

Design and Fabrication of Tri-Wheel Single Seater Electric Scooter

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ABSTRACT: The major objective of the study is to design and fabricate a tri-wheel single seater electric scooter that would be used as a multi-purpose transportation medium in our acropolis institute main campus. The project is developed to understand and learn about electric vehicles and their basic fundamentals. The project developed is made up of locally available materials. It has three key important parts, the hub motor, the battery and the controller module. It is especially useful in indoor use, within the vicinity of a campus, shopping mall and the like. It is designed for single person only. The hub motor is kind of engine for electric scooter which drives the whole scooter while the battery is the fuel source for scooter to run the hub motor and the controller is the brain which commands the hub motor, lights, sensors, horn etc. The scooter is powered using a 48V rechargeable li-ion battery and can run in forward and reversed directions. The scooter provides a cost-effective approach to providing individualized transport system in a variety of applications.

KEYWORDS: Electric, tri-wheel, single seater, scooter, electric vehicles

SUBJECT AREAS

Education, mechanical engineering, electric engineering

1. INTRODUCTION

For thousands of years, human transported themselves primarily by walking and running. As the time passes, human developed various methods of transportation. They learned to ride horses, elephants and camels, etc and now we use faster modes of transportation which is safe, reliable, comfortable and convenient. However, they also leave behind a terrible trail of environmental damage since typical automobiles uses readily available fossil fuel from various sources.

These days one of the major problems faced by our country is the increased demand and high price of fuel with the increase in number of vehicles on the road. The more and incomplete combustion of fossil fuels are responsible for air pollution. The health risk of air pollution is extremely serious. Poor air quality increases respiratory ailments like asthma, bronchitis and lungs disease which burdens our health care systems with substantial medical cost. Particulate matter is singlehandedly responsible for up to 30,000 premature deaths each year.

Our research is about the design and fabrication of an economical, compact and eco-friendly or easy to ride electric vehicle for the large campus where walking consumes a lot of time, but the vehicle can be used according to one's need. The vehicle is a front wheel drive battery operated scooter, specially designed with the help of 3D designing software tools after a lot of research and calculation work.

EV's first came into existence in the mid19 century and continuously developing till the time. Due to the benefits from EV's many of biggest sectors turn towards electrifying such as railways, small vehicle manufacturers and many other.

1.1 LITERATURE REVIEW

The Navigant Research forecast that the worldwide sales of electric motorcycles and electric scooter will reach 6 million annually starting from 2015 to 2023, and this will total up the rapid increment of the sales is about 50 million. Driven by rising fuel prices and increasingly congested city streets, more consumers are starting to turn to two-wheel vehicles, including electric motorcycles (e-motorcycles) and electric scooters(e-scooters).



Scooters are classified as subclass of motorcycle. Nowadays, there are variety type of scooters we will find on city streets and park. The main parts of electric scooters are main frame, wheel, tire, brake system, battery and charger, motor, on/off switch, speed control, and one way bearing. This type of scooter is easy to operate and easy to carry anywhere since it is small and light. It can be use either for indoor or outdoor, but most people used it for outdoor/recreation activities.

Generally, there are several types of scooter operation. It is depending on how people want to use it. It may be operated by engine power, electric power or foot power. Each type of them carry their own advantage and disadvantage. However, this electric scooter is the common choice since it is light, cheaper, and easy to manufacture. It captures many eyes out there and increasingly rising sales day by day.

1.2 THE RESEARCH PROBLEM

The major objective of this undertaking is to design and fabricate an Electric Tri-Wheel Scooter. Specifically, the study aims to answer the following:

- 1) Design a detailed 3D model of scooter with complete analysis.
- 2) Develop a tri-wheel scooter that has a forward and reverse operation.
- 3) Design a scooter that is easy to use and can be compared with other expensive brands available in the market today.

II. METHODOLOGY

The methodology includes following point: -

- Survey
- Cost
- Design
- Analysis
- Manufacturing
- Assembly

2.1 SURVEY: -

Do some reviews regarding to project title. The team started searching for various parts related to the project. After done with this, we started doing research on material of the components that we will be using.

LIST OF THE COMPONENTS AND MATERIAL

SR No.	PART NAME	MATERIAL/SPECIFICATION	QUANTITY
1	Rectangular hollow pipe	AISI 1018/(20*40)	As required
2	Hub motor with tyre	350W	1
3	Battery	48v li-ion	1
4	Controllor module	48v	1
5	DC to DC converter	12v	1
6	Wheel	STD	2
7	Digital Throttle	48v	1



8	Electric brake lever	12v	2
9	Disc brake	STD	2
10	Seat	STD	1
11	Front and rear light	STD	1
12	Battery charger	48v	1
13	Front shock absorber	STD	1

2.2 COST: -

After surveying the market, we have tried to keep the cost of our project to a minimum, we also decided which part is to be bought from the market and which part is to be fabricated as it will become an economical. The estimated cost of overall project is around 30,000 Rs.

2.3 DESIGN: -

Do some sketching of electric scooter based on what have been explain by the guide. The aim is to make a light weight and ergonomic design.Finally, the 3D CAD model of the scooter is created with detailed dimensions of all part.

2.4 ANALYSIS: -

Analyze the design for stress strain structure by using ANSYS, if some of the parts are under stress strain failure then refine the dimensions of the model.

2.5 MANUFACTURING: -

We have to manufacture the parts like main frame, battery cage and cover. Nuts-bolts are used wherever required, some of the parts are welded for perfect finishing and strength.

2.6 ASSEMBLY: -

In the end all parts are to be assembled together and painted well on aesthetic point of view.

III. VEHICLE SPECIFICATION:

Wheel base	590.34mm
Width	640mm
Ground clearance	100mm
Weight	110kg(assuming)
Battery type	lithium ion



Figure 1. Conceptual Model

IV. CALCULATION

The calculation part consist of various calculations for rolling friction, drag force, power, motor rpm, torque required on wheel, battery calculation etc which are very important or can say primary step in any vehicle design.

4.1 ROLLING FRICTION

$$F_r = CW$$

Where, F_r = rolling friction

C = coefficient of rolling resistance

$$W = m \cdot a$$

$$F_r = 0.004 \cdot 110 \cdot 9.81$$

$$= 4.3164 \text{ N}$$

4.2 DRAG FORCE

$$F_d = C_d (1/2) \rho (V \cdot V) A$$

Where = F_d = drag force

= C_d = coefficient of drag

= ρ = density

= A = characteristic frontal area of body

$$= 1\text{m}(\text{height}) * 0.64(\text{width})$$

$$= 0.64\text{m}^2$$

$$= F_d = 28\text{N}$$

4.3 POWER

$$P = F_t * v / n$$

Where P = Power

F_t = total force

n = efficiency

v = velocity

$$P = (4.3164 + 28) * (9.72 / 0.85)$$

$$= 369.02 \sim 370\text{W}$$

4.4 MOTOR RPM

= wheel rpm (hub motor)

For 1 revolution of wheel we will cover the distance of 0.785m (10inch tyre)

At 35 kmph = 35000m/h

= 35000/60 meter/minute

= 583.33 m/m

Wheel rpm = 583.33/0.785

= 743.09

Motor rpm = 800rpm

4.5 TORQUE REQUIRED ON WHEEL

$$V = u + at$$

$$V = 0 + a(20)$$

$$V = 0.48 \text{ m/s}^2$$

$$F = ma$$

$$= 120 * 0.48 = 57.2\text{N}$$

Torque max.

Radius of tyre = 10inch = 0.254m

$$F * r = 57 * 0.254$$

$$T_{\text{max}} = 14.6\text{Nm}$$

4.6 BATTERY CALCULATION

Motor power = 350w

Voltage = 48v

Ampere required is calculated as

Let take xA are required

Therefore,

$$48V * xA = 350w$$

$$xA = 350/48$$

$$xA = 7.29$$

for 1-hour usage and 80% battery efficiency

$$350w * 1hr = 350 whr$$

$$350w * 1.20 = 420whr \text{ (80\% efficiency)}$$

Therefore

For Ah calculation

$$420/48 = 8.75Ah$$

If motor runs at full speed for 1hr i.e. 35kmph it requires 8.75Ah capacity battery

For 70 km it requires 17.5Ah = 20Ah (say)

Hence, we required a 20Ah battery at 48V

V. STRUCTURAL AND MODEL ANALYSIS OF SCOOTER FRAME

This analysis discusses the stress and deformation developed in chassis during the different load cases and identifying the failure modes by the model analysis.

5.1 METHODOLOGY: -

collect the material property of the frame and its allied parts. Carry out the design calculations and assume the required parameters. Model the frame structure in the SOLIDWORKS for different dimensions. Finite element meshing of these models to be carried out in ANSYS. The element properties can be defined either in the HYPERMESH or in the ANSYS.

In this project we have defined the elements and load, parameters at ANSYS itself.

These meshed models are taken in to the ANSYS solver for solving. Record the result and analyse the same.

5.2 MESHING IN ANSYS: -

The following are the no. of elements and the nodes created for the different models.

SNO.	MODEL NAME	NO. OF ELEMENTS	NO OF NODES
1.	SCOOTER FRAME	26224	52169

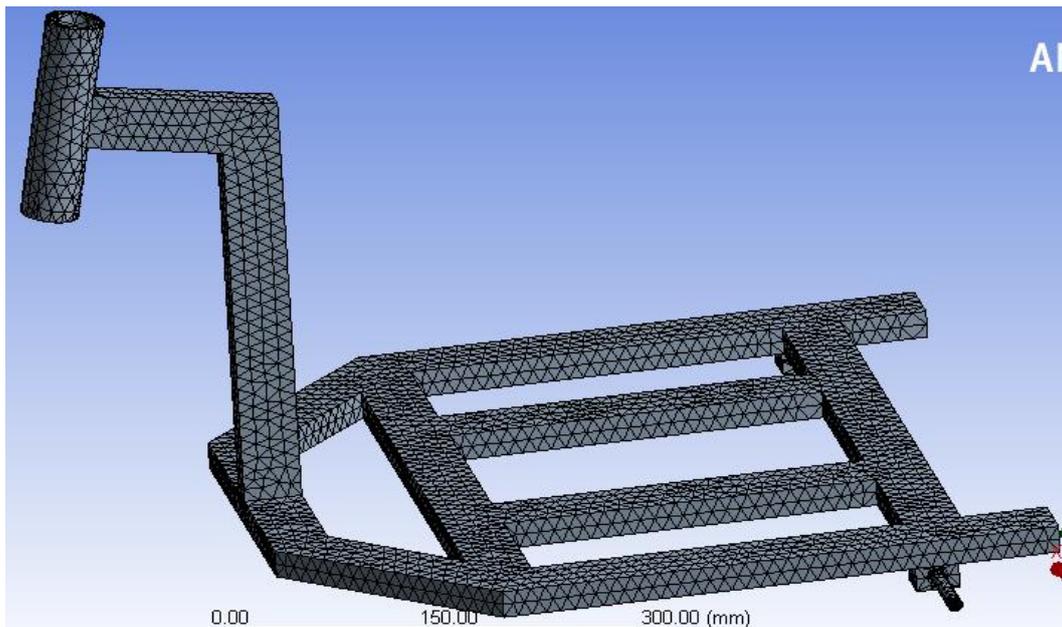


Figure 5.2.1 Meshing of frame

5.3 STATIC AND STRUCTURAL ANALYSIS

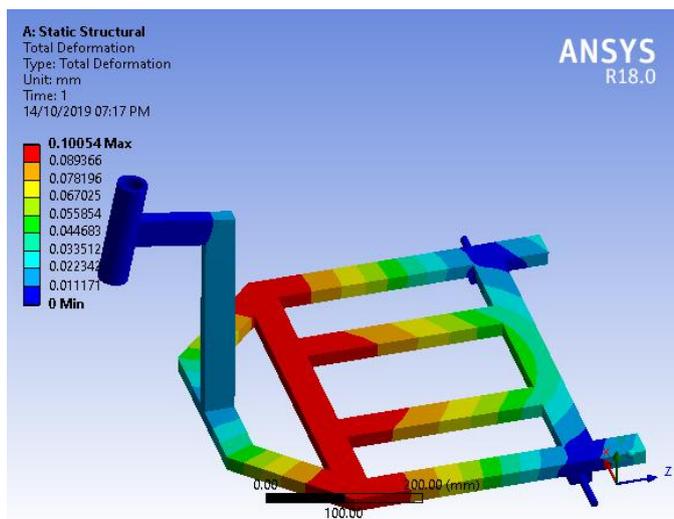


Figure 5.3.1 total deformation

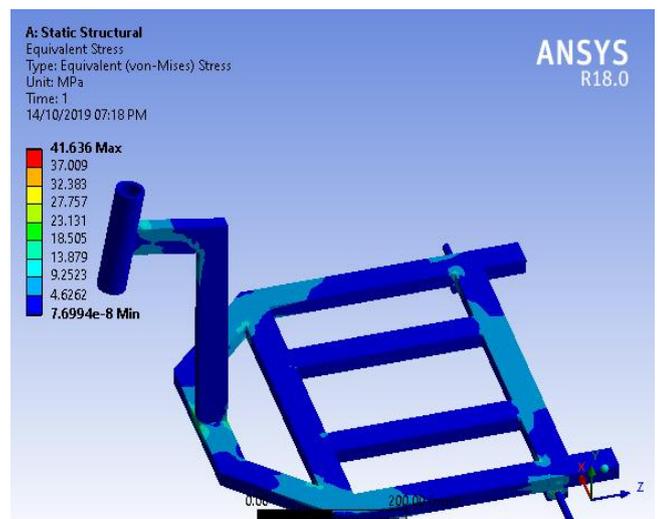


Figure 5.3.2 equivalent (von-mises) stress

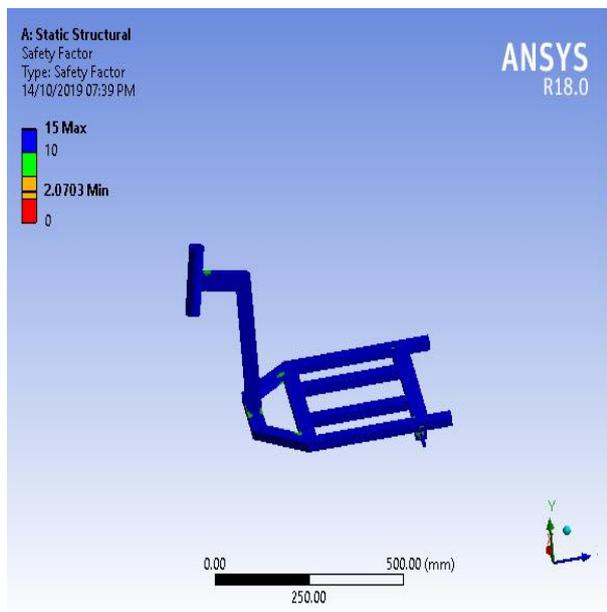


Figure 5.3.3 safety factor

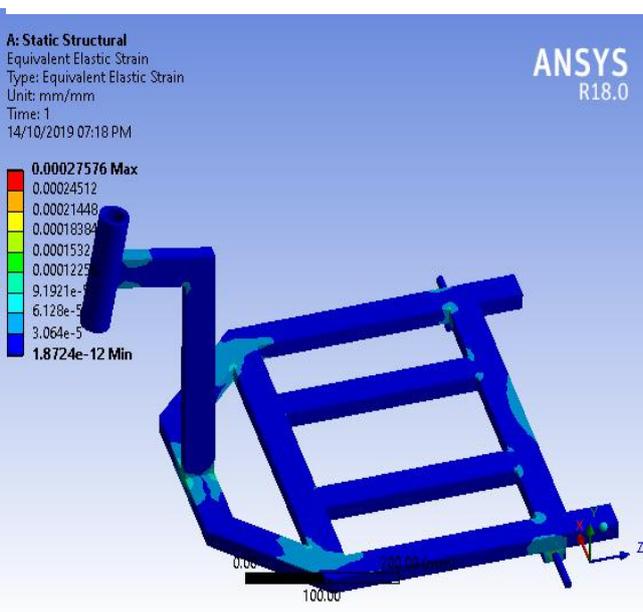


Figure5.3.4 equivalent elastic strain

VI. CONCLUSION

This project brought together several components and ideas to achieve a common goal: to prove that it is possible to build a Tri-wheel electric scooter by own. By this project we learn about the concepts of electric vehicle and how it works, various manufacturing methods and lots of more. Our team put a lot of time into this Tri-wheel electric scooter to make sure that it was perform best it possibly could. Some of the conclusions are:

- The scooter is designed as compact as possible to take less space that makes it easy to park.
- The scooter is designed for 36-48 volts hence it consumes less power.
- As electric hub motor is used, it creates less noise.
- By using this vehicle, we can move on limited space easily.

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