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Fabrication And Testing Of A Lead-Acid Battery Powered Go-Kart

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ABSTRACT

This paper presents the fabrication of an electric-powered go-kart designed to achieve an optimal balance between lightweight construction, durability, safety, and high performance. Engineered specifically for racing on flat circuits, the go-kart features a streamlined design that includes four wheels, a seat, a steering mechanism, and a braking system, intentionally excluding suspension and differential components to minimize weight and mechanical complexity. Powered by a lead-acid battery, the vehicle offers an eco-friendly alternative to conventional fuel-driven models. The design focuses on four primary attributes: durability, safety, minimal weight, and enhanced performance. The chassis is constructed using mild steel pipes, chosen for their strength-to-weight ratio, ensuring a rigid and secure frame. Special attention has been given to material selection and structural design to ensure mechanical integrity and stability under race conditions. The result is a dependable, efficient, and race-ready electric go-kart, well-suited for high-speed performance on smooth tracks.

Key Words

Electric Go-Kart, Fabrication, Lightweight Chassis, Lead-Acid Battery, Differential Drive Elimination

1. Introduction

Electric vehicles have been around since car manufacturing began. Robert Davidson in Scotland created the first functional electric vehicle, a 16-foot (4.9 meter) truck powered by electro- magnetic motors, in 1837[1]. Although the internal combustion engine gradually gained the upper hand partly because of the limited range of electric vehicles little known ventures into making electric cars continued. In motor sport, Formula E kicked off the electric street racing revolution at the 2014 Beijing E- Prix on September 13, 2014, and 25 laps of racing were done [2]. With this growing interest in electric vehicles and the numerous benefits they have on the environment and the economy at large, in this project we want to take a deeper look at the design and manufacturing of an electric go-kart. A go-kart, in accordance with the definition given by the International

Karting Commission Federation International Automobile (CIK–FIA), is a land vehicle with or without body work that has four wheels that are in touch with the ground; two of these wheels are used for steering while the other two are used to transmit power. Go-kart chassis typically have a body frame made of welded steel tubes in addition to the engine and attached wheels.

The go-kart is a racing vehicle that is lightweight, compact, and primarily powered by an internal combustion engine (ICE). An electric go-kart is a type of go-kart powered by electric motors and batteries, as opposed to a traditional petrol engine. In this project, we want to design from scratch a car chassis, couple it to an electric motor through a chain drive system, and propel the car forward. A controller can be used to vary the speed and change the direction of rotation of the motor. We want to show the numerous advantages of using an electric go-kart in motorsport as opposed to the traditional internal combustion go-kart available on the market. With the rise of the Tesla car company Elon Musk has proven that not only electric cars are capable of replacing the IC cars, they are actually better in numerous ways.

The project's main tasks will be designing the chassis, choosing the material for the chassis frame, analyzing and calculating the forces and stresses acting on the chassis, acquiring parts that are challenging to manufacture, and fabricating the chassis and attaching it to the front and rear axles, employing batteries to power the motor and a chain drive to connect it to the rear axle. Safety is negotiable in go-karting. The chassis becomes a cocoon of protection for the motorist. Integral roll bars, five-point harnesses, and energy-absorbing accoutrements are incorporated into the design. Adherence to safety regulations and racing norms is consummate, securing the motorist's well-being in .

and recreational settings likewise

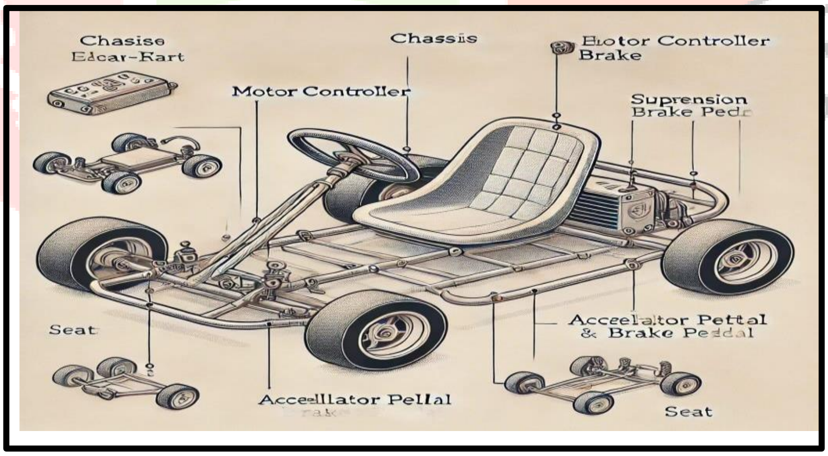

Figure 1.1: Fabrication of E-Kart

2. Literature Survey

Go- karts are an excellent option for individuals active in racing due to their simplicity, low cost, and safer way of driving. Vasant et al [3] discussed the advantages of creating an electric go-kart. He demonstrated that the price of gasoline and diesel fluctuates daily. They increase with higher rates but rarely fall, and this was tremendously depleting the fuel reserves. He then made the case that it is crucial to create a vehicle that can run on electricity rather than gasoline because it is more readily available. S.Arshibad et al [4]. electric go-karts are replacing conventional go-karts due to all the benefits they provide, which include less pollution, low maintenance requirements, good fuel management, and environmental friendliness. He went on to show that a vehicle's chassis is crucial to preserving its speed and performance, making it necessary to do static and dynamic analyses of go-kart chassis.

N.A.Z. Abdullah et al [5] By handling the record of dynamic reactions from test structures to have an accurate model for any reenacted examination and limited component, they showed that model refreshing is concerned with the remedy of limited component models. The topic of model refreshment had been important in underlying elements a long time ago. It had been used frequently and had been successfully applied to numerous disciplines, especially in identifying the strong solidity of a design. Santhosh Kumar et al [6]. offered a detailed examination of the systems used in a go kart, including the steering and braking, transmission, wheel and hub analysis, design parameters, steering system, static strength evaluation, components and dimensions, and consideration for steering selection.

The International GO-KART Championship Season 8 - Rules & Guidelines document likely contains the official regulations, safety protocols, and technical specifications that all participating teams must follow in the competition. It outlines important details such as the permissible weight limits for the go-kart, approved engine specifications, and constraints related to chassis design, ensuring standardization across all entries. Additionally, the document emphasizes safety regulations, including the mandatory use of personal protective equipment like helmets and fire- resistant suits, along with safety features integrated into the vehicle design. These guidelines aim to promote fair competition while ensuring the safety of drivers and team members throughout the event [7].
Nithin S. Gokhale et al [8]. This book provides an introduction to the Finite Element Method (FEM) and its application in engineering. It covers topics like meshing, material properties, boundary conditions, and stress-strain analysis. Essential for performing structural analysis on

go-kart components like chassis, steering knuckles, and braking systems. R.K. Rajput et al [9]. A fundamental textbook on mechanics of materials, covering concepts like stress, strain, bending, torsion, and deflection. Helps in understanding material selection and structural integrity of go- kart components under dynamic loads. The article "How to Design a Double Four-Bar Steering System" from Machine Design discusses the design principles and functioning of a double four- bar steering mechanism, which is commonly used in race karts for improved handling and performance. The article also explains methods for optimizing the turning radius, which is crucial for achieving high-speed stability and maneuverability on the track. This resource is particularly useful for engineers and designers aiming to develop an efficient and responsive steering system for competitive racing applications [10]. Milliken D., Karsprak E., Metz L., and Milliken W. (2003) et al [11]. A comprehensive book on race car handling, aerodynamics, and vehicle stability. Covers suspension tuning, tire behavior, weight distribution, and roll center analysis. Highly relevant for optimizing go-kart performance in high-speed racing conditions. Thomas D. Gillespie et al [12]. A widely used textbook on vehicle dynamics, covering acceleration, braking, cornering, and suspension behavior. Essential for understanding how different forces act on a go-kart and how to enhance traction and stability. The paper also discusses critical factors such as brake force distribution, which ensures balanced stopping power, and heat dissipation, which is essential for maintaining braking efficiency during prolonged use. This study serves as a valuable resource for designing an efficient and reliable braking system that enhances the safety and performance of go-karts in competitive racing environments [13].

The technical paper titled "Design of Braking System of Go-Kart" published in IJETER, Volume 5, Issue 11 (November 2017) focuses on the key design parameters involved in developing an effective braking system for go-karts. It covers important aspects such as the selection of appropriate materials, the comparison between disc and drum brakes, and factors influencing overall braking efficiency. The paper also provides detailed methodologies for calculating braking force and stopping distance, which are critical for ensuring the safety and performance of the vehicle. This study serves as a practical guide for engineers and designers seeking to enhance the braking systems of go-karts through improved design and material choices [14]. B. Babu, M. Prabhu, P. Dharmaraj, R. Sampath (2014) (International Journal of Research in Engineering and Technology) et al [15]. A study on stress analysis of a steering knuckle, a critical component in the go-kart's steering system. Covers finite element analysis (FEA) to determine stress concentration points and potential failure modes. Useful for designing a lightweight yet strong steering knuckle for durability.

Heinz Heisler et al [16]. A technical book covering various aspects of vehicle engineering, including aerodynamics, powertrains, and suspension systems. Provides insights into advanced materials, hybrid technologies, and performance enhancements. Milliken, William F. & Douglas L. Milliken (1995) et al [17]. This is a fundamental textbook on vehicle dynamics, covering suspension design, aerodynamics, tire behavior, and chassis tuning for race cars. It is widely used in motorsports engineering and provides in-depth mathematical models and case studies. Dr. B. Vijaya Kumar et al [18]. This research focuses on the constraints of Gas Tungsten Arc Welding (GTAW), a precision welding technique. It may discuss limitations such as heat-affected zones, welding speed, and material compatibility in automotive and aerospace applications. T. Z. Quazi, Omkar Jalvi et al [19]. This paper reviews different go-kart chassis designs, analyzing factors such as strength, weight distribution, and material selection using computational tools like Finite Element Analysis (FEA). Koustubh Hajare et al[20]. Another review paper focusing on go-kart chassis, but may compare different designs, materials, and manufacturing methods.

Ammar Qamar Ul Hasan et al [21]. Discusses the roll cage design of an All-Terrain Vehicle (ATV) and its structural integrity under crash simulations. Babaarslan N et al[22].A master's thesis focusing on designing a chassis for an M1 category electric sports car, likely involving lightweight materials and aerodynamics. P. Bhatt et al[23] bElectrical Motors for Electric Vehicle – A Comparative Study (2019, SSRN Electronic Journal)Compares different electrc motors for EV applications, analyzing efficiency, torque, and cost.19. Rahul Thavai et al [24]. "Static Analysis of Go-Kart Chassis by Analytical and SolidWorks Simulation" (2015, IJMER) Uses SolidWorks simulation to validate the mechanical strength of go-kart chassis.

3. Methodology

The design of an electric go-kart involves multiple critical constraints that must be addressed to ensure optimal performance, safety, and usability. Weight is a fundamental consideration, as heavier vehicles suffer from reduced acceleration and agility. Therefore, every effort is made to maintain a lightweight structure without compromising strength or durability. A minimalistic design approach is employed to create a compact and user-friendly vehicle, keeping the structure simple yet effective. Comfort is another key factor, and the vehicle is designed with ergonomic principles in mind to ensure the driver maintains a comfortable posture during operation. Achieving this while minimizing overall weight presents a unique challenge.

Environmental considerations also play a major role in the design. The use of an electric propulsion system reduces harmful emissions and supports sustainable practices. Energy-efficient components are selected to further minimize the environmental footprint. Safety remains a top priority, with the chassis engineered to provide maximum protection to the driver during impacts or high-stress situations. The structural integrity of the go-kart is evaluated through rigorous analysis to ensure it can withstand forces generated during acceleration, braking, and cornering.

Integration of electric systems is another significant constraint. The chassis must accommodate the motor, battery, and controller, providing suitable mounting and space while ensuring efficient heat dissipation. Performance and handling are closely linked to chassis geometry, which is optimized to maintain a low center of gravity and ensure responsive steering and braking. The design also emphasizes ease and cost-effectiveness in manufacturing, using commonly available materials and standard fabrication techniques. Additionally, the go-kart must comply with all relevant regulatory standards and karting guidelines. Driver experience is enhanced through ergonomic considerations, ensuring visibility, accessibility, and overall ease of use, all while maintaining high levels of performance.

Figure 3.1 Motor and Battery used in the E-kart

The electric go-kart incorporates a variety of mechanical and electrical components to ensure efficient operation and performance. At the heart of the system is a 2 kW brushless DC motor operating at 48 volts with a peak current of 34 amps and a maximum speed of 4500 rpm. This motor offers advantages such as reduced noise, minimal maintenance, and lightweight construction, making it ideal for vehicle applications. It delivers a torque output of 30 Nm and is powered by a 48V battery pack, which consists of four 12V, 7.2Ah lead-acid batteries connected in series. These batteries are chosen for their affordability, recyclability, and ease of disposal. They recharge within 2 to 3 hours and provide sufficient power for the motor through a 48V, 34A controller that regulates speed and optimizes efficiency. The chassis frame is constructed using square hollow structural sections, which provide uniform strength in all directions and excellent resistance to torsional loads. These characteristics make them ideal for supporting dynamic loads and preserving structural integrity during operation. The steering system is a pre-assembled unit that includes the steering wheel, column, arms, tie rods, and knuckles, allowing for smooth directional control with a minimal turning radius. The wheels are small yet robust, designed to handle the speeds and forces typically encountered in karting. Bearings are integrated to reduce friction and support axial and radial loads, ensuring smooth wheel rotation and long service life.

Power is transmitted from the motor to the wheels through a chain and sprocket system. Unlike gears, sprockets rely on chains to transfer motion, offering dependable performance with minimal slippage. A 16 mm rod is used in various structural applications within the go-kart, particularly in areas that endure high loads. Plywood is used in non-structural parts such as the floorboard, providing insulation, comfort, and additional support. Couplings are employed to connect shafts and compensate for minor misalignments, transferring torque while protecting components from shock and overload.

Assembly of the kart relies on bolts and nuts, particularly hexagonal ones for ease of use in confined spaces. Locking features like nylon nuts are included to prevent loosening due to vibrations. The braking system consists of disc brakes, which offer reliable and responsive stopping power. By clamping brake pads onto a rotating disc, kinetic energy is converted into heat, slowing the kart efficiently. This system includes components such as the brake caliper, rotor, and hydraulic connections, playing a vital role in ensuring driver safety during operation.

4. Estimation Of Cost Analysis

The following section performs over cost in order to produce a single seater Go-Kart. The costing includes the components cost, machining cost and other cost Which may involve. However, the table below shows estimation for costing of our project because the fabrication of our project will be done in this semester. There is main part already bought to study to get exact dimension of the Part (refer appendix). Table below shows the costing of electrical part and manufacture part.

SL.NO	MATERIALS	QUANTITY	COST
1	48V DC Motor	1	6000/-
2	Controller	1	3500/-
3	Battery	4	10000/-
4	Square Tube	3	1500/-
5	Steering	1	1500/-
6	Wheel	4	6760/-
7	Bearing	4	600/-
8	Sprocket	1	1500/-
9	16mm Rod	1	200/-
10	Ply Wood	-	1000/-
11	Coupling	-	120/-
12	Bolts & Nuts	-	250/-
13	Break	1	1350/-

14	Painting	-	300/-
15	Workshop allowances	-	4000/-
16	Seat	1	1000/-
17	Shock absorbers	2	1150/-
	TOTAL		**40720/-**

5. Results and Discussions

The main objective of our project is to build a highly efficient and high acceleration Electric Go-Kart for reducing the spark obtained in PMDC motor and fuel cost of the IC engine kart. we have successfully built the project with BLDC motor.

S. No	OUTPUT	TORQUE IN NM	SPEED IN RPM	SPEED IN KMPH
1	pr Output T1	5.6	3000	Forward: 50 Reverse: 30
2	pr Output T2	19.9	1100	Forward: 40 Reverse: 15-20

Figure 5.1 Final Image of Go-Kart

6. Conclusion

The successful fabrication of the electric go-kart highlights an effective balance between lightweight construction, durability, safety, and performance. Based on calculations, the vehicle is capable of supporting the intended load while reaching speeds of approximately 40–45 km/h. The build was completed without compromising structural strength or the quality of components. By omitting suspension and differential systems, the design remains simple yet highly efficient, making it ideal for racing on flat circuits. The chassis, fabricated from mild steel pipes, provides a strong and rigid framework while minimizing overall weight. Powered by an electric battery, the go-kart offers an environmentally friendly alternative to traditional fuel-powered models. The project successfully met its objective of developing a durable and efficient electric go-kart. Future enhancements may include the integration of improved batteries, higher-performance motors, and lighter materials to further boost speed and overall performance.

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