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# DESIGN AND FABRICATION OF ELECTRIC BIKE

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## ABSTRACT

*The main gist of this paper is to give the exact view by bridling the various sources of energy available to mankind. In today's modernized world travelling is very essential for human beings in order to protract in this world. And to do so his travelling should be done in minimum possible way and in jiffy. This paper details about the Electric Bike which runs on the battery thereby providing voltage to the motor. This paper compromises with design and fabrication of Electric Bike which makes use of Electric energy as the primary source and solar energy if possible by attaching solar panels. It also highlights on the design aspects of the bike. There is a provision for a charging the battery by ejecting it from the main system. The electrical power generated which is used to run the bike can give better fuel economy compared to conventional vehicle, better performance and also causes less pollution.*

**Key words:** Travelling, Electric Bike, Electric Energy, Solar Panels, Fuel Economy.

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## Notations

P = Power

N = revolution per min

T = Torque

σs = Shear stress

σt = Tensile stress

σut = Ultimate Tensile Stress

fos = Factor of safety

# 1. INTRODUCTION

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 paper proposes 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. The following table shows the specification of various electric bikes used in few countries:

**Table 1** Specifications of E-Bike in various countries

| Country | Type of bike | Speed limit in km/hr | Watt | Weight in kgs | Age required in yrs |
|---|---|---|---|---|---|
| Australia | Pedal | 25 | 250 | None | None |
| Canada | Hand | 32 | 500 | None | Various |
| China | P/H | 30 | 200 | 20 | None |
| Norway | Pedal | 25 | 250 | None | None |
| Israel | Pedal | 25 | 250 | 30 | 14 |
| UK | Hand | 27 | 250 | 40 | 14 |
| Taiwan | Hand | 25 | 200 | None | None |
| US | Hand | 25 | 750 | None | None |
| China | P/H | 30 | 500 | None | None |

## 1.1. What is Electric Bike?

The Electric bike is a bike which is driven with the help of battery which is coupled to electric motor.

**Main 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.

**Working medium:** 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 $SO_4$ 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 $SO_4$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 $SO_4$ comes into existence thereby ruling the combination of $O_2$ which leads to formation of $PbSO_4$. The atoms of oxygen and hydrogen from electrolyte are released together to form water thereby decreasing the density of battery acid.

**Operatio**n: In this a DC waveform which is obtained id made sinusoidal due to operational transistorized D.C. to A.C. amplifying circuit by switching the electric energy in the form of electric current which flows from battery to D.C. to A.C. converter circuit. By using amplifier circuit the small A.C. current is amplified again. In order to drive the circuit through the condenser, this amplified current is fed to the stator winding of the A.C. motor. The condenser which is used acts as a storage of electric energy and delivers at the time of requirement. The sprocket wheel installed on motor shaft is driven by the motive power of the electric energy. The rear sprocket wheel is being rotated by the chain drive mechanism on which the other two remaining sprocket wheels are installed. The wheel is driven by the rear wheel installed on the rear sprocket. Thus the electric bike is mobilized by using electric power.

## 2. COMPONENTS OF E - BIKE

The Electric bike consists of following components viz, DC motor, Frame, Platform, Battery, Drive etc. (Barve, Design and Development of Solar Hybrid Bicycle, 2016)

**1. Dc motor**: The motor is having 250 watt. Capacity with maximum 2100 rpm. Its specifications are as follows:

Current Rating: 7.5amp

Voltage Rating: 48 Volts

Cooling: Air – cooled

Bearing: Single row ball


**Figure 1** DC Motor.

**2. Frame:** The Frame is made up of M.S. along with some additional light weight components. The frame is designed to sustain the weight of the person driving the unit, the weight of load to be conveyed and also to hold the accessories like motor. Also it should be design to bear and overcome the stresses which may arise able to due to different driving and braking torques and impact loading across the obstacles. It is drilled and tapped enough to hold the support plates.

**3. Platform:** The Platform is designed with robust base so that it can hold the load along with the weight of the driving person uniformly. It is fabricated from Mild Steel at a specific angle in cross section and welded with a sheet of metal of specific thickness. The platform's alignment is kept horizontal irrespective whether it is loaded or unloaded and this is directly bolted and welded to the frame.

**4. Battery:** The battery also acts as a condenser in a way that it stores the electric energy produced by the generator due to electrochemical transformation and supply it on demand.

Battery is also known as an accumulator of electric charge. This happens usually while starting the system.

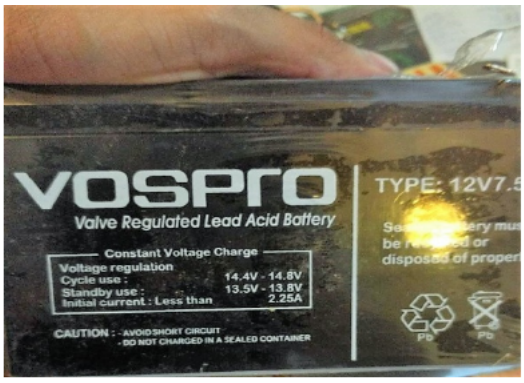


**Figure 2** Battery

**5. Chain Drive:** A Chain is an array of links held together with each other with the help of steel pins. This type of arrangement makes a chain more enduring, long lasting and better way of transmitting rotary motion from one gear to another.

**Figure 3** Chain Drive

The major advantage of chain drive over traditional gear is that, the chain drive can transmit rotary motion with the help of two gears and a chain over a distance whereas in traditional many gears must be arranged in a mesh in order to transmit motion.

**6. Braking System:** For the braking system it is convenient to use braking system used in band brake system which consist of spring loaded friction- shoe mechanism, which is driven with the help of hand lever.

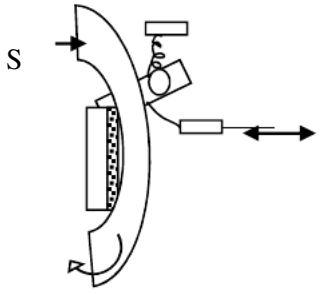


**Figure 4** Braking System

**7. Sprockets:** The chain with engaging with the sprocket converts rotational power in to rotary power and vice versa. The sprocket which looks like a gear may differ in three aspects::


**Figure 5** Various types of Sprockets

- Sprockets have many engaging teeth but gears have only one or two.
- The teeth of a gear touch and slip against each other but there is basically no slippage in case of sprocket
- The shape of the teeth are different in gears and sprockets.

(Barve, Design and Development of Solar Hybrid Bicycle, March 2016)

## 3. DESIGN OF ELECTRIC BIKE

Here we have used permanent magnet self generating motor with 250 watt power and 2100rpm. The motor runs on 48volts and 7.5amps power source. This motor can reach a peak current during starting equal to 15 amps. (Barve, Design and Development of Solar Hybrid Bicycle, March 2016)

P = 2 x 3.14 x N x T /60

250 = 2 x 3.14 x 2100 x T /60

T = 1.13 N m = 1136 N-mm

Reduction in chain drive

R chain = 66/11 = 6:1

Torque at wheel shaft = T x R chain = 1136 x 6 = 6820 N mm

Speed of wheel shaft = 2100 /6 = 350 rpm

## DESIGNING OF SHAFT

### BENDING:

The force which develops across a specific cross section of the shaft, it generates stress at that point of cross section that are subjected to maximum loading. This internal or resisting moment gives rise to the stress called as bending stresses.

**Torsion:** When the shaft which is twisted by the couple such that the axis of that shaft and the axis of the couple harmonize, that shaft is subjected to pure torsion and the stresses generated at the point of cross section is torsion or shear stresses.

**Combined Bending and Torsion:** In actual practice the shaft is subjected to combination of the above two types of stresses i.e. bending and torsion. The bending stresses may occur due any one of the following reasons:

1. Weight of belt
2. Pull of belts
3. Eccentric Mounting of shafts/gears
4. Misalignment of shafts/gears

On contrary, the torsional movement occurs due to direct or indirect twisting of the shaft. Hence at any given point on cross-section of the shaft, the shaft is subjected to both bending and torsional stresses simultaneously. Following stresses are taken in consideration while designing the shaft:

## Shaft design

T = 36000 N mm

$T = 3.14 / 16 \times \sigma_s \times d^3$

Fs allowable = 80 $N/mm^2$

$6820 = 3.14 \times \sigma_s \times d^3/16$

$\sigma_s = 34.73\ N/mm^2$

Material = C 45 (mild steel)

$\sigma_{ut}$ = 320 N/mm2 ---------- PSG design data book.

factor of safety = 2

$\sigma_t = \sigma_b = \sigma_{ut}$/ fos

= 320/2

= 160 $N/mm^2$

$\sigma_s = 0.5\ \sigma_t$

= 0.5 x 160

= 80 $N/mm^2$

$\sigma_s$ is less then allowable so our shaft design is safe.

## Design of Sprocket and Chain for Electric Bike

We know,

TRANSMISSION RATIO = Z2 / Z1 = 66/11 = 6

For the above transmission ratio number of teeth on pinion and the number of teeth sprocket is in the range of 21 to 10, so we have to select number of teeth on pinion sprocket as 11 teeth.

So, Z1 = 11 teeth

## SELECTION OF PITCH OF SPROCKET

The pitch is decided on the basis of RPM of sprocket.

RPM of pinion sprocket is variable in normal condition it is = 2100 rpm

For this rpm value we select pitch of sprocket as 6.35mm from table.

P = 6.35mm

### *CALCULATION OF MINIMUM CENTER DISTANCE BETWEEN SPROCKETS*

THE TRANSMISSION RATIO = Z2 / Z1 = 66/11 = 6 which is less than 7

Dia. of small sprocket,

Periphery = π × dia. Of sprocket

$11 \times 6.25 = \pi \times D$

$D = 11 \times 6.25 / \pi$

D = 21.8 mm

Dia. of sprocket,

Periphery = π × dia. Of sprocket

$66 \times 6.25 = \pi \times D$

$D = 66 \times 6.25/ \pi$

**D = 131.3 mm**

So from table, referred from PSG Design Data book

**The minimum centre distance between the two sprocket** = C' + (80 to 150 mm)

Where $C' = \frac{Dc1 + Dc2}{2}$

$C' = \frac{131.3 + 21.8}{2}$

C' = 76.5 mm

MINIMUM CENTER DISTANCE = 76.5 + (30 to 150 mm) MINIMUM CENTER DISTANCE = 170 mm

## CALCULATION OF VALUES OF CONSTANTS K1 K2 K3 K4 K5 K6 – (with help of PSG Design Data)

Load factor K1 = 1.25 (Load with mild shock)

***Distance regulation factor K2 =1.25(Fixed center distance)***

Center distance of sprocket factor K3 =0.8

Factor for position of sprocket K4 = 1

Lubrication factor K5 = 1.5 (periodic)

Rating factor K6 = 1.0 (single shift)

## CALCULATION OF VALUE OF FACTOR OF SAFETY

For pitch = 6.35 & speed of rotation of small sprocket = 2100 rpm

Factor of Safety for this drive = 8.55

Calculation of Allowable Bearing Stress:

For pitch = 6.35 & speed of rotation of small sprocket = 2100 rpm

Allowable Bearing stress in the system = 2.87kg / $cm^2$

$=2.87 * 981/100 =28 \text{ N /mm}^2$

***Calculating Maximum Tension on Chain***

Maximum torque on shaft = $T_{max} = T_2 = 6820$ N-mm

Where,

$T_1$ = Tension in tight side

$T_2$ = Tension in slack side

$O_1$, $O_2$ = center distance between two shaft

$\text{Sin} \propto = \frac{R_1 - R_2}{O1O2}$

$\text{Sin} \propto = \frac{65.65 - 10.9}{170}$

$\text{Sin} \propto = 0.33$

$\propto = 18.78$

TO FIND θ

$\theta = (180 - 2\propto) \times 3.14/180$

$\theta = (180 - 2*18.78) \times 3.14/180$

$\theta = 2.48$ rad

According to this relation,

$T1/T2 = e^{\mu\theta}$

$T1/T2 = e^{0.35 \times 2.48}$

$T1 = 2.38T2$

We have,

$T = (T1 - T2) \times R$

$6820 = (2.38\ T2 - T2) \times 65.65$

$T2 = 75.27$ N

$T1 = 2.38 \times 75.27$

$T1 = 179.16$ N

So tension in tight side = 179.16 N

We know,

Stress = force / area x 2

Stress induced = $179.16/ (3.14 * 3^2 / 4) \times 2$

Stress induced = 12.67 N /$mm^2$

As induced stress is less than allowable stress =28N /$mm^2$design of sprocket is safe.

## 4. ADVANTAGES

- Easy to commute with low fatigue.
- Less maintenance cost.
- Normal Drag/Pedal is possible when power is not in use.
- Deployable batteries – can be taken inside house.
- Cost of the unit is very low.
- Easy to carry since it is portable.
- Less energy consumed.
- High efficiency can be obtained if inverter is used.
- If using solar panel, free utilization of energy can be done.

(T.Bhavani, April 2015)

## 5. DISADVANTAGES

- High intensity of wind load.
- High centre of gravity.
- Cannot tolerate drastic changes in environment.
- Needs Periodic Monitoring.

(T.Bhavani, April 2015)

## 6. CONCLUSION

With the increasing consumption of natural resources of petrol, diesel it is necessary to shift our way towards alternate resources like the Electric bike and others because it is necessary to identify new way of transport. Electric bike is a modification of the existing cycle by using electric energy and also solar energy if solar panels are provided, that would sum up to increase in energy production. Since it is energy efficient, electric bike is cheaper and affordable to anyone. It can be used for shorter distances by people of any age. It can be contrived throughout the year. The most vital feature of the electric bike is that it does not consume fossil fuels thereby saving crores of foreign currencies. The second most important feature is it is pollution free, eco – friendly and noiseless in operation. For offsetting environmental pollution using of on – board Electric Bike is the most viable solution. It can be charged with the help of AC adapter if there is an emergency. The Operating cost per/km is very less and with the help of solar panel it can lessen up more. Since it has fewer components it can be easily dismantled to small components, thus requiring less maintenance.

## REFERENCES


[1] Aikenhead, G. S. (2011). Bicycle Applications for On-Board Solar Power Generation. 9,10.

[2] Barve, D. S. (2016). Design and Development of Solar Hybrid Bicycle. International Journal of Current Engineering and Technology, 377,378,379,380.

[3] Barve, D. S. (March 2016). Design and Development of Solar Hybrid Bicycle. International Journal of Current Engineering and Technology, 378,379.

[4] Barve, D. S. (March 2016). Design and Development of Solar Hybrid Bicycle. International Journal of Current Engineering and Technology, 380.

[5] FOGELBERG, F. (2014). Solar Powered Bike Sharing System. Goteberg, Sweden: Viktoria Swedish ICT.

[6] FOGELBERG, F. (2014). Solar Powered Bike Sharing System with. Goteborg, sweden: Viktoria Swedish ICT.

[7] GOODMAN, J. D. (2010, Jan 31). An Electric Boost for Bicyclists. The New York Times.

[8] Prof. Palak Desai, P. D. (June 2016). Design and Fabrication of Solar Tri Cycle. International Journal of Engineering Sciences & Research, 664.

[9] Hameed Majeed Saber and Deepak Lal, Assessment of Solar Energy Distribution For Installing Solar Panels Using Remote Sensing & GIS Techniques, *International Journal of Advanced Research in Engineering and Technology (IJARET)* Volume 5, Issue 10, October (2014), pp. 157-164.

[10] Srijan Manish, Jitendra Kumar Rajak, Vishnu Kant Tiwari and Rakesh, Quad Bike Design And Simulation: A Pre-Manufacturing Methodology, International Journal of Advanced Research in Engineering and Technology (IJARET)Volume 5, Issue 6, June (2014), pp. 68-76

[11] T.Bhavani. (April 2015). Novel Design of Solar Electric Bicycle with Pedal. International Journal & Magazine of Engineering, 108.