Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

Optimization of Chassis Using Aluminium and Bonding Technology

Yan Li

Roger Dowden

School *of* **Engineering**

BEng Automotive Engineering

Introduction

Nowadays, optimization work is carried out nearly in every industry. After analyzing some researchers study process, it can be found that the process of optimization work can be subdivided into 4 steps [1]:

Firstly, create a CAD model;

Then, run the FE model;

Next, compare the FEA results with standards or ideal results to find the problems in FE model;

Finally, optimize the FE model and determine the final design layout.

This gives a strong guide to the work on the given chassis.

Project Aim and Direction

The aim of this project is optimizing the structure of the chassis. In addition, the optimization direction in this project is reducing the weight. The method of lightweight is using 6063-T6 aluminium bars to replace triangulation AISI 4130 steel bars. What's more, bonding technology using 3M DP420NS [2] adhesive is determined as the joining process between al and steel.

Modelling Work

The CAD model is built based on the data from measurements on the real chassis, shown in *Figure 1*.

Physical Testing

Physical testing is processed to verify FE model by comparing torsional stiffness of CAD model and real one. Virtual Model has been modified several times by until all components used in real testing are added and its stiffness is close to the testing results, shown in Figure 2-3. Because of lockdown, it's a simplify model

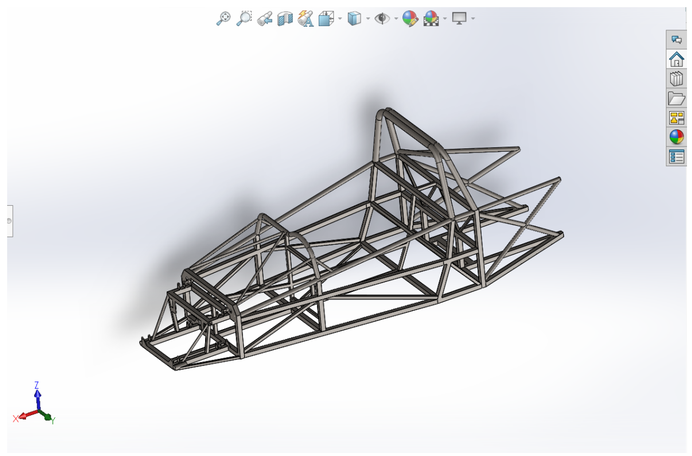

Figure 1 CAD Model of Chassis

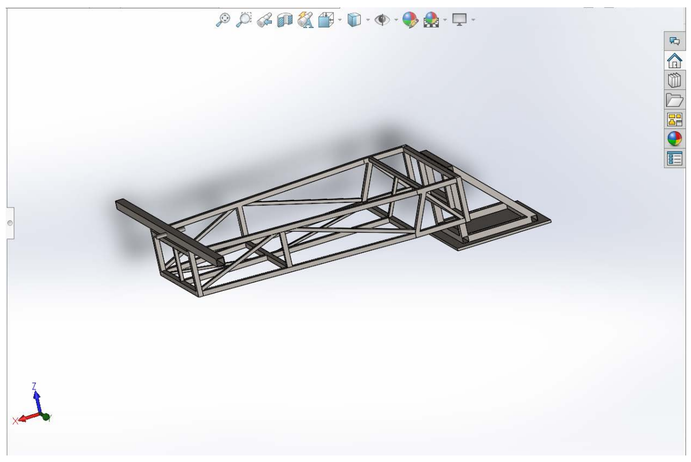

Figure 2 Modified Model

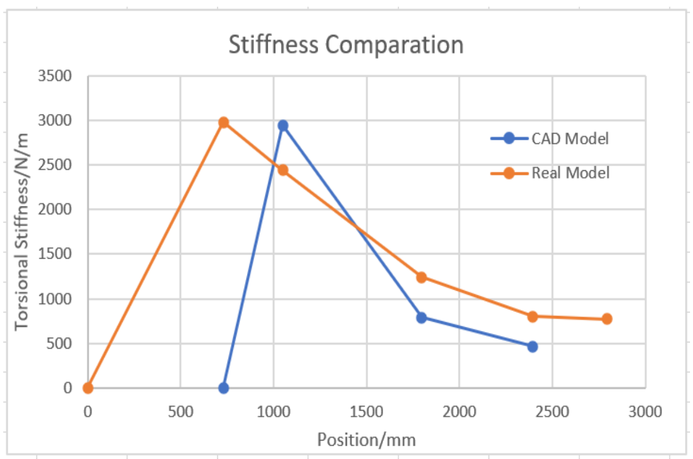

Figure 3 Stiffness Comparation between CAD Model and Real Chassis

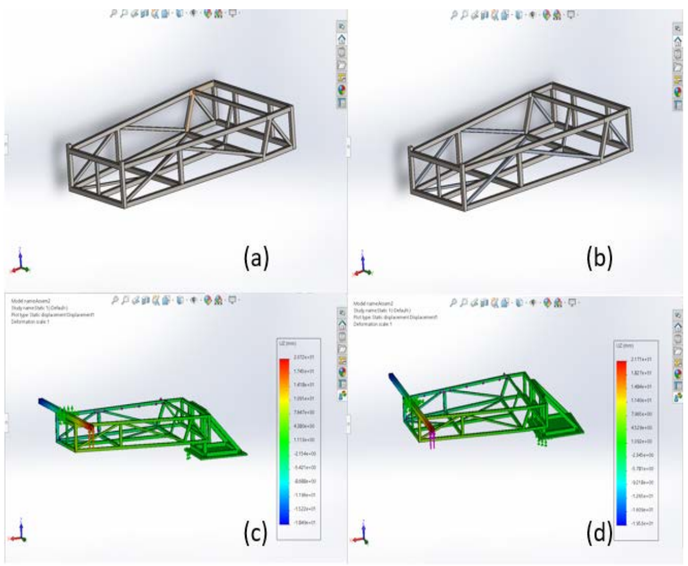

Figure 4 Lightweight Results of Rear Model: CAD model and FEA Displacements Results of Original (a)(c) and Lightweight Model (b)(d)

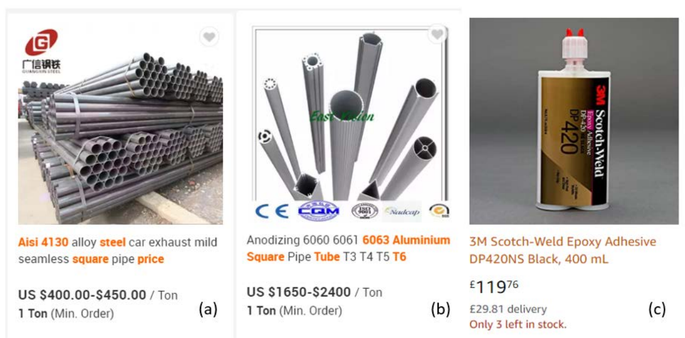

Figure 5 Price of Steel Tube (a), Al Tube (b) and DP420NS Adhesive (c)

Joining Process

Though the al and steel bars are defined bonded together, other bars are weld together in real chassis. In addition, in previous FE model, connection is defined as 'bond'. However, the strength of 'bond' joints is proved to be close to the 'weld bead' joints by FEA in SolidWorks. Therefore, previous lightweight results are still convictive.

Final Lightweight Work

FEA results indicates that the lightweight model is weaker than original model. However, because the strength of bond and weld connection can't be defined by customer in SolidWorks and the DP420NS adhesive bonding joint is even stronger than weld, the stiffness of lightweight model is assumed not weaker than original frame. Therefore, in final lightweight FE model, it's feasible to set all connection as bond. Results are shown in *Figure 4* and Table 1.

Table 1 Lightweight Results

	Original Model	Lightweight Model
Mass /grams	21958.59	19837.71 (9.7%↓)

Cost

A rough calculation about the cost of lightweight model because the lockdown. Results indicates that the lightweight model is £120.20-£120.75 more expensive. Some prices[3] are shown in *Figure 5*.

References

Hashfi. (2018, 3). Vertical Bending Strength and Torsional Rigidity Analysis of Formula Student Car Chassis. *Industrial, Mechanical, Electrical, and Chemical Engineering*, pp. 1-9.

3M. (2019). 3M™ Scotch-Weld™ Structural Two-Part Epoxy Adhesive Performance vs. Mechanical Fasteners .

Amazon. (2020, 4 29). *3M DP420NS* . Retrieved from Amazon.