Design And Development Of Three Wheeled Campus Vehicle

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Abstract: In today's world, infrastructure of College and Industries are becoming large so if one has to travel or visit from one place to another he has to walk long distance and sometimes it becomes very hasty and inconvenient. Sometimes after too many traveling in campus it causes strain and pain in body. So to travel these distances two-wheeled or three wheeled electric scooter like Segway PT, Irrway were introduced. But, these scooters are very costly such as they starts from □ 50,000 Another problem with those vehicle is that they are difficult to handle when we drive first time. So in alternate to this product we developed whole newly designed product and this is Reliable, Ecofriendly, Compact vehicle for campus. It's utilities are college campus, Airports, Industries, Recreational Parks, Sanctuaries, Museums, Palaces, Villas etc. So Our research is on design and development of three-wheel campus vehicle and also its multipurpose utility among the society.

Index Terms: Elec-trike vehicle, Campus Mobility Solution, Campus Vehicle, Three Wheel Campus Vehicle, Front wheel drive, Electric Vehicle, Campus Transporter, Personal Mobility.

1 Introduction

Our research is about the design and development of an economical, compact and eco-friendly electric vehicle for the large campuses where walking consumes a lot of time. It is a front wheel drive battery operated vehicle, specially designed in Solid Edge 3D designing software for indoor mobility in large campuses. It is front wheel drive with In-wheel hub motor mounted on front of the vehicle. Simultaneously this arrangement reduces Front wheel is provided with a drum brake. Four batteries are used (each of 12 volts 20 Ah) total 48 volts 20 Ah is supplied to the front hub motor of 250 watts. Also strength and stress analysis is performed on Solid Edge software to analyzed the material yield limit.

Fig (1)

Another important and integral part of this project is that it will contribute in the 'MAKE IN INDIA' concept. Project is primarily designed for green mobility thus it will also help to control the pollution which is one of the major crises nowadays. Our research consists of following methodology:

1) Study of various applications of campus vehicles.
2) Literature Review
3) Formulate the design requirement and specification of Campus Vehicle.
4) Part modelling and assembly of Campus Vehicle in Solid Edge.
5) Strength and stress analysis of Campus Vehicle.
6) Fabrication of Campus Vehicle.
7) Testing of Campus Vehicle at different conditions.
8) Evaluation and suggestion of further action/research.

2 Literature

It is in this seen that the researchers choose to develop an electric scooter that can help ease the problems of conventional transportation by being a much cheaper alternative than gas powered scooters. The study aims to underscore the importance of tapping alternative and clean energy sources to address various energy issues confronting the global environmental landscape. This burning desire of the researcher leads to the realization of the major objective of the study, which is to design and develop an Electric Tri-Wheel Scooter. Increasing interest from large manufacturers and decreasing battery costs offer an opportunity to drastically change the current market landscape for electric motorcycles and electric scooters. With well-known players such as Yamaha and Harley Davidson poised to expand offerings into this space, and low battery costs making products more affordable, sales of these vehicles are expected to experience stable and continuous growth in the coming decade. According to a recent report from Navigant Research, sales of electric motorcycles and scooters are expected to total 55 million from 2015 to 2024. In the India recently three-wheel electric scooters, designed for short distance mobility, will be introduced on an experimental basis at the Mysore palace and the zoo during the upcoming Dashhera season. The manufacturers are also in talks with the Tourism Department about introducing the scooter in different places of tourist interest across the State. After reviewing this we can finally say that wheel motor in electric scooter can be effectively used as front wheel drive. And it also occupies less space compare to conventional drive and having less weight which is major advantages of this motor. Also lead acid battery is suitable for small utility vehicle as it has low maintenance cost and large current density. Which directly said that it can suitable with our three-wheel campus vehicle. After this whole reviewing process, we started working our next phase of proposed methodology. The companies like Segway & Irrway have launched their electrical models since last few years. Their concept was very authentic and reliable for using in campus especially for the employees of organization. But, their price was very hefty and it caused much capital to invest for the large scale amount and that was not affordable by the buyers and dealers. And thus it became major problem and drawback for the companies that they couldn't even reach the break-even point for their production and eventually they were in loss.

3 PROPOSED WORK

After the topic of the project was decided and problem statement was defined the team started to study the different Literature which was directly or indirectly related to our project idea. The first step was to find and study the correct course of action that should be followed so that we become successful in completing the project within time limits. Thus we decided what was supposed to be done by whom and when. Each of the members started with the study of the project reports and journal papers which were related to our project. Then we identified the different types of mechanisms required in our project and then found various mechanisms to perform the required task. For this we studied different patents associated with the different mechanisms. After scrutinizing the mechanisms, the team started surveying of market for various parts related to the project. Then we started doing the research on materials of the components that we will be using. We also decided which part is supposed to be bought from the market and which part is to be fabricated as it will become an economical.

3.1 DESIGN

After reviewing and studying we finally came to know that what would be design. The aim is to make a light weight and ergonomic design. The whole vehicle is designed on Siemens Solid edge ST8 software. First we created a part modelling of components such as Frame Structure, Steering Column, Foot Platform, Front and Rear Wheels, Rear axle and Battery Cage. After it all parts are assembled in assembly modelling.

3.1.1 Frame

First of all, we fabricated the frame. A frame is made up of mild steel pipe of 38 mm diameter. Compare to other available frame structures such Solid bar section, square section, I section the hollow pipe structure has minimum weight and enough strength. Following image shows the fabricated frame.

Fig (2)

Battery cage is welded below the platform so that more floor space available. This arrangement also helps in lowering the center of gravity which is advantageous while fast turning. Back axle is 20mm dia. of solid bar.

3.1.2 Wheels

The front wheel is Brushless DC hub motor (Fig 3) and also a power source to drive the vehicle. It is also called as an In-wheel motor in which the motor assembly is comes inside the wheel itself. So there is no need of extra chain sprocket mechanism as motor is inside the wheel. This way arrangement reduces space for power drive mechanism and makes it more compact and light weight.

Fig (3)

Then the next step was to select the bearings and mounting on all the rear wheels. Retrofitted bearings (Fig 4) are mounted on the wheels by machining on the lathe machine to provide the space for the bearing on the hub of wheels.

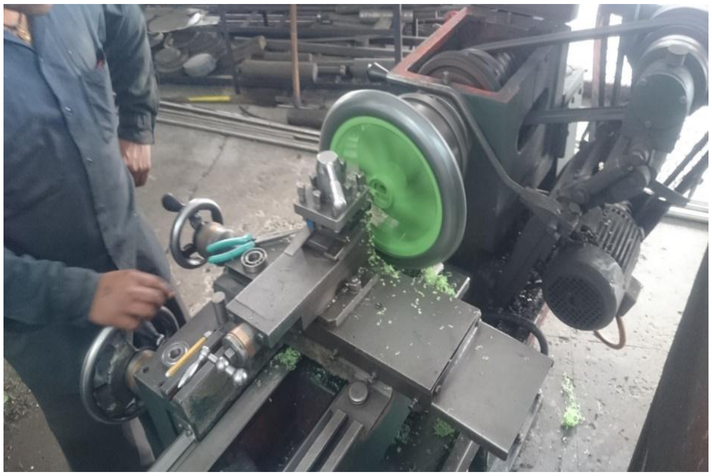


Fig (4)

3.1.3 Chassis

When all above parts are ready the next step was to assembling the chassis. As shown in the Fig (5) front and rear wheels are mounted, batteries are placed inside the battery cage at center. The battery supply is connected to front hub wheel motor makes it front wheel drive.

Fig (5)

3.1.4 Platform

A platform consists of two components. First one is 15 mm thick wooden sheet (Fig 6) and second is 4 mm thick mild steel sheet(Fig 7). A wooden sheet is mounted between M.S. sheet and frame. This arrangement insulates steel plates and motor wiring and ensures that they do not touches each other.

Fig (6)

Fig (7)

3.1.5 Final Model

In the end all parts are assembled together and painted well as an aesthetic point of view. Here is the actual model that we have built.

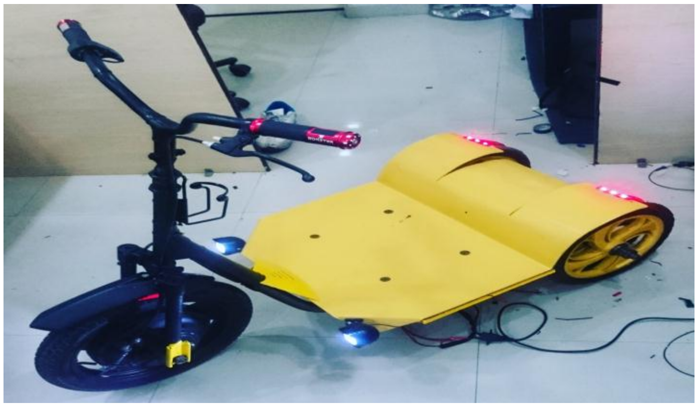


Fig (8)

3.2 STRESS AND STRENGTH ANALYSIS

After designing it is necessary to check whether design is safe or not against static and dynamic load conditions. Our prepared design is now tested in Solid edge ST8 software. As the platform and frame is the main parts that comes under various load condition. Therefore, only these parts are taken into consideration for analysis

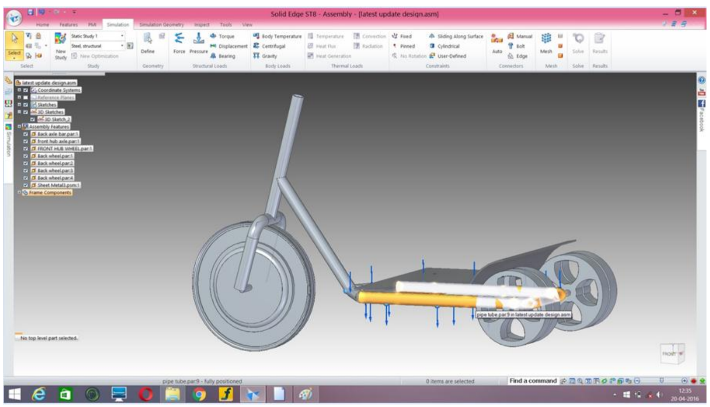


Fig (9)

After we did analysis on this software we got following results.

3.2.1 Study Properties

Study Property	Value
Study name	Static Study 1
Study Type	Linear Static
Mesh Type	Tetrahedral
Iterative Solver	On
NX Nastran Geometry Check	On
NX Nastran command line	
NX Nastran study options	
NX Nastran generated options	
NX Nastran default options	
Surface results only option	On

Table 3.1

3.2.2 Study Geometry

Solid Name	Material	Mass	Volume	Weight
Sheet Metal3.psm	Steel, structural	10.323 kg	1317922.140 mm^3	101168.184 mN

Table 3.2

3.2.3 Material Property : structural steel

Property	Value
Density	7833.000 kg/m^3
Coef. of Thermal Exp.	0.0000 /C
Thermal Conductivity	0.032 kW/m-C
Specific Heat	481.000 J/kg-C
Modulus of Elasticity	199947.953 MegaPa
Poisson's Ratio	0.290
Yield Stress	262.001 MegaPa
Ultimate Stress	358.527 MegaPa
Elongation %	0.000

Table 3.3

3.2.4 Loads

Load Name	Load Type	Load Value	Load Distribution	Load Direction	Load Direction Option
Force 1	Force	2e+006 mN	Per Entity	(0.00, -1.00, 0.00)	Along a vector

Table 3.4

3.2.5 Constraints

Constraint Name	Constraint Type	Degrees of Freedom
Fixed 1	Fixed	FREE DOF: None

Table 3.5

3.2.6 Mesh Information

Mesh type	Tetrahedral
Total number of bodies meshed	1
Total number of elements	4,831
Total number of nodes	10,001
Subjective mesh size (1-10)	3

Table 3.6

3.2.7 Displacement Results

Result component: Total Translation				
Extent	**Value**	**X**	**Y**	**Z**
Minimum	0 mm	409.963 mm	0.000 mm	-267.257 mm
Maximum	0.818 mm	572.473 mm	4.000 mm	16.738 mm

Table 3.7

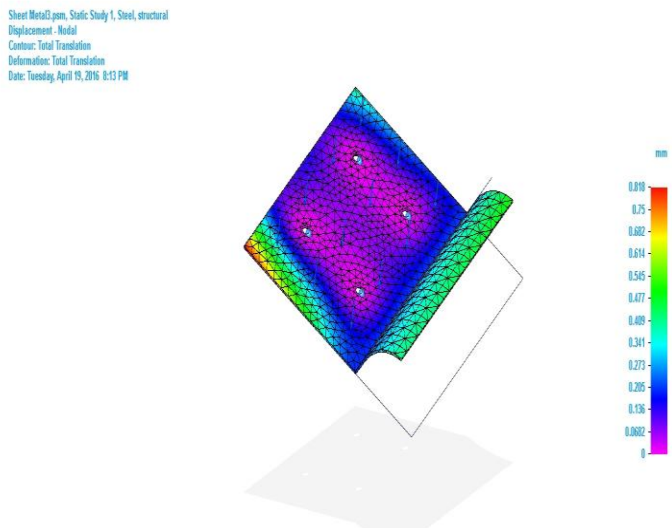


Fig (10)

3.2.8 Stress Results

Result component: Von Mises				
Extent	**Value**	**X**	**Y**	**Z**
Minimum	0.337 MegaPa	518.663 mm	104.372 mm	-473.442 mm
Maximum	91.7 MegaPa	412.892 mm	4.000 mm	-84.328 mm

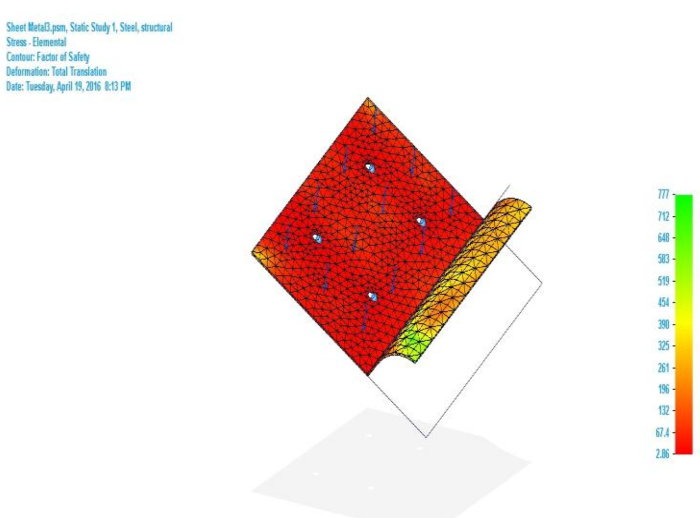
Table 3.8

3.2.9 Factor of Safety Results

Result Component: Factor of Safety				
Extent	**Value**	**X**	**Y**	**Z**
Minimum	2.86	412.892 mm	4.000 mm	-84.328 mm
Maximum	777	518.663 mm	104.372 mm	-473.442 mm

Table 3.9

Fig(11)



3.2.10 Conclusion

The above is safe as the observed von mises stress is of magnitude 92 Mpa which is well below our allowable stress limit of 174.5 Mpa. Therefore, above stress and strength results are taken by considering a weight of 200 kg on it. So it is directly concludes that vehicle is safe against load condition of 200 kg.

4 Conclusion and Future Work

After doing all above analysis and design calculation this paper clearly concludes that design is safe against corresponding various load conditions. We also noted down various parameter after testing to evaluate vehicle's performance. As already discussed the model satisfies the primary requirement of campus mobility. According to our team, to make the model viable the only possible option is to lower the weight and cost of vehicle. This may be achieved by studying various materials which are light in weight and removing material at unwanted or less critical regions. Another possible way is to use composite material at some of the areas as we can get the benefit of higher strength with less weight.

Following Observations are concluded after testing:

- Load carrying capacity: Max. 200 kg
- Speed: 40 km/hr. max
- Full charge time: 4-5 hrs.
- Full charge capacity: 50-55 km
- Weight: 56.8 kg
- Parking space: 0.69 m^2
- Ground clearance: 95 mm

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