International Journal of Research in Engineering, Science and Management
Volume-2, Issue-2, February-2019
www.ijresm.com | ISSN (Online): 2581-5792

Design and Analysis of Electric Kid's Car

Abhishek Kharabi[1], Aniket V. Kharabi[2], Aniket H. Kharabi[3], Tanmay Kharabi[4], Mangesh Kale[5]
[1,2,3,4]*Student, Department of Mechanical Engineering, Savitribai Phule Pune University, Pune, India*
[5]*Assistant Professor, Department of Mechanical Engineering, Savitribai Phule Pune University, Pune, India*

***Abstract*: The issue of the depletion of oil reserves in the world, and the problem of air pollution produced by motor vehicles, motivate many researchers to seek alternative energy sources to propel the vehicle. One promising way is to replace combustion motor with an electric motor, which is known as an electric vehicle. Electric vehicles (EV), as a promising way to reduce the greenhouse effect, have been researched extensively. With improvements in the areas of power electrics, energy storage and support, the plug-in hybrid electric vehicle (PHEV) provides competitive driving range and fuel economy compared to the internal combustion engine vehicle (ICEV). Operating with optimized control strategies or utilizing the concept of the energy management system (EMS), the efficiency of the PHEV could be significantly improved. In this review paper, the operating process of the various types of EVs will be explained. Battery technology and super capacitor technology will also be discussed as a possibility to increase the energy capacity of PHEV. Model of chassis has been developed on Solid edge ST8 and analysis is done on Ansys Workbench 17.2.**

Keywords: **Ansys, Battery, Chassis, Hybrid electric vehicle, Total Deformation, Von Mises Stress**

1. Introduction

This project consists of design and analysis of electric kid car. Electric vehicle is an automobile propelled by one or more electric motors, drawing power from an on-board source of electricity. Electric cars are mechanically simpler and more durable than gasoline-powered cars. They produce less pollution than do gasoline-powered cars. An electric car stores its energy on board-typically in batteries, but alternatively with capacitors or flywheel storage devices. A more recent development is the hybrid electric vehicle (HEV), which uses both an electric motor or motors and a gasoline or diesel engine, which charges the batteries in order to extend the car's range and often to provide additional power. Regardless of the energy source, an electric car needs a controller, which is connected to the accelerator pedal, for directing the flow of electricity from the energy source to the motor.

Sub Departments for design :

- Chassis Department
- Steering Department
- Brakes Department

A. Chassis design

The automotive chassis serves as a frame work for supporting the body and different parts of the automobile. The chassis acts as the backbone of a heavy vehicle which carries the maximum load for all designed operating conditions. Automotive chassis or automobile chassis helps to keep an automobile rigid, stiff and unbending. Chassis ensures low levels of noise, vibrations and harshness throughout the automobile. The chassis is considered to be the most significant component of an automobile. It is the most crucial element that gives strength and stability to the vehicle under different conditions.

Table 1
Chassis Dimension

Length	1422.4 mm
Width	889 mm
Thickness	63.5 mm

Table 2
Material Selection

Material	Yield strength (mpa)	Percentage elongation at break
AISI 1026	260-440	17-27 %
AISI 4130	435-979	18-26 %
AISI 1020	230-370	18-28 %
AISI 1018	270-400	18-29 %

AISI 1018 has excellent weldability and produces a uniform and harder case and it is considered as best steel for carburizing parts. The 1018 carbon steel offers a good balance of toughness, strength and ductility. Considering the above factors we choose AISI 1018 for our chassis material.

B. Chassis analysis

1) Color/Grayscale figures

Front Impact Analysis

Generally, in the case of pure elastic collision in frontal impact the linear velocity remains at 64 Kmph according to ENCAP (The European new car assessment program) Hence the value of force is calculated by mass moment equation that is- $F = P\times\Delta T$ Where ΔT is the duration of time, generally the collision takes place for a very short duration of time. We assumed this time as $\Delta T = 1.01$ seconds. And the gross weight of the vehicle is Estimated some around (M=250 KG), hence the moment of the vehicle at 64 Kmph or 17.8 m/s that is-

$$P = M \times V$$
$$P = 250 \times 17.8$$
$$P = 4450 \text{kgm/s}$$

And the frontal impact force i.e.

$$F = P \times \Delta T$$
$$F = 4450 \times 1.10$$
$$F = 4895 \text{ N}$$

Now the calculated force were placed on the frontal part of frame by keeping the rear part fix on ANSYS the result along with the image as,

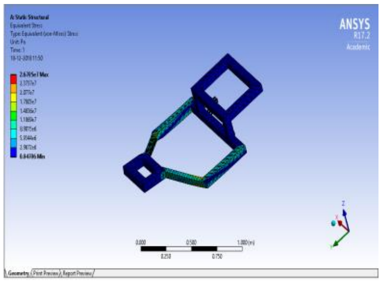
Fig. 1. Front equivalent stress

C. Rear Impact Analysis

The rear impact force is also calculated in the same way as remaining two. In this case the velocity of collision were taken 50kmph or 13.8m/s by the calculations and also as according to the ENCAP standards .the calculations are as-

P = M × V

P = 250 × 13.8

P = 3450kgm/s

And the rear impact force-

F = P× ΔT

F = 3450 × 1.10

F = 3795 *N*

Hence the calculated value of the rear impact force was placed on the rear part of the frame while keeping the frontal part fixed. The analysis result is shown as,

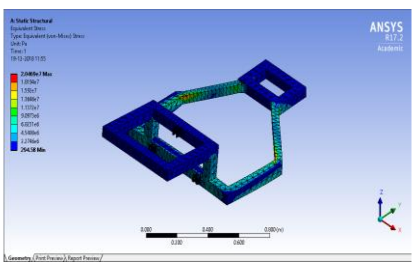
Fig. 2. Rear equivalent stress

D. Side Impact Analysis

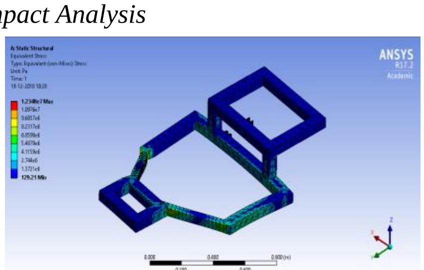
Fig. 3. Side Equivalent stress

In the case of collision by side impact the value of the impact force generated is calculated in the same way as in front impact. For the side impact the velocity of vehicle is taken 48 kmph or 13.3m/s according to ENCAP Standard and then the force is calculated i.e.

F = P × ΔT

Where,

P = M × V

P = 250 × 13.3

P =3325kgm/s

The side impact force

F = 3325 × 1.10

F = 3657.5 N.

Hence the calculated force was placed on one side of the modal of frame while keeping another side fixed and the stresses were simulated the image is shown as,

Table 3
Analysis result

Factors	Front	Rear	Side
Impact force	4895 n	3795 n	3657.5 n
Stress generated	267.05 mpa	204.69 mpa	123.48 mpa
Total deformation	0.6756 mm	0.5686 mm	0.1742 mm
F.O.S	1.011	1.31	2.18

E. Steering system calculations

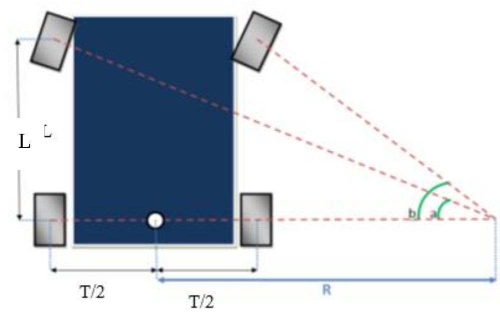

Fig. 4. Ackermann steering mechanism

Considering the turning radius of 3m, using the Ackerman equation

Wheelbase (L): 1095.25 mm

Track width (T): 863.6 mm

Actual Turning Radius (R): 3000 mm

Ackerman Angle:

Tan A=Track width/2/Wheel base

=863/2/1095

A=21.5°

INNER ANGLE:

Tan A = L / (R - T/2)

= 1095.25 / (3000-863.6/2)

Tan A = 0.4263

A = Tan`(0.4263)

A = 23.09°

OUTER ANGLE

Tan B = L /(R + T/2)

= 1095.25 / (3000+863.6/2)

Tan B = 0.3190

B = Tan `(0.3190)

B = 17.7°

Actual Turning Radius:

= T/2+L cosec (23.09/2 + 17.7/2) = 3573.92 mm

F. Braking systen calculation

The calculations for the selected components of the brake system were done by considering a driver input force of 70lbs (i.e.., and mechanical leverage as 4:1. For better stability of the vehicle during braking, the main aim was to have minimum weight transfer along with an optimum stopping distance. Iterations were performed accordingly.

Inputs Gross weight (m): 200 kg
Deceleration in g's (a): 0.9 g
Height of C.G (h): 254 mm
Wheel base (b): 1095 mm
Initial velocity (u): 6.94 m/s
Final velocity (v): 0 m/s

The braking system exists to convert the energy of a vehicle in motion into thermal Energy, more commonly referred to as heat.

From basic physics, the kinetic energy of anybody in motion is defined as:

Kinetic Energy = ½ Mv * Vv2
Mv = 200 Kg
Vv = 25 Km/hr
= (25 * 1000) / 3600
= 6.94 m/s
K.E = ½ (200 * 6.94) = 4.816 KJ.

Where,
Mv = the mass (commonly thought of as weight) of the vehicle in motion.
Vv = the velocity (commonly known as speed) of the vehicle in motion.

Force applied on brake:
Fd = 70 lb.
= (70 * 0.454) * 9.81
= 311.76 N

The Brake Pedal:
The brake pedal exists to multiply the force exerted by the driver's foot. From elementary statics, the force increase will be equal to the driver's applied force multiplied by the lever ratio of the brake pedal assembly:
Fbp = Fd*(L2/L1)
Fd = 305.58 N
Assume,
L2 = 6m
L1 =1m
Fbp = 311.76 * (6/1)
= 1870.56 N
Where, Fbp = the force output of the brake pedal assembly
Fd = the force applied to the pedal pad by the driver
L1 = the distance from the brake pedal arm pivot to the output rod clevis attachment.
L2 = the distance from the brake pedal arm pivot to the brake pedal pad.

2. Pressure in master cylinder

It is the functional responsibility of the master cylinder to translate the force from the brake pedal assembly into hydraulic fluid pressure. Assuming incompressible liquids and infinitely rigid hydraulic vessels, the pressure generated by the master cylinder will be equal to

Pmc = Fbp / Amc

Normally the diameter of master cylinder of brake is 0.785 to 0.994 inch.
We assume d=0.785 inch =20mm
= Fbp / (π/4* d^2)
Amc = 3.14 * 10-4 m^2
Pmc = 1870.56 / (3.14 * 10-4)
= 5.95 * 106 N/m^2
Where, Amc = Area of the master cylinder.
Pmc = the hydraulic pressure generated by the master cylinder
d = diameter of the master cylinder piston.

Stopping time (t)= (v-u)/a=6.94-0/0.9*9.81
=0.7860 sec

3. Conclusion

We used the finite element analysis system to evaluate, create, and modify the best vehicle design to achieve its set goals. The main goal was to increase its ground clearance and to reduce its emissions to make it pollution free with the use of electrical battery.

References

[1] Alireza Zakariazadeh a, Shahram Jadid a, Pierluigi Siano , "Multi-objective scheduling of electric vehicles in smart distribution system", December 2013
[2] C.-C. Liang, C.-H. Yu & C. C. Wu, "A study on torsional stiffness of the competition go-kart frame, 2007
[3] Prashant Tiwari, Hemant Porwa, "Go Kart Championship-2013 RIT Indore", 2013.
[4] Anjul Chauhan, Lalit Naagar, Sparsh chawala, "Design and Analysis of a Go-Kart", September 2016.
[5] Alejandra de la Guerra Luis Alvarez, "Brushless DC motor control with unknown and variable torque load", 2018
[6] S. Nagendhra, A. S. Rami Reddy, Preetham Kumar G V, "Workability Study on Austempered AISI 1018", 2018.
[7] Gert Berckmans, Maarten Messagie, Jelle Smekens, Noshin Omar, Lieselot Vanhaverbeke and Joeri Van Mierlo , " Cost Projection of State of the Art Lithium-Ion Batteries for Electric Vehicles Up to 2030", September 2017.
[8] Electric vehicle Wikipedia.
[9] Takaaki Abe, Kazuki Miyatake,Yoshio Shimoida and Hideaki Horie, "Research and Development Work on Lithium-ion Batteries for Enviromental Vehicles" May 13-16, 2009.