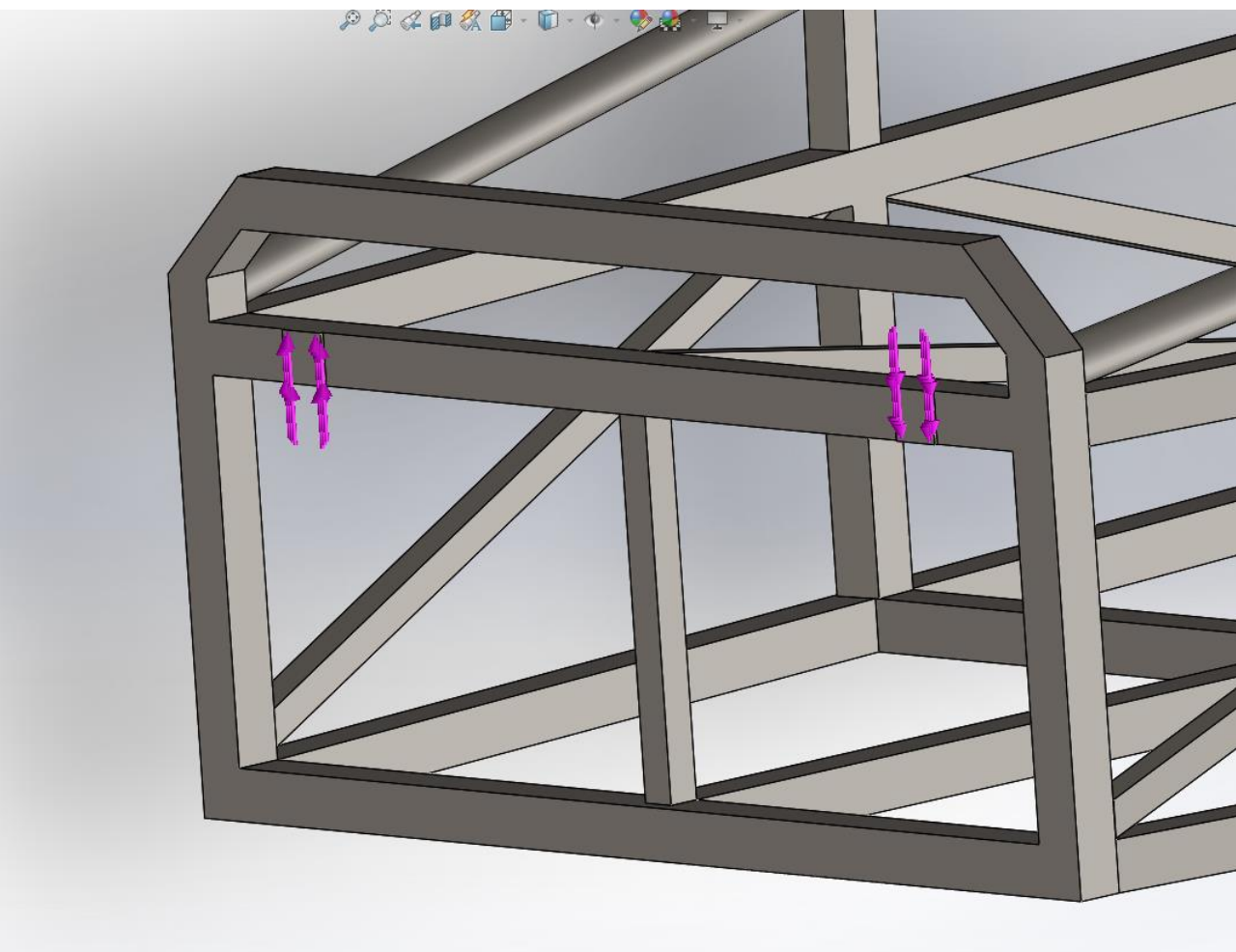
The reference plane method is used to measure the structure of the vehicle chassis, accurately measure the size of the workbench and the structure of the vehicle chassis, and then determine the center of the vehicle to align the vehicle chassis.



It is flat, and the entire vehicle chassis structure is divided into multiple parts and then separated, so the measurement of the vehicle chassis



In the actual torsional stiffness test, one side is loaded, the preload is 25 kg, and the experimental load is 65 kg.



In the FEA analysis, an asymmetric loading method was adopted. The bilateral load was 1127.23N, and the total torque was consistent with the actual torsional stiffness test to 538.81N * m.

Bending stiffness is calculated by formula 1,
$$K = F/Z \quad (1)$$

In which Z is the average value of the deformation, F is the load applied on the central axis, K is the bending stiffness (Yang Lei, 2017).

Torsional stiffness is calculated by formula 2,
$$K = T/\theta \quad (2)$$

In which T is the torque, θ is the torsion angle measured, K is the torsional stiffness (Li & Huang, 2019).

Results

Comparing the torsional stiffness FEA results with the actual test, it can be seen that the model is relatively accurate, and at the same time, the performance of the model optimized after the analysis of the FEA results has been improved.

TABLE: Improvements Results		
Factor	Value	Improved (%)
Stress Limit	450 MPa	0
Bending Stiffness (Middle)	1071.81 N/mm	33.33
Bending Stiffness (Rear)	2538.79 N/mm	11.71
Torsional Stiffness (Point A)	5513.68 N*m/°	8.27
Weight	47.72kg	6.14
Height of Centre of Gravity	280.09 mm	15.83

Conclusion

Due to the outbreak of the COVID-19 virus, the campus was temporarily close to students, so the actual test only completed the torsional stiffness part and the cost could not be completed due to the lack of computer-aided software. However, all aspects of the frame optimized after using the finite element analysis results as a reference have been improved.

References

Yang LeiLi, Chuxuan Wang and Yunqing ZhangQiang. (2017年03月28日). Loads Analysis and Optimization of FSAE Race Car Frame. SAE INTERNATIONAL, 页 12-18.

LiTietie, & HuangHaisong. (2019年08月12日). Finite Element Static Analysis and Research of Commercial Vehicle Frame. Machinery and Electronics, 页 29-32