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Design and Fabrication of Foldable Electric Bike

Mohammed Iqbal Khatib[1], Shahin Shaikh[2], Abrar Ahmed[3], Shaik Jahangir[4]

[*1]Assistant Professor Mechanical Engineering department Lords Institute of Engineering And Technology, Hyderabad, Telangana, India

[*2]Assistant Professor, Mechanical Engineering Department, J.B.I.T , Hyderabad, Telangana, India

[*3,4]Mechanical Engineering, Lords Institute of Engineering And Technology, Hyderabad, Telangana, India

ABSTRACT

In the concept of smart cities, quickness is something which everyone craves for. People prefer the fastest means while travelling from one place to another. Generally, while maintaining a trade-off between speed, comfort and cost public transit comes out to be the best solution. But since these vehicles have specific routes and stations, people face difficulty in going to the station from source location and then from the other station to destination. Use of fuel powered vehicles is not recommended due to the depletion of fossil fuels, also these vehicles pose a major threat to the safety to the lives of many. Apart from the noise and air pollution, fuel powered vehicles are quite powerful and thus unsafe if don't used with care. A foldable electric bike may be possible solution to these problems. While serving to the needs for ease and speed, it maintains safety. This bike has an upper limit for the power and speed which ensures safety of the rider. This bike can be folded to an extent (25in * 20in * 15in) that it can be stored in a backpack after use. This foldability makes it compatible for use with public transit, user can use it to travel to station and then fold & store it the backpack while travelling from the public vehicle. The weight of the bike is kept such that it may easily be carried on shoulders without the feeling of uneasiness. This bike is ideal to use for short distance (around 12 kilometers) trips.

Keywords: Electric Bike, Foldable, Motor, Power.

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 Foldable e-bike is a bike which can be folded easily ; hence it does not require the parking place. The size of the foldable e-bike is 46"x 22", 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. foldable e-bike can be used to cover short distance at many instances. It can be used for travelling purpose on the roads. Instead of waiting in line for a taxi or shuttle. It can be assembled in about 1 to 2 minutes & comes with functional brake lights & turn signals.

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. foldable e-bike can be assembled and dissembled whenever required as well as we can carry it anywhere. If required we can assemble it in just less than ten minutes and drive it. In this foldable e-bike 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. This portable vehicle can carry weight up to 80kg and it has Maximum speed of 15 km/hr.

The Foldable Electric bike which will be running on battery, the power is supplied by the motor, thereby supplying this power to drive the other gear components. The main purpose of using this E-bike is that it is user friendly, economical and relatively cheap. The efficiency of this system undeniable compared to conventional modes of transport.

Fig-1.Folded e-bike

Fig-2. Unfolded e-bike

Undesirable climate change is an indication for not to use more fossil fuel any more. Best alternative for the automobile fuels to provide the mobility & transportation to peoples is sustainable electrical bike. Future e-bike is the best technical application as a visionary solution for the better world and upcoming generation. Main reason to identify the need of finding and modifying E-Bike is to overcome the issue of the pollution because of vehicles in metro towns & urban zones is growing uninterruptedly. Considering a class of society it is not reasonable for all to purchase (scooters, mopeds or motorcycles). So, combining issues, environmental progress supporting and economical affordable alternative would be the best solution.

- To build a foldable e-bike 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 e- bike should be light weight so it can be lifted.
- Driver comfort is also important factor, so it must not be compromised.

Fig-3. Electric Motor

Chain 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.

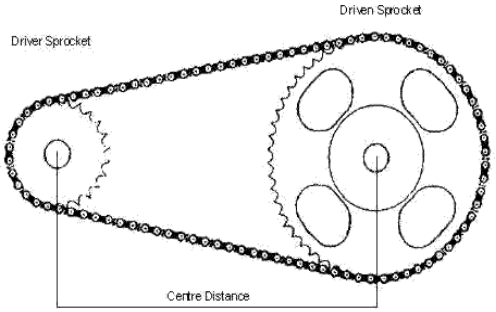

Fig –4. Chain drive

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 pre-loaded with software to work for the given electric motor. This works for all functions given above.

Fig-5. Controller for Electric Motor

Battery

Lead-acid batteries are employed in a wide variety of tasks, each with its own distinctive duty cycle. In internal-combustion-engined vehicles (ICEVs), the 'automotive' battery provides a quick pulse of high current for starting and a lower, sustained current for other purposes; the battery remains at a high state of charge for most of the time. The same is true of 'stationary'batteries used for backup power in telecommunications and in other uninterruptible power supplies, although in such service (the so-called 'float duty') the battery should We have used lead acid batteries for our vehicle‟s electric motor. They have high capacity than their respective counterparts as well as small in size. Since motor was of 24 V and 14.7 A, two batteries of 12 V were sufficient to use.

Fig-6. Lead acid Battery

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.

Fig-7. Electronic Throttle Body

Wheels

Wheels must be strong enough to support the vehicle and withstand th e forces caused by normal operation. At the same time, they must be as light as possible, to help keep un-sprung weight to a minimum.

We have used three wheels for the vehicle. Out of these three wheels, one wheel at front steering handle and other two wheels used with shafts at rear of the vehicle for propulsion purpose. These wheels are made up of hard rubber which will help in transferring weight to the roads. Due to their smaller size and high weight handling capacity they are best for use. Specifications for the used wheel are as follows:

Fig-8. Front wheel

Fig-9. Rear wheel & tyre

II. Literature Review

Raleigh stow e-way

This bike can be folded and can run up to 24 miles in single charge. It uses Li-ion battery and it is hidden inside the frame, thus it is very good looking. It costs around £1350(approx.1 lakh INR).

A2B Kuo

Fig-10. Raleigh stow e-way

This bike is quite advanced than the previous ones. It consists of an electronic display which shows the level of battery used. The battery is placed inside the seat tube and it takes about 6 hour to charge for 25 miles. It costs £999 (about 80000 INR.

Fig-.11 A2B kuo

Mazda Suitcase Car

The seeds of Mazda‟s „suitcase car –a functioning car built into a piece of luggage –had been sown in the run-up to the co1 Fantasyard event, an inter-departmental contest to see which group of employees could come up with the most innovative and creative solution to produce a “moving machine‟ .

The early 1990s were a golden era for Mazda. Mazda had already successfully reimagined the roadster with the MX-5 and won Le Mans with the rotary-powered 787B racer. It was the perfect time for Mazda to

develop a suitcase car. Unfortunately, they did not mass produce the vehicle.The selected group of seven engineers from the Manual Transmission Testing and Research Group convened and set to work on their creation. They purchased the largest Samsonite suitcase they could find and a Pocket Bike motorbike. The 33.6cc, 1.7 hp, two-stroke engine, handlebars and 4-6 inch-diameter tires from the Pocket Bike were then fitted into the suitcase. The rear wheels could be slotted onto the outside of the case while the front wheel would pop through a removable hatch in the front. The suitcase car took just a minute to assemble and had a top speed of 30km/h. While the original prototype was accidentally destroyed just a few months after the Fantasyard event, one suitcase car still remains in existence and it gives same performance till today, without any change from last 24 years.

Fig-12. Mazda suitcase car

If you're concerned about safety, the suitcase car has turn signals and brake lights. If you need additional safety features, maybe it's best that you stick to cars that can't be folded up and carried.

The "Suitcase Car," as it's referred to, was created as part of a design contest held by the automaker's engineering department at that time. The three-wheeled vehicle would be rather handy if one didn't feel like waiting in line for a taxi or shuttle; he/she could just open his/her suitcase and drive off. The Suitcase car is now maintained by Road/Race Engineering in Huntington Beach, California.

III. Methodology

Design & Fabrication phase

In design phase, we had designed the structure of the vehicle on Solid works on the basis of design and calculations for each part of vehicle.

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. Changes were done on the project with respect to calculate test data.

Working principle

It works on the principle that the electromotive force of an A.C. motor which receives electrical energy stored in D.C. battery is converted with the help of D.C. to A.C. converter. Here for the motivation of prime mover the chemical reaction takes place from which an energizing current is evolved which is responsible for the working. The working medium is sulphuric acid which is separated into columns of H ions and negative SO4 ions when mixed with water. If the poles of the cell are connected by a load, the flow of the electrons is from negative to positive. A bivalent positive lead is produced from neutral lead when combined with bivalent negative of SO4 group to form lead sulphate. This results due to scarcity of electrons at negative pole. Through the electron supply a bivalent positive lead is produced at positive pole from quadrivalent positive lead. A combination of SO4 comes into existence thereby ruling the combination of O2 which leads to formation of PbSO4.The atoms of oxygen and hydrogen from electrolyte are released together to form water thereby decreasing the density of battery acid.

Selection of material

Material selection is a step in the process of designing any physical object. In the context of product design,

the main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of candidate materials. For example,a thermal blanket must have poor thermal conductivity in order to minimize heat transfer for a given temperature difference. It is essential that a designer should have a thorough knowledge of the properties of the materials and their behavior under working conditions. Some of the important characteristics of materials are: strength, durability, flexibility, weight, resistance to heat and corrosion, ability to cast, welded or hardened, machinability, electrical conductivity, etc.

Mild steel

Mild steel (iron containing a small percentage of carbon, strong and tough but not readily tempered), also known as plain-carbon steel and low-carbon steel, is now the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. Mild steel contains approximately 0.05–0.30% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and easy to form; surface hardness can be increased through carburizing.

In applications where large cross-sections are used to minimize deflection, failure by yield is not a risk so low-carbon steels are the best choice, for example as structural steel. The density of mild steel is approximately 7.85 g/cm3 (7850 kg/m3 or 0.284 lb/in3) and the Young's modulus is 200 GPa (29,000 ksi).

Low-carbon steels display yield-point runout where the material has two yield points. The first yield point (or upper yield point) is higher than the second and the yield drops dramatically after the upper yield point. If a low-carbon steel is only stressed to some point between the upper and lower yield point then the surface develops slip bands. Low-carbon steels contain less carbon than other steels and are easier to cold-form, making them easier to handle.

IV. RESULTS AND DISCUSSION

4.1. Model of Foldable Bike

Fig.13. Final Model of Foldable Bike

4.2 DESIGN

Design Of The Foldable Electric Bike

Fig.14.3D Model of Foldable Bike

4.2.1.Design Of Opened Electric Bike

Fig.15. 3D Model of Opened Electric Bike

4.2.2.Caster Wheel

Fig. 16.3D Model of Caster Wheel

4.2.3.Handle Bar

Fig.17. 3D Model of Handle Bar

4.2.4.Foot Rest

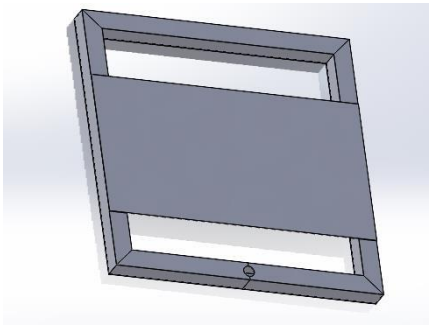

Fig.18. 3D Model of Foot Rest

4.2.5.Bottom Frame

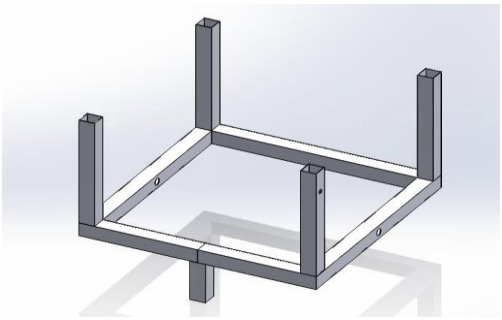

Fig.19. 3D Model of Bottom Frame

4.2.6.Motor

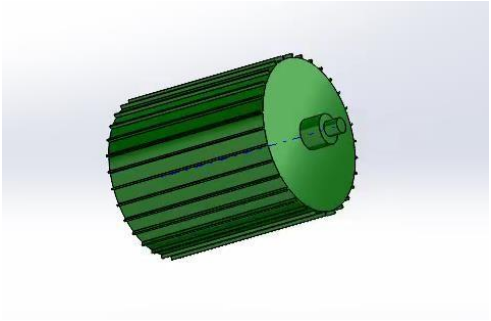

Fig.20. 3D Model of Motor

4.2.7. Rollers

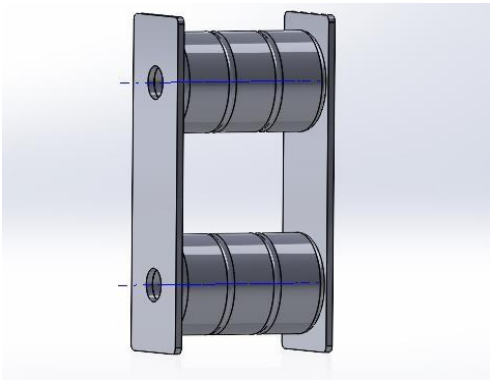

Fig.21. 3D Model of rollers

4.2.8.Seat

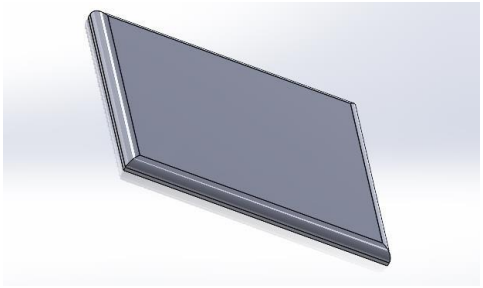

Fig.22.3D Model of Seat

4.2.9. Sprocket

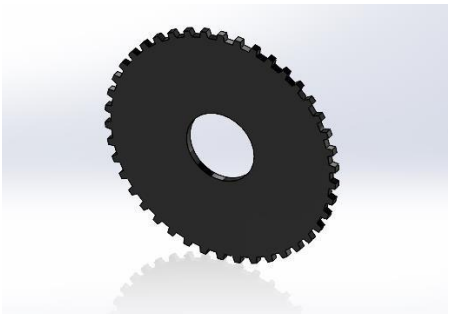

Fig.23. 3D Model of sprocket

4.2.1.REAR WHEELS

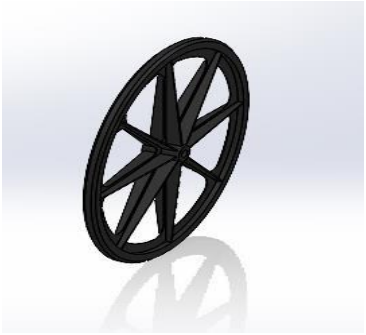

Fig.24. 3D Model of Rear Wheel

V. CONCLUSION

Our project "Design and Fabrication of foldable e-bike 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 e-bike 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 ANSYS 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 e-bike. 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 e-bike" is a successful attempt to overcome traffic congestion and parking problems

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