Prototype Design and Research Collection

Series 1

Universiti Teknologi MARA
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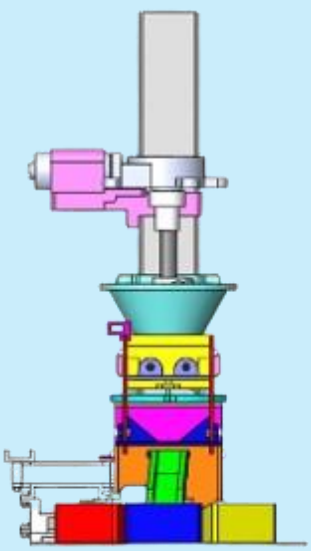

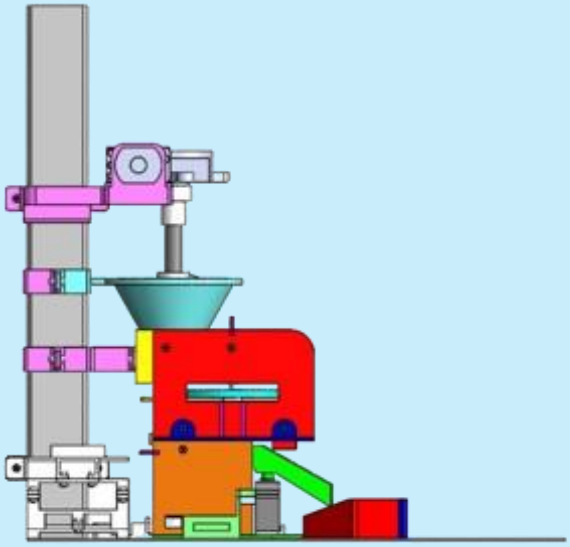

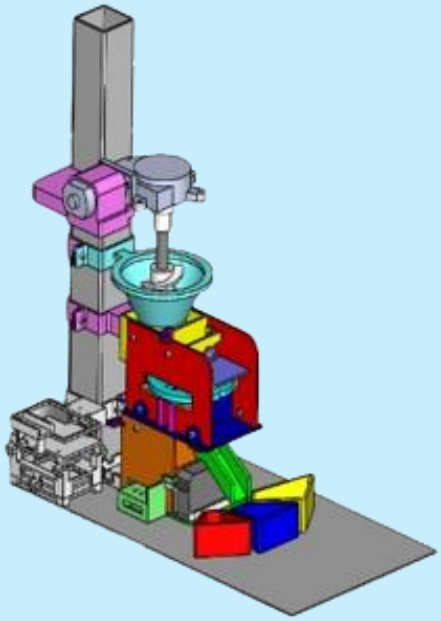

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FOREWORD

This digital book on Prototype Design and Research Collection Series 1 (PDRC Series 1), is designed as a comprehensive reference for mechanical engineering students. The designs featured in this collection undergo an extensive analysis process, incorporating both prototype development and research to ensure a thorough understanding of design principles. Each project is carefully analysed before the prototype fabrication with detailed summaries of the project description and design parameters. The design and research products presented in this series cover a wide range of tools and equipment for various applications including household, workshop and entrepreneurial purposes.

This collection aims to foster innovation by offering students valuable insights into both the technical and research aspects of product design. It is hoped that this book will inspire future engineers and designers to approach product development with a deeper understanding of the design and research processes.

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CHAPTER 14

Design and Fabricate Back Suspension System for Go-Kart

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ABSTRACT

The design and development of a go-kart rear suspension system play a crucial role in enhancing stability, traction, and ride comfort. This project aimed to create a functional and durable suspension system by integrating key components such as shock absorbers, coil springs, brackets, and a backframe. Three existing designs were benchmarked to evaluate their strengths and weaknesses, leading to an optimized system that could handle various terrains and driving conditions. The fabrication process involved material selection, cutting, sanding, drilling, welding, and assembly, ensuring structural integrity and precision. Shielded Metal Arc Welding (SMAW) was initially used but later replaced with Tungsten Inert Gas (TIG) welding for better material compatibility. Rigorous testing confirmed that the suspension system provided improved handling, reduced vibrations, and enhanced ride quality. The results demonstrated that the developed suspension system met performance, durability, and safety standards. The final prototype ensured smooth driving dynamics, better weight distribution, and optimal shock absorption. This study provides valuable insights for further adjustability, maintenance, and customization improvements to enhance go-kart performance. The successful implementation of this project highlights the practicality and effectiveness of a well-designed rear suspension system in go-kart engineering.

Keywords: Design, Fabrication, Back suspension system

1 INTRODUCTION

A go-kart's rear suspension system is a crucial component that absorbs shocks, maintains tyre contact with the ground, and enhances traction and stability during driving. It consists of mechanical parts such as springs, dampers, and sway bars, designed to evenly distribute weight, control body roll, and adjust handling characteristics. Standard configurations include live axles for simplicity, independent suspension for improved performance, and swing axles for high-performance applications. Ultimately, the rear suspension system plays a key role in ride quality, handling, and overall driving experience.

However, several challenges can affect a go-kart's rear suspension system, including traction loss, handling instability, bottoming out on bumps, component wear and failure, adjustment complexity, and cost. Poor suspension setup or alignment may result in traction issues, making control difficult, particularly on turns or uneven surfaces. Additionally, worn-out or poorly maintained components can cause discomfort and compromise safety. Simplifying adjustments and ensuring easy access to replacement parts can help users address these issues efficiently. Regular inspection and maintenance ensure optimal performance and

a smooth driving experience.

Modern go-kart rear suspension systems emphasize adjustability, durability, and ease of use. Manufacturers improve reliability and reduce maintenance needs by utilizing high-quality materials and innovative designs. Adjustable components allow users to customize settings for different tracks and driving preferences, while modular systems enable easy installation and upgrades. These advancements significantly enhance performance, comfort, and user satisfaction.

2 LITERATURE REVIEW

The evaluation and comparison of go-kart rear suspension systems were conducted based on the project title, identifying key design features for implementation. Instead of designing a suspension system from scratch, a commercially available suspension was acquired, requiring modifications to fit the go-kart design. This benchmarking and comparison study assessed three selected designs, Design 1, Design 2, and Design 3 which to determine their suitability for the final year project.

Design 1, invented by Rip Uphaus (US6749039B1), features a modular go-kart assembly with a central body, front and rear drive assemblies, and a protective cage, allowing easy construction and disassembly. The system includes a motor with multiple power take-off shafts, simplifying connections to the acceleration and braking systems controlled by a single pedal for enhanced safety. Additionally, the go-kart incorporates a rear suspension system, improving ride comfort, stability, and control, particularly for drifting. Design 2, patented by Peter R. J. Derviller (US5199526A), integrates rear caster wheels that rotate and swivel for dynamic drifting, controlled by a hand lever. The inclusion of a rear suspension system enhances comfort, stability, and control, enabling precise drift management and improved overall safety.

Design 3, developed by Edwin L. Etnyre and John O. Heimbecher (US5823552A), features a vehicle suspension system with a cross-frame member, upper spring seat, spindle knuckle for wheel attachment, and a suspension strut with a coil spring. The strut consists of a housing with a movable piston and a fixed lower spring seat, supporting the coil spring concentrically around the strut. This design ensures a compact and well-aligned suspension system within the cylindrical plane of the tyre tread, optimizing efficiency and performance. Based on product specifications, manufacturer information, and user reviews, the benchmarking and comparison study provided valuable insights to refine the go-kart suspension system. Additionally, the analysis of each design's strengths and weaknesses assists in making informed decisions regarding fabrication and implementation.

3 METHODOLOGY

The structural design of a go-kart rear suspension is essential for ensuring stability, traction, and ride comfort. Based on the detailed drawings as in Figure 1, the design focuses on precision, durability, and efficient load distribution. The drawing illustrates the individual components and their assembly, clearly understanding how the suspension integrates with the go-kart's frame.

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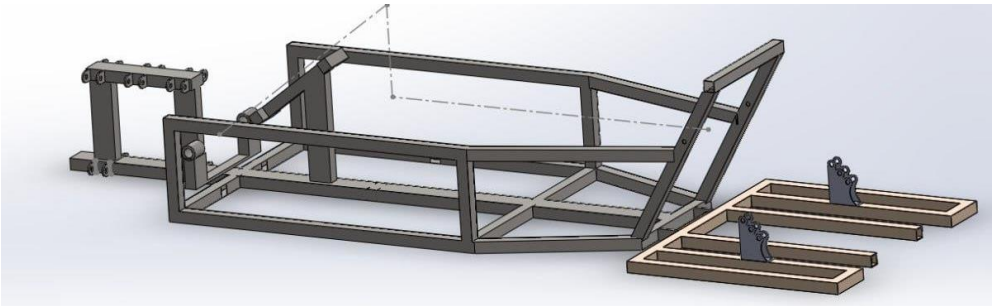

Fig. 1: Structural design of a go-kart rear suspension

Key components in the structural design include bolts and nuts, which serve as essential fasteners to hold the system securely. The shock absorber is critical in reducing vibrations and maintaining tyre contact with the ground, ensuring a smoother ride and better handling. The back suspension bracket is a mounting structure for the absorber, while the backframe provides structural support to the entire system, reinforcing the chassis for strength and rigidity.

Fig. 2: Fabrication process

The material selection process plays a crucial role in developing the go-kart rear suspension system. It involves assessing materials based on durability, strength, and compatibility with design specifications to ensure optimal performance. Although no specific safety precautions were required during this phase, selecting the right materials is essential for maintaining structural integrity and longevity in the suspension system.

The fabrication process as in Figure 2 show the cutting process, where a cutting machine is used to ensure precision and efficiency. Safety measures were strictly followed, including wearing protective attire such as jackets, pants, boots, gloves, and safety glasses. After cutting, the sanding process is performed to refine the material's edges, ensuring accurate measurements and eliminating sharp edges. A sanding machine was used, and gloves and safety glasses were worn for protection. The next step, drilling, was carried out using a standing drill machine to enhance accuracy. Materials were securely clamped to the platform to prevent movement, and workers adhered to safety protocols by wearing appropriate attire, gloves, and glasses.

The welding process initially used Shielded Metal Arc Welding (SMAW) but was later switched to Tungsten Inert Gas (TIG) welding due to material compatibility issues. Welding

was conducted at 80–90V to ensure strong and reliable joints for the suspension base. Safety precautions included using welding gloves, masks, and protective clothing. Lastly, in the assembly process, all fabricated components were assembled according to the design, ensuring proper ride height, damping, and alignment for optimal handling stability. No specific safety precautions were required during assembly, but careful attention was given to achieving a smooth and functional suspension system

4 RESULTS AND DISCUSSION

Figure 2 shows prototype viewed from the front, featuring a chain-driven axle connected to a central electric motor. The system is designed for stability on uneven terrain, supported by red spring shock absorbers and two wheels on each side, which help absorb shocks and maintain traction.

At the rear, a black panel is likely a structural component or enclosure for electronic systems such as the battery, motor controller, or wiring. This configuration suggests the prototype is built for load-bearing or mobility applications, potentially for off-road use, industrial transport, or autonomous vehicle testing. The combination of electric power and a chain-drive system ensures efficient torque transmission, while the suspension system enhances ride comfort and control over rough surfaces.

Fig. 3: Final prorotype

This guide provides detailed instructions on operating, assembling, and maintaining the rear suspension system in an electric go-kart. The system comprises key components, including shock absorbers, the backframe, brackets, and coil springs, all of which contribute to the go-kart's stability, handling, and ride comfort. Understanding the role of each component ensures that users can operate the system effectively and safely, maximizing both functionality and lifespan.

The shock absorbers play a crucial role in the rear suspension system, utilizing dual coil-over springs to absorb impacts and minimize vibrations. This helps improve ride comfort and control, particularly on rough or uneven surfaces. Meanwhile, the back frame is responsible for evenly distributing weight across the rear section of the go-kart, enhancing handling performance and structural support. A well-designed back frame ensures better stability and maneuverability, especially when navigating tight turns or varying terrain.

The brackets serve as essential mounting components, securing the upper and lower ends of the shock absorbers to ensure they remain in place during operation. Properly installed brackets help maintain the effectiveness of the suspension system, allowing it to absorb shocks efficiently. Additionally, coil springs provide further shock absorption, reducing the impact of bumps and vibrations to deliver a smoother, more controlled ride for the driver.

Proper installation, maintenance, and periodic inspection of these components are necessary to maintain the optimal performance and durability of the rear suspension system. By following the guidelines in this manual, users can ensure safety, longevity, and improved ride quality, making the electric go-kart more efficient and comfortable

5 CONCLUSIONS

In conclusion, the design and fabrication of a go-kart rear suspension system were successfully implemented, effectively meeting the project's objectives. The primary goal of developing a functional prototype was achieved by analysing key factors such as performance, comfort, and durability. The design incorporated essential elements, including spring rate, damping characteristics, and structural integrity, ensuring that the suspension system could withstand various terrains and driving conditions while maintaining stability and control.

The second objective, which focused on manufacturing the suspension system based on the design prototype, was also accomplished. The fabrication process involved sourcing appropriate materials, precise assembly, and rigorous testing to validate the system's performance. Testing results confirmed that the constructed suspension system met the required standards, providing a smooth and stable driving experience while ensuring safety and durability. The successful completion of this project highlights the effectiveness of the design and its practical application in go-kart engineering

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