DESIGN AND ANALYSIS OF HYBRID ELECTRIC GO-KART

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Abstract: The enormous increase in fuel consumption from ages in the automobile area causes the exhaustion of fuel reserves and deficiency for future generations. An increase in the global warming temperatures by the emission of the pollutants from the conventional drive systems can cause a grave problem in the future. This challenging situation requires hybrid vehicles to subdue this problem. A hybrid electric go-kart vehicle is a type of hybrid vehicle that combines the traditional electrical propulsion system and internal combustion engine in the go-kart and provides increases in the competence of the formal drives and the conserve in the fuel economy. The sight of an electric propulsion in the kart vehicle involves more wide-range of fuel-efficient than the formal vehicle propulsion systems. The main intention of the project is to design the hybrid go-kart in the diminutive which is eco-friendly, comfortable and provides safe driving exposure to people and racers and also to a more enhanced fuel-efficient go-kart than the conventional Go-karts that run on electric drive and IC engines system. In this kart, cradle frame body intended and the IC engine gives a mileage of 50km/l and brushless dc motor gives a distance of 45km

***Index Terms*– Brushless DC Motor, Conventional Go-Kart, Cradle Frame Electric Drive, Hybrid Go-Kart.**

I. INTRODUCTION

Traditional vehicles with Internal Combustion engines afford good performance characteristics and long operating range by appropriating the high-energy-density benefits of petroleum fuels. But, traditional IC engine vehicles have the limitations of lower fuel-saving and environmental pollution. Battery-powered EVs, on the other hand, possess some improvements over standard Internal Combustion engine vehicles, such as high-energy efficiency and zero environmental pollution. The analysis particularly the working range per charge, is significantly minor competitive than IC engine vehicles, due to the much more dwindle energy density of the batteries than that of petrol, due to the much more moderate energy density of the batteries than that of petrol. Hybrid electric vehicle uses two energy sources and have the aid of both the IC engine and Electric Vehicles and subdue their limitations.

1.1 Hybrid Technology

A hybrid vehicle unites two systems for the propulsion of a vehicle. Desirable combinations include electric and petrol, battery and fuel cell. One energy source is for a depot, and the other is a changeover of fuel to power. The mixing of two energy sources may support two different propulsion systems. The hybrid vehicles are classified as follows.

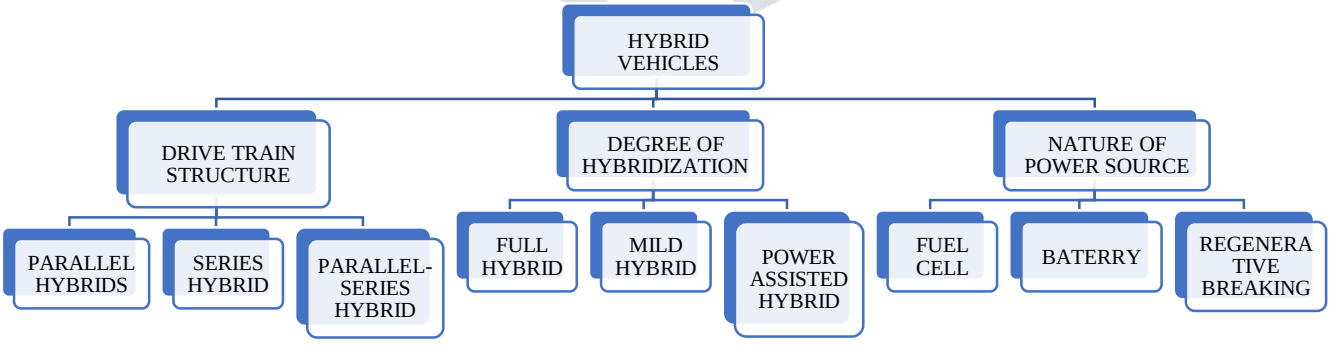


Fig.1.1 (a) Assortment of Hybrid Vehicles

We are acknowledging the parallel hybrid technology for our hybrid electric Go-kart project and it has outlined below:

1.1.1 Parallel Hybrid Vehicle

The parallel hybrid vehicle is one of the most significant and commonly used types in hybrid vehicles and it is more fuel-efficient than the other traditional systems. And it is a combination of the electric drive train and the internal combustion engine. Initially, for the low starting torque, the Internal Combustion engine is used for some time and then to get high torque and to save

fuel vehicle runs on the electric motor. A both electric and Internal Combustion engine used for a particular period resembles the hybrid power.

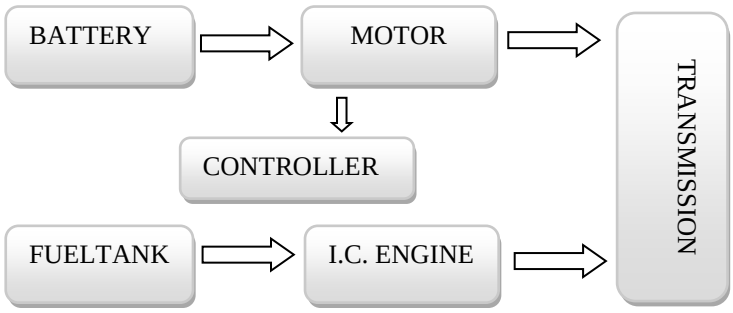


Fig.1.1.1 (a) Parallel Hybrid Vehicle

1.1 Go-Kart

Go-kart is a commercial vehicle that has used for racing championship. It powered by the IC engine propulsion and incompetent in nature and go-karts was self-propelled vehicles that were compressed in size. Mainly handled in the racing loop trails and the outdoor tracks. It has low least ground clearance because the racing tracks for go-karting requires fewer perimeters in the outdoor tracks.

It consists of many parts like chassis, steering, seat, wheels, brakes, engine and tires. It uses a 2-stroke or 4-stroke IC engine for the running of the kart chassis is one of the most important parts of the go-kart in which the tubes of good thickness weight were the used all auxiliaries were attached to the chassis by using various welding techniques. The cradle frame with closed segments was planned for this project. The steering also plays an influential role in the go-kart, it is used to make the turning movements of the wheels and overall vehicle. Due to the lower ground room, the suspension system was not introduced in the kart. The chassis and the other components were designed to withstand the high stability and the loads basically the go-kart is fun, reliable and adventurous sporting vehicle

This project is intentionally created with the tubes in CATIA and the analysis was carried out in the Ansys this is the first vehicle carried out the racing universally these vehicles were called go-karts were grow into the large and fast-growing business in India by the sponsors and conductors of these championship events nationally and internationally.

II. AIMS AND OBJECTIVES

The objective of this seminar work is to analyze the Design and Analysis of Hybrid Go-kart. Scope of this work includes:

- Study of the principles and working of Hybrid Electric Go-kart in working parameters and performance parameters
- Design the structural Frame and components for the Go-kart
- Static Structural analysis on the Go-kart frame and various components regarding the Structure
- Calculations For Hybrid Electric Go-kart Model
- Implementation of combined drive train for Electric and Ic engine
- Large flexibility to switch between electric and IC Engine power
- To investigate methods to increase the efficiency in order to conserve power and the money

III. COMPONENTS OF HYBRID ELECTRIC GO-KART

Hybrid electric Go-kart consists of following components:

(a) Chassis
(b) Engine and Transmission
(c) Steering
(d) BLDC Motor
(e) Battery
(f) Controller

3.1 Chassis

Chassis is a primary component of Go-kart which is rigid in structure and it is made up of hollow tubes that are in circular or rectangular cross-section. The auxiliaries and driver bed were mounted on the chassis. In our project, we have adopted closed frame chassis to withstand the loads and weight which acts on it and it doesn't have the roll cage. This chassis which we have designed can absorb some jerks, vibrations and it is also strong enough to break. The wheels were attached to chassis on either side.

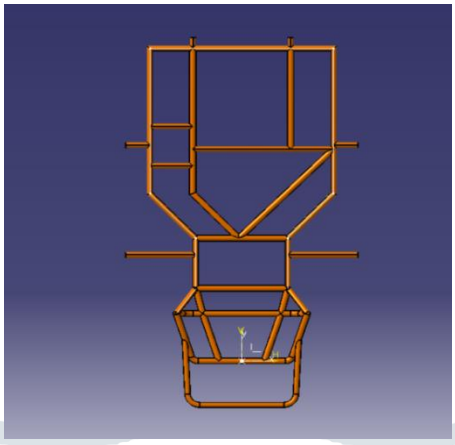


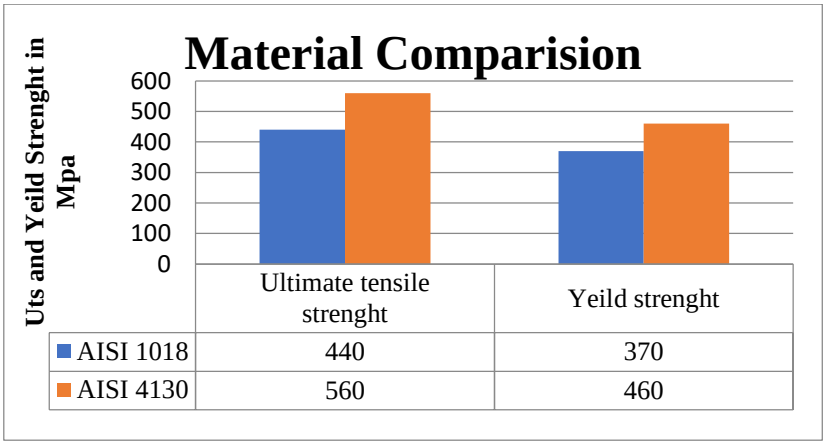
Fig.3.1 (a) Chassis

Table: 3.1(a) Chassis parameters

Parameters	Values
Vehicle length	63inches(1646.2mm)
Vehicle wheel base	42inches(1066.8mm)
Vehicle Front Track width	34inches(863.6mm)
Vehicle Back Track Width	40inches(1016mm)
Chassis material	AISI4130
Pipe Thickness	2.0mm

The assortment of frame material while designing any chassis, strength, and lightweight is the basic consideration. So material used in chassis is one of its important criteria. AISI 4130 is one of the suitable materials for a go-kart frame. AISI 4130 alloy steel contains chromium and molybdenum as reinforcing agents. It has low carbon content, and can be welded easily .it is having high tensile strength and high machine-ability and offers a good balance of toughness and ductility.

The frame material used for this go-kart was Chromoly steel which was technically named as AISI 4130 Alloy steels are assigned by AISI four-digit numbers. They are more compassionate to mechanical and heat treatments than carbon steels. They include different types of steels with compositions that greater the limitations of B, C, Mn, Mo, Ni, Si, Cr, and Va in the carbon steels.



Graph 3.1(a) Comparison between AISI 1018 and AISI 4130

Table: 3.1(b) Material Properties of AISI 4130

Properties	Units
Ultimate tensile strength	560mpa
Yield Strength	460mpa
Modulus of elasticity	190-210Gpa
Bulk modulus	140Gpa
Shear modulus	80Gpa
Poisson ratio	0.27-0.30
Hardness, Brinell	217
Machinability	70
Density	7.85g/cm³
Melting point	1432°C

3.2 Engine and Transmission

The GO-Karts moves with the Internal Combustion engine which used in smaller ratios about 100-200 CC. In this, we have taken the Honda shine CB engine which had a 124.7 CC a Four-valve single-cylinder engine that produces about 10.3 BHP at 7500 rpm and highest torque of 10.9 N-m at 5500rpm, We have used four-stroke single-cylinder for this kart

Transmission is a fundamental aspect of any vehicle which the entire mechanism of transmission of energy from the engine to the transaxle, it connected to the wheels utilizing sprocket which is having 45 teeth on driver and 15 teeth on the driven gear allows the sprocket ratio of 3 and these sprockets connected using the chain drive for transmission

Table: 3.2 Engine Parameters

Model	Honda shine
Makers name	Honda
No of strokes	4 stroke Si engine
Maximum power	10.3 at 7500rpm
Maximum torque	10.9 at 5500rpm
No cylinders	1

3.3 Steering

Steering is an important part of any vehicle which is used for turning and cornering of the vehicle steering is the combination of the tie rods, linkages, stub axles, kingpins. The Ackerman steering system is the most commonly used steering mechanism. The principle allows the help of effort on the steering wheel by the driver this describes the relationship between the front wheels when in turn

It is the connection between the driver and the vehicle regarding turning, good riding and safe handling

Table: 3.3 Steering Geometry

Steering parameters	Values
Ackerman percentage	100%
Turning radius(R)	2.2meters
Ackerman angle(β)	34.2°
Length of tie rod(l)	220.02mm
Steering effort required	116.7N

3.3.1 Kingpin

Kingpin is one of the linkage parts in the Go-Kart which plays a major and significant role it works on pivot mechanism that acts on the wheels and allows the wheels to rotate in the restricted angle and the pivot pins were further attached to the steering axle allows the effort by the driver transferred to the wheel

3.3.2 Yoke

A yoke is a C-shaped part that welded to the chassis rigidly and connected to the kingpin. It allows the wheel to turn at the pivot end.

3.4 BLDC Motor

The electric motors were generally classified based on the electric power supplied to it they are Ac, Dc, and induction motor, the brushless dc motor consists of permanent magnet stator and the rotor placed inside it. Brushless dc motor most widely used for commercial purposes because of its extraordinary performance in the commercial region the BLDC motor used in this project.

Table: 3.4 BLDC Motor Specifications

Commutation	Brushless
No of poles	8
Phase	3-phase
Speed	3000rpm
Torque	70 N-m peak torque
H.p	3.5
Power	2646watts

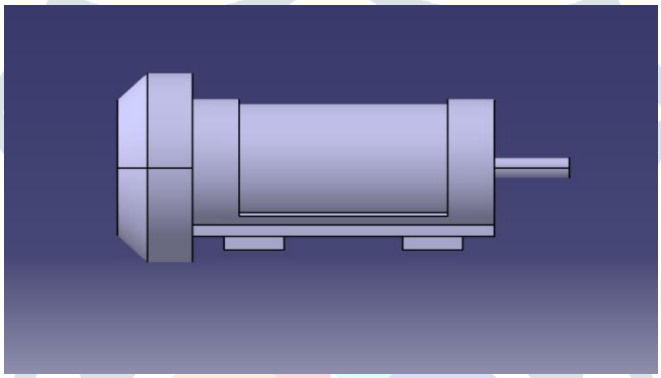


Fig.3.4(a) BLDC Motor

3.5 Battery

The battery used for the primary purpose of energy storage the battery used in this project was lead-acid battery the battery containing the lead and acids inside it the battery has a rating of 12V and 24 Ah used in this project

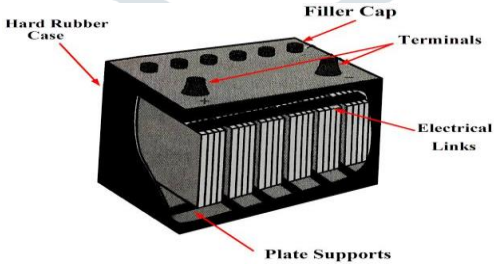


Fig.3.5 (a) Lead Acid Battery

3.6 Controller

The controller is one of the important parts for the electric motor it is the subsidiary which comprising of various wirings for the motor isolation the hall sensor impinges the pulses for the motor driving frequency, and the charging port, battery connection, speed regulator, control switch.

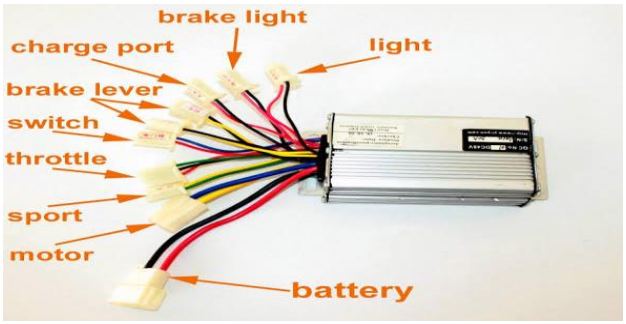


Fig.3.6 (a) Controller

IV. DESIGN METHODLOGY

4.1 Introduction to Design

The design is the most important necessity of any vehicle or project is defined by considering various factors such as compactness, reliability, aesthetics, durability and weight consideration, the driver ergonomics.

4.2 Design of Chassis

The chassis is designed on the consideration of the overall weight of the vehicle, strength, durability and the factor safety

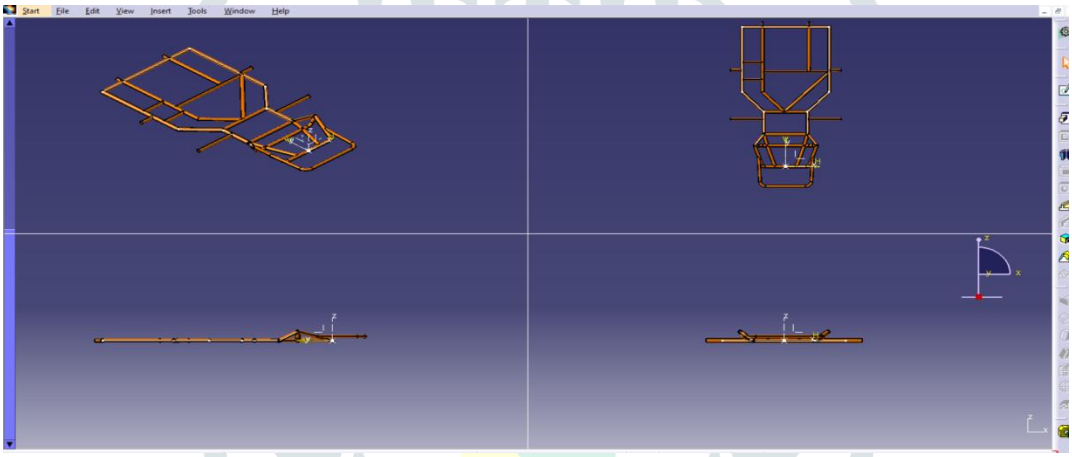


Fig.4.2 Sectional Views of Chassis

4.3 CAD Model

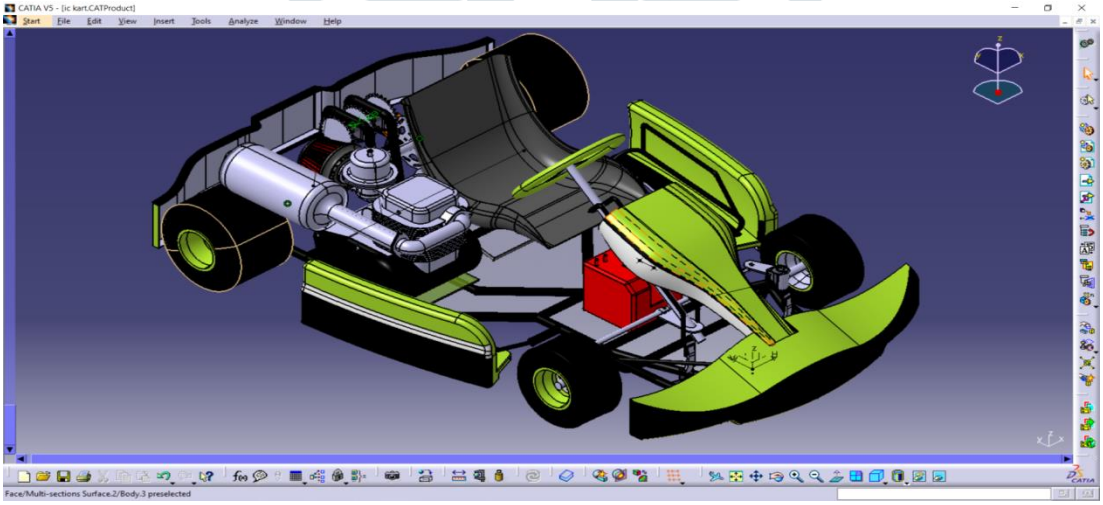


Fig.4.3 (a) CAD Model

V. Finite Element Analysis

Finite element analysis was the simulation technique used in the Ansys used for analyzing the various stress, vibrations, displacement and strains in the Ansys workbench. In this Ansys software were going to calculate

- Front-impact
- Side impact and
- Rear impact

5.1 Front Impact

Considering the kart moving with the highest velocity of 60 km/hr, the time taken for the impact is 0.2 second. Force exerted by the kart is:

$$F = 0.5 \times ((MASS \times VELOCITY) / TIME)$$

Where,

V = 60 km/hr
= 0.01666 km/s
= 16.66 m/s

Hence,

F = 0.5× ((220 × 16.66) /0.2)
F = 9163.5 N

Where 220 → Maximum approximate weight of the go-kart.

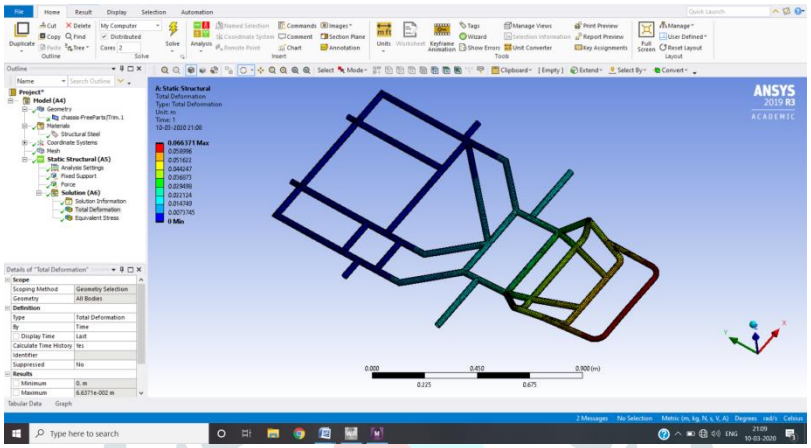


Fig.5.1 (a) Front Impact

5.2 Side Impact

Considering the kart moving with the highest velocity and it is called from side by a moving object, creating side impact and the go-kart deviated at an angle of 25°. So the speed of the kart will be

$$F = 0.5 \times ((MASS \times VELOCITY) / TIME)$$

Where,

v = 60 cos 25
v = 54.38 km/hr
v = 0.0151 km/s
v = 15.1 m/s

Force exerted by the kart

Hence,

F = 0.5× ((220 × 15.1) /0.3)
F = 5536.66 N

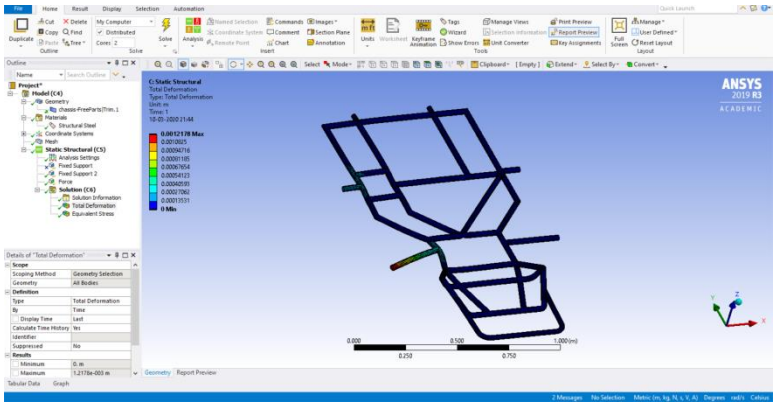


Fig.5.2 (a) Side Impact

5.3 Rear Impact

Consider the kart in stationary position and is collided from rear by any moving object.
Considering the velocity of moving object is 18 m/s. The impact time is 0.3s.

So the force exerted is

$$F = 0.5 \times ((MASS \times VELOCITY) / TIME)$$

Where,

V = 60 km/hr
= 0.01666 km/s
= 16.66 m/s

Hence,

F = 0.5× ((220 × 18) /0.3)
F = 6600 N

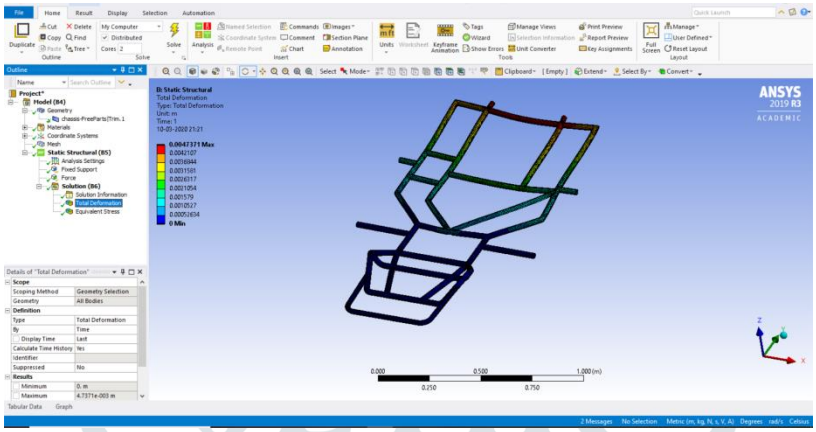


Fig.5.3 (a) Rear Impact

VI. WORKING

The hybrid electric go-kart works on the principle of parallel hybrid technology. It is employed with the ic and electric drive train mechanism which involves the shifting range of power between two energy sources while at different conditions. The working of hybrid electric go-kart consists of 3 working modes mentioned below

IC Mode

It is the conventional method of driving the vehicles using the internal combustion engine. The IC drive was connected to the wheels by using sprocket and chain. Initially the go-kart requires the low starting torque so the IC drive was used for the driving.

Electric Mode

Electric drive mechanism is method of driving the kart with the help of the brushless dc motor having 3.5hp and the 3000rpm power. The BLDC motor was connected to the axle by using the chain drive the motor provides the amount of power when the moderate speed of travelling is required.

Hybrid Mode

The hybrid mode is the drive in which electric and IC drives were combined parallel together and maintained in a constant running of the vehicle or kart for the high power and torque at different required conditions.

VII. CONCLUSION

We have determined the basic need of the hybrid kart than the conventional and electric drives for the efficient fuel saving and reducing the global warming effect caused by the conventional drive vehicles and we have designed the chassis was successfully completed using CATIA software

AISI 4130 is the material we have selected for the chassis and the finite element analysis of the chassis was carried out in the Ansys software and the factor safety was found more than 1 and the Front impact was 9163N and Side impact was 5536N and Rear Impact was 6600N and max deformation found is 4.0mm

In this kart, cradle frame body intended and the IC engine gives a mileage of 50km/l and brushless dc motor gives a distance of 45km. By considerations and the calculations we have concluded that combination of the IC and electric drive provides 95 km.

VIII. ACKNOWLEDGEMENT

Authors express sincere gratitude to Godavari Institute of Engineering and Technology (Autonomous), Rajahmundry.

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