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Design of SUPRA-SAE Student Version (A Review)

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Abstract: The most important part of any vehicle is the Chassis. The chassis is the support system for all components in the vehicle. It is responsible for supporting all functional systems of a vehicle and accommodates the driver in the cockpit. Therefore, its design must sustain the weight of the components. Designing a chassis for driver's safety is always been a concern, especially for a race car. In this report, a few techniques are mentioned on how to analyze a formula student race car chassis to ensure its structural stability for the driver's safety.

I. INTRODUCTION

Our project is about the design & analysis of the supra-sae student version. In this, we are going to design the body and all the parts in the supra vehicle to analyze the proper functioning and strength of the vehicle. The design of the supra SAE student version represents an exciting blend of innovation and engineering prowess.

This high-performance vehicle is the result of the collective creativity and expertise of budding automotive engineers, showcasing cutting-edge technology and a passion for pushing the boundaries of automotive design. In this introduction, we will delve into the key features and design philosophy that make the supra-SAE student version a remarkable and competitive entry in the world of student-built race cars.

Although, this document discusses the design of the Supra SAE student version, with a specific emphasis on the chassis. The chassis is highlighted as a critical component of any vehicle, serving as the support system for various vehicle elements. The report addresses the challenges associated with chassis design, particularly in the context of a race car, focusing on structural stability for driver safety. It explores various materials for chassis construction, comparing factors such as density, tensile strength, and modulus of elasticity.

The problem identification and formulation section outlines key challenges, including safety, weight, cost, manufacturability, durability, and performance. The research methodology involves setting objectives, reviewing the literature, budgeting, acknowledging limitations, designing the research, and creating a prototype. The working section delves into the engine, steering, suspension, and braking system of the Formula Supra SAE, emphasizing performance enhancement. The document concludes with a list of references from various sources in the field of automotive engineering and chassis design.

II. PROBLEM IDENTIFICATION AND FORMULATION

When dealing with systems like chassis design in vehicles. Problem identification and formulation is crucial. This involves identifying the main challenges and turning them into clearly defined problems to solve.

1) *Safety:* The primary concern for any vehicle design. The chassis should withstand impacts and protect passengers.
2) *Weight:* A lighter chassis can lead to better fuel efficiency but might compromise on strength.
3) *Cost:* The materials and design processes chosen can greatly affect the cost of production.
4) *Manufacturability:* Some designs might be ideal theoretically but difficult to produce on a large scale.
5) *Durability:* The chassis should resist wear and tear, corrosion, and other long-term issues.
6) *Performance:* It should allow for optimal vehicle dynamics, including handling, ride quality, noise, and vibration.

Once these challenges are identified, we formulate them into solvable problems. For example:

a) *Safety Problem:* Design a chassis that meets or exceeds all regulatory crash test requirements while minimizing weight.
b) *Weight Problem:* Identifying the best suitable material and proper design methodology that will help in reducing the chassis weight without compromising the strength of the material, and hence also saving the cost of the material.
c) *Durability Problem:* The chassis should have a life expectancy of at least A years under regular driving conditions without major maintenance.
d) *Performance Problem:* Optimize the chassis design to ensure a balance of ride quality, and handling.

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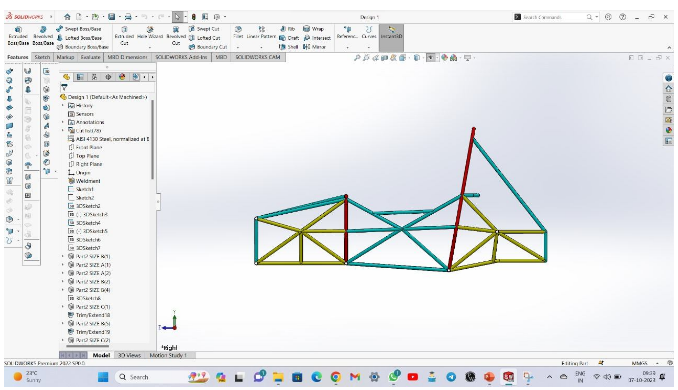
III.DESIGN OF CHASSIS

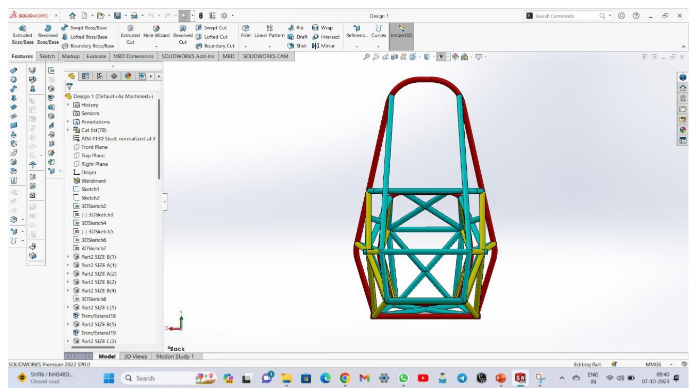
The design of the chassis is made with respect to the rules in the Supra SAE rulebook All the aspects of the piping and cockpit have been considered before designing the chassis Triangulations of the weldments have been made with proper aspects. The key aspect is the construction of a chassis design is it's the material, the better the material the best will its strength analysis and the defamation will be less.

Therefore, a complete comparison between the material should be done for selecting the material.

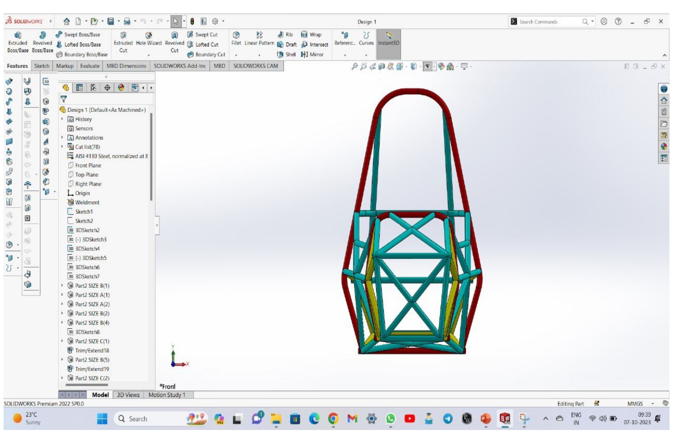
COMARISION FACTOR	AISI 4130	AISI 4140	GREY CAST IRON G1 800	SAE 1018	ASMT A710
DENSITY (X1000)	7.85 Kg/M^3	7.85 Kg/M^3	7.15 Kg/M^3	7.87 Kg/M^3	7.85 Kg/ M^3
TENSILE STRENGTH (U)	670 MPa	655 MPa	440 MPa	440 MPa	585 MPa
TENSILE STRENGTH (Y)	460 MPa	415 MPa	400 MPa	370 MPa	515 MPa
MODULUS OF ELASTICITY (GPa)	190-210	190-210	95-110	205	205
BULK MODULUS	140 GPa	140 GPa	90 GPa	135 GPa	160 GPa
SHEAR MODULUS	80 GPA	80 GPA	75 GPa	80 GPa	80 GPa
POISSONS RATIO	0.27-0.30	0.27-0.30	026	0.29	0.29



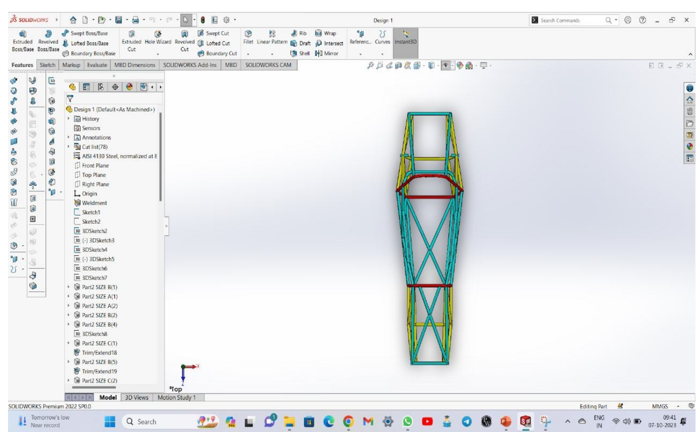
SIDE VIEW



REAR VIEW



FRONT VIEW



TOP VIEW

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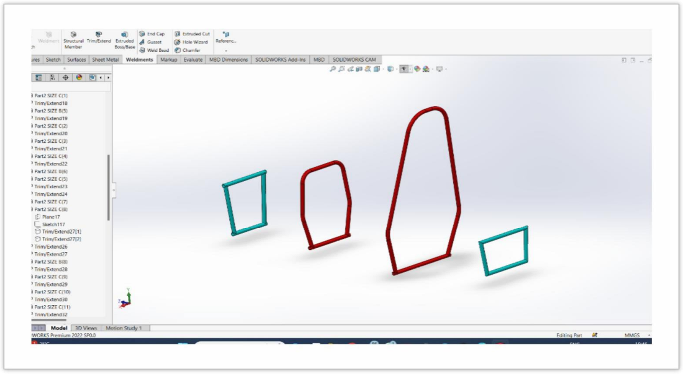


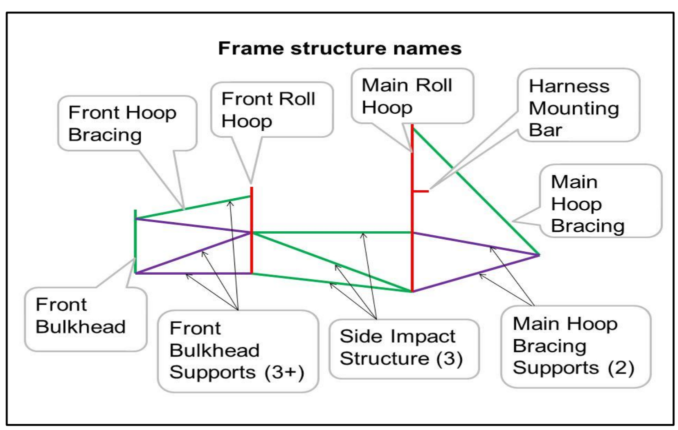
MAIN HOOPS ON WHICH BRACES AND
SUPPORT MEMBERS ARE PROVIDED

PROTOTYPE MODELS

IV. NOMENCLATURE OF CHASSIS

Primary Structure:

- Front Bulkhead
- Front Bulkhead Support
- Main Roll Hoop
- Front Roll Hoop
- Side Impact Structure
- Roll Hoop Bracings.



V. RESEARCH METHODOLOGY

To conduct A research methodology for formula SAE, India, we followed the below steps.

1) *Research Objective*: To build a whole new chassis that is air-resistant, driver-comfortable, and performance-based.
2) *Literature review*: Many literature reviews were studied for proper design and analysis.
3) *Budget*: A proper budget was made so that the vehicle was not so expensive.
4) *Limitations*: The chassis needs to be made within limited resources and time constraints.
5) *Research design*: Many designs and rule books of formula supra sae were studied carefully for proper output of the design and proper quality chassis was designed.
6) *Prototype*: The prototype of the model was made so that it could be made into existence.

VI. WORKING

A. Engine

The formula supra sae works on the 4-stroke engine. The engine mounted will be a 390cc KTM DUKE engine which is the most powerful in this range. Further tunning will be done in the engine and sensors, which will further enhance power output. A data comparison sheet will be made comparing the data before and after
tunning the engine.

B. Steering

The chosen steering system is Ackerman steering, designed to align the vehicle's path in accordance with the driver's requirements or the characteristics of the race track. The challenge of ensuring that wheels trace out circles with different radii on the inside and outside of a turn prompted the development of Ackermann steering geometry. This geometric design involves interconnected components in the steering system of an automobile or other vehicle. Ackermann steering geometry, a widely adopted configuration in all automobiles, addresses the issue of achieving the correct turning angle of the steering wheel when navigating through bends or curves.

C. Suspension

All the components in a road car's suspension are also present in a Formula One vehicle. These parts include arms, anti-sway bars, dampers, springs, and dampers. High loads must be supported by the suspension. The suspension of an F1 car must be sturdy and rigid to manage the pressures placed on it while it travels through a curve at high speeds without being damaged. Suspension's primary function is to join a car to its wheel. Because moving a heavy requires a sophisticated system with many parts, this is not necessary.

D. Braking System

Disk Brake: One of the Formula One car's strongest points is its braking system. Formula 1 cars use composite brake discs that include carbon fiber reinforcement. When the disc is heated up due to the friction in the disc and brake pad, the coefficient of friction between the pads and the discs might reach 0.6. At these high temperatures, steel brake discs would have a higher rate of wear.

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