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Research Paper

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Design and Fabrication of Foldable Tricycle

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***Abstract*—** the population of world is increasing and therefore the area is decreasing. The essential aim behind our project is to form a transportable vehicle which might be easy to handle by both genders and it should emit 0% emission, also keeping in mind the parking problems, we've decided to form a transportable suitcase vehicle which may be folded easily. So after the utilization, one can fold a suitcase and may carry it alongside him or her as a luggage and keep it in home or wherever there's place for the dimensions of suitcase. For power supply we've introduce DC brush motor, which cannot consume fuel for running thus preventing emissions problems. The Dc motor will work on batteries which may be charged reception. Since batteries are often charged, the project is more economical to bourgeoisie peoples. We've applied our engineering knowledge also as some references from Mazda's Suitcase car for the event of this product. It's an environment friendly, small & cheap project which may be hold by any household member and used within certain limits on public roads. While designing, we've targeting power, economy, ease and luxury of riding and low maintenance cost. Also we've targeting ergonomics factor to gives the user a cushy ride.

Keywords—Foldable Tricycle, Electric, Compact, Emission Free, Enviornment Friendly.

I. INTRODUCTION

As the population is increasing there is increase in demand of automobiles. Due to increase in automobiles, people will require space for driving and also for parking. As we know there is limited space available and due to increase in the number of cars on roads they are causing traffic congestion and with that they require a place for parking. In addition to these pollution is also a priority nowadays. The pollution is reaching new limits day by day. So the idea of a foldable and portable vehicle comes into concept.

The Suitcase Car is a car which can be folded in a suitcase; hence it does not require the parking place. The size of the suitcase car is 46"x 22", so it's five times smaller than normal car. Due to its compactness it can be used in various shopping malls, industries, college campuses etc. Portable car are often wont to cover short distance at many instances. It can be used for travelling purpose on the roads.

It was originally designed & inbuilt 1991 as a part of a design contest held at Mazda's Engineering department which was created with an easy idea to possess a 3-wheeled car inside a suitcase. Instead of waiting in line for a taxi or shuttle, just open your suitcase & chase away. It was powered by a 42 cc, 2 stroke engine, as suitcase car is running on the two stroke engine with the speed of 27 mph it can run for 2 hours with the fully filled fuel tank. It can be assembled in about 5 to 10 minutes & comes with functional brake lights & turn signals. Vehicle was rebuilt in 1994. Because of two stroke engine vehicle, it causes pollution as well as noise.

In order to beat above mentioned disadvantages within the present invention, we will replace engine with motor and battery. But it will add more weight to vehicle. Portable vehicle can be assembled and dissembled whenever required as well as we can carry it within the suitcase anywhere. If required we can assemble it in just less than ten minutes and drive it. In this portable vehicle we used three wheels, out of that the power is given to rear wheels via shaft and steering of the vehicle is done by front wheel. Power is produced in vehicle employing a DC brush motor.

If there is no use of vehicle then we can just simply disassemble the vehicle parts & can keep it in the suitcase. This portable vehicle can determine up to 90kg and its Maximum speed of 20 km/hr.

Rest of the paper is organized as follows, Section I contains the introduction of topic. , Section II contain the related work of foldable tricycle, Section III contain the objective of topic, Section IV contain the methodology, section V explain the components used, Section VI describes results and discussion, Section VII concludes research work with future directions.

II. RELATED WORK

Bjarni Freyr Gudmundson and Mr Esben Larsen in their research paper have discussed about various techniques in which the foldable electric motorbike can be developed. They made a conceptual design and did detailed analysis on specification, material selection, design and structural analysis, component selection, test drive. Their basic idea behind manufacturing this type of design was to give the

comfort and compact ability to the driver, so that driver can feel safe and comfortable to enjoy the every ride of kart. For making a vehicle the following subsystems such as chassis subsystem handling subsystem, wheel and tire subsystem, brake subsystem and power train subsystem should be designed and fabricated. They worked on the power train for the vehicle and also initiated work on developing powerful, light weight motorbike. They thought about the cost and efficiency of vehicle. To minimize the cost of the vehicle, they used electric arc welding as it is cheap and reliable option available. They also made a foldable electric bike, providing with their all details and procedure. They also discussed about various future works that can be done on their project [1].

Mr Sachin Achari with his team has discussed the feasibility, use and design procedure of the foldable tri scooter. They made effort in the experimental analysis as well as in design part of the project. Their main aim was to design a portable automobile which should be very easy to carry as well as easy to handle by both the sexes with equal ease. The aim was also that it should be environmental friendly and should be non-polluting. They used D.C motor as their main power source due to which there is no emission at all and also the problem of fuel consumption can be solved. Also keeping in mind the parking problems, they made a triscooter which can be folded easily, so after the use one can fold the triscooter and can carry it along with him/her. Their design allows users to easily transport the triscooter using less space when it is "folded" into a compact size. They were the first to offer foldable triscooter in the market. While designing they concentrated on power, economy, ease and comfort of riding and low maintenance cost. Also they concentrated on ergonomics factor to give the user a comfortable ride. Their objectives included folding ease, Portability, Reliability and retailer network. They used mild steel as the frame material welded in suitcase shape which serves as the base to hold all the accessories such as motor, weight of the load to be conveyed and the weight of the person driving the unit. They also discussed about advantages of the foldable triscooter [2].

Mr Akash Chaudhary Raghuvanshi with his team had made effort in developing foldable kart chassis. They understood the thing that the world is going towards the compactness, where the all things are going to compact and its time is to think about vehicle which can be folded easily and can be taken everywhere as a luggage. By this innovative idea, he conducted the structural analysis on the frame of their kart vehicle and developed a GO KART named as "ASHVA" which can be folded by it's mid with the help of a joint that connected between its two chassis front chassis-rear chassis. They knew that Karts are used to just take the experience of racing cars. Mostly they are very entertaining vehicles in the markets. Taking this into consideration they manufactured an automobile that would be something really out of the box. As the speed of kart varies on the power of engine and how much fuel it takes. The chassis of kart was made up from the mild steel and the joint of kart had been made up of mild steel. This joint gave more power and stability to their vehicle. They used mechanical chain to transmit the power from the engine to the axle of kart. For a better karting experience, rack and pinion system was used by them. A fish body is a perfect aerodynamic natural structure, one can get inspired with hence the chassis of the kart was developed with an igniting idea of a fish body. Selection of material plays an important role on strength and safety of the product that was the reason they chose AS-202 stainless steel round tubes as a chassis material. Also they chose the material for shaft so that it can bear all the stresses. They discussed about the material selection procedure. They made an effort in describing the joints that can be used in foldable vehicle chassis. [3]

Researchers at MIT with backing from General Motors Corp. are building a prototype of a lightweight electric vehicle that can be cheaply mass-produced, rented by commuters under a shared-use business model, & folded & arranged like grocery carts at subway stations or other central sites. It's called the City Car, and the key to the concept lies in the design of its wheels. [4]

III. OBJECTIVES

- To build a suitcase vehicle to overcome problems arising due to shortage in space.
- Time required for assembly and disassembly should be as less as possible.
- The maintenance of suitcase vehicle should be low.
- The vehicle should be light weight so it can be lifted.
- Driver comfort is also important factor, so it must not be compromised.

IV. METHODOLOGY

The work had been done and was consisting of following phases:

- Design and Analysis
- Manufacturing
- Test

Design & Analysis phase:

In design phase, we had designed the structure of the vehicle on CAD software on the basis of design calculations for each part of vehicle. After the design phase, we analysed the structure on ANSYS 15.0. Necessary changes were made.

Manufacturing Phase:

We have completed our manufacturing phase, in which we manufactured our project or vehicle within time limit. We had tried our best to stick with the calculated design data and giving our project precision and accuracy.

Test phase:

In test phase, we tested our project at different parameters such as vehicle's speed, acceleration, braking etc. We also compared it with go-kart competition as our project is kind of a go kart. Changes were done on the project with respect to calculated test data.

V. COMPONENTS

Listings of main components are done as follows:

- Electric motor
- Drive
- Wheel
- Chassis
- Brakes
- Reverse Switch
- Battery
- Bearing

Fig-1: Electric Motor

Fig-2: Electronic Throttle Body

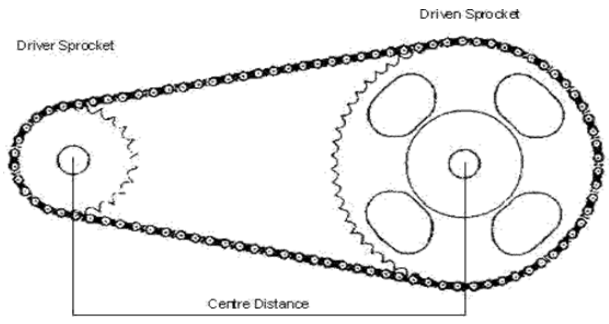

Fig-3: Chain Drive

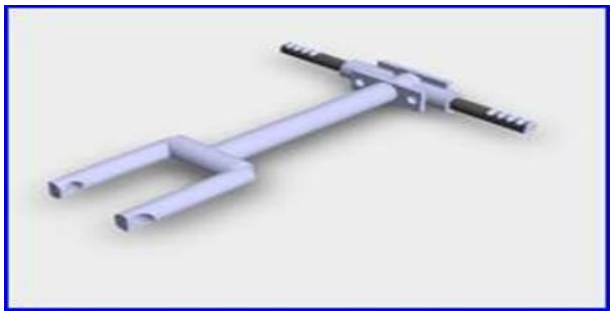

Fig-4: Steering handle

Fig-5: Alkaline Battery

Fig.-6: UCP200 Series Pillow Block Bearing

Total Deformation during right side impact has value of 0.0012 m. The result is significantly less and will not cause major defect on chassis.

Equivalent stress of 9.77e7 Pa has observed which determines the range of stress generating in chassis during any impact.

Safety factor of 0.88 has observed which signifies that there is less difference between design and working stress in chassis. Since it is in permissible limit we can continue with this safety factor.

VI. RESULTS AND DISCUSSION

CAD Model:

Fig.-7: CAD Model of tricycle

Bearing

Bearing load: 60 kg……assumed Load factor for chain drive: - 1.5

Bearing load (total) = 60 1.5 = 90 kg = 882.9 N

For the machines working 8 hr/day

L_{10h} = (12000 – 20000) hrs.

L_{10} = 60* L_{10} *40h/106

L_{10} =60* 3567.690* 20000/106

L_{10} = 4281.228

C_1 = P (L10)^1/3= 882.9 (4281.228)^(1/3) = 14336.199

But standard Value for C_1= 15900 for bearing 6007

So selecting bearing = 6007

D_2= 47mm, B_2= 20mm

Analysis

Impact force= =1166.4 Kg.m/sec2 = 1166.4 N~1200 N

Front Impact

It has been done using software on front part of vehicle. Vehicle's weight and forward velocity has used to calculate force arising due to impact. Front bar of chassis has used to absorb impact force and rear bar has been used as a fixed support.

Total Deformation has checked for changes arising due to impact force. The total deformation has been equal to 0.0011552 m

Rear Impact:-

Analysis for rear impact has been performed on vehicle. For this mass and velocity of an incoming vehicle is taken into consideration. Rear end bar has force acting over it and front end bar acts as a fixed support.

Total Deformation due to collision has calculated as 0.00118 m.

Equivalent stress of the value 2.06e7 Pa has been observed during rear end collision. This value is largely affected by velocity of an incoming vehicle.

Safety Factor of 4.16 has observed which also signifies about the strength and load bearing capacity of chassis.

Left Impact

Left impact analysis has performed to check side performance of chassis during collision. Total Deformation of 0.00147 m has been observed.

Equivalent stress of 1.103e8 Pa has been observed after left impact analysis was performed. This signifies low stress generation during any impact.

Safety factor of 0.78 has observed after analysis test. The value of 0.78signifies low strength ratio but it has been affected by incoming vehicle.

Right Impact

Right Impact is also a side impact test which is carried out on other side of vehicle. It also signifies side performance of chassis during impact.

Total Deformation during right side impact has value of 0.0012 m. The result is significantly less and will not cause major defect on chassis.

Equivalent stress of 9.77e7 Pa has observed which determines the range of stress generating in chassis during any impact.

Safety factor of 0.88 has observed which signifies that there is less difference between design and working stress in chassis. Since it is in permissible limit we can continue with this safety factor.

COST EXPENDITURE

Table 1.Cost Expenditure

Sr. No.	Material/Part	Specification	Quantity	Cost	
				Estimated(₹)	Actual(₹)
1	ASTM Pipe	1"x1"x0.078"	10 meters	3000	2800
2	Electric Controller, Throttle	24 V, 15 A	1	8000	6000
3	Wheels	26" & 20"	3	1300	950
4	Sprocket	13 teeth	1	200	150
5	Chain	1 meter	1	300	250
6	Brake levers		2	50	50
7	Friction pads		2	100	120
8	Disc	0.16 meters	1	100	110
9	Shaft	D=19mm, L=0.8	1	1000	800

		meters			
10	Headlight		1	200	180
11	Switches		3	200	100
12	Battery	12 V	2	3500	3400
13	Miscellaneous	Nuts, Bolts, Etc.		600	500
		Total		20250-	16550-

VII. CONCLUSION AND FUTURE SCOPE

The project "Design and Fabrication of foldable vehicle" is the perfect application of theory and practical we have studied in engineering. The aim of this project was to design and build a coaxial, light weight vehicle which will consume less space for parking and can be carried along. This aim has achieved and a foldable suitcase vehicle with electric motor has manufactured and successfully tested.

It can be used in college campuses and industrial areas to minimize the walking distance. As it is electric motor powered, it is easy to operate. The vehicle is compact, lightweight, has simple design and hence easily portable. Cost of manufacturing is moderate. Other vehicles can be manufactured having greater capacity as well as larger area for heavy duty works.

Advantages:

This vehicle has an advantage due to its folding characteristics.

- This type of vehicle fits in a category of Portable vehicle which means handling of vehicle from one place to another is easier without any hesitation.
- This vehicle is compact in size so it can be used where other vehicles have restriction due to their huge sizes i.e. in big shopping mall and industries.
- This vehicle can be assembled in 5 to 10 minutes and similarly disassembles in the same time.
- The vehicle can use engine instead of an electric motor, hence its operating cost required will be less than any other ordinary vehicle.
- Due to the use of engine, speed and load carrying capacity can be increased for vehicle.
- Weight of vehicle has reduced as no. of batteries required is less and smaller in size.
- This vehicle can be assembled and disassembled by a single person.
- With the introduction of reverse switch, a person can make the vehicle move backwards without leaving from his/her seat.

Future Scope

- This vehicle can be modified to provide more space by increasing suitcase size and motor capacity.
- Engine can be used to provide more power and torque if needed.
- Weight can be optimized by using more strength and light weight material.
- Thickness of chassis material can be reduced if high strength material is in use.
- If the vehicle is equipped with safety equipment, then it can be used on public roads within certain limits.
- It can be made into four wheel drive if size of suitcase is increasing.
- We can use electric motor hub if there is only one wheel to transmit power to vehicle.
- A differential can be used to reduce turning radius.

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