

Design and Fabrication of Foldable Suitcase Tri - Wheel Vehicle Powered by Electric Motor

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Abstract

The population of world is increasing and the area is decreasing. We are in the stage of compact world, where all things are going to compact, the time is to think about the vehicle which can be folded easily and can be taken everywhere. The basic aim behind our project is to make a portable vehicle which would be easy to handle by everyone. Also keeping in mind the parking problems, we have decided to make a portable suitcase vehicle which can be folded easily. So after use one can fold a suitcase and can carry it along with him or her. While designing, we have concentrated on power, economy, ease and comfort of riding and low maintenance cost. Also we have concentrated on ergonomics factor to gives the user a comfortable.

Keywords: Foldable Suitcase, Tri- Vehicle, Electric Motor, Parking

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 31"x 22x12", so it is five times smaller than normal car. Due to its compactness it can be used in various shopping malls, industries, college campuses etc. Portable car can be used to cover short distance at many instances. It can be used for travelling purpose on the roads.

It was originally designed & built in 1991 as part of a design contest held at Mazda's Engineering department which was created with a simple idea to have a 3-wheeled car inside a suitcase. Instead of waiting in line for a taxi or shuttle, just open your suitcase & drive off. 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 full 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 overcome above mentioned disadvantages in the present invention, we can replace engine with motor and battery. But it will add more weight to vehicle. Portable vehicle can be assembled and disassembled 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 using a DC brush electric 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 carry weight up to 90kg and it has Maximum speed of 20 km/hr.

II. CONCEPTUAL DESIGN

A. Frame:

It is made from the mild steel body along with some of the light weight components, 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. Also it should be able to overcome the stresses, which are coming due to different driving and braking torques and impact loading across the obstacles in the traveling ways. It is with the linkage and wheels to propel it and the platform plates. It is drilled and tapped enough to hold the support plates.

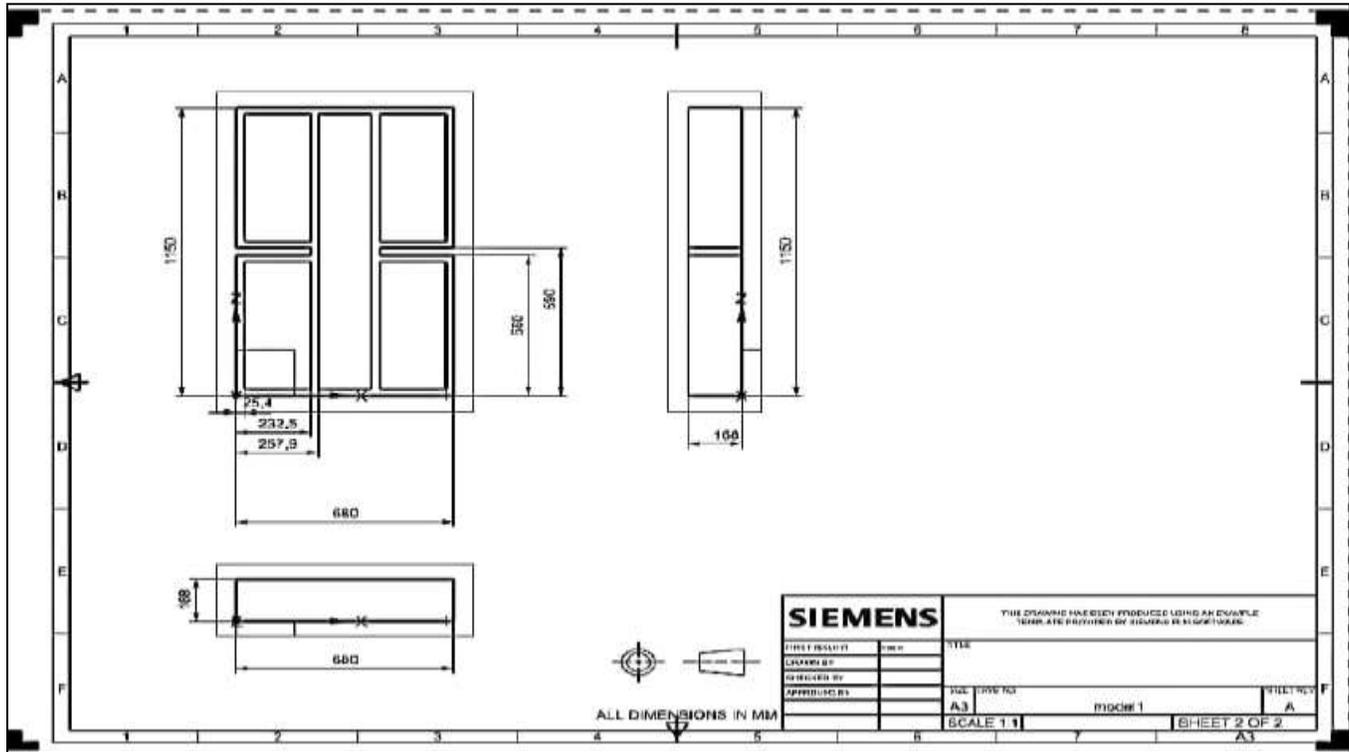


Fig. 1: Drawing of frame Structure

B. Battery:

It is the accumulator of electric charge. It must store the electrical energy produced by the generator by the electrochemical transformation and give it back again on demand. E.g. while starting.



Fig. 2: Battery

C. Construction:

The basic element of battery is the cell. It contains the plate block which consists of a set of positive plates and a set of negative plates. The individual plates are separated from one another by separators placed in between. The cell is filled with the mild sulphuric acid. The block cases e.g. of a 12V battery, is divided in to six cells that are mutually sealed and are tightly closed at the top by the block case cover. The individual cells are connected in series by the cell connector.

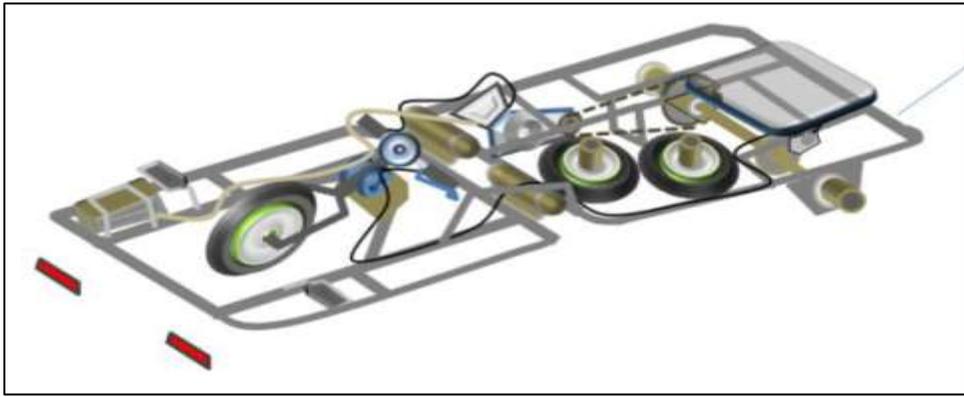


Fig. 3: CAD Design of Foldable Tri Vehicle

D. Foldable Motorbike:

These aren't a new invention, according to Di Blasi, the American company making these bikes; the model has been around for quite many years now. It weighs in at less than 30 kg (64 lbs.) & can be folded to fit in a bag measuring 73 cm (L) by 53 cm (H) by 30 cm (W), i.e., less than 5 cubic feet, or into the trunk of any standard car. Using its 1.3 - 3800 rpm engine, it can reach speeds of 50 kmph (about 30 mph) & according to Di Blasi, gets up to 130 miles per gallon (though its fuel tank holds only 3/4 of a gallon), and comes with a price tag of \$2000.

An electric motor is an instrument which converts electrical energy into mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy. General-purpose motors with highly standardized dimensions and characteristics provide convenient mechanical power for industrial use.

Motor consists of Rotor, Stator, Windings, Air Gap, and Commutator which works together to convert electrical energy into mechanical energy which may be linear or rotary depending upon motor. There are four types of brushed DC motors. The first type is the Permanent Magnet Brush DC Motor. Second, the shunt-wound brushed DC motor. Third is the series-wound DC motor and fourth is the compound-wound brushed DC motor which is a combination of both the shunt and series wound brushed DC motors.

E. Electric Motor:

The Project uses electric motor instead of IC engine in our project. But due to space constraints, we opted for electric motor. Motor which we used is reduction electric DC motor which provides required torque. Also reason behind choosing this motor is we did not want emission issues with our vehicle. Only disadvantage with this motor is increase in size of battery and decrement in RPM. Also this reduction motor comes with controller and throttle control for handle. Specification for the electric motor is provided below.



Fig. 4: Electric Motor

Table - 1
Specification for the electric motor

Parameters	Specifications
Type	DC Motor
Voltage	24
RPM	2750
Rated Wattage	350
Rated Current	19.1
Torque	22

F. Controller:

Controller is a device that serves to govern the performance of an electric motor. This may have automatic or manual means of starting and stopping the motor, selecting forward and reverse rotation, selecting and regulating or limiting the torque and protecting against overloads and faults. The given controller is of manual starting or stopping Direct on Line (DOL) type which is controlled by using throttle. This is preloaded with software to work for the given electric motor. This works for all functions given above.



Fig. 5: Controller

G. Throttle:

Electronic Throttle control (ETC) is an automobile technology which electronically connects the accelerator pedal to the throttle, replacing mechanical linkages. ETC consists of accelerator pedal module, ETB and ECM. There are throttle positions sensor embedded in ETB which helps in determining the required throttle. The given ETB works on potentiometer.

H. Drive:

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle using a chain. Since there is a reduction gear mounted in electric motor, that's why we do not need different gear ratios and because of this we are using direct chain drive. Moreover gearbox in vehicle will increase in weight; we are rejecting the use of gearbox. Motor sprocket has attached to motor and with its specification we have designed our shaft ratio. Since there was already reduction setup in motor we were trying to achieve 1:1 ratio from motor output to shaft. Pinion details are as follows.

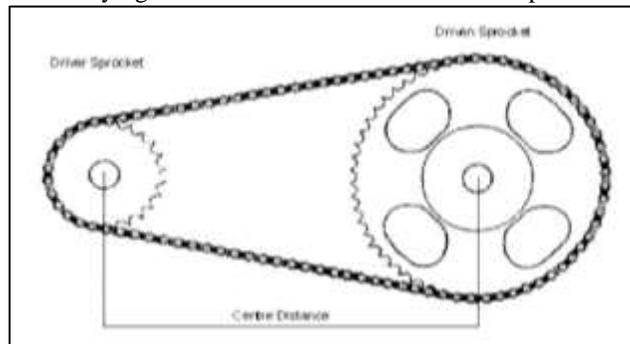


Fig. 6: Chain Drive

I. Steering:

The primary purpose of the steering system is to allow the driver to guide the vehicle. As the vehicle is not too heavy so we used a simple steering mechanism. Following things were mounted on steering handle.

- 1) Handle Driven Single Wheels.
- 2) Brakes on handle.
- 3) Throttle on handle

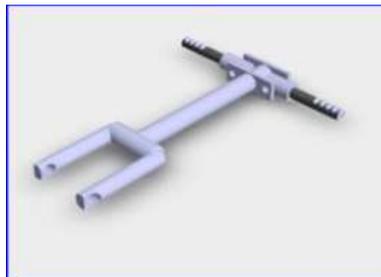


Fig. 7: Steering

J. Brakes:

Brakes have used to stop the vehicle. As the vehicle has speed limitation of 35 Kmph, we have used mechanical brakes. The system includes disc and caliper which actuates by using linkages from brake handle at steering.



Components	Parameter	Specifications
Caliper		
	Piston Diameter	15 mm
	No. of pistons	2
	Area of piston	176.6 mm ²
Disc		
	Outer diameter	160 mm
	Inner diameter	134 mm
	Mean effective radius of rotor	73.7 mm
	Thickness	2.5 mm

K. Toggle Switch 3 Way:

Reverse switch or toggle switch has been used in the vehicle to move it into reverse direction. This has been achieved using 3 Way- 6 point toggle switch. This switch reverses the current phase coming to it and provides the output to reverse the direction of motor. It has been provided in vehicle so that the driver will not need to get out of the car to move it into reverse direction.

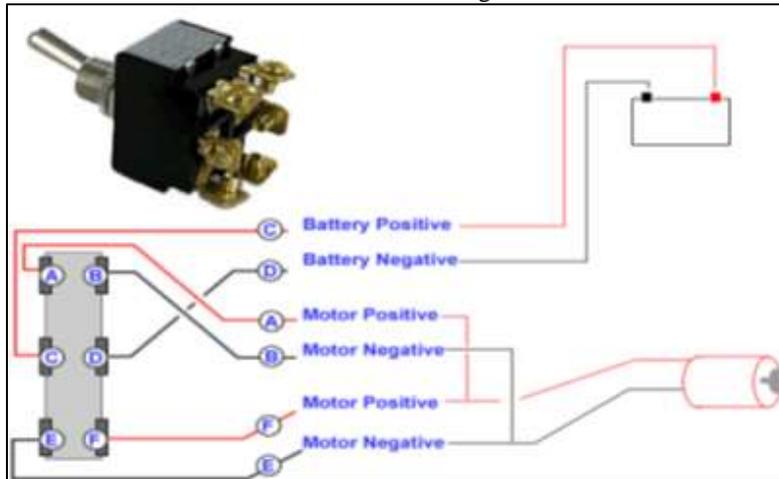


Fig. 8: Toggle Switch 3 Way

III. PROJECT IMPLEMENTATION

A. Design & Analysis phase:

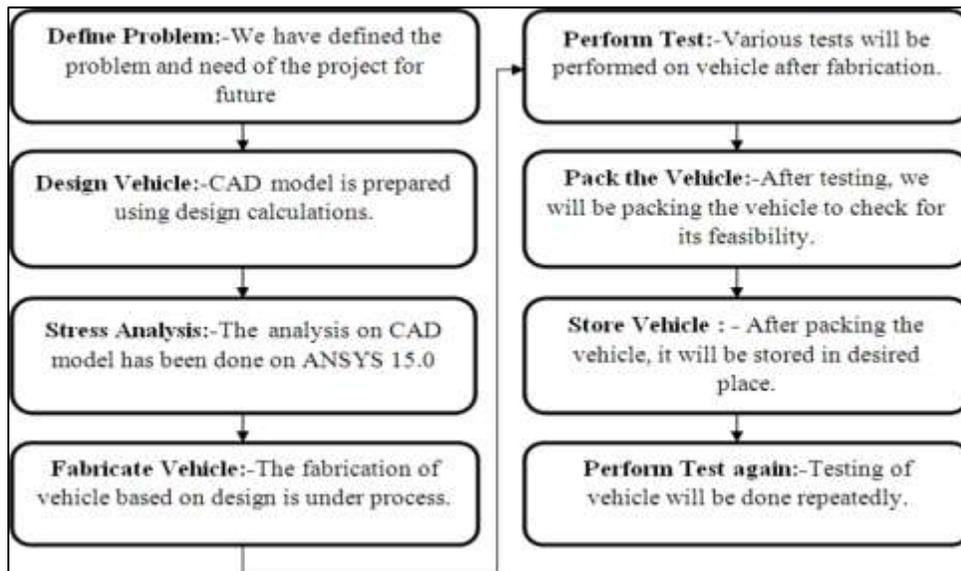
In design phase, we had designed the structure of the vehicle on CAD software on the basis of design calculations for each part of vehicle. After the design phase, we analyzed the structure on ANSYS 15.0. Necessary changes were made.

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.



IV. RESULTS

- 1) This vehicle has an advantage due to its folding characteristics.
- 2) 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.
- 3) 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.
- 4) This vehicle can be assembled in 5 to 10 minutes and similarly disassembles in the same time.
- 5) The vehicle can use engine instead of an electric motor, hence its operating cost required will be less than any other ordinary vehicle.
- 6) Due to the use of engine, speed and load carrying capacity can be increased for vehicle.
- 7) Weight of vehicle has reduced as no. of batteries required is less and smaller in size.
- 8) 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



Fig. 9: Closed Suitcase vehicle

V. CONCLUSION

Our project “Design and Fabrication of foldable vehicle” is the perfect application of theory and practical we have studied so far 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.

A comprehensive literature review has conducted, covering technical information relevant to the project. An analysis has done by using CAD software to measure impact effect on the vehicle to be manufactured. A formulated design approach was used to create the most efficient and robust configuration for fabrication of the foldable vehicle. The structural design was considered concurrently with component selection, aesthetics, and ergonomics to minimize mechanical, electrical and rider integration problems.

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. Thus, our project “Design and fabrication of foldable vehicle” is a successful attempt to overcome traffic congestion and parking problems.

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