

Design & Analysis of Structure of Roll Cage for SUPRA SAE: A Review

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Abstract— This paper involves a detailed literature study on the design and analysis of a roll cage structure for Supra SAE. Formula SUPRA (SAE) competitions offers a challenging environment where an engineering student can practice and develop various engineering skills. This increases the practical and application oriented approach towards a real engineering. This paper deals with the study of overall design procedure of roll cage of SAE vehicle from start to end, as well as Finite Elemental Analysis (static & dynamic) of it, carried out in previous literatures. 3D CAD model of roll cage will be modeled using Solidworks software and FEA analysis will be done using Nastran.

Key words: SAE, Roll Cage, Finite Elemental Analysis, Solidworks, Nastran

I. INTRODUCTION

In this work, we presented in detail the literature study on roll cage structure. The type of structure used generally are reviewed. The method for structure design is elucidated. This work emphasizes the study of method for designing and analyzing the roll cage structure for SUPRA SAE in various aspects.

The Student Formula competitions challenge teams of university undergraduate and graduate students to conceive, design, fabricate, develop and compete with small, formula style, vehicles. The vehicle should have very high performance in terms of acceleration, braking and handling and be sufficiently durable to successfully complete all the events described in the Student Formula Rules and held at the Student Formula competitions. A complete design and analysis report of roll cage structure is must for the competition.

A Formula student race car is a simplified version of Formula One race car designed and built by the university students for competitions like FSAE, Supra SAE, and Formula Student etc. body structure plays a major role during race car racing. Usually, in race a car, roll cage structure with minimum 3.5mm thickness is used owing to ease of design and lighter in weight. However, various combinations of material and thickness used.

This paper will give brief idea about the design parameters which are to be considered as well as how to design and optimize the roll cage considering the safety of driver and overall performance of the vehicle.

II. AIM & OBJECTIVES

- To generate the CAD model of roll cage structure.
- To perform design and analysis of roll cage structure using FEA.
- To increase the product durability

III. LITERATURE REVIEW

Dhruva Khazode, Nilay Akre and Akshay Deotale [1] An all-terrain vehicle also known as quad, quad bike, three wheeler or four wheeler is defined by the American National Standards Institute (ANSI) as a vehicle that travels on low pressure tires, with a seat that is straddled by the operator along with the handle bars with steering control. A roll cage is a skeleton of an ATV. A roll cage is not only forms a structure base but also a 3D shell surrounding the occupant which protects the occupants in case of impact and roll over. The roll cage also adds to the aesthetics of a vehicle. This paper deals with design of roll cage for an ATV.

Mahendra H M, B S Praveen Kumar, Puttaswamaiah.S and G.S Prakash [2] The objective of this thesis is to analyze the design of the Formula SAE roll cage both analytical and by numerical methods. This analysis is based on the dynamic loads experienced by the roll cage under normal driving conditions, along with the torsional stiffness of the roll cage. A roll cage which is torsionally stiff enables a desirable roll moment distribution to be achieved for good handling balance. A roll cage which can absorb high energy impacts whilst controlling the rate of deceleration will increase the likelihood of drivers surviving a crash without injury. This work describes how a common model of the roll cage is developed using catia v5 and Hyper Mesh to allow both linear and non-linear Finite Element Analysis to be performed by LS-DYNA software. The results from this analytical calculations will be used in future designs of Formula SAE roll cage, with the recommendations made that the future design incorporate stressed mild steel and carbon-fiber skins on a tubular space frame. This is in preparation for a future semi-monocoque design. Improvements for the testing procedures include a need for a lighter and more accurate car swing setup, along with a more rigid torsional test.

Nagurbabu Noorbhasha [3] Baja SAE is an intercollegiate competition to design, fabricate, and race a small, single passenger, off-road vehicle. The objective of the present research was to optimize the design of roll cage in compliance with the guidelines set by SAE and to perform the finite element analysis (FEA) for validating the design. Initially, a preliminary design of the rollcage was produced based on the rules of the competition and a 3-D model was generated using CAD. To study the effects of stress and deformation on the frame members, linear static frontal impact analysis was carried out using FEA techniques for different loading conditions on the roll cage model

Pruthviraj Vitthal Wable [4] This paper involves in detail description of overall design considerations, static and dynamic analysis of FSAE roll cage. Formula SAE (FSAE) competitions offers a challenging environment where an engineering student can practice and develop various engineering skills. This increases the practical and

application oriented approach towards a real engineering. This paper deals with the overall of design procedure of roll cage of FSAE vehicle from start to end, as well as Finite Elemental Analysis (static & dynamic) of it. 3D CAD model of roll cage is made using CREO 2.0 software and FEA analysis is done using ANSYS 17.0.

Denish S. Mevawala¹, Mahesh P. Sharma², Devendra A. Patel³, Darshan A. Kapadia [5] An all-terrain vehicle (ATV), also known as a quad, quad bike, three-wheeler, or four-wheeler, is defined by the American National Standards Institute (ANSI) as a vehicle that travels on low pressure tires, with a seat that is straddled by the operator, along with handlebars for steering control. A roll cage is a skeleton of an ATV. The roll cage not only forms the structural base but also a 3-D shell surrounding the occupant which protects the occupant in case of impact and roll over incidents. The roll cage also adds to the aesthetics of a vehicle. So determining strength requirements of roll cage, stress analysis is carried out using FEA software Ansys workbench. This paper deals with design of roll cage for an ATV and Various loading tests like Front Impact, Side Impact and rear impact have been conducted. The modeling and stress analysis is done by ANSYS software. We have focused on every point of roll cage to improve the performance of vehicle without failure of roll cage.

Bharat Kumar Sati, Prashi Upreti, Anirudh Tripathi & Shankar Batra [6] A roll cage is a skeleton of an All-Terrain Vehicle (ATV). The roll cage forms a structural base and a 3-D shell around the driver. The objective of the study is to analyze and optimize the roll cage designed under a set of particular rules given by Society of Automotive Engineers (SAE). This paper outlines static and dynamic analysis of the roll cage of ATV. Static analysis of the roll cage is done using ANSYS Static Structural for different collisions like front, side, rear and roll over. Dynamic analysis of different crash conditions like head-on, front, side, rear and roll over of the roll cage is done using ANSYS Explicit Dynamic. The main objective of analysis is to obtain optimum factor of safety which ensures that the roll cage of ATV will be safe in all conditions.

IV. PROBLEM FORMULATION

This project is limited to design and analysis of roll cage structure by using FEA. The project will involve the generation of CAD models of structure, performing FEA analysis, modifying the design if needed. With this project will be benefited with optimized design; Thus by performing finite element efficient and durable structure dimension can be obtained.

V. RESEARCH METHODOLOGY

To design and analyze a roll cage structure for Supra SAE, using CAD and FEA Techniques. This analysis report is mandatory for competition. The project involves the detailed study and getting the information from the sources available about roll cage structure. On the basis of data accumulated CAD model and Finite Element Analyses will be performed. According to the results obtained, results will be discussed and design will be finalized.

VI. CONCLUSION

This project involves the design and analysis of structure of roll cage for SUPRA SAE to meet the regulations of SAE in this article we focused on the literature based on roll cage. Design and Analysis of roll cage will be the part of our next article so this work will be a complete advantage to the fabrication of structure for Supra SAE.

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