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DESIGN AND STRUCTURAL ANALYSIS TO ANHANCE PROFROMANCE OF COMPACT VECHCLE

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Abstract:
This report delves into the intricate process of designing, analyzing, and calculating the performance metrics of a racing vehicle, aiming to push the boundaries of conventional design paradigms. Through a systematic methodology, various aspects of racing vehicle engineering are explored, including chassis design, power train configuration, and aerodynamic considerations. Utilizing advanced simulation tools and mathematical models, this study offers insights into optimizing performance, enhancing safety, and achieving superior handling characteristics. By integrating theoretical frameworks with practical experimentation, the report provides a holistic understanding of the complexities involved in racing vehicle design, catering to both novice enthusiasts and seasoned engineers alike. The findings presented herein serve as a foundation for future advancements in racing vehicle technology, promising a thrilling evolution in recreational motorsport
Keywords: Small-scale racing vehicles, go-karts, transmission systems, braking systems, performance optimization, safety enhancement, reliability.

INTRODUCTION

Background of small compact Vehicles:

Small compact vehicles, commonly referred to as compact cars or subcompact cars, are automobiles designed to be smaller in size compared to midsize or full-size cars. They typically offer better fuel efficiency and maneuverability, making them popular choices for urban driving and commuting. Here's a brief overview of the background and characteristics of small compact vehicles:

Introduction to Small Compact Vehicle :

Small compact vehicles, also known as compact cars or subcompact cars, represent a vital segment in the automotive industry, celebrated for their smaller size, efficiency, and practicality. Engineered to cater to urban environments, daily commutes, and budget-conscious consumers, these vehicles boast advanced safety features, surprisingly spacious interiors, and a plethora of customization options. Furthermore, with the advent of hybrid and electric variants, compact cars offer environmentally friendly alternatives. Enhanced connectivity and infotainment systems ensure a seamless driving experience, while a diverse range of models from various manufacturers reflects the global demand for compact yet versatile transportation solutions. Compact cars continue to hold their ground as reliable, economical, and sustainable choices in the automotive landscape, meeting the needs of modern drivers worldwide.

Size and Dimensions: Compact cars are smaller in size compared to midsize or full-size vehicles. They typically have shorter overall lengths, narrower widths, and lower heights, making them easier to maneuver in tight spaces and navigate through crowded city streets. The compact size also contributes to easier parking in urban environments where space is limited.

Fuel Efficiency: One of the key advantages of compact cars is their fuel efficiency. They are often equipped with smaller, more fuel-efficient engines that consume less fuel per mile compared to larger vehicles. This makes compact cars an attractive option for drivers looking to save money on fuel costs and reduce their environmental impact.

Affordability: Compact cars are generally more affordable than larger vehicles, both in terms of upfront purchase price and ongoing operating costs. Their smaller size and simpler design often result in lower manufacturing and maintenance costs, making them accessible to a wide range of consumers, including students, young professionals, and budget-conscious families.

Urban Mobility: Compact cars are well-suited for urban driving due to their small size and nimble handling. They can easily navigate through congested city streets, fit into tight parking spaces, and maneuvers through traffic with ease. This makes them popular choices for city dwellers and commuters who need a practical and efficient mode of transportation for daily use.

Features and Technology: Despite their smaller size, modern compact cars often come equipped with a range of advanced features and technology options. This may include touch screen infotainment systems, Smartphone connectivity, advanced safety features such as lane departure warning and automatic emergency braking, and efficient engine options, including hybrid and electric power trains.

Variety of Models: There is a wide variety of compact cars available from various manufacturers, offering consumers plenty of options to choose from based on their preferences and needs. Whether it's a practical hatchback, a sporty sedan, or a versatile crossover, there is a compact car model to suit every lifestyle and taste.

Environmental Considerations: With growing concerns about environmental sustainability and climate change, compact cars are becoming increasingly popular as eco-friendly transportation options. Their smaller size and more efficient engines result in lower greenhouse gas emissions and reduced fuel consumption compared to larger vehicles, making them a greener choice for environmentally conscious drivers.

Importance Of Design:

Design plays important in a vehicle making. The designing is the imagination of person, ensure the performance and safety. Designing impacts the speed, handling and driving experience. Chassis is the main part of the vehicles. The stability of chassis depending upon the material is selected for the chassis. In design of chassis the shape and weight matters.

Dimensions:

Length	**72.25", 182.88 cm**
Height	37.71", 95.78cm
Weight of chassis	24 kg
Wheel base	53.2 in", 1346.2cm
Track width– front	42.91", 81.28 cm

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Track width – rear	32 in”, 117.29cm
Total mass	18 kg
Ground clearance	1.4”, 3.30 cm

Design considerations are as follows:

- Ensuring safety of passengers in impact from different directions.
- Comfortable maneuvering: low Center of gravity, small turning radius, and smooth steering.
- Providing effortless and efficient transmission to simplify and optimize driving.
- Swift kart with considerable acceleration, braking and targeted velocity of 90 kmph.
- Economical design that can be modified for mass production for commercial purpose.

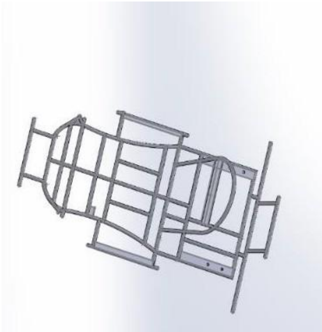


Fig 1.1 Bumpers along chassis

For the safety of the chassis we have add bumpers to protect the chassis for the heavy damage while collision with the other vehicles or wall or other hadal in the way.

Role of Analysis:

The analysis performance plays a crucial role in various aspects of karting, including design, development, optimization, and racing strategy. Through systematic analysis, engineers and drivers can gain valuable insights, allowing them to make informed decisions aimed at improving performance and achieving competitive success. The analysis consists of a various impact test that shows the capability of the chassis.

Impact Test:

The first major subcomponent is chassis which has been tested in impact tests in Ansys in all three ways, be it a front-impact test, side-impact test, and rear impact test

Front Impact Test:

A front impact test assesses a vehicle's crashworthiness by simulating a frontal collision. The test typically involves crashing a vehicle into a solid barrier or another vehicle at a predetermined speed. Sensors measure the forces exerted on crash test dummies inside the vehicle to evaluate potential injuries. Results help determine a vehicle's safety rating and inform design improvements aimed at enhancing occupant protection in real-world crashes.

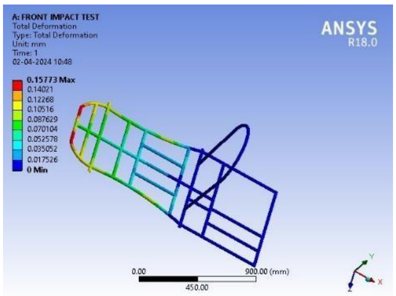


Figure 1.2: Front Impact test of chassis in Ansys work Bench

4.22 Rear Impact Test:

A rear impact test evaluates a vehicle's ability to protect occupants in a rear-end collision scenario. During the test, a vehicle is struck from behind by another vehicle or a test device at a predetermined speed. Crash test dummies are placed inside to measure forces exerted on occupants and assess potential injuries, particularly to the neck and spine.

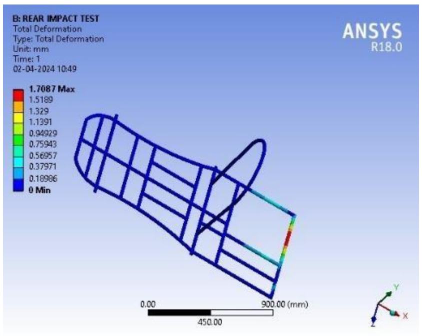


Figure 1.3: Rear Impact Test of chassis in Ansys workbench

4.23 Side Impact Test:

In a side impact test, a vehicle's ability to protect occupants in a lateral collision is evaluated. The test typically involves a movable barrier or another vehicle striking the test vehicle perpendicular to its side at a predetermined speed. Crash test dummies positioned inside measure forces and potential injuries, focusing on the head, chest, and pelvis regions.

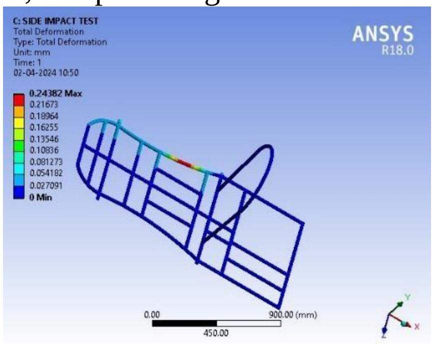


Figure 1.4: Side impact test of chassis in Ansys workbench

4.24 Rollover Impact Test:

In conducting a rollover impact test, the initial step involves either importing an existing vehicle geometry or creating one within the simulation environment. Rollover is also known as the firewall. The main role or prepose of the firewall is to protect the driver for the heat which is produced by the engine.

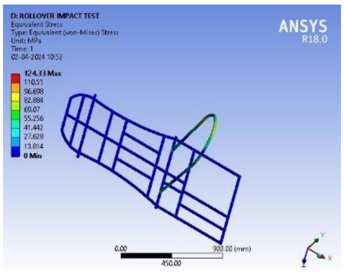


Figure 1.5: Rollover impact test if chassis in Ansys workbench

4.25 TORSION TEST:

It seems like you're referring to a "torsion test" of a chassis. A torsion test evaluates the torsional stiffness or resistance to twisting of a structure, such as an automotive chassis.

- Setup
- Loading
- Measurement
- Data Analysis
- Comparison
- Adjustments and Optimization

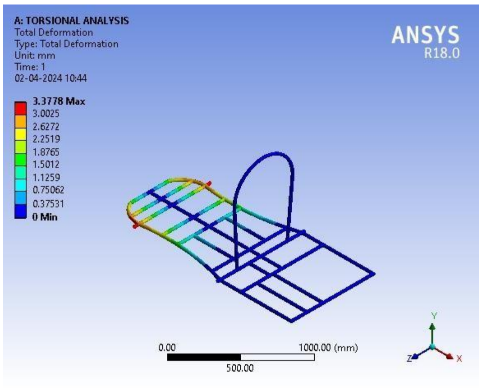


Figure 1.6: Torsion Test

4.26 BENDING IMPACT:

Analyzing and testing the bending impact of chassis is crucial in ensuring the structural integrity and safety of automotive vehicles.

Structural Analysis:

- Finite Element Analysis (FEA): Engineers use FEA software to simulate the bending impact on the chassis structure. They model the chassis geometry, material properties, and loading conditions to predict stress distribution, deformation, and potential failure points during bending impacts.
- Stress Analysis: Stress analysis techniques are employed to evaluate the maximum stresses induced in the chassis components under bending loads. This helps identify areas prone to failure and guides reinforcement or redesign efforts.

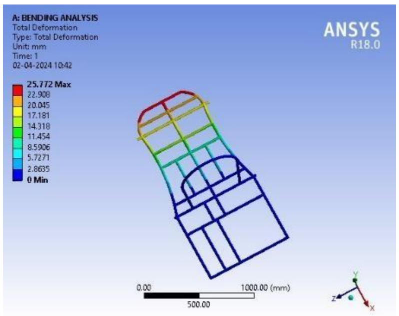


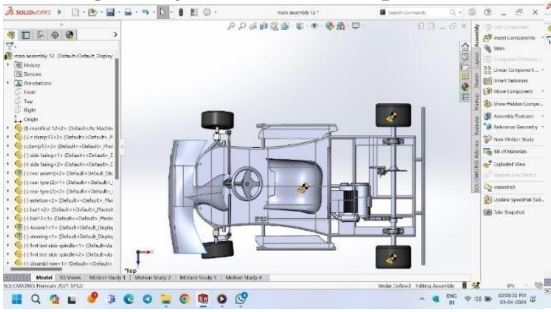
Figure 1.7: Bending Test

Methodology:

Once the prototypes are developed, rigorous testing is conducted in controlled environments to evaluate their performance. This includes dynamometer testing for transmission performance and braking tests for stopping power, fade resistance, and heat dissipation. Through iterative testing and optimization, the performance of transmission and braking systems is fine-tuned, adjusting parameters such as gear ratios, friction materials, hydraulic pressures, and electronic control algorithms. Data acquisition systems and onboard sensors are utilized to gather real-time performance data during testing and racing simulations, enabling data-driven decision-making for further improvements.

Assembly:

The assembly is component that is mixer of various material. In the assembly process of a go-kart, meticulous attention to detail and adherence to safety standards are paramount. It begins with the preparation of components, where all necessary parts are gathered and inspected for quality assurance. The chassis assembly follows, where the frame is meticulously put together, ensuring proper alignment and fitment of structural elements. Engine installation is the next step, with careful mounting onto the chassis and connection to essential systems like fuel and exhaust. Drivetrain assembly comes next, ensuring smooth operation by installing components like the clutch, chain, and sprockets with precision. Electrical and control components are then integrated, followed by the installation of wheels and tires to optimize traction and handling. Final checks and adjustments conclude the process, with comprehensive inspections and test runs to verify safety and performance. By following this systematic approach, builders can ensure that the go-kart is assembled correctly, meeting safety standards and performance expectations for an exhilarating racing experience.



1.8: top view

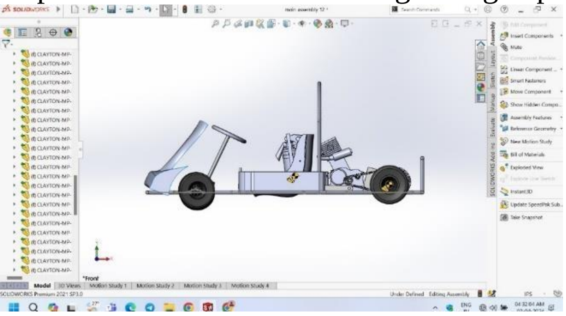


Fig 1.9: side view

CONCLUSION:

In conclusion, the symbiotic relationship between design, analysis, and manufacturing is paramount in achieving successful product development. Throughout this discussion, we have explored how these three components interact and complement each other to bring innovative products to fruition. Design serves as the creative genesis, laying the groundwork for product form, functionality, and user experience. Analysis acts as the critical evaluator, validating design decisions, predicting performance outcomes, and optimizing product characteristics. Manufacturing serves as the practical executor, translating design concepts into tangible products through efficient and cost-effective production processes. The integration of design, analysis, and manufacturing is not merely a sequential process but a dynamic and iterative cycle. Effective collaboration and communication between these disciplines are essential for driving innovation, optimizing performance, and ensuring product success.

FUTURE SCOPE:

The future scope of design and structural analysis for compact vehicles is poised for remarkable advancements, driven by a convergence of technological innovations and evolving consumer demands. As urbanization continues to intensify, the need for compact vehicles that offer efficient mobility solutions within congested city environments becomes increasingly pronounced. With the integration of lightweight materials such as carbon Fiber composites and advanced alloys, designers can achieve a delicate balance between structural integrity and weight reduction, thereby maximizing energy efficiency without compromising safety. Compact vehicles of the future may feature adaptable interiors that can transform to accommodate varying passenger configurations or even serve as mobile workspaces. Human-cantered design principles will play a pivotal role in creating comfortable and intuitive user experiences within these compact yet versatile vehicles. Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) simulations allow for the optimization of vehicle architectures, ensuring robust crashworthiness while minimizing weight and material usage. Additionally, real-time structural health monitoring systems may be integrated into compact vehicles to continuously assess their condition and detect any potential structural vulnerabilities, thereby enhancing overall safety and reliability.

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