Design and Fabrication of Electric Vehicle

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Abstract: In today's life vehicles are important factor. But due to environmental impact there is limitation of utilization of conventional vehicle. Places like airport, hospital, college campus gasoline vehicles are ban because of pollution. We observe the difficulties of old people, physical handicap and patients in public places. To avoid such problem electrical vehicle play important role. Generally we preferred electric cars which is driven by battery powered electric motor. Those vehicle are manufactured for above concern. The numbers of electric vehicles are increasing day by day because of environmental concern and high gasoline price. In this paper we focus on electrical tri wheeler. For this tri wheeler 36V lead acid battery is used and it is driven by PMDC motor. Controller is the brain of electric vehicle that controls all the functions of electrical accessories. In this paper we discuss about structural designing and fabrication of electrical tri-wheeler.

Index Terms **– Chassis, PMDC motor, PMDC motor controller, Battery, Throttle, Brakes.**

I. INTRODUCTION

In our world the energy conservation and environmental protection are growing rapidly, this development is fulfilled by Electrical Vehicle technology. These vehicles are able to provide emission free environment in urban transportation. Even we can consider conservation in power plant emission which produce fuel for gasoline vehicle. The use of electrical vehicle automatically reduce global air pollution. Therefore electrical vehicle creates good impact on transportation, environmental, economic aspects as well as give contribution in development of technology.

Therefore design and fabrication of electrical vehicle has become a major concern. Battery operated vehicle eliminate need of fuel and thus becomes economical. It gives silent operation which reduce noise pollution as well. As design of vehicle gives us idea about looks and geographical structure. This design will help us to construction and mounting of electrical component. Design is also important for weight calculation and other physical quantities like body shape structure and tire diameter. These quantities has effect on aerodynamic of vehicle. Calculation of many factors like battery rating, size of motor are made easy due to design. Places of sensors are easy to specify due to design.

II. LITERATURE SURVEY

On conduction of an experiment on design and development of electrical car to illustrate an implementation of electric vehicle technology on a small scale, we observed how to design an electric car with less cost and have studied about various components that is required to design an electric car. It shows that electrical battery operated vehicle is more suitable than other vehicle because the cost of the electricity is low and also maintenance cost is less. Also we got an idea about how to calculate the torque required to move the vehicle. In this study we understand the basic principles of chassis designing, steering system, caster, camber, drift, acceleration, top speed and performance tuning of the vehicle.

On structural analysis of vehicle chassis frame, design modification for weight reduction were done for optimization of the vehicle chassis with constraints of maximum shear stress, equivalent stress and deflection of chassis under maximum load. Here we observed that how the chassis serve as a frame work for supporting the body and different parts of the automobiles. Here we analyzed how to design a chassis, its load withstanding capability and the calculations required for the chassis frame. This paper also gives idea about, how to modify the design for the required weight of vehicle.

III. PROBLEM IDENTIFICATION

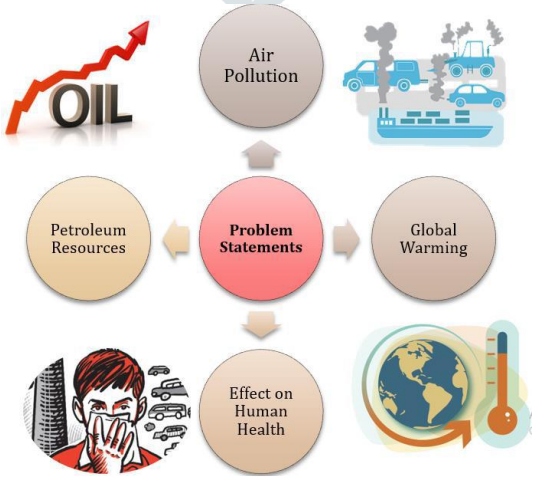

Fig (1): Problem Identification.

Current scenario indicates that fossil fuels are depleting rapidly because of overuse of fuel vehicle. Generally the main fuel of conventional cars are petrol and diesel. Because of these fuel cause heavy damage to environment. The emission of gas like HC (hydrocarbon), CO (carbon monoxide) and NOx are contributing to increase global warming and dangerous to human being. There are many alternative for fuel like biogas, natural gas, bio diesel, peanut oil, linseed oil, rapeseed oil, sunflower oil, etc.

The electric vehicle play important role to boost automobile in advance generation. Mostly electrical vehicle are driven by batteries. But the problem seen in this is it require steady long time to charge. It leads towards consume more conventional power for generation of electricity. System advancement and developments are made nowadays to use more renewable energy resources so as to consume less conventional power from utility for charging the vehicle. Use of solar cells and wind power for charging the vehicle battery can be done which will considerably reduce the fossil fuel use for conventional power generation, greenhouse emission, etc.

IV. METHODOLOGY

The design and fabrication work of electric vehicle start with the collection of data regarding the need for different EV components, chassis design and strength, battery power calculation, selection of motor, etc. the flowchart describe the plan of action carried out in order tips on discipline to design and Fabrication of the car from the development stage. After literature survey, brainstorming session was conducted to decide on possible features to be incorporated in the electric car.

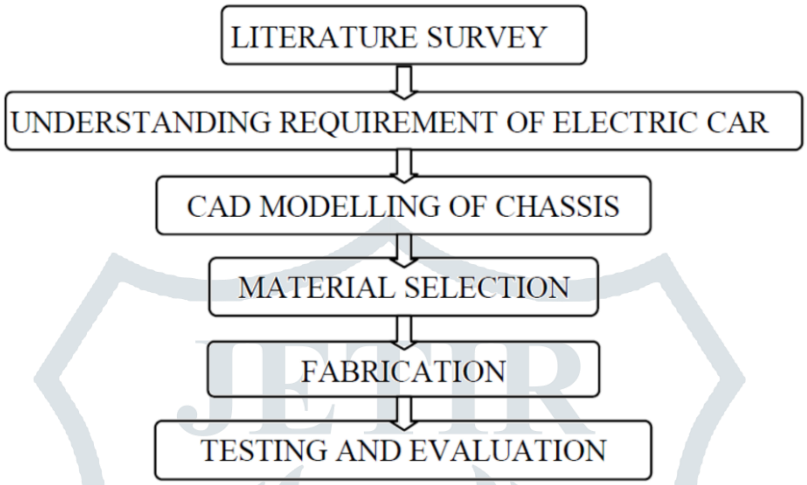

Fig (2): Methodology and Flow of design implementation.

V. SYSTEM DEVELOPMENT, DESIGN AND FABRICATION

The Design of chassis was developed in SolidWorks Software and the hardware model was developed. The design of components started from scrap defining dimensions for each and every component. Various models were developed and tried before actually confirming the final design. Due to several reasons such as material wastage, weight, cost effectiveness, time involved in fabrication, difficulties in manufacturing many design changes were made and obtained as final model as shown in the figure 2 and 3.

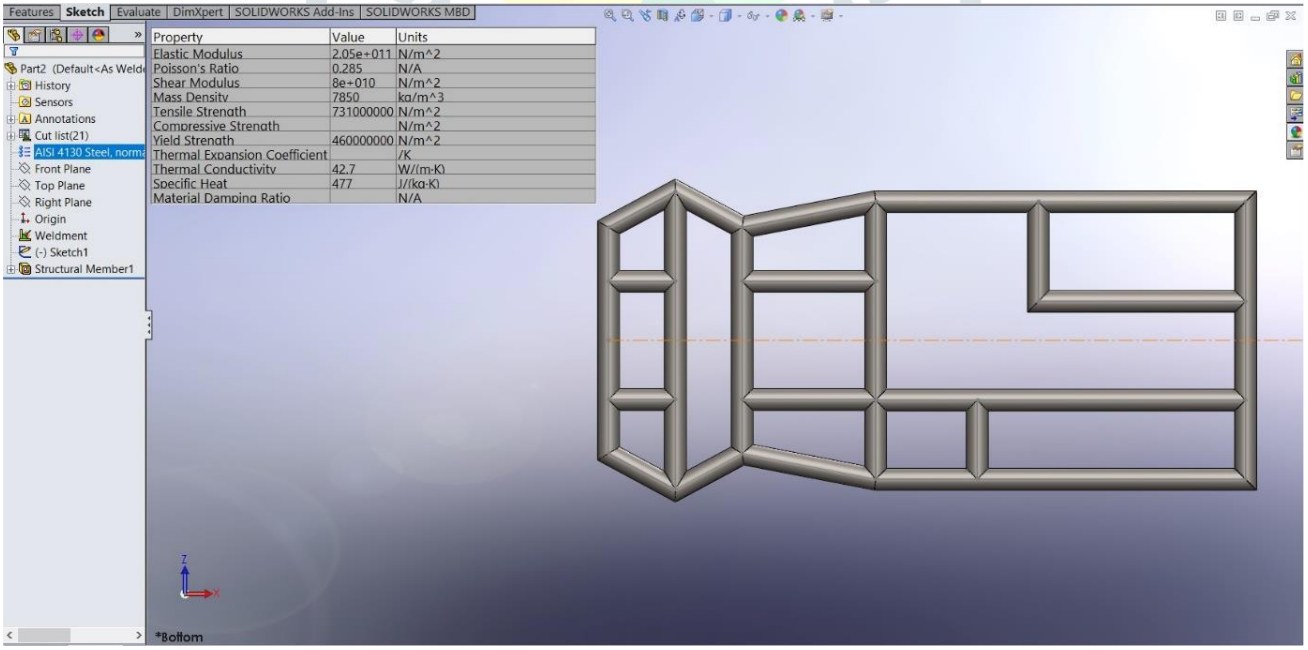

Fig (3): Top View of Chassis

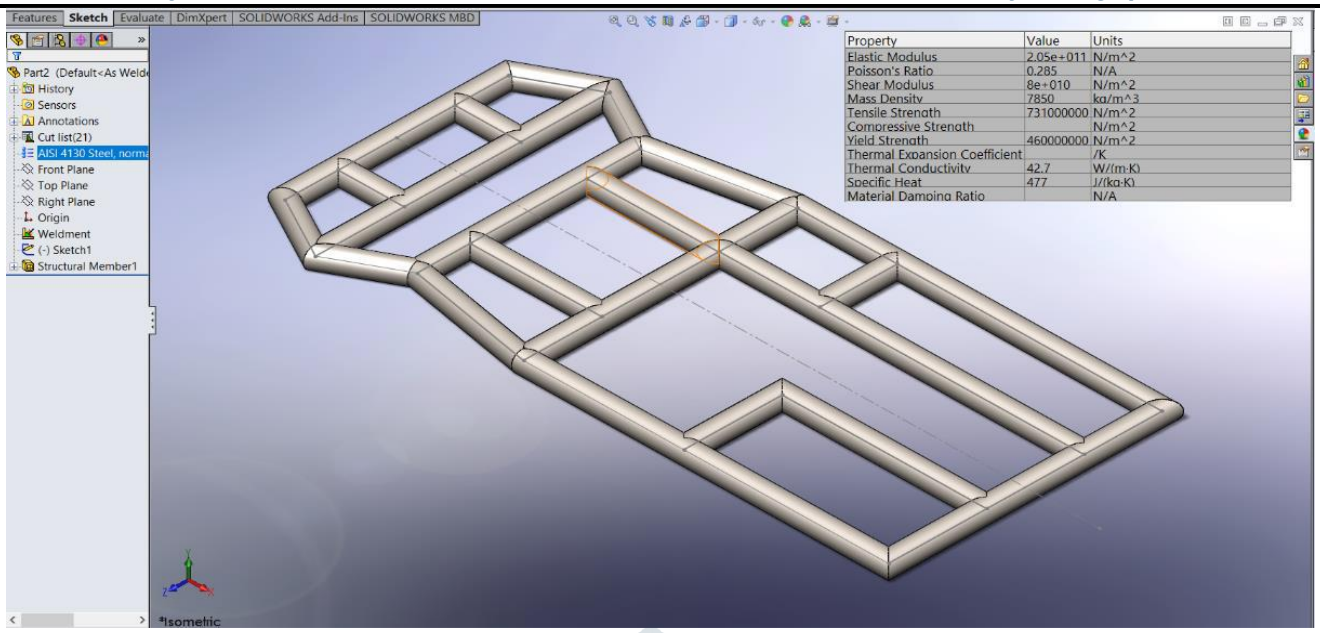

Fig (4): 3D View of Chassis

VI. DESIGN CALCULATION

A. CALCULATION OF GRADE RESISTANCE

Grade Resistance = Gross Vehicle Weight * sinø
Grade or inclination angle ø = 0° [Since the surface is Flat]
Grade Resistance = 90 * sin (0°)
Grade Resistance = 0 N

B. ACCELERATION FORCE CALCULATION

FA = m * a
m = Gross Vehicle Weight / g

Here,

FA = Acceleration Force
m = Mass of the vehicle
g = Acceleration due to gravity (9.81m/sec²)
a = Required acceleration
m = 90 kg
a = final velocity – initial velocity /time
Final velocity = 25kmph = 6.944m/s
Initial velocity = 0m/s
Time = 25sec
a = 6.944/60
a = 0.11573 m/s²
FA = 90 * 0.11573
FA = 10.415 N

C. CALCULATION OF ROLLING RESISTANCE

Rolling Resistance = Gross Vehicle Weight * Crr

Here,

Gross Vehicle Weight is 90 kg = 882.9 N
Co-efficient of Rolling Resistance is 0.015 (Concrete-Fair)
Rolling Resistance = 882.9 * 0.015
Rolling Resistance = 13.2435 N

D. CLACULATION OF TOTAL TRACTIVE EFFORT

TTE = Rolling Resistance + Grade Resistance + Acceleration Force
TTE = 13.2435 + 0 + 10.415
TTE = 23.6585 N

E. CALCULATION OF TORQUE REQUIRED ON THE DRIVE WHEEL

Torque = Rf * TTE * r (wheel)
Rf = Friction factor = 0.7
r (wheel) = Radius of the drive wheel = 0.36m
Torque = 0.7* 23.658 * 0.36
Torque = 5.9618 Nm

VII. VEHICLE OPERATION SUMMARY

A battery bank with capacity 36V (12V * 3 nos. = 36V), 65Ah is connected to 36V, 1000W Permanent Magnet DC Motor using 16 sq. mm copper wire so as to withstand the load. This motor arrangement is connected to shaft with the help of chain transmission and gear arrangement.

Initially the PMDC motor draws power from the battery for starting at idle speed when acceleration is given through Throttle. Once ignition power lock is made on, the power from the battery is allowed to flow to the motor through controller circuit as per the acceleration requirement. As the motor starts rotating, the power is transferred from motor to the rear wheel shaft with the help of chain transmission which then drives the vehicle.

As the battery drains with use and time, solar charging and plug-in charging facility is provided to charge the battery.

VIII. FINAL ASSEMBLY

As per the above specifications the vehicle chassis was designed and components such as motor, batteries, controller and accessories were mounted. Thus the vehicle has been fabricated and components were painted. The fully assembled vehicle was tested on flat road under different load condition. Tables below shows the experimental results.

The real photographic view is as shown in figure below which also includes the side and front view.

Fig (5): Photos of actual assembly

IX. RESULTS

As per design specification, battery rating, motor capacity and chassis design fully assembled vehicle was tested on flat road under different load conditions (depending on weight and number of persons carried) the following results were obtained:

Case I: For gross weight of 120 kg (2 persons) and 450 m distance.

Table 9.1: Results for 120 kg load.

Sr. no.	Current (A)	Voltage (V)	Time (min)
1	0	37.8	0
2	16	37.6	0.30
3	16	36.8	1
4	17	36.9	1.30
5	20	33.6	2
6	14	36.3	2.30
7	21	33.8	3
8	24	36.7	3.30

Case II: For gross weight of 167 kg (3 persons) and 900 m distance.

Table 9.2: Results for 167 kg load.

Sr. no.	Current (A)	Voltage (V)	Time (min)
1	0	37.5	0
2	22	37.0	0.30
3	22	35.7	1
4	18	35.3	1.30
5	21	32.5	2
6	24	31.7	2.30
7	16	36.0	3

Case III: For gross weight of 210 kg (4 persons) and 2500 m distance.

Table 9.3: Results for 210 kg load.

Sr. no.	Current (A)	Voltage (V)	Time (min)
1	0	37.1	0
2	26	36.5	0.30
3	22	36.0	1
4	14	35.8	1.30
5	16	33.4	2
6	20	35.9	2.30
7	24	34.1	3
8	22	33.9	3.30
9	20	34.0	4
10	20	34.1	4.30
11	20	34.4	5
12	18	35.5	5.30

X. FUTURE SCOPE

We can further develop more features in this car. This car can be fabricated for the purpose of self-charging the battery when the vehicle is in moving condition with the help of wind turbine and dynamo as well. This vehicle uses a Lead acid battery which needs replacement after some period. Instead of using Lead acid battery, we can switch over to Lithium-ion batteries which provides more life cycles and they are much reliable. We can use high rated DC motor to drive the high loads as possible. New inventions of lighter but stronger materials like carbon fibers, High strength polymers can help in reducing the overall weight of the car and thus smaller sized high efficiency motors can be used. In future, we can add solar panels to this car to make it more economical. We can encrypt the idea of multipurpose vehicle similar to existing, so that we can develop the electric car to the next level.

XI. CONCLUSION

The car is much comfortable which supports the driver for easy riding. It is very less weight compared to a small car and provides better safety than a two-wheeler. This project provides flexibility in operation and noiseless operation. The scope of this project lies in fully determining and understanding the functioning of car. This project gives solution to the old problems, where the most common problem arising from existing electric car is the recharging system. The conventional system leads to consume more conventional power and time.

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REFERENCES

[1] Design and Development of Electric Car by Kusekar S.K., Bandgar P.M, Andhale P.S, Adlinge G.H, Gaikawad V.V, Dhekale S.P., International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 4, April 2015.

[2] Design and Fabrication of Self Charging Electric Vehicle by Srinivasa Kannan Jeyakanthan, Sudharshan V, International Journal of Innovative Research in Science, Engineering and Technology, An ISO 3297: 2007 Certified Organization, Vol. 6, Issue 9, September 2017.

[3] M.R.El-Sharkawy, M.A.Mourad, M.M. M. Salem, M M. Youssef / International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622 Vol. 1, Issue 2, pp.092-101, Construction of an Electric Vehicle Implemented in Egypt.

[4] Hybrid Electric Vehicle Propulsion System Architectures of the e-CVT Type by John M. Miller, Fellow, IEEE, IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 21, NO. 3, MAY 2006.

[5] The State of the Art of Electric and Hybrid Vehicle by C. C. CHAN, FELLOW, IEEE, PROCEEDINGS OF THE IEEE, VOL. 90, NO. 2, FEBRUARY 2002.