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Design and Analysis Of Supra Car

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Abstract: *Chassis is a major part of any automotive design. It is responsible for supporting all functional systems of a vehicle and also accommodates the driver in the cockpit. So it must be strong enough to resist the shock, twist, vibration and other stresses. Maximum stresses and maximum deflection are important criteria for design of the chassis. The objective of present is to determine maximum stress, maximum deflection and to recognize critical regions under static loading condition.*
Keywords: *SAE SUPRA, Impact analysis, Calculations*

I. Introduction

The purpose of this report is providing a summary of the chassis design for formula student project. This document will present an overview of the project, the project scope and the design requirement, while outlining the selected final design. This year chassis has been designed for max. adjustability, with focus on reliability, weight reduction and manufacturing. The objective of chassis design group was o design a chassis in accordance with the SAE rule book along with providing a lighter, stiffer frame keeping in mind the aesthetics and ergonomics of the driver. The design started with a through study of the rule book.

The chassis is an integral part of a formula style race car, encompassing the frame, suspension, steering, and hub and upright assemblies. For this project, the chassis is defined as including all frame members, with the forward vehicle limit being the front bulk head, and the rear vehicle limit being the differential mounts. Project scope will be included design selection, use of modelling tools and simulation and construction of final design.

In order to select the final design of our project the group has created several requirements which have been divided into constraint and criteria. This design requirement are a combination of rules and self-set goals to improve upon the chassis of last year vehicle and the success of the design group will be based on being able to effectively meet this requirement.

Constraints -

The following requirements must be followed in the design of chassis if any of the requirements are not met, the design will consider unsuccessful.

- Must meet all formula SAE requirements, as outline in the 2018 formula SAE rules.
- Must ensure the safety of driver at all the times.
- Weight of the frame must be within 50-60 kg.
- The wheelbase must be 1550 mm.
- Minimum height from the driver’s seat base to the ground must be 350 mm.
- Width of chassis must be 850 mm

Criteria -

The following requirements should be followed in the design of the chassis. This criterion is not critical to the success of the chassis however they will enhance performance.

- Strengthen the frame by minimising number of bends
- Including rear bulk head in the design
- Using ANSYS software for torsional stiffness and model analysis.

II. Design of car

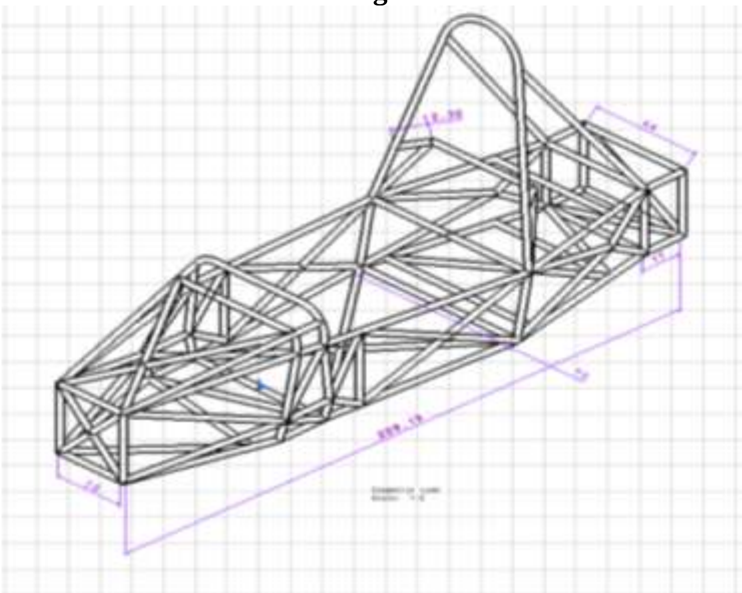

Fig 1: Draft view of chassis

III. Race car design procedure

A rulebook is followed to design the student formula vehicle. Once the designing of the car is completed, the next task is to carefully select material for the chassis. Strength, Weight to Strength ratio and Cost of the material should be considered while selecting the material. Comparative chart of the properties of few available materials is shown.

Table – 1: Comparison of material properties

Material Name	Tensile Strength(N /mm²)	Yield Strength (N/mm²)	Mass Density (Kg/m³)	Cost (Rs./Meter)
AISI4130	731	460	7850	450
AISI1020	420.5	351.5	7900	375
AISI1018	440	370	7870	390

AISI 4130 is selected for chassis material after the comparison and extensive market survey. Cost per meter is high but strength to weight ratio is more. So, AISI 4130 is being considered as the structural member for the construction of student formula car chassis by team Iron Head.

IV. Student Formula Vehicle Analysis Types

Now, after the selection of chassis material, types of analysis to be performed to ensure its stability under various conditions is mentioned below:

(i) Front impact analysis.
(ii) Rear impact analysis.
(iii) Side impact analysis.
(iv) Static analysis.

(i) Front impact analysis.

For the front impact, rear suspensions mounting points and rear wheel position kept fixed. Front impact was calculated for an optimum speed of 60 kmph. The loads were applied only at front end of chassis because application of forces at one end, result in a more conservative approach of analysis. Time of impact considered is 0.3 sec.

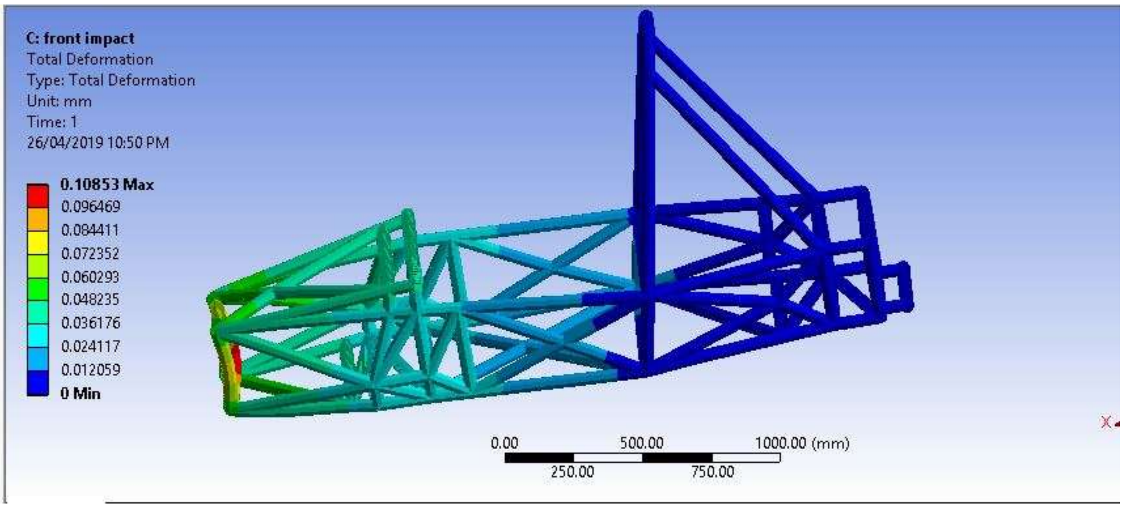

Fig 2: Front impact analysis

Calculation of force:
Initial Velocity= 60kmph=16.67 m/s, final velocity=0 m/s
Mass of vehicle= 350 kg, time of impact=0.3 sec.

$V = u + a \times t$

$0 = 16.67 + a \times 0$

Acceleration= $a = 55.56$ m/s^2

$F = m \times a = 350 \times 55.56$

$F = 19446\ N$

(ii) Rear impact analysis

Considering the worst case collision for rear impact, force is calculated similar to front impact for 60 kmph. Load applied at rear end of chassis while constraining front suspension mounting points. Time impact considered is 0.3 seconds. Approximately 6G force is applied.

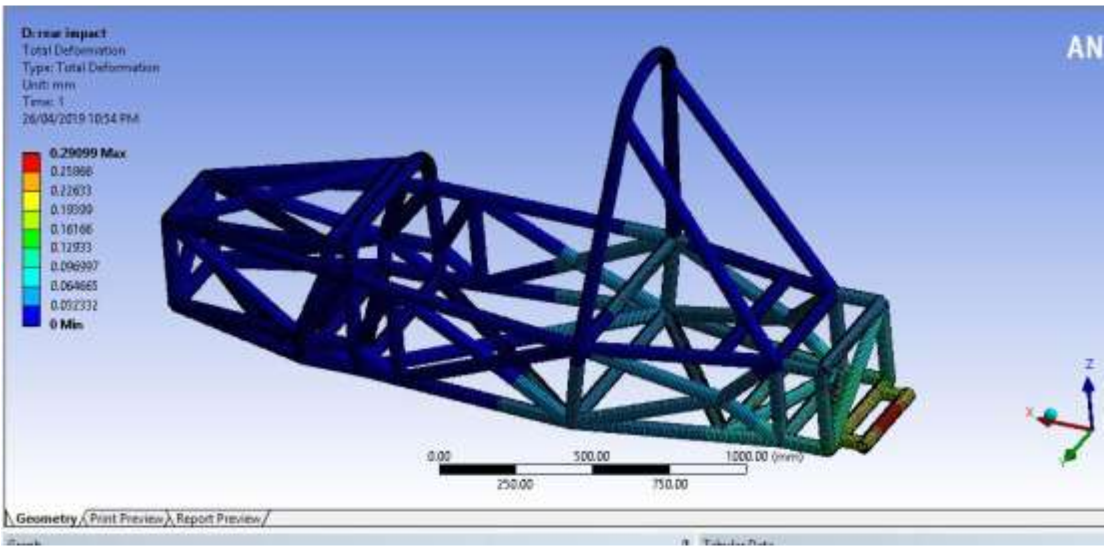

Fig 3: Rear impact analysis.

Force calculation:

$$F \times t = m \times (V - u)$$

$$F \times 0.3 = 350 \times (16.67 - 0)$$

$$F = 19446\ N$$

From the analysis it is observed that, the total deformation due to rear impact is 0.29099 mm and maximum combined stress is 43.828 MPa and design is safe.

(iii) Side impact analysis

For side impact test, the vehicle speed considered is 40 kmph. Constraining the front as well as rear suspension mounting points and impact timing is 0.3 sec.

$$V = 40\ kmph = 11.11\ m/s$$

Force calculation:

$$F \times t = m \times (V - u)$$

$$F \times 0.3 = 350 \times (11.11 - o)$$

(1) $$F = 12961.67\ N$$

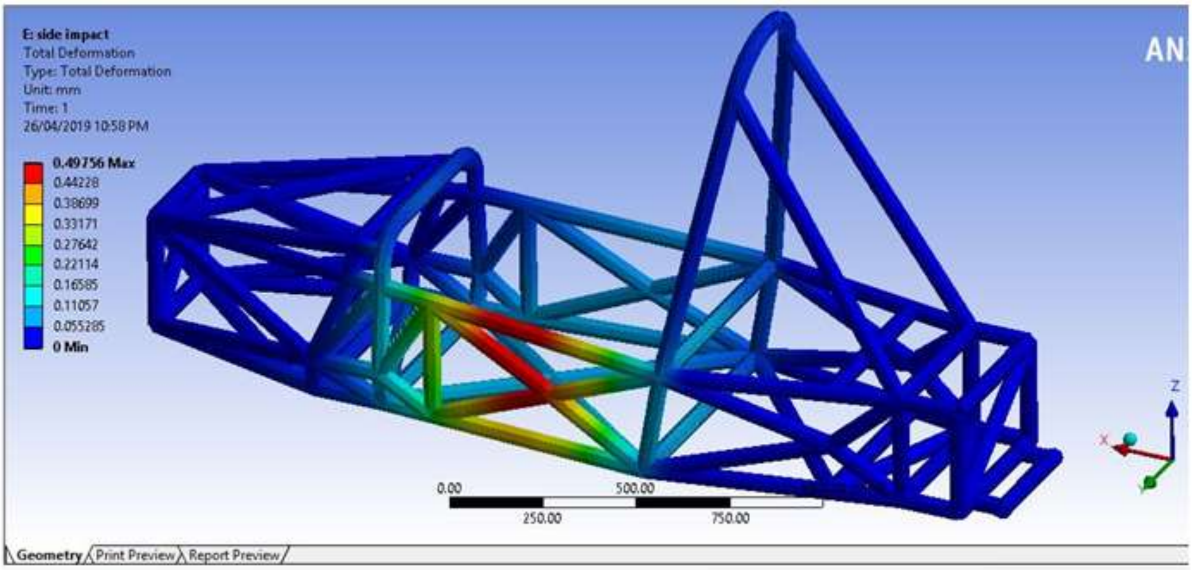

Fig. Side Impact Total Deformation

(iv) Static analysis.

Due to weight of driver and engine there is some stresses will generate. Consider the combine weight of driver and engine is 200kg. This load will act in some part of cockpit and some rear part of chassis. This load is main load act on chassis, so neglect the other loads in this analysis.

$$F = m \times g$$

$$= 200 \times 9.81$$

$$F = 1962\ N.$$

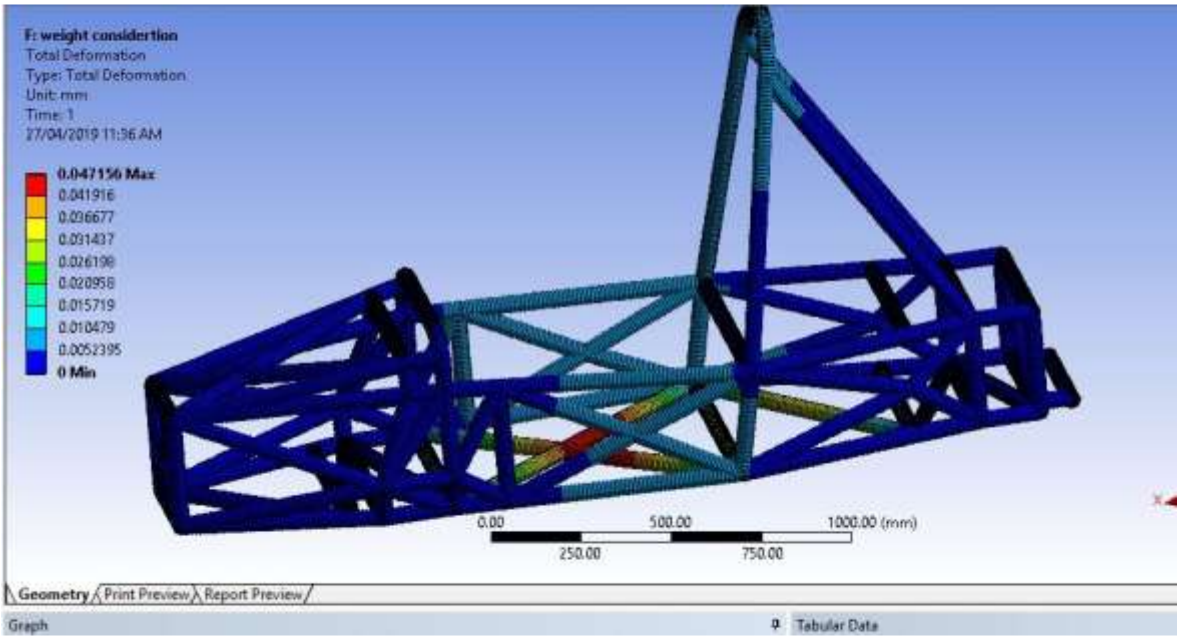

Fig. Static Loading In Cockpit

V. Conclusion

We learn how to select appropriate material for the safe design of chassis. Successful analysis was perform on the chassis of CAD modal using ANSYS WORKBENCH to determine, equivalent stresses, and total deformation results.

Stress distributions were found to be even and less than the yield strength of material. After applying different types of static analysis and by giving different loads while performing the analysis on chassis, it is concluded that the chassis is safe for the driver.

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