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# Design and Fabrication of Foldable E-Cycle with Self Rechargeable Battery

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**Abstract** -In the current lifestyle, man isn't able to dedicate specific time for his health. This importance towards exercise and body fitness thanks to time shortage and stressful life is extremely low. To address the time deficit, we are able to utilise the time spent on commuting efficiently to exercise by using bicycles, thereby also contributing to pollution control. But regular bicycles occupy 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 and a chic 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 conceptualised to style and fabricate a foldable bicycle. We have already seen many foldable bicycles within the global market but the main idea of this project is to supply a foldable bicycle which is light & sleek yet rigid & safe. It's easy to handle and straightforward to take care of. Unlike the standard cycles, this bicycle will occupy very less space and is also very easy to hold around. Also it utilises the regenerative braking system. The most objective is to style and develop a foldable bicycle which is comfortable to ride and economical.

***Key words**: E-Bicycle. Re- generative braking, Foldable.*

## 1.INTRODUCTION

In the present lifestyle, man isn't ready to dedicate specific time for his health, importance is least given to exercise and body fitness thanks to time shortage and stressful life. Obesity is one in every of the common issues seen in society, which results in many health hazards. Exercises are advised for health promotion, and treatment for several diseases. Among the exercises aerobic exercises are appropriate for these purposes. To try and do aerobics many methods are available for example: running, jogging, walking, cycling et al. Transport has been one of the foremost issues in developing cities like Bangalore since commuting from one place to another has become tedious and expensive. With petrol and diesel prices increasing day by day, most modes of transport are getting expensive. It's difficult to achieve the closest transport facility and in many cases the destinations are removed from most roads where the general public transport won't be ready to reach. thanks to the little roads, to avoid which the majority use vehicles of their own, which successively results in issues with parking, traffic, etc. Conventional bicycles occupy sufficient space and hence providing one at work or reception is sort of difficult. they're likely to be exposed to the weather outside and do require frequent maintenance. With all such issues in conventional bicycles, the subsequent possible solution is the usage of foldable bicycles. With foldable bicycles, there's no issue since the bicycles are often folded and carried around to the workplace or perhaps it may be wont to reach the closest conveyance facility and so folded and carried along. Since the bicycle is being folded, it occupies very less space and doesn't require any special automobile parking space. they're not exposed to the weather since they will be carried inside buildings with ease and hence vulnerable to less maintenance. The usage of foldable bicycles helps combine the various modes of transport as mentioned above, which helps in reducing some cost involved in travelling.

Foldable bicycles are available within the market, but are expensive since they're being imported. There are only a few recognized foldable bicycle manufacturers in India. Hence we seized the chance to produce a coffee cost, locally manufactured foldable bicycle. The study on the aspects of materials, properties and style of folding bicycle frames was performed. The fatigue problem is usually considered because of the main problem regarding the properties of the materials. The coated swing hinge in folding bicycles is taken into account as an improved joint technique within the design and carries benefits to the user to fold the bicycle since it overcomes the limited lifecycle and moreover is easy and price effective.

Hence we are focused on "Design and fabrication of dual chargeable bicycles'' Topic. We got the concept of the Self Chargeable Concept. When the battery is fully charged a speed of 10-15km/hr is obtained. When downhill the charging is achieved in 1hr. Here the motor performs as a Generator. By the appliance of brakes a relay is operated. Hence this induced within the motor recharges the battery with the assistance of a boost converter. thanks to friction driven mechanism wheel wear at a faster rate. Fans are

the foremost used items in India despite the widespread availability of Cooler's and air conditioners. Since the initial opportunity cost of solar systems remains quite high, when it involves generating power for a domestic use and energy saving and energy generating may be a major issue for mankind. This paper presents a way of generating power by a ceiling fan. The generated power may be either used or is stored in an exceedingly large battery for powering other devices. By this we use Dynamo to convert K.E. of it's chain wheel by meshing Gear teeth with small gears. By this we generate power.

## 2. LITERATURE SURVEY

### 2.1 Shishir S, Manjunath P, Pavanasudan R, Ravi Sathyajith (June 2015) "Design and Fabrication of Foldable Bicycle"

To overcome a common problem faced by the society, an idea is conceptualized to design and fabricate a foldable bicycle. We already have seen many foldable bicycles in the global market but the main idea of this project is to provide a foldable bicycle which is light & sleek yet rigid & safe, easy to handle and easy to maintain. Unlike the conventional cycles, this bicycle will occupy very less space and also is very easy to carry around. The main objective is to design and develop a foldable bicycle which is comfortable to ride and economical.

### 2.2 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 improvise 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.

### 2.3 Morteza Hanifezade and Arian Ashrafi (April 2014) "Folding and Self-Propelling Bicycle".

Recently there are studies on air pollution of big cities and results proved that air pollution is increased in general. This problem is the base of our research and so we should try to decrease this. Regarding to the point that some people for solving this problem use bicycles as a transportation.

### 2.4 AnopMundel, 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.

### 2.5 Arunabh Choudhury, Swapna neel Sarma (2018) "Design and Fabrication of a self charging Bicycle".

In this paper, the designing and fabrication of a self-charging bicycle is described. The pollution due to automobiles is increasing with every passing day and the use of electric vehicles for short distance travelling will help to reduce the pollution to some extent. These electric vehicles need to be recharged at a power point which is again very time consuming. An attempt is made to eliminate or reduce dependency on recharging from main supply by introducing a Self Recharging Mechanism. The model consists of five separate parts, namely: the Battery, the Dynamo, the DC motor, controller and charging system. The BLDC motor uses electric energy from the battery to provide torque to wheels and the battery receives electric energy from the Dynamo.

### 2.6 Prof S.B. Thakre,Akshay S. Dhabekar, Ankush N. Peshne, Akash P. Satpute (2017) "Design and Fabrication of Self charging Bicycle".

In the new era the e- bicycle has more importance than other fuel vehicles like motorcycles, cars etc. basically for short distance travel the bicycle is more useful and e-bicycle is effortless. It is also an eco-friendly technology bicycle was the most dependent mode of transportation. A self-charging battery electrical bicycle which utilizes the mechanical energy to electrical energy of wheels to charge the battery. A system which makes vehicle pollution free. We are using components like hub motor, dynamo, controller, battery, etc. It is pollution free and no fuel consuming type of vehicle and it is good for greenhouse effect. The rider can choose that the bicycle can be driven completely with the hub motor or to be driven manually by him with a pedaling.

## 3. FORMULATION OF METHODOLOGY

First we've got to shop for a cycle. After that, the concept is to create the cycle foldable by using it as an easily portable one, so we will use it in such a way that we will take anywhere we would like for that we concise the cycle.

The plan is to create a foldable part within the middle part of the cycle, to line a robust lock within the folding part of the cycle. subsequently we analyzed the capacity of the cycle, that is, what quantity weight it can tolerate. The lock on the foldable part of the cycle is formed of soft-cast steel. The forethought is to figure the cycle with a 12 Volt 30 Ampere motor which is 360 watt. The cycle may be charged in two ways either by pedaling or regenerative braking, additionally with the charging port.

The regenerative braking will be made possible by fixing a relay at the position of the brake. Once we apply the break, a relay is operated, then the circuit to the boost converter is completed. Through this the charging is made possible. The accelerator is employed by a trigger, which is connected to the controller and this controller is connected to the motor. The controller consists of a 555 IC circuit. The acceleration is completed by the heart beat width modulation method. The cycle is meant to hold a weight up to 80kg, whether it's man or object.

## 4. DESIGN AND DEVELOPMENT

### 4.1 Detailed 3D Design

**Fig. 1**

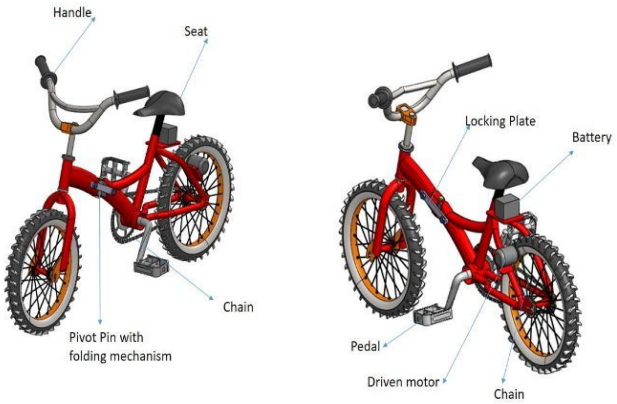


**Fig. 2**

## 5. FORMULATION OF WORK PLAN

### 5.1 Fabrication Details

Firstly we want a standard bicycle. For that an existing old used bicycle was borrowed. The cycle was borrowed for rupees 2,000 from the vendor. After borrowing it we did some small repairs on it, to make it perfect. Then the rear wheel was bent to make further modifications. A collar was welded so we wanted a series and sprocket mechanism. For that we took the wheel of a motorbike, it consists of 42 teeth. This sprocket is welded to the collar. The collar is welded in such the way that there'll be no change within the alignment.

By providing a sprocket mechanism to the left side of the wheel and an already existing freewheel on the correct side. The rear wheel is assembled back to the cycle and also the wheel alignment is checked. Hence, there's a freewheel on one side and sprocket on the opposite side of the rear wheel.

After assembling the rear wheel back to the cycle we've got to put the drive motor near and above the sprocket. For that a bed is welded on the stay bar which is coming from the hub of the rear wheel and two supports were also provided from the bed to offer a decent support and rigidity to position the motor. The drive motor was borrowed for rupees 2000. A 12 Volt 30 Ampere DC motor is employed to drive the bicycle. This motor also features a range of 12 to 24 volt. The motor can produce a complete of 12*30 = 360 watts. it's placed during a bed on the chassis on the subject of the rear wheel. The motor has an RPM of 1500. Chain drive mechanism is employed for power transmission. After placing the motor on the supports a discount mechanism is implemented from the motor. We've connected a smaller gear which has only 12 teeth to a different larger gear which has 52 numbers of teeth which is placed under the smaller gear. By meshing a socket gear with small gear RPM increases. That is, when the teeth of the gear decrease, RPM increases. From the centre of the larger gear, a shaft is connected and making this shaft as an axis, another gear with 14 teeth is solely rotating. This is often connected with the chain drive and power gets transmitted. From this gear a sequence is provided to the sprocket and also the wheel alignment is completed.

Our next work was to form the traditional bicycle into a foldable bicycle. For that foldable joint should be designed. After some analysis we preferred low-carbon steel material to be used for creating the lock mechanism to fold the bicycle.

Bolted joint mechanism is employed because the lock mechanism creates a foldable one. The chassis of the cycle is cut from the center portion where it's best suited to fold the one bicycle. A pair of soft-cast steel flats with 3 mm thickness and 40mm width is welded at the cut section.

The joint is fabricated separately, that is, we've made the joint and so we cut the chassis of the cycle, where it's best suited by taking some dimensions and also the joint is being welded at the cut section of the chassis. A bolted lock system is additionally fabricated at the joint. The designed bolted joint consists of two bolts to tighten the rod and make it a rigid one. Stress analysis was conducted on the lock mechanism and it was found that it can carry a load of 80 kilogram with 3 because of the factor of safety.

The designed joint is welded to the steel flat and therefore the locking system is fabricated. Now we will fold the bicycle and reduce its length and thereby we are able to easily transport.

Now the motor system needs to be connected to an acceleration mechanism so the driving force can adjust and control the speed consistent with the wants of the driving force. Therefore an acceleration system is provided by a knob at the side of the proper handle of the bicycle. The acceleration system is implemented by employing a 555 IC and MOSFETS. The 555 IC circuit may be a pulse width modulation (PWM) circuit. when the knob of the accelerator is rotated or increased the on time will increase the off time will decrease. And also when the accelerator is decreased, the off time will increase and also the on time will decrease. When the on time is increased the voltage is supplied within the style of fast switching pulses instead of a nonstop analogue signal. But the pulses generated don't seem to be enough to run the motor. So we use some MOSFET which are connected parallel to amplify the heart beat so are connected to the motor as an output. The MOSFET is placed before the career below the motive force seat. The charger carriers enter into the channel through the source terminals and exit via the drain. The width of the channel is controlled by the voltage on an electrode which is named the gate and is found in between the source and drain. Since one MOSFET isn't adequate, MOSFETS are connected in parallel to amplify the heart beat so are connected to the motor as an output.

The next objective is to produce some considerable amount of charge back to the battery when running through the regenerating braking system. For the regenerating braking system to be implemented firstly we placed 30 A 12V relay in between the left handle of the cycle and therefore the brake lever. It's placed in such the simplest way that once we reduce the acceleration and therefore the brakes are applied, the brakes lever touches the relay and also the relay is switched on. The relay is then connected to a lift converter which gets on by the provision.

The motor now works as a generator and from this only atiny low amount of voltage is obtained. So this small voltage is boosted by the booster circuit and it's then converted or given to the battery by the converter bond where a small LED bulb is placed. When the LED bulb lights it indicates that the battery is gaining or receiving some amount of charge. The circuits and converters are all placed before the carrier under the driver's seat.

Now the battery is placed about the career and therefore the on/off switch is connected to most circuits. The finishing works are done like being painted the parts where we've modified the lock and folding part, the motor and its beds etc; we cleared the bicycle after work to convey a fresh look and also poured oil and lube to the chain and sprocket mechanism and thereby our fabrication works finished.

### 5.1.1 Steps in Fabrication

- An existing old Bicycle is being taken and repaired.
- The back wheel is taken out and a collar is welded. We took the sprocket wheel of a bike and welded to the collar without any change in alignment. Hence there is a free wheel on one side and a sprocket wheel on the other side of the rear wheel.
- The real wheel is assembled back to the cycle and wheel alignment is checked
- A bed is welded on the stay bar and a motor and the reduction gear mechanism is added and the sprocket wheel alignment is done
- A foldable joint is designed
- The chassis of the cycle is cut from the middle and a pair of MS flat with 3mm thickness and 40mm width is welded at the cut section vertically
- The designed joint is welded to the MS flat and a locking system is also fabricated
- An acceleration system is implemented using a 555 IC and MOSFETS
- Regenerative braking system is being assembled using a 30A 12V relay
- Battery is placed and on/off switch is connected to the main circuit
- Finishing works are done

Fig. 3

Fig. 4

## 6. ANALYSIS

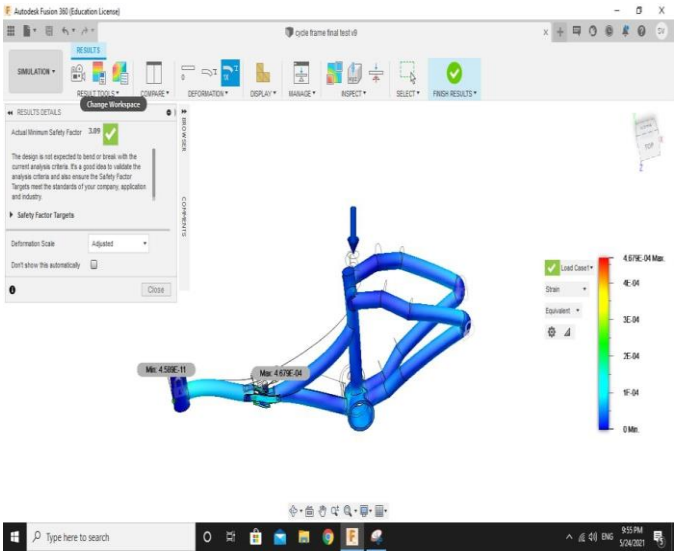

Fig. 5

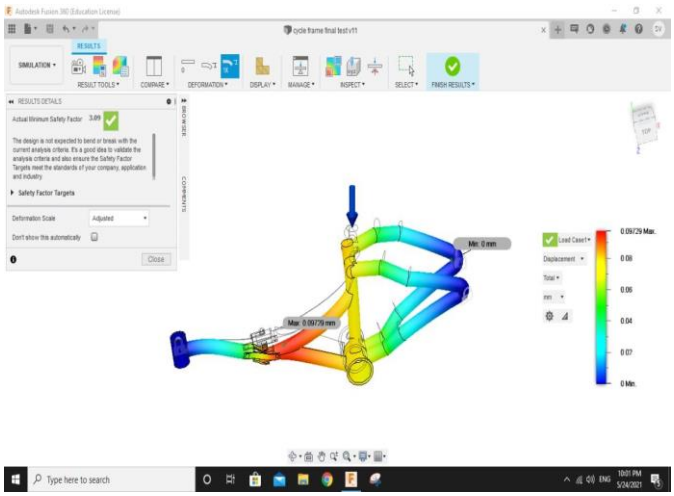

Fig. 6

### 6.1 Result of Analysis

An analysis has been done by using ANSYS 15.0 and fusion 360 software to leave an impact effect on the vehicle to be manufactured.

Here we've done the analysis with the load of 800 Newton and therefore the factor of safety is 3.1As shown the bicycle withstand the load and pass the test, so someone with 80kg can drive the cycle with none failure

### 6.2 Result of Regenerative Braking

On testing with a multimeter we are able to know that when the regenerative braking is actuated, we get an output of .6 Ampere and 12 Volts. Hence it produces a complete of seven.2 watts, when connected to 2 20 AH parallelly connected Lithium Ion Batteries, we have gotten an efficiency of 2% from the motor which produces 360 watts. The efficiency of a standard conventional motor is incredibly less even when working as a motor, so when it acts as a generator its efficiency will decrease more. This can be the explanation behind the lower magnitude readings from the multimeter.

A brushless DC motor (BLDC motor or BL motor), also referred to as an electronically commutated motor (ECM or EC motor) or synchronous DC motor, may be an electric motor employing a DC (DC) power supply. It uses an electronic control system controller to modify DC currents to the motor windings producing magnetic fields which effectively rotate in space and which the static magnet rotor follows. The controller adjusts the phase and amplitude of the DC current pulses to regulate the speed and torque of the motor. This system is another to the mechanical commutator employed in many conventional electric motors.

**Power from regenerative braking = V*I**

= .6 Ampere * 12Volt

= **7.2 watts.**

**Efficiency of regenerative braking** = (7.2 ÷ 360) * 100

= **2%**

## 7. CONCLUSIONS

Our project "Design and Fabrication of foldable Bicycle with self Rechargeable Battery" 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. This aim has been achieved and a foldable suitcase vehicle with motor has been manufactured and successfully tested.

A comprehensive literature review has been conducted, covering technical information relevant to the project. An analysis has been done by using ANSYS 15.0 and fusion 360 software to live impact effect on the vehicle to be manufactured. A formulated design approach was wont to create the foremost efficient and robust configuration for fabrication of the foldable vehicle. 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.

Thus, our project "Design and fabrication of foldable Bicycle with self Rechargeable Battery" could be a successful attempt to overcome hold up and parking problems.

### 7.1 Merits of Foldable Bicycle

- Easy to transport
- Easy storage
- Security
- Environmental benefits
- Eco friendly

### 7.2 Demerits of Foldable Bicycle

- High initial cost compared to normal cycle
- Maintenance cost is high
- More weight compared to normal Cycle

### 7.3 Future Scopes

As for the long run work, this study only deals with the evaluation of existing folding bicycles within the Indian market. Hence further, the proposed concepts are to be evaluated to seek out the most effective available concept using the standard concept selection methods. The ultimate concept design that has been selected by these methods would be considered for embodiment design during which the fabric and dimensions are selected. The embodiment design stage is followed by analysis and optimization.

### 7.4 Kinetic Energy Reservoir System

Kinetic energy of the cycle can be stored and later it can be utilized whenever the user feels tired, exhausted or when he wants to use it .The kinetic energy can be stored in any reservoir type device such as batteries. Besides this flywheel attached to the rear wheel is also an important mechanical device which can be used to store the kinetic energy for future use.

### 7.5 Installation of Electronic Gadgets

Various varieties of electronic gadgets like mobile charger, music pods charger etc. are installed easily on the 4 fold foldable bicycle. They'll draw energy for them through the K.E. of the wheels of the bicycle and this may be conducted and initiated with the assistance of the transducers. These Equipment will make the riding experience of the user enjoyable and fun loving.

### 7.6 Chainless Cycle Technology

Various kinds of electronic gadgets like mobile charger, music pods charger etc. are installed easily on the 4 fold foldable bicycle. They'll draw energy for them through the K.E. of the wheels of the bicycle and this could be conducted and initiated with the help of the transducers. These Equipment will make the riding experience of the user enjoyable and fun loving.

## REFERENCES

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