IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 12, Issue 1, January 2024

DOI: 10.17148/IJIREEICE.2024.12111

DESIGN AND FABRICATION OF ROLL-CAGE LITERATURE REVIEW

Swaroop G[1], Shreyas Tandel[2], Sharun Mohan P[3], K V Abhishek[4]

Department of Mechanical Engineering, Mangalore Institute of Technology & Engineering, Karnataka, India[1-4]

Abstract: This project meticulously designs and optimizes an All-Terrain Vehicle (ATV) roll cage, conforming rigorously to SAE regulations. Using tools like SolidWorks, Lotus Suspension Analyzer, and ANSYS, the study emphasizes safety, manufacturing feasibility, and structural robustness. The roll cage serves as a critical protective shell for the driver while supporting essential vehicle systems. Ensuring compliance with SAE standards, the design prioritizes safety measures, efficient manufacturing, and structural integrity. The meticulous analysis and optimization phases utilize SolidWorks for comprehensive vehicle creation, Lotus Suspension Analyzer for steering and suspension geometry iterations, and ANSYS for component analysis and optimization.

I. INTRODUCTION

The Society of Automotive Engineers (SAE) sponsors design contests to expose students to the fundamentals of mobility engineering. This study presents the design and analysis of a roll cage for an all-terrain vehicle, developed to meet the functional goals and regulations established by the SAE Baja. The objective of SAE BAJA competition is to simulate real world engineering design projects and their related challenges. A roll cage is a structural framework that provides protection to the occupants in the event of a rollover or other impact. It is typically made of metal tubing and is designed to maintain the structural integrity of the vehicle's cabin in the event of a crash. The roll cage is also an important mounting point for other components of the vehicle, including the suspension, powertrain, and electrical systems: The design factor contains safety, easy manufacturing, durability & maintenance of the frame and a compact, lightweight & ergonomic design.

II. MATERIAL SELECTION

Material Selection As per the constraints given in the rulebook, the roll cage material must have at least 0.18% carbon content. The following materials which are commercially available and are currently being used for the roll cage of an ATV are shortlisted. A comparative study of these shortlisted materials is done on the basis of strength, availability and cost.

III. MATERIAL PROPERTIES

	AISI 1018 steel	AISI 1026 steel	AISI 4130 alloy steel
Density (g/cc)	7.87	7.85	7.85
Poisson's ratio	0.29	0.27-0.30	0.27-0.30
YoungsModulus (GPa)	205	190-210	190-210
Carbon content (%)	0.14-0.2	0.22-0.28	0.28-0.33
Tensile strength Yield (MPa)	370	415	460

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 12, Issue 1, January 2024

DOI: 10.17148/IJIREEICE.2024.12111

IV. MATERIAL REQUIREMENTS

The materials used in the cage must meet certain requirements of geometry as set by SAE, and other limitations. As the frame is used in a racing vehicle, weight is a crucial factor and must be considered. The proper balance of fulfilling the design requirements and minimizing the weight is crucial to a successful design.

The rules define the cage to be made with materials equivalent to the following specification Steel members with at least equal bending stiffness and bending strength to 1018 steel having a circular cross section having a 25.4 mm (1 inch) OD and a wall thickness of 3 mm (0.120) A key factor of this statement is those only steel members are allowed for the frames construction. However the alloy of the steel is definable by the competitor as long as it meets the equivalency requirements. These values are required to be calculated about the axis that gives the lowest value. Calculating the strength and stiffness this way ensures that tubes with a non-circular cross-section will be equivalent even in a worstcase loading situation. The rules go on further to define bending strength and stiffness by: Bending stiffness is proportional to the EI product and bending strength is given by the value of SyI/c, (for 1018 steel the values are; Sy= 370Mpa (53.7ksi) E=205GPa (29,700 ksi).

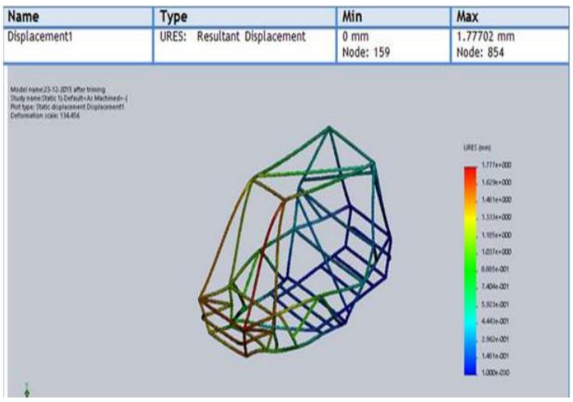
E = the modulus of elasticity
I = the second moment of area for the cross section about the (inch) axis giving the lowest value
$I = \pi(Do^4 – Di^4)/64$
Sy = the yield strength of material (psi)
c = the distance from the neutral axis to the extreme fiber

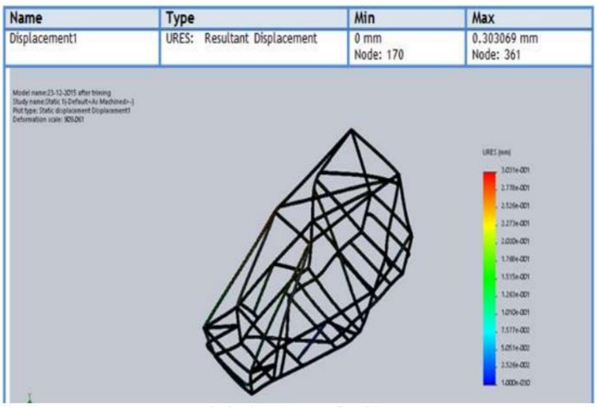
V. LITERATURE REVIEW

1. DESIGN AND ANALYSIS OF CHASSIS FOR SAE BAJA VEHICLE

Shiva Krishna J, Ambesh Shetye, Prabhudev Mallapur of Mechanical Engineering, Agnel Institute of Technology and Design, Assagao, Goa, India

This paper focuses on designing a resilient BAJA vehicle chassis for SAE's off-road competition. Utilizing AISI 4130 for its high yield strength and strength-to-weight ratio, the circular cross-section enhances torsional rigidity and force distribution. The chassis, model in SOLIDWORKS, undergoes rigorous stress analysis in ANSYS Workbench. Results confirm compliance with BAJA SAE India 2017 standards, ensuring the chassis safety and structural integrity in diverse impact scenarios. The chosen materials and design elements collectively contribute to a robust chassis, safeguarding both occupants and vehicle components during the demanding challenges of off-road racing. In conclusion, Chassis conforms to BAJA SAE India 2017 standards, crafted with robust AISI 4130 material. Circular cross-section chosen for superior strength and even force distribution. Validated safety via SOLIDWORKS design and ANSYS analysis ensures impact resilience, securing driver and components.





2. DESIGN, ANALYSIS AND OPTIMIZATION OF A BAJA-SAE FRAME

Yogesh Chandra Manipal Institute of Technology, Department of Mechanical and Manufacturing Engineering, Manipal University, Udupi-576103, Karnataka, India

The report details the design, analysis, and fabrication of a multi-tubular space frame roll cage for a vehicle, prioritizing structural safety and driver comfort. Utilizing software like Solidworks, CATIA, ANSYS, the design underwent

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

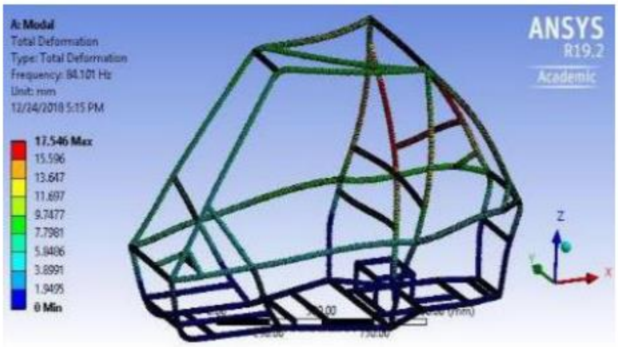
Impact Factor 8.021 ⸎ Peer-reviewed & Refereed journal ⸎ Vol. 12, Issue 1, January 2024

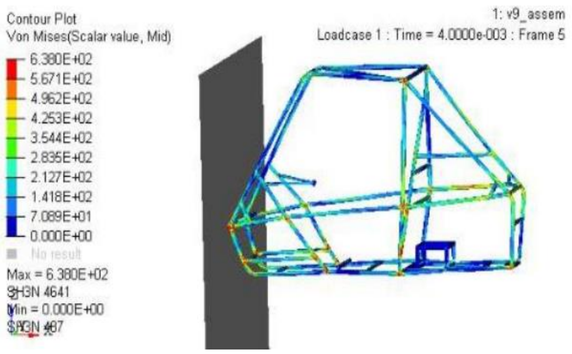
DOI: 10.17148/IJIREEICE.2024.12111

optimization based on 3D CAD modeling and FEA. After rigorous testing, the finalized chassis proved stiffer and stronger than the initial design, meeting safety criteria in front impact, side impact, and roll-over scenarios. Deformation in critical areas was within acceptable limits, ensuring driver safety. Modal analysis, though conducted without damping components, indicated a robust structure, with potential for further improvement with added elements.

Conclusion

- "The optimized chassis design is notably more robust and rigid than the initial model, achieved by adjusting pipe dimensions strategically."
- "Ensuring driver safety, the front and side impact analyses confirmed deformations below 10%, with safety factors of 1.47 and 1.37, respectively."
- "In front roll-over scenarios, the 1.37mm deformation prioritizes safety over maximum stress concerns for the driver."
- "The modal analysis conducted excluded damping components, hinting at potentially lower frequencies upon their inclusion.



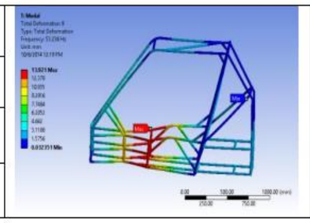


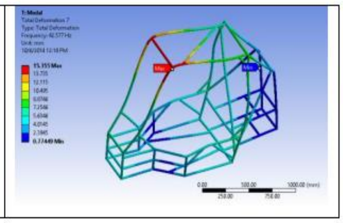
3. DESIGN AND DEVELOPMENT FOR ROLL CAGE OF ALL-TERRAIN VEHICLE

Deepak Rains, Rahul Dev Gupta, Rakesh Kumar Phanden Department of Mechanical Engineering, M. M. University, Mullana (Ambala). INDIA

BAJA is a collegiate competition sponsored by the Society of Automotive Engineers. India (SAEINDIA00). Its aim is to build an All-Terrain Vehicle (ATV) as per the constraints given by the organizers. The growing popularity of the competition coupled with the need to design and dynamically balanced ATV has led to the origin of the idea of this paper. The process of Finite Element Analysis (FEA) is expensive and time consuming as well as simulating the problem statement is unnecessarily tedious at an initial design stage. Therefore, it is always advantageous to do extensive research on the basic requirements of roll cage design. To understand the changes that need to be incorporated in the design, perform the static stress analysis first. This will offer a simplistic simulation criterion of the problem statement and requires a lower computational time; and then dynamic analysis to validate the safety of the preliminary design. The paper aims to give an introduction to the material selection procedure, pipe size selection and various tests that need to be done before finalizing the design, using ANSYS WORKBENCH 14.0. In this present work, various factors such as impact force determination, loading points, the mesh size dependence of generated stress, Von-Misses Stress, Deformation and Factor of Safety (FOS) are studied. In conclusion, Ensuring safety for the driver, crew, and environment remains paramount in all aspects. The roll cage design employs a significant Factor of Safety (FOS) to minimize failure risks and potential injuries, signifying safe load capacities and deformations. This underscores the vehicle's resilience in extreme conditions. Finite element analysis proved crucial in designing and assessing the All Terrain Vehicle frame, despite the complexities of conducting numerous tests within constraints. The chassis was purposefully crafted to endure diverse loads and navigate challenging terrains such as hills and rocky landscapes. This study comprehensively addressed various load analyses concerning the Roll Cage, leading to the selection of the most secure and dependable design for prolonged journeys across varied terrains.

Mode No.	Frequency (Hz)
7	42.577
8	45.203
9	53.236





4. SIMULATION OF AN OFF-ROAD VEHICLE ROLL CAGE A STATIC ANALYSIS

Vikas Sharma Divyanshu Purohit, RustamJi Institute of Technology, Tekanpur

The report emphasizes the significance of simulating and predicting failure modes of the rollcage in an off-road vehicle for SAEINDIA's BAJA competition. The objective is to develop a rugged and economical vehicle frame meeting SAE BAJA design requirements while ensuring driver safety and comfort. Static analysis, specifically frontal collision simulation, was conducted, applying loads and constraints to assess deformation and von-Mises stress on different rollcage members. Results indicated stress concentrations within acceptable limits.

In conclusion, the project demonstrated a sound understanding of vital design components, considering the material's yield strength (294.8 MPa). The maximum stress during a frontal impact on the rollcage (191.299 MPa) fell well within safety limits, yielding a factor of safety of 1.54. Prioritizing safety for the driver, crew, and environment, a considerable factor of safety was applied to minimize the risk of failure and potential injuries, ensuring the rollcage resilience to applied loads and deformations.

5. DESIGN IN MARKETIZATION – THE INVENTION OF CAR SAFETY AUTOMOBILE MARKETS

Karl palmas, Division of Science, Technology and Society, Chalmers University of Technology, Sweden

The paper provides a comprehensive exploration of the intricate relationship between design, economics, and innovation, focusing on the concept of value. It navigates the distinctions between economic and social values while highlighting design's pivotal role in corporate strategy and its assessment within contemporary economics. Notably, it critically examines John Heskett's work, challenging conventional economic perspectives and emphasizing design's integral contribution in translating technological opportunities into innovative realities. Through a blend of design studies and economic sociology, the paper illuminates broader implications, extending beyond product development to encompass socio-economic, political, and cultural dimensions. It acts as a catalyst for continued research, urging scholars to delve deeper into design's societal impact and explore further avenues in this interdisciplinary field.

The conclusion underscores the relevance of externalities as a pivotal area for examining the interconnection of design, economics, and innovation. It emphasizes why design scholars should engage with this economic phenomenon rather than leaving it solely to economic sociology or Science and Technology Studies. The discussion advocates diverse approaches, highlighting design's role in envisioning future possibilities and navigating diverging trajectories. It promotes collaborative research between design scholars and those in economic sociology or STS, exemplified by the emerging DARN field. Urging a shift from historical to contemporary contexts, it emphasizes studying reframing processes in today's economies, involving non-governmental organizations in market dynamics and underscoring the evolving nature of design's impact on markets.

6. HEAD AND NECK DYNAMICS IN AN AUTOMOBILE ROLLOVER

Narayan Yoganandan, Ph.D., Abdullah Almusallam, Ph.D., and Anthony Sances, Jr., Ph.D. Department of Neurosurgery, Medical College of Wisconsin, Marquette University, and Veterans Administration Medical Center, Milwaukee, Wl 53226, USA

The study aimed to investigate how roof deformation and head clearance impact the forces experienced by restrained occupants during a vehicle rollover. Utilizing a modified Total Articulated Body 3D model, simulations were conducted to represent the occupant, vehicle components, and ground. Results indicated that increased roof crush amplified forces on the head-neck region, while greater head clearance amid roof deformation decreased these forces. Minimal forces were observed without roof crush. The study suggests a critical threshold, balancing roof crush, head clearance, and roll velocity, limiting forces transmitted to the occupant. Beyond this point, increased forces pose higher injury risks for restrained occupants during rollovers.

In conclusion, Article says that about analysed how different roof deformations and head clearances affect occupant safety during vehicle rollovers. Increasing roof crush pushed occupants into the seat, resulting in higher head forces and accelerations. Limited head clearance intensified forces on the head and neck, especially with significant roof crush. Minimal forces occurred without roof crush. During roof deformation, occupants experienced the highest forces on the head-neck region, even though subsequent contacts occurred. This suggests that roof crush and head clearance significantly impact head-neck forces during rollovers, highlighting their crucial role in occupant safety.

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⁘ Peer-reviewed & Refereed journal ⁘ Vol. 12, Issue 1, January 2024

DOI: 10.17148/IJIREEICE.2024.12111

7. DESIGN, ANALYSIS AND OPTIMIZATION OF A MULTI-TUBULAR SPACE FRAME

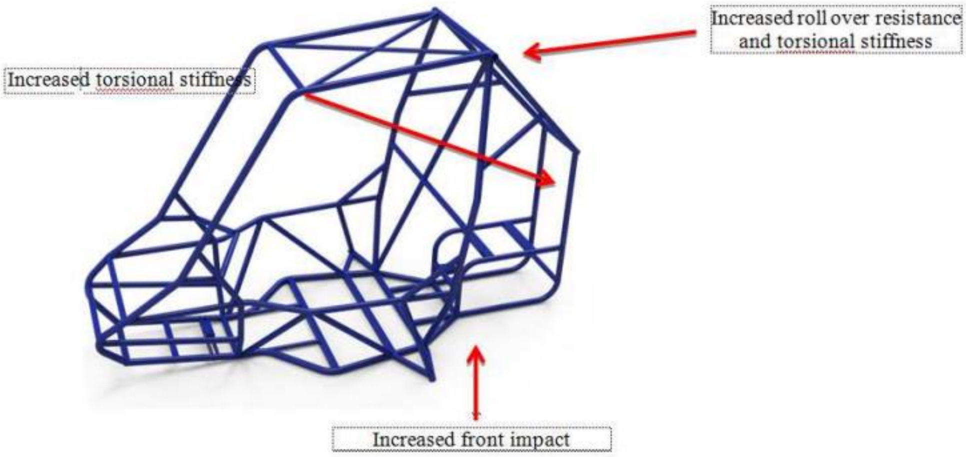
Suraj Aru, Pravin Jadhav, Vinay Jadhav, Akool Kumar, University of Florida

Multi tubular space frames, often referred to as roll-cage act as a structural embody for various types of automotive vehicles. A space frame serves a dual function of giving structural safety to: the vehicle and at the same time incorporates the different subsystems like suspension, steering. transmission on to it. This makes the space frame a very vital and most cautious designed component, especially in case of vehicles like race cars and All-Terrain Vehicles In order to ensure maximum safety along due consideration to the weight aspect, the roll-cage of an All-Terrain Vehicle is designed. To fulfil these criteria, it is important to consider various parameters involved in the design of a roll-cage, right from the material to be used up to the forces and impacts that it might encounter. Through this study, we aimed to design, analyse and optimize a roll-cage so as achieve the target of age strength to weight ratio.With the help of MATLAB, CAD modelling software's and ANSYS workbench, the model was designed and optimized to serve the desired purpose. Material was selected her conducting an extensive market survey and on the basis of weighted point method. This sequential approach adopted for the roll-cage design of BAJA vehicle and proved to be effective.

Conclusion

After performing the Front impact, side impact, and roll over and torsion analyses and making the necessary changes, the following design was finalized.

- The above designed chassis is much stiffer and stronger than the preliminary design. The chassis members were optimized by changing dimensions of the pipes in required positions.
- In the case of front impact and side impact analysis, the deformation of the front most member of the roll cage must be less than 10% of the clearance between driver roll cage members ensuring the safety of the driver. Though the factor of safety in front impact is 1.116 and in side impact is 1.446, deformation is within limit, ensuring that the driver is safe.
- For front roll over, the deformation is important than the maximum stress. The deformation is 4.6033mm and it is safe for the driver.



Final Optimised Space Frame

• Usually side roll over analysis is not so significant in case of commercial vehicles, since if the vehicle topples while cornering; it will be because of the faulty suspension design. But in case of an ATV, there are chances that the vehicle will topple while encountering a treacherous terrain.

• The modal analysis was carried out without any consideration of damping components such as vibration isolators, Panels, etc. If they are included, the frequency will be even much lower.

8. DESIGN AND OPTIMISATION OF SAE MINI BAJA CHASSIS

P. Anjani Devi, A. Dilip Department of Mechanical Engineering, Chaitanya Bharati Institute of technology, Hyderabad-75

The objective was to design a lightweight yet structurally sound roll cage for an All-Terrain Vehicle, adhering to the SAE Baja 2014 rulebook. Pro-engineer was used to create a software model, and ANSYS 13 facilitated simulations and stress analysis. Material selection was based on strength and availability, with modifications made to the design based on test

IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

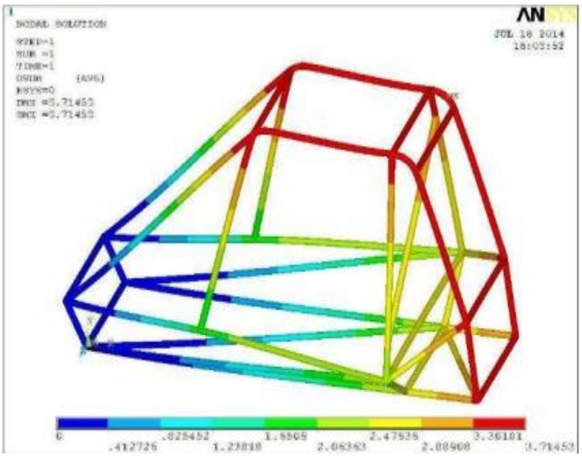
Impact Factor 8.021 ⨳ Peer-reviewed & Refereed journal ⨳ Vol. 12, Issue 1, January 2024

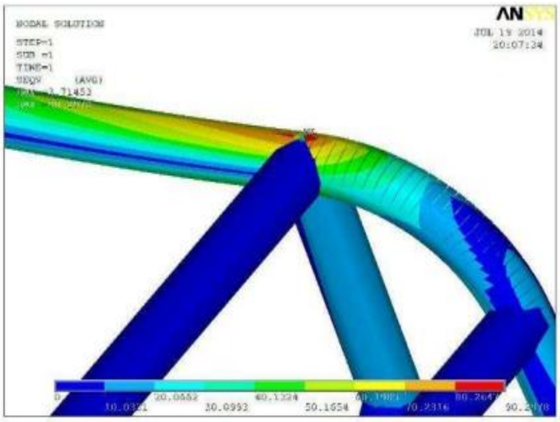
DOI: 10.17148/IJIREEICE.2024.12111

results. Finite element analysis proved crucial in identifying key structural components for impact resistance. Despite challenges in addressing rollover stresses within set constraints, the analysis accurately predicted failure points. The target Yield Factor of Safety was set at 2.

Conclusion

The usage of finite element analysis was invaluable to the design and analysis of the frame. The analysis allowed the addition of important and key structural components to help the vehicle with stand front, side impacts as well as the rear impacts. While a viable solution to the stresses seen in a rollover type impact could not be found due to the set design constraints, the finite element analysis gave a very accurate prediction of where failure would occur in this situation.





9. OPTIMIZATION AND IMPACT ANALYSIS OF A ROLL CAGE MODEL

Panthapilli Karishma, K.Vamssi Venugopal, I.R.K Rajut, Dept. of Mechanical Engineering, Chaitanya Engineering College, afflicted to JNTUK, Andhra Pradesh, India

This paper focuses on designing and analyzing a roll cage for automobiles, comparing steel, glass epoxy, and carbon epoxy materials. CATIA V5R20 is used for design, and ANSYS 16.0 for analysis. Von Mises stress diagrams indicate that all materials withstand roll-over impacts, with glass epoxy showing the highest factor of safety.

Weight comparison reveals glass epoxy is one-fourth the weight of steel, and carbon epoxy is one-fifth. Despite higher deformations in carbon epoxy, factors of safety for all materials exceed automobile standards. Glass epoxy is identified as the optimal choice, providing a lighter and safer alternative to steel.

Conclusion

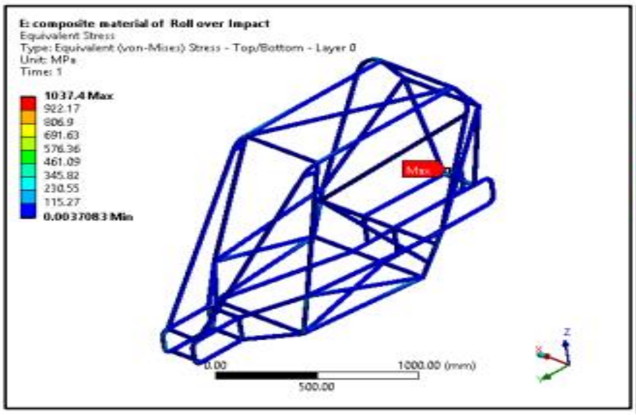
- The stress distribution in individual members under applied loads is shown by the von Mises stress diagram. The maximum von Mises stress occurs during roll-over impact analysis, well below the yield strength for Steel. Total displacements comply within Steel and Glass Epoxy limits, yet Carbon Epoxy displays greater deformations.
- Roll-over analysis highlights the highest stress and deformation among Steel, Glass Epoxy, and Carbon Epoxy. For design consideration, values of 584.18 MPa for Steel, 611.45 MPa for Glass Epoxy, and 1037.4 MPa for Carbon Epoxy are utilized. Factor of Safety stands at 1.27529 for Steel, 2.8620 for Glass Epoxy, and 2.120686 for Carbon Epoxy, ensuring safety against specified stresses, allowing higher stress tolerance in automobiles.
- The designed roll cage weights are as follows: Steel - 62.915 kg, Glass Epoxy - 16.818 kg, Carbon Epoxy - 12.013 kg. Glass Epoxy weighs a quarter of Steel, while Carbon Epoxy is one-fifth, achieving lightweight strength with composite materials. Post-material optimization, static conditions derived from finite element analysis highlight Glass Epoxy as the optimal choice, outperforming other materials. Von-Mises stress values remain below yield stress, ensuring safety.
- Glass Epoxy displays superior performance compared to industrial materials, with higher factors of safety.

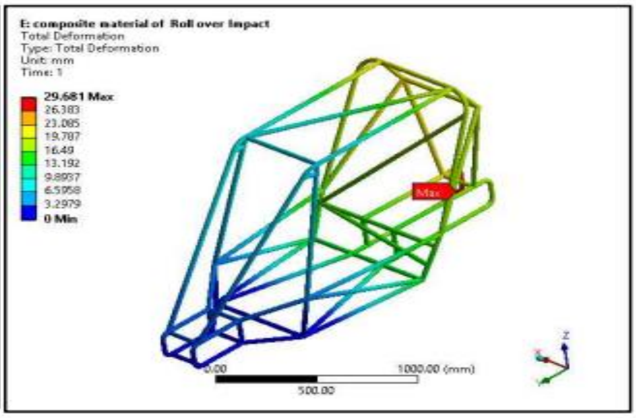
IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ※ Peer-reviewed & Refereed journal ※ Vol. 12, Issue 1, January 2024

DOI: 10.17148/IJIREEICE.2024.12111



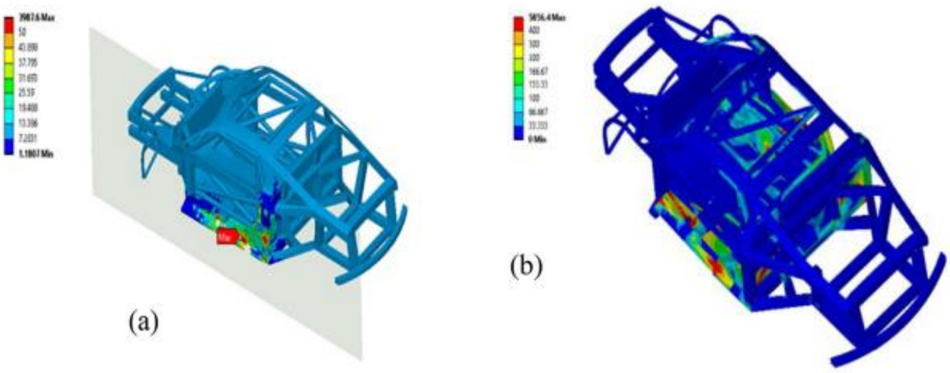


10. COMPARATIVE DESIGN AND ANALYSIS OF ROLL CAGE FOR AUTOMOBILES

T. SAFIUDDEEN, P. BALAJI, S. DINESH, B.MD. SHABEERHUSSAIN, M.R. GIRIDHARAN, Dhaanish Ahmed College Of Engineering, Chennai 601301, India

This paper conducts a comparative analysis of roll cages for performance automobiles, using finite element analysis (FEA) to virtually test a Body in White (BIW) part with a carbon fiber (ePA-CF) roll cage and ASTM A36 steel. Highlighting the challenges of practical crash tests, the study advocates for FEA's cost-effectiveness and timely benefits. Three crash test modes—Frontal Impact, Side Impact, and Roll Over—are discussed, emphasizing the importance of structural integrity certification from global organizations. The research aims to explore ePA-CF behavior in roll cage design and its suitability for future fabrication. Sections cover SolidWorks for 3D modeling, ePA-CF composite filament properties, and FEA principles. The results indicate that ePA-CF shows promise for roll cage fabrication, providing a lightweight and versatile alternative. The study underscores the significance of FEA in optimizing designs and highlights the potential benefits of using carbon fiber composites in the automotive industry, emphasizing their structural integrity. In conclusion, the research suggests ePA-CF as a viable material for roll cage construction, contributing to the ongoing evolution of automotive safety and design.

In Conclusion the effort to explore the capabilities of a roll cage designed to fit inside an automobile, the study was conducted on roll cages made of two different materials ASTM, A36 Steel and epoxy polyamide carbon fiber (ePA-CF). Initial design of the roll cage was developed using SOLID WORKS 2020 and then the analysis part was completed using ANSYS 19.2 with the respective parameters of both the materials separately. The results of the analysis reveals that the internal energy of the roll cage increases in the crash test due to the effect of the impact force on the roll cage material at the molecular level. Change in internal energy causes variation in the Maximum stress experienced by the roll cage. The Maximum stress developed plays a major role in determining the FOS of the roll cage material. The structural integrity of the roll cage is determined using the FOS. The fall of momentum in the graph indicates the loss of momentum from the vehicle to the object with which it collides. The impact force and FOS derived from the analysis results emphasizes that ePA-CF has better performance than ASTM, A36 Steel roll cage



IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.021 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 12, Issue 1, January 2024

DOI: 10.17148/IJIREEICE.2024.12111

VI. OVERALL CONCLUSION

- The chassis, meeting BAJA SAE India 2017 standards, is crafted with robust AISI 4130 material, featuring a circular cross-section for superior strength and even force distribution.
- Safety is validated through SOLIDWORKS design and ANSYS analysis, ensuring impact resilience and securing both driver and components.
- The roll cage design prioritizes safety with a significant Factor of Safety (FOS), minimizing failure risks and potential injuries in various load scenarios.
- Finite element analysis proves crucial in designing and assessing the ATV frame, demonstrating resilience to extreme conditions.
- Material yield strength and stress analyses confirm the chassis's capability to endure impacts while maintaining safety margins.
- The roll cage, analyzed for front, side, rear, and rollover scenarios, aims for an optimal factor of safety, adhering to Society of Automotive Engineers (SAE) guidelines.
- Rigorous analyses, including von Mises stress diagrams, provide insights into stress distribution and deformations under applied loads, guiding material choices for enhanced safety.
- The finalized chassis design, after front, side, and roll-over analyses, showcases improved stiffness and strength, ensuring driver safety with deformation limits within 10%.
- Finite element analysis proves invaluable in adding key structural components to withstand front, side, and rear impacts.
- Roll-over impact analysis reveals stress and deformation values for different materials, emphasizing safety factors and stress tolerance in automobiles.
- Comparative analysis between ASTM A36 Steel and ePA-CF materials for roll cage design concludes that ePA-CF performs better, emphasizing superior internal energy and FOS.

REFERENCES

[1]. Shiva Krishna J, Ambesh Shetye, Prabhudev, Design and Analysis of Chassis for Sae Baja Vehicle.
[2]. Yogesh Chandra, Design, Analysis and Optimization of a Baja-Sae Frame.
[3]. Deepak Rains, Rahul Dev Gupta, Rakesh Kumar Phanden, Design and Development for Roll Cage of All-Terrain Vehicle.
[4]. Vikas Sharma Divyanshu Purohit, Simulation Of an Off-Road Vehicle Roll Cage A Static Analysis.
[5]. Bharat Kumar Sati, Prash Upreti, Anirudh Tripathi & Shankar Batra, Static and Dynamic Analysis of the Roll Cage for an All-Terrain Vehicle.
[6]. Ashwin Jacob, Kurbaan, Rahmat Ulla, L. Jino, Manoj, A. Jayaganthan, Design and Analysis of SAE Baja Electric Vehicle Monocoque Chassis.
[7]. Suraj Aru, Pravin Jadhav, Vinay Jadhav, Akool Kumar, Design, Analysis and Optimization of a Multi-Tubular Space Frame.
[8]. P. Anjani Devi, A. Dilip, Design and Optimisation of Sae Mini Baja Chassis.
[9]. Panthapilli Karishma, K.Vamssi Venugopal, I.R.K Rajut, Optimization And Impact Analysis Of A Roll Cage Model.
[10]. T. Safiuddeen, P. Balaji, S. Dinesh, B.Md. Shabeerhussain, M.R. Giridharan, Comparative Design and Analysis of Roll Cage for Automobiles.
[11]. Chris Bennett, Eric Lockwood, Anthony McClinton, Robin McRee and Colin Pemberton "SAE Mini Baja Frame Analysis".
[12]. MohdHanif Mat*, Amir Radzi Ab. Ghani "Design and Analysis of 'Eco' Car Chassis",International Symposium on Robotics and Intelligent Sensors 2012 (IRIS 2012)