

Design and Fabrication of Foldable E-Bike

¹Raghavendra N, ²Harish A, ³K J Madhushree, ⁴Shashi Kumar S

¹Professor, ²Associate Professor, ³Assistant Professor, ⁴Student

¹Mechanical Engineering,

¹B.N.M Institute of Technology, Bangalore, India

¹ragul676@gmail.com, ²harishbba@gmail.com, ³kjmadhushree@gmail.com

Abstract—As we all know the fuel rate like the petrol is increasing price steadily day by day. Again the pollution due to A vehicle in big cities and urban areas is increasing continuously. To overcome these problems, an effort is being made to find out next alternative sources of energy for the vehicles Again, it is also not effort to get vehicles (scooters, mopeds or motorcycles) for all the category of society. Keeping this in mind, a economically poor people as well on provide an answer for the environmental pollution was in progress.

The solar operated e-bike developed is driven by DC motor fit in rear axle housing and operated by solar energy. The solar panels mounted on the carriage which in turn drive the motor and charges the battery. When the bike is idle, battery will be charged by the solar and also regenerative power generates by using dynamo. The regular e bike occupies sufficient space to park and aren't easy to hold around additionally because of the possibility of theft.

Transport has been one of the foremost important issues to be restricted within the present day situation, as commuting from place to position within the town has become a tedious task. It's very difficult to succeed in the closest transport facility and in many cases the destination is very far away from most roads where the general public transport won't be able to commute or it'd be very expensive. To overcome a typical problem faced by the society, a plan is conceptualized to style and fabricate a foldable E-bike. We have already seen many foldable bicycles within the global market but the main idea of this project is to supply a foldable bike which is light & sleek yet rigid & safe. It's easy to handle and carry along. Unlike the standard bike, this bike will occupy very less space and is also very easy to hold around. . The most objective is to light weight and consume less space and develop a foldable bike which is comfortable to ride.

Index Terms— E-Bike, Urban Mobility, Foldable bike

I. Introduction

The Electric bike is a bike which is driven with the help of battery which is coupled to electric motor. Energy crisis is one of the major concerns in today's world due to fast depleting resources of petrol, diesel and natural gas. In combination with this, environmental decay is an additional factor which is contributing to the depletion of resources which is an alarming notification. Our project has the solution for this above perilous problems. The system which we innovated is the Electric Bike. This project has various benefits both to the members of the team and also external benefits thereby making awareness of using alternative modes of transport. The Electric Bike which works on the battery that is powered by the motor is the general mode of transport for a local trip.

The solar panels can be alternative source for this by adding it to the system. The 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. E-bike comprises the features like high mobility efficiency, compact, electrically powered, comfortable riding experience, light weight vehicle. E-bike is the most versatile future vehicle considering its advantages. Electric motorcycles and scooters are plug-in electric vehicles with two or three wheels.

The electricity is stored on board in a rechargeable battery, which drives one or more electric motors. Energy crisis is one of the major concerns in today's world due to fast depleting of petrol, diesel and natural resources. The electric bike is driven with help of battery which is coupled to electric motor. In combination with this, environmental decay is an additional actor which is contributing to the depletion of resources which is an alarming notification. Electric bike which works on the battery that is powered by the motor is the general mode of transport for local trip. The solar can be alternative source of charging for this by adding it to the system. Main purpose of using this e-bike is that it is user friendly, economical and relatively cheap. The present work has the solution for this perilous problem, the system which we innovated is the electric bike.

II. Related Work

Shlok Desai, Kavan Mehta, ZinalKheni, Naitik Bhatt, Rahul Patel (May 2019) "Design, Analysis and Fabrication of Foldable Electric Bike" The purpose of the research is to find an alternative to improve human comfort, solve global problems and promote sustainable development. An Electric Bike is a battery-operated vehicle which is economical with low maintenance cost. Using a PMDC motor instead of an IC engine will reduce harmful emissions and reduce weight for easy commuting. This research is based on designing a Foldable electric bike, material optimization using various design & simulation software and fabrication of the electric bike by using aluminium 7075 grade material. Anop Mundel, Ashwani Gupta, Devansh Dixit, Ganesh Patel, Mayank Aggarwal, Ajay Kumar Dhanopia (2017) "An Introduction to the Design of Foldable E-Bike for Clean & Safe Travelling in Smart Cities" A foldable electric bike may be a 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, users can use it to travel to the station and then fold & store it in 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. Vivek Sunil Walde, Dr. Akash Langde - Design and Analysis of electric operated foldable bicycle-. This article provides an exposure to foldaway cycle and operate emission free, we tend to get result satisfactory. Electric cycle is lightweight, rigid & safe and use of fasteners for folding mechanism. The hub motor used is 360W and can attain a speed of 15kmph. Vignesh Swaroop, Vivek Iype Kurian -Foldable EBicycle, Battery can be replaced by lithium polymer battery in which is considerably lighter than convectional batteries.

A self-designed frame aids in weight reduction and improved aesthetics. The hub motor of approx. 1kW is been used which can go up to a speed of 20kmph. Lithium ion battery can be replaced by lithium polymer battery which is considerably lighter than convectional batteries. There is one head frame and a lower frame which is in two parts. A self-designed frame aids in weight reduction and improved aesthetics. Amey D. More, Shitansh J. Jain, Snehal M. Shirsat - Design and Development of Foldable Electric Bicycle.

In order to address the issues of economic infeasibility and pollution, research is being conducted in the fields of energy that is directly delivered by living beings and to living beings when it comes to vehicles powered by manual energy. The most common vehicles are bullock carts, horse carts, and other similar vehicles. Cycles is one of the most well-known names among them. In my opinion, the bicycle is the most efficient and practical mode of transportation. The only disadvantage of the cycle is that it takes up a lot of room, hence foldable cycles were invented to solve this problem and used hinged mechanism which connects two solid objects, typically allowing only a limited angle of rotation.

III. Design and Fabrication



The e-bike consists of the main body frame, solar panel, battery, D C Motor, Folding Hinges, Axel, Wheels and Charge controller. This is the rear wheel drive system. The rear wheel is driven by chain connected to DC Motor. Frame is made up of aluminum. Its width 235mm and length 900mm. The second frame is covered from all the sides with metal sheets. The first half of the frame consists of handle for steering and the second half of the frame consists of main components and these two halves are connected by a hinge mechanism. The folding works on hinged mechanism where the first half of the frame is folded. The second half of the frame also consists of a solar panel for regenerative purposes.

IV. Design Calculations

TOTAL BENDING FORCE

$$\begin{aligned}
 &= \text{passenger weight} + \text{battery weight} \\
 &= (80+20)*9.81 \\
 &= 100*9.81
 \end{aligned}$$

$$\text{Total bending force} = 981\text{N}$$

SPEED CALCULATION:

$$\text{Small sprocket teeth} = \llbracket 10t \rrbracket$$

$$\text{Large sprocket teeth} = \llbracket 44t \rrbracket$$

$$N_1 t_1 = N_2 t_2$$

$$N_2 = N_1 t_1 / t_2$$

$$= (100*44)/10 = 440\text{rpm}$$

Speed of vehicle:

$$N = \text{speed of wheel} + \text{circumference of wheel}$$

$$= 440 * 1256$$

$$= 552640 \text{ mm/min}$$

$$= 552.64 \text{ m/min}$$

$$= 552.64 * 60$$

$$= 33158 \text{ m/hr}$$

∴ Approx. speed of the bike is 30km/hr

Motor Selection:

The force required for driving a vehicle is calculated below:

$$F(\text{total}) = F(\text{rolling}) + F(\text{gradient})$$

Where, $F(\text{total})$ = Total force

$F(\text{rolling})$ = force due to Rolling Resistance

$F(\text{gradient resistance})$ = force due to Gradient Resistance

$F(\text{total})$ is the total tractive force that the output of motor must overcome, in order to move the vehicle.

Rolling Resistance:

Rolling resistance is the resistance offered to the vehicle due to the contact of tires with road. The formula for calculating force due to rolling resistance is given by equation.

$$F(\text{rolling}) = C_{rr} * M * g$$

Where, C_{rr} = coefficient of rolling resistance

M = mass in kg

g = acceleration due to gravity = 9.81 m/s^2

For the application considered, $C_{rr} = 0.01$, $M = 120 \text{ kg}$.

Therefore, $F(\text{rolling}) = 0.01 * 120 * 9.81 = 11.77 \text{ N}$

Power required to overcome the rolling resistance of 11.77 N is:

$$P(\text{rolling}) = F(\text{rolling}) * V / 3600$$

$$= 11.77 * 30 / 3600 = 98.08 \text{ W}$$

Where, V = velocity in kmph.

Gradient Resistance:

Gradient resistance of the vehicle is the resistance offered to the vehicle while climbing a hill or flyover or while travelling in a downward slope. The angle between the ground and slope of the path is represented as

α .

The formula for calculating the gradient resistance is given by equation :

$$F(\text{gradient resistance}) = M * g * \sin \alpha$$

In this illustration, let us consider the electric car runs on a flat road.

Therefore, the angle $\alpha = 0^\circ$

$$F(\text{gradient}) = 120 * 9.81 * \sin 30^\circ = 588.6 \text{ N}$$

Therefore, the total tractive power required to move the vehicle is

$$P(\text{total}) = 98.08 + 588.6 = 686.68 \text{ W.}$$

But electric motor with output power rating of 98.08 W should not be selected. The losses due transmission of power

to the wheel must be included. Therefore, the mechanical power output $M(\text{tractive})$ required to drive the vehicle is given by equation

$$M(\text{tractive}) = P(\text{total}) / \eta$$

Where, η = efficiency of the transmission system.

Let us consider the efficiency of the transmission system to be 0.85. Therefore, the mechanical power output

Required is:

$$M(\text{tractive}) = P(\text{total}) / \eta = 98.08 / 0.85 = 115.38\text{W (approximately).}$$

For the illustration of selection of power rating for an electric bike of 120 kg, a motor with output power rating of 115 W has to be selected.

In this way, power rating required to drive an electric vehicle of particular load is calculated.

TIME REQUIRED TO CHARGE THE BATTERY:

Battery rating = 12A, 12V

J Current produced by the solar panel (I) = Maximum

Power (P)/ Voltage rating (V) = 50 /12 = 4.17A

Theoretical charging time (T) = Rating of battery/ Total
current consumed = 12 /4.17 = 2.88hr

V. COMPONENT SELECTION AND SPECIFICATIONS

SI NO	Component Details			
	<i>Component</i>	<i>Specification</i>	<i>Dimension</i>	<i>Quantity</i>
1	Battery	12v & 12 Ah	-	2
2	Solar panel	100W, 17.9 V, & 3A	36x30x3.5cm	1
3	DC Motor	250 Watt	-	1
4	Wheel	Bike Wheel	Dia 400mm	1
5	Charge Controller	12V, 20A	-	1

VI. 2-D AND 3-D MODELS

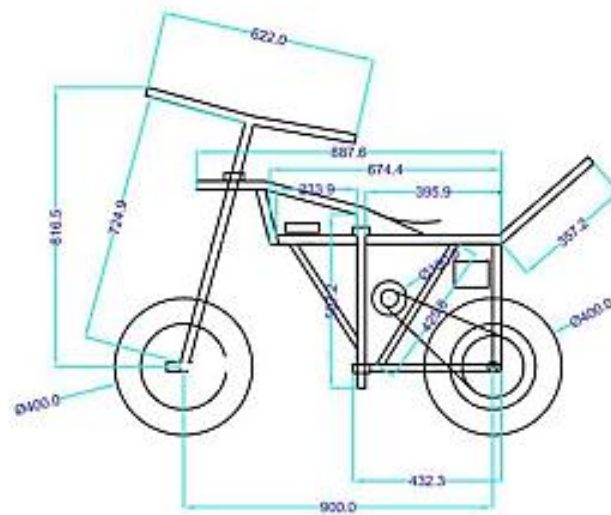


Fig.1. Side View of Bike skeleton

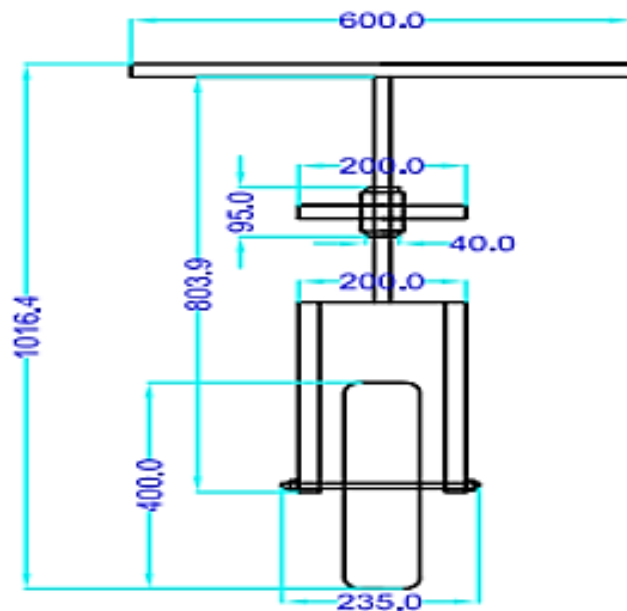


Fig.2.Front View Bike skeleton

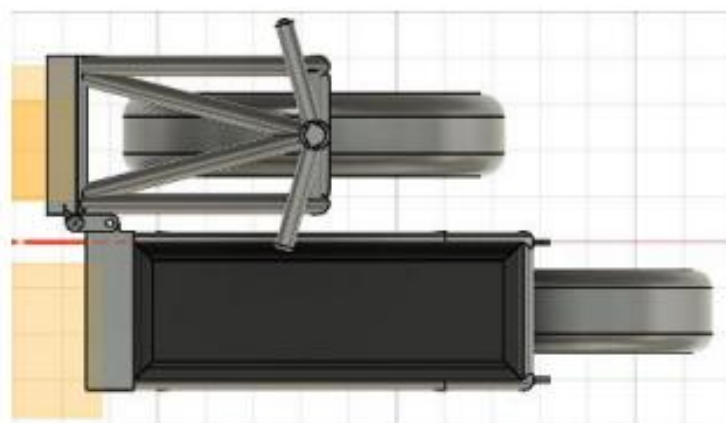


Fig.3.Top view of 3-D model in folded position

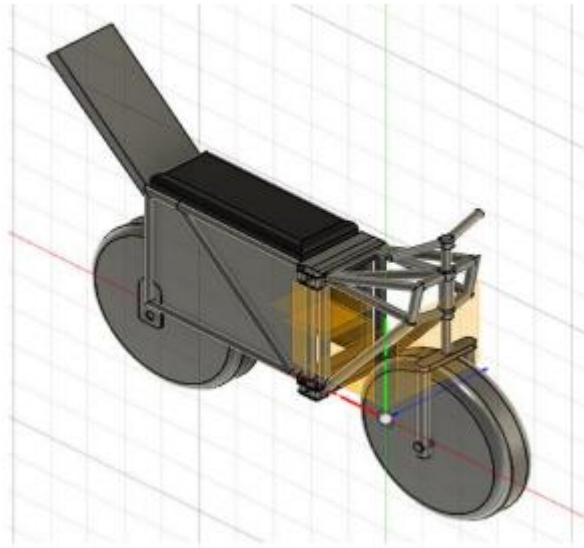


Fig.4. Isometric View of the 3-D model

VII. CONCLUSION

The work “Design and Fabrication Regenerative foldable e-bike” is the perfect application of theory and practical we've got studied thus far in engineering. The aim of this project was to style and build a coaxial, light weight vehicle which is able to consume less space for parking and may be carried along. A comprehensive literature review has been conducted, covering technical information relevant to the project. The structural design was considered concurrently with component selection, aesthetics, and ergonomics to attenuate mechanical, electrical and rider integration problems. It may be employed in college campuses and industrial areas to reduce the walking distance.

The vehicle is compact, lightweight, has simple design and hence easily portable. Cost of production is moderate. Other vehicles will be manufactured having greater capacity likewise as larger area for heavy duty works. This work “Design and fabrication of solar powered foldable E-Bicycle” could be a successful attempt to overcome hold up and parking problem.

VIII. Acknowledgment

Authors wishes to acknowledge B.N.M Institute of Technology, Bangalore for supporting the project and Publication.

References

- [1] Design, Analysis and Fabrication of Foldable electric bike – Shlok Desai, Kavan Mehta, Zinal Kheni, Naitik Bhatt (International Research Journal of Engineering and Technology (IRJET) (2019)
- [2] Foldable E-Bicycle – Vignesh Swaroop, Vivek Iype Kurian (International Journal of Engineering ad Science and Computing (2018)
- [3] An Introduction to the Design of Foldable E-Bike for Clean& Safe Travelling in Smart-Cities - Anop Mundel , Ashwani Gupta, Devansh Dixit , Ganesh Patel (International Journal of Engineering ad Science and Computing (2018)
- [4] Design and Analysis of electric operated foldable bicycle- Vivek Sunil Walde, Dr. Akash Langde (International Research Journal of Modernization in Engineering Technology and Science (2022)

- [5] Design and Development of Foldable Electric Bicycle - Amey D. More, Shitansh J. Jain, Snehal M. Shirsat (2021)