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Design and Analysis of Vehicle Dynamics Parameters for Low Weight Electric Go-Kart

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Abstract.

In day to day our life, the cost of petrol and diesel keeps on increasing. This is huge requirements of fuels will exhaust the fuel reserves. So this situation leads to make a vehicle that could work on electric energy instead of using fuel. We have fabricated a low cost running model of electric go-kart and easy to fabricate the vehicle in all possible aspects. Main objective is to design a safe and fabricate the electric go -kart in order to make it with, improving its strength and lower cost model. Moreover our vehicle design also supported for physically challenged people to make them drive by themselves. Rather than using wheelchair it will be more convenient for them with more comfort.

Key Words - Electric energy, Go-kart, Motor, Battery, Eco-friendly.

1. Introduction

A go-kart is a small racing car that is popular all over the world. K. Art Ingles produced it in the late 1950s. Go-kart vehicle is mainly introduced for motor sports. They were designed for Formula One cars, they are not faster for race but the price is very minimum. This kart is a best for those who are interested in racing. Kart racing is typically used as a low-cost model. In terms of safety, young drivers are safer comparatively adults, but adults are also involved in kart racing. The evaluation of this electric kart has been started at era, i.e. in the 19th century. Our motive is to develop the vehicles for non-professional as well as the physically challenged people.

2. Design of Electric Go – Kart Circuit Diagram

Figure 1 illustrate that the circuit diagram of electric Go kart Vehicle. The speed controller is directly connected 12Volts batteries and hub motor. It regulates the speed of vehicles. Motor is connected to series batteries with a capacity of 48Volts and 7A. Circuit breaker is used to prevent the overload power supply to motor.

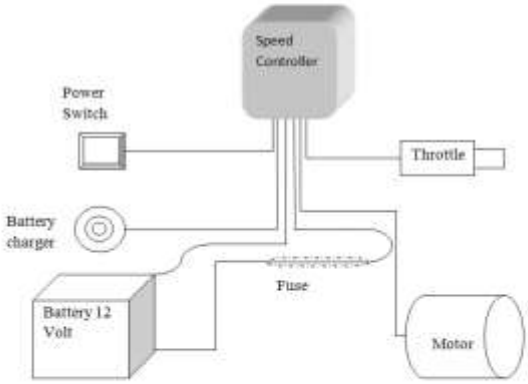

Figure 1 Circuit Diagram of Electric Go-Kart

3. Parts of Go-Kart

In a GO-Kart, the following main parts are used in electric Go kart vehicle and their description are given as follows

1. Chassis
2. Battery
3. Handle bar
4. Hub motor
5. Tires
6. Controller
7. Shock absorber
8. Accelerator
9. Wheel

3.1 Chassis

Chassis is also known as 'Frame' of the vehicle. It serves as the vehicle's primary support structure. The frame bears the stress on the vehicle in both static and dynamic situation.
It is a skeleton frame constructed of hollow tube bar and other materials with varying cross sections. The chassis must be stable with torsion rigidity and have a relatively high degree of flexibility. Chassis construction is typically tubular bar, normally MS with varying grades.
It affords assistance to the power unit and the operating system, among other things.

3.2 Battery
The two couples of Lead-Acid battery (48V) are used. A twelve volt (efficiency 52 – 93 percent) battery with six sigma cells in series generates a fully charged output voltage of 12.6 volts. Each cell is capable of storing 2.1 volts. It also consists of positive and negative electrodes. Negative electrode is made up of spongy or porous lead. Lead oxide is used for the positive electrode. Both electrodes are immersed in a sulphuric acid and water electrolytic solution. These batteries power is mainly applied in other battery-powered and golf carts vehicles.

3.3 Handle Bar
The handle bar is a tubular component of the steering mechanism on a motorcycle. It provides a mounting speed for controls like the throttle, brake, light switch, clutch, horn and rear view mirror. Besides steering, handle bars also often supports a portion of the riders weight.

3.4 Hub Motor
A kart hub motor is a device that exchanges electrical energy into mechanical energy.
It generates a rotating magnetic field by using an electric coil (stator winding). The rotor squirrel cage type closed Aluminium (Al) frame to generate a torque by using magneto electric rotation. It is also play vital role in industries, for example, as a driving wheel on assembly lines. They were developed by component and tyre manufacturers, and the LUKA EV by MW Motors was the first production vehicle to use them and established in buses.

3.5 Tires
Modern pneumatic tyres are made of, fabric, natural rubber, synthetic rubber and wire, as well as carbon black and other chemical compounds. Pneumatic tyres are cast-off on a wide range of vehicles, including automobiles, buses, heavy vehicles, and aircraft. Its purpose is to support the vehicle's weight, torque, transfer transaction, breaking forces and absorb road shocks to the road surface. It should both sustain and adjust direction. Tires are made of resilient rubber and filled with compressed air to perform these four basic functions.

3.6 Controller
The electric vehicle controller is an electronic package that maintains the batteries and motor to control the speed and acceleration of the electric vehicle, much like a carburettor does in a gasoline-powered vehicle. High speeds were the only times when all of the existing power was used.

3.7 Shock Absorber
Shock absorbers are an integral part of a vehicle suspension. The shock absorber's function is to keep the vehicle's tyre in constant contact with the road, assisting in maintain the optimal grip when cornering and braking. Because it is a component of the suspension, if the shocks wear, the vehicle's ride and comfort suffer.

3.8 Accelerator
Newton's Second Law states that acceleration is the rate of change of velocity of an object with respect to time. Acceleration is calculated in metre per second squared. Acceleration is a vector quantity that calculated by using the parallelogram law. The net force acting on a body has the alike direction as the vector of the body's acceleration, and its magnitude is proportional to the magnitude of the acceleration, with the object's mass (a scalar quantity) serving as the proportionality constant.

3.9 Wheel
Wheel is circular equipment that can rotate on its axis, allowing for transportation, movement or labour in machines .A wheel and an axle overcome friction by facilitating rolling motion. A moment must be applied to the wheel about its axis in order for it to rotate, either by gravity or by the purpose of other external force. More broadly, the term refers to any circular object that rotates or turns, such as a ship's wheel or flywheel.

4. Design of Go-Kart

A design process is drafting of electric vehicle by using solid works software as per required specification for our fabrication process. Figure 2 shows the 3D image of final go kart vehicle and Figure 3 shows the 2D image of vehicle.

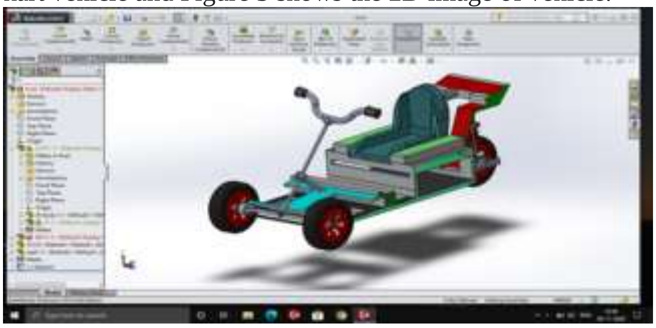

Figure 2 Isometric View of Go Kart

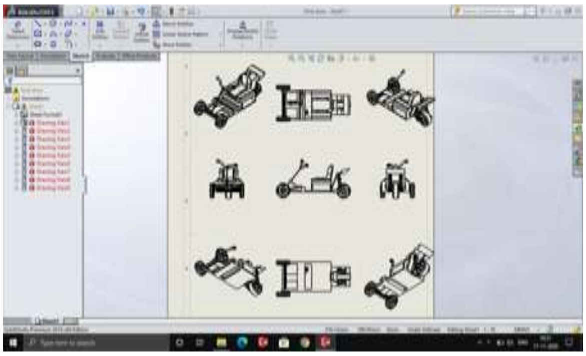

Figure 3 Combined View of Go-Kart

5. Working of Electric Go-Kart

Go-Kart vehicle is an electric vehicle which contains the battery (48V), hub motor, shock absorbers, and wheel and speed controller. The whole set up is mounted on the chassis frame which is made up of both mild steel material (MSS) and Stainless Steel (SS). The steering geometry (handle bar) of the vehicle consists of Ackermann steering mechanism. Also, we have coupled a ball bearing with the rear and front wheel along with steering. Whenever the vehicle is switched ON the power will be generated from the battery which will be used to run the motor. The motion of motor is transmitted to rear wheel.

6. Calculation

6.1. Battery Backup		
Charging current	=	Ah of battery / charge current
	=	35 *(10/100)
	=	3.5 Ah
Charging time	=	35 / 3.5
	=	10 hrs
Practical case (40% losses)	=	35 * (40/100)
	=	14
Charging current	=	14 + 35
	=	49Ah
Charging time	=	49 / 3.5
	=	14 hrs
Discharge	=	(Ah * volt) / (applied voltage)
	=	(35 * 16) / 1000
	=	0.42hrs
Discharge	=	25.2min
Maximum loss	=	0.42 * (40/100)
	=	0.168hrs
6.2. Speed		
Speed for Electric Vehicle (Standard [i = 3.828])	=	<u>rotational velocity* tyre radii</u> 168 * gear ratio
	=	(8 * 3000) / (168 * 3.828)
	=	37.41674 m/h
	=	37.41674 * 1.60934
	=	60.21kmph
Power	=	Force * velocity
		(F_1+F_2) * velocity
		F_1 - air resistant and other component movements F_2 - accelerating the kart F_1 = mass * acceleration ((16m/s) / (8m/s^2))
F_1	=	mass * acceleration ((16m/s) / (8m/s^2))
	=	700 * 2
	=	1400 N
		Where, [F1 = F2];
F_2	=	1400 N
Power	=	(1400 + 1400) * 16
	=	44.8kw
Torque	=	Force * wheel radius
	=	2800 * 0.4 = 1120 Nm
6.3. Steering (Handle Bar)		
Turning radius (R)	=	(root $(L^2 + D^2)$) + D
	=	(root $(1255.2^2 + 1102.8^2)$)+1102.8

Outer angle		
Tan X	=	D/(R-(d/2))
	=	1255.2/ (2706.16 – (1102.8/2))
X	=	30.26
Inner angle:		
Tan Y	=	D/(R+ (d/2))
	=	1255.2/ (2706.16 + (1102.8/2))
Y	=	21.09
Ackermann Angle	=	
Tan Z	=	$\frac{\text{Sin Y} - \text{Sin X}}{\text{Cos X} + \text{Cos Y} - 2}$
	=	$\frac{\text{Sin}(21.09) - \text{Sin}(30.26)}{[\text{Cos}(30.26) + \text{Cos}(21.09)] - 2}$
Z	=	35.33

7. Results and Discussions

7.1. Analysis of Go kart vehicle Chassis

Stress analysis is the most common design investigation application in mechanical engineering. Stresses (both structural and thermal) are used to verify whether it will fail or not, and design changes are necessary to address potential issues. This project is analysed by using Ansys 17.2 software.

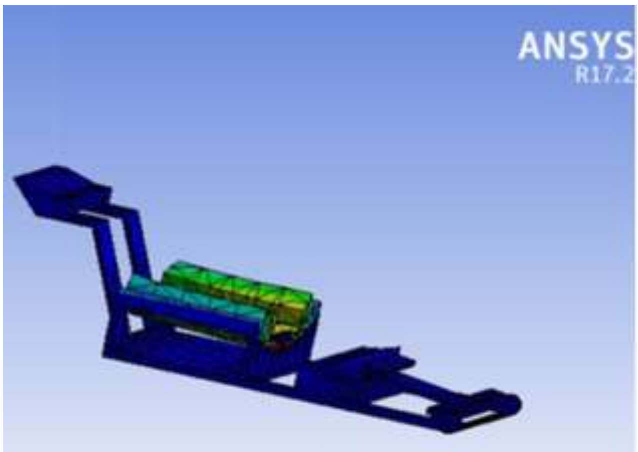

Figure 4 Go kart vehicle Chassis after meshing

A human load of 60kg (max.80kg) is acted on the seat and withstand the maximum deflection of 1000N. Static structure stress analysis of vehicle's chassis is done by free meshing and it consists of 40840 elements with 82124 nodes.

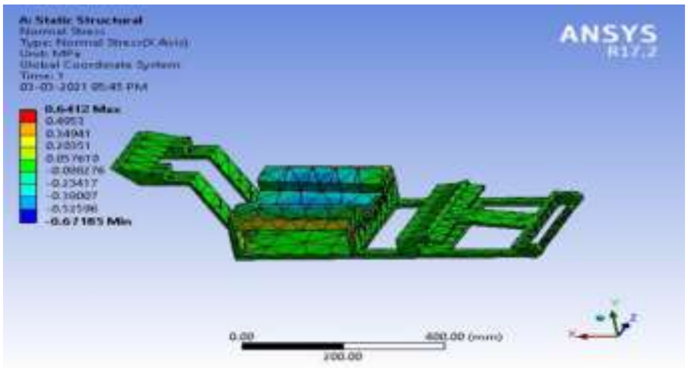

Figure 5 Stress Analysis of Fabricated vehicle

Figure 5 shows the static structure stress analysis of vehicle's chassis. The volume of go kart is 1.2052e+007 mm³ and mass is 94.426 kg. A human load of 968N is acted on the body. From results, we found that the maximum stress obtained is 2.8985e-002 MPa. The maximum stress is happen at seating of the chassis and minimum stress is takes place at top the chassis. Design will ensure the safe load carrying of load during all conditions.

7.2. Analysis of Fabricated vehicle

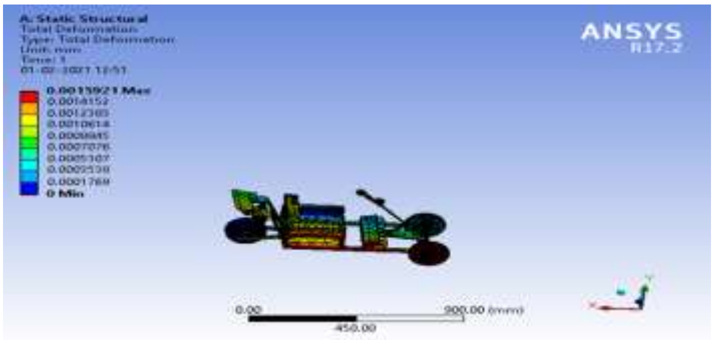

Figure 6 Deformation of Fabricated vehicle

Figure 6 shows the deformation analysis of fully fabricated model of vehicle is done by free meshing and it consists of 40840 elements with 82124 nodes. The volume of go kart is 1.2052e+007 mm³ and mass is 94.426 kg. A human load of 968N is acted on the body. From results, we found that the maximum deflection obtained is 8.9646e-006mm. The maximum deflection is happen at bottom of the chassis and minimum deflection is takes place at top the chassis. Design will ensure the safe load carrying of load during all conditions.

8. Conclusion

Thus the electrical go-kart is designed as per design requirements by using Solid Works. The fabrication is done as per the design and vehicle design is analysed by using Ansys software. The cost of fabricated vehicle is compared with existing models. The exiting carbon fibre reinforcement frame material is changed into mild steel material and this helps to reduce the cost and weight from 600kg to170kg and width is reduces from 70 inches to 35 inches. Designed frame is gives higher safety when compared to existing model.

9. Future Scope

- Hybrid and electric vehicles are the future, with numerous opportunities to amalgamate new and eco-friendly technology.
- The growth of hybrid karts, fuel cell powered karts, hydrogen powered karts and solar powered karts in order to reduce the use of rapidly depleting fossil fuels.

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