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Converting Conventional Bike into E-Bike: Design & Fabrication "A Concept"

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Abstract: *With the growing emphasis on environment-friendly technologies in the automobile industry, it's no surprise that two-wheelers are also heading towards this direction. Presently in India, electric two-wheelers are not much appreciated due to their limited speed, range and not so good performance. First and the foremost reason for the failure of such products in the country is the initial acquisition cost of an electric vehicle, which is way higher than a petrol vehicle. The second challenge is the limited range it covers. People feel that in conventional vehicles one is free to travel without worrying about refueling, but with an electric vehicle, their range is limited to the amount of the battery charged. To overcome such issues, the Government has to take an initiative to provide charging infrastructure. The private companies are not willing to do the same due to the low revenue perspective.*

The concept aimed to modify a conventional bike into cost efficient bike with higher mileage and high rated speed, and which can purchased by an ordinary man. Because in starting 2025, the govt. scraping bikes below 150cc, if successfully will be able to modify old bikes at minimum cost which can bring changes, because the new bikes are too expensive and unaffordable. The concept is very promising and has technical interest in the future. In this, the engine and gear unit were replaced with Direct Current motor is done in which power is supplied by battery. Power generated by motor shaft transmitted to rear wheel with the help of chain drive. Then work will be modified by fix the gear arrangement and charging system while running. The torque of the motor is gradually increased, which can increase its carrying capacity and mileage to obtain a better and best output.

Key Words: Charging Structure, Electric Motor and Control, Electric vehicles, Solar Panel, Sustainable Energy, Travelling.

1. INTRODUCTION

The calamity of energy crisis is one of the major problems in the world.[1] The rapid depletion of gasoline, diesel and natural gas resources due to the continuous growth of the population, coupled with the increase in gasoline prices, environmental degradation [2] is another cause of resource depletion, which makes people Shock. Our philosophy is to provide solutions to the above-mentioned dangerous problems. Our innovative system is electric bicycles. The use of electric technology is not a supplement to the internal combustion engine, but an independent product. This concept has various benefits for team members and external interests, thereby raising awareness of using alternative transportation methods. Electric bicycles rely on batteries powered by motors to provide power for driving gear components. They are a general vehicle for local travel. By adding solar panels to the system [3], solar panels can be used as an alternative energy source. The main purpose of using this E-bike is that it is user friendly, economical and relatively cheap. [4]

Nomenclature

P	Power developed by motor
N	Speed of motor in rpm
T	Torque developed by motor
$[\sigma_c]$	Compressible Strength
$[\sigma_b]$	Compressible Strength

1.1 Basic principle

It works on the principle of the electromotive force of an alternating current. The motor, which receives electrical energy stored in the direct current battery, is converted into alternating current with the help of direct current. Converter. In this case, by switching the electric power in the form of current flowing from the battery to the DC-AC converter circuit, the DC waveform obtained by operating a transistor DC-AC booster circuit by switching the electric current is switched Energy in the form of electrical current direct current to alternating current amplifier circuit, the small alternating current is amplified again. To drive the circuit through the capacitor, this boosted current is fed to the stator winding of the AC motor. The capacitor serves as a store for electrical energy and is made available when required. The sprocket mounted on the motor shaft is driven by electrical energy. The rear sprocket is rotated by the chain transfer mechanism, and the other two sprockets are installed on the chain transfer mechanism. The wheels are driven by the rear wheels mounted on the rear sprocket

***1.1.1* How to Use Electricity to Mobilize Electric Bikes? These are the following instruments with specification that were issued in the construction of an ELECTRIC BIKE.**

- BLDC Motor
- lithium-ion Battery
- Programmable Interface Controller

- **Motor**

The brushless DC motor includes a sequence of coils that intertwine with a desk bound magnetic field. The stator has a coil arrangement, and those stator windings may be organized in exclusive ways. The essential distinction among the 2 modes is that the supermegacelebrity mode gives excessive torque at low revolutions in line with minute, and the delta mode gives low torque at low revolutions in line with minute. The brushless DC motor has many benefits, which include higher pace and torque. Features, excessive-dynamic response, excessive-efficiency, lengthy provider life, noiseless operation, better pace range. Brushed vehicles are typically managed via way of means of three-segment strength semiconductor bridges. [5]

Figure-1 BLDC MOTOR

- **Battery**

Electric bicycles use rechargeable batteries, electric powered motors, and a few shape of control. Battery structures used consist of sealed lead acid (SLA), nickel cadmium (NiCad), nickel steel hydride (NiMH), or lithium ion polymer (Li-ion) [6]. Batteries rely on voltage, general rate capacity (at amp-hours), weight, wide variety of rate cycles to deterioration, and the capacity to deal with overvoltage rate conditions. The power fee of running an electric powered motor motorcycle is low, however it could fee a large amount of battery replacement. Battery lifestyles relies upon on how you operate the battery. Some manufacturers, along with American E + (synthetic via way of means of Electric Motion Systems), have the choice of the use of regenerative braking, wherein the motor acts as a generator to gradual down the motor motorcycle earlier than the brake pads engage. This enables amplify the variety and lifestyles of the brake pads and rims. There also are experiments the use of gasoline cells.

Figure-2 lithium-ion Battery

- **Controller:**

It is a controller, which is the brain of the e-bike. This smart device controls all aspects of the electrical system and the BLDC motor and the throttle, too. The battery powers the controller, which powers the motor. The battery and the controller are required for controlling the different parts of the electric bike. This controller has different purposes, such as protecting against under voltage, controlling overcurrent, and supplying power to the control motor. There are different ways to send signals to the PIC controller to drive and control a brushless dc motor. One of these three signals is the current detection signal, one is the motor speed control signal, and one is the capacity detection System.

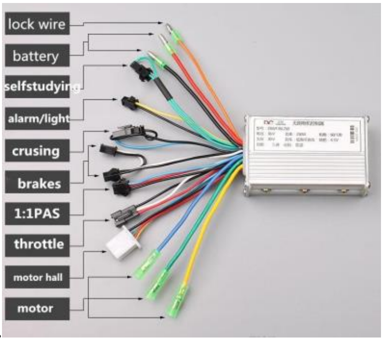

Figure-3 Controller

- ## Electronic throttle :

Electronic Throttle Control (ETC) is an automobile generation that electronically "connects" the accelerator pedal to the throttle and replaces mechanical linkage. A standard ETC device includes 3 essential components: an accelerator pedal module (preferably with or greater unbiased sensors), an electric powered motor (electric powered or digital throttle body (known as ETB)). Throttle valve that may be opened and closed with the aid of using)), and powertrain or engine manage module (PCM or ECM). The advantages of digital throttle manage are in large part neglected with the aid of using maximum drivers due to the fact they purpose to seamlessly align the powertrain traits of the vehicle, irrespective of not unusual place situations such as: Engine temperature, altitude, and accent load. Electronic throttle manage additionally works "at the back of the scenes", dramatically enhancing the convenience with which the driving force can carry out tools modifications and address dramatic torque modifications related to surprising Torque modifications related to surprising acceleration and declaration.

Figure-4 Electronic throttle control

- ## Chain Sprocket set :

A chain and sprocket transmission is a common type of power transmission in which a roller chain engages with two or more toothed wheels or sprockets, used in engines to transmit power, convey materials, and for timing purposes. This is not the most concise or elegant way to say this, but Chains and sprockets are used to transmit power from one component to another. They transfer speed and torque through the use of a chain and sprockets.

Figure-5 chain and sprocket drive

- ## Battery charger:

Level 1—Home Charging: Level 1 charging cords are standard equipment on new electric vehicles. Level 1 charging requires a grounded (three-prong) 120V outlet and can add about 40 miles of range in an 8-hour overnight charge. These plug-in hybrids (level 1 chargers) are appropriate for drivers who don't use their vehicles very often.

Level 2—Home and Public Charging: Level 2 Charging normally calls for a charging unit on a 240V circuit, similar to the circuit used to electricity everyday electric powered garments dryers. The charging charge relies upon at the popularity charge of the car and the most modern-day available. Using a standard 30-amp circuit, charging for eight hours can upload about one hundred eighty miles

Charging—Public Charging:

DC speedy charging is the quickest charging approach presently available. It can normally upload 50 to ninety miles in 30 minutes, relying at the electricity ability of the station and the logo of electrical vehicle.

Figure-6 Battery Charger

Working:

In this DC waveform, because the transistorized DC to AC amplifier circuit is operated, the electrical electricity is switched with inside the shape of contemporary flowing from the battery to the DC to AC converter circuit, in order that the DC waveform will become a sine wave By the use of an amplifier circuit, the small Alternating Current is amplified again. To pressure the circuit via the condenser, an amplified contemporary is fed to the stator winding of the Alternate Current motor. The condenser makes use of up power whilst it is wished and releases it whilst it is not. The sprocket wheel established at the motor shaft is pushed with the aid of using the cause energy of the electrical electricity. The rear sprocket wheel is being circled with the aid of using the chain pressure mechanism on which the alternative last sprocket wheels are established. The rear sprocket turns the rear wheel with the aid of using using it towards the ground. The electric powered motorcycle is powered with the aid of using electric powered energy.

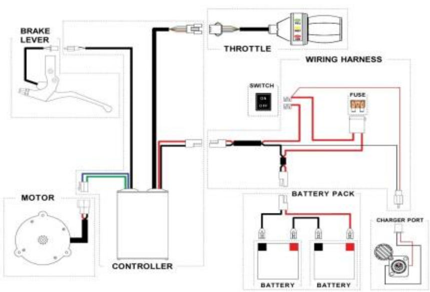

Figure-7 CIRCUIT DIAGRAM

1.1.2 Applications

Electric motors are in development, from automobiles or motor motorcycle to jet skis, however batteries stay expensive, heavy and tough to price without full-size charging points. Electric motors are an opportunity to inner combustion engine motors, considering the fact that Electric motor motorcycle does now no longer calls for fossil fuel, as properly because it does now no longer unlock any pollutant to the environment.

2. Literature Review

2.1 Contributions from researcher:

The Release of the 2017 Chevrolet Bolt

Facts have proved that the highly anticipated 2017 Chevrolet Bolt release has changed the rules of the game in the electric vehicle industry. In terms of balancing performance and price, this car is in the middle. After deduction of applicable federal tax credits, the retail price of the car is approximately $29,995. As for range, it can travel 238 miles on a fully charged battery. Compared with the 83-mile travel range provided by Volkswagen e-Golf, this is a huge increase, but the price has not risen sharply. After the applicable incentives, the Volkswagen e-Golf is priced at US$21,495. This range is slightly less than the 315 miles provided by the Tesla S P100D model. However, for many American consumers, the huge price of $118,500 for this model is out of reach. This careful balance of performance and price is why Chevrolet Bolt may eventually push the use of electric vehicles into mainstream life

2.2 Electric Vehicle Battery Advancements

The reason for the decline in the costs associated with electric vehicles is the advancement of the batteries. The gradual decline in the cost of electric car batteries helps to make electric cars more affordable for various customers. Since 2010, the average cost of batteries has dropped from US$1,000/kWh to approximately US$227/kWh. This leads to a substantial reduction in the total cost associated with the vehicle. In addition to the reduction in battery production costs, the battery itself has also become more efficient. In general, most electric vehicles use lithium-ion batteries. Because of the high charging capacity of these batteries, companies like Tesla continue to invest heavily in this technology. Researchers at Stanford University have made an example of the main development of lithium-ion batteries. They made a protective Nano layer that expands as the temperature of the battery rises.

Table: 2.2.2 Electric-Bikes available at market [8]

NAME	MILEAGE	GAERBOX	PRICE
REVOLT 400	156 KM/CHARGE	AVAILABLE	1.5 LAKH
EMFLUX ONE	200 KM/CHARGE	NA	5.5 LAKH
TORK T6X	100 KM/CHARGE	AVAILABLE	1.25 LAKH
ATHER 450	75 KM/CHARGE	NA	1.3 LAKH
HERO NYX E5	50 KM/CHARGE	NA	66 K

3. Problem Identification

3.1 General problems identified:

We found that the mileage and efficiency are too low, and the crew capacity is as high as about 120 kg. We have seen all kinds of electric bikes, the price is very high, and most people can't afford it. If the vehicle is damaged, it needs to be repaired immediately and can only be repaired at the service center, which is expensive. Electric vehicle parts are not easily available on the market, and charging points are also not nearby.

3.2 Gaps identified from literature:

After reviewing the literature through periodicals, we came to the conclusion that the electric bikes launched do not have a gear transmission system. We will correct this problem to improve the efficiency of the bicycle. [9]

3.3 Objectives of the Work:

1. To Study and preparation of potential, for alternative technology in automobile, such as Electric vehicles.
2. To know why electric vehicles couldn't get enough consumer attraction
3. To study the maximum price consumers can afford electric vehicles.
4. To study the other option available for range anxious consumer with respect existing batteries used in Electric Vehicles.
5. To study the current expectation of consumers with respect to electric vehicle, this will lead to its potential for future.
6. To study current threats, this is causing slow growth of Electric Vehicles.
7. To develop a simple vehicle model and sizing of power train components followed by selection power train components.
8. To estimate the battery pack cost based on battery type and driving cycle and also study the battery life cycle on payback period.
9. To assess the annual saving of gasoline and reduction of CO_2 emission for the span of next 10 year.

4. Procedure/Steps in conducting the Work

This guide describes the process of physically rebuilding a motorcycle and the decision-making process for optimizing your design.

These are 6 main steps to converting a motorcycle that will guide the structure of this instruct able:

- **Initial Plan.** (Get a Donor Bike)
- **Gut & Clean Chassis.** (Dirty Part)
- **Design & Planning.** (Mathematics part for nerds)
- **Install the motor, battery, controller, and charger. The frustrating part was the long journey up the**

mountain. (Main contractor, throttle valve, fuse, etc.)Mount Peripherals. (Main Contactor, Throttle, Fuses, etc)

- **Connect everything together. (Very careful part)**

Step 1: INITIAL PLAN AND RESEARCH.

Step 2: GUT & CLEAN THE FRAME

Once you non-public a motorcycle, you could start going for walks proper away and promote off the whole lot related to the internal combustion engine. Proceed to disconnect and easy the bicycle. You ought to make some coins through manner of approach of scrapping the leftovers from your motorcycle parts, but first try to take away all dimensions from the motor energy shaft and mounting points. It can be very important that the output shaft of the electric motor is with inside the equal position due to the fact the real motor. As the rear suspension actions up and down, the distance from the driven wheels to the energy shaft changes, which can confuse the energy chain. The real fashion designer decided on a particular energy shaft position due to the fact the terrific position to avoid this problem. This approach is also a terrific time for truly all of us who needs to repair the chassis to do this. I need to restore the brakes.

Step 3: DESIGN & PLANNING

This is an exciting part, wherein you could make measurements, calculations, and pre-measurements to decide which hardware to apply and wherein to put in it to your bike. The biggest and maximum steeply-priced are motors, controllers, batteries, and chargers. Initially, it's far tough to pick out and regulate the dimensions of those parts, as there does now no longer appear to be sufficient records to make a decision. In concept there are numerous options, however in reality, positive matters are simplest decided on in the event that they may be achieved. Now we understand that we want to size the battery, motor, and controller in order that a unmarried issue does now no longer emerge as a main impediment to the system. All additives have their very own most transmission potential and all additives ought to function on the equal voltage. The left and proper aspects of the layout aren't symmetrical.

The layout includes parts-

1. Chain power strength transmission
2. Gear power strength transmission

It is feasible to use new hybrid structures to the bike, along with sun panels, alternators, and different structures, to lessen its carbon footprint and efficiency.

Step 4: MOUNT MOTOR, BATTERIES, CONTROLLER, CHARGER

The physical quantity is an enormous limitation of this project. Everything is heavy, so installing it in a tight space is a good way to crush your fingers. Installing these things requires making custom brackets and some welding. Long threaded rods and hose clamps are used to provide a certain degree of adjustability. A strip of rubber is wrapped around the battery to keep it from coming off the bike if I fall. The engine sits between the wheels and the frame. In this step, we will replace the engine head with a motor and a sprocket. The sprocket is connected to the engine crankshaft, and the crankshaft is connected to the gearbox, which is driven by a rechargeable battery. In this case, the power of the rear wheels is transmitted with the help of the chain drive, this step is completed when the frame is manufactured and all large electrical components are installed.

Step 5: MOUNT PERIPHERALS

The main contractor is a main part of the system that included a manual disconnect switch, a cycle analyst (voltmeter/ammeter/odometer), a DC-DC converter, and all the little things like diodes and resistor.

Step 6: CONNECT EVERYTHING TOGETHER

This is the step that leads to the most danger. Be careful not to accidentally damage or short the battery terminals! The size of the high-voltage line is crucial to the operation of the power plant. The larger you go, the lower the resistance, but thicker copper wires can become very expensive. The interesting thing is that voltage has no direct effect on the ampere city of the wire. The wire ampere rate of current is a function of the wire diameter and length. The voltage drop is only a function of the length of the wire.

4.1 Data collection [10]

1. BLDC Motor

A brushless DC motor, made of aluminum, with a copper coil and a low noise, high quality, long life. High speed brushless DC motor, Voltage 48V, power 2000W max, current 42A, rated speed 4300 rpm, with T8F 11 teeth sprocket. Weight: 3.58kg approx., Diameter: 95mm, Nominal torque / Nm: 4 Nm.

2. Controller

48 volts of power and 2000 watts of speed and a 15 Mosfet brushless motor, a 33 amp controller, an E-brake, 3 speeds, a reverse, and indicators lights and a power lock.

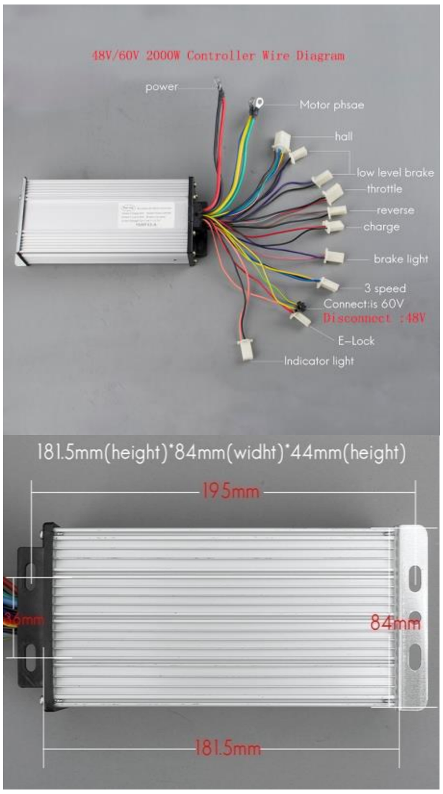

Figure-8 CONTROLLER

3. Electronic Throttle

48V Lithium Battery Handlebar Throttle Twist Grips, With Battery Indicator, Ignition Lock, Twist Throttle Accelerator 3 in 1 Function Handlebar Grip, With High Quality Rubber Grips, For A More Comfortable Ride.

4. Battery

Capacity: 30 - 40 Ah, voltage: 48 V, type: lithium battery capacity: electric bike battery 48 V 30 Ah, weight: 8 kg, discharge current: 50 A, max. 85X153X420mm.

5. Battery Charger

Input: 100-240 V AC • Output: 54.6 V / 2000 mA (2 A) • Size: 142 mm x 60 mm x 32 mm • Weight: 235 grams • Output connector: DC 5.5 * 2.1 • Scope of delivery: Charger * 1 + AC cable * 1.

6. Battery Indicator

Voltage: 8-63V, Suitable Battery Type: Lithium, Lead Acid Battery Temperature: -10-40 °, Support Type: 2-15 String Lithium, 12-48 Lead Acid Battery, and Hibernate Consumption: 10μA.

Analysis/Design Calculation:

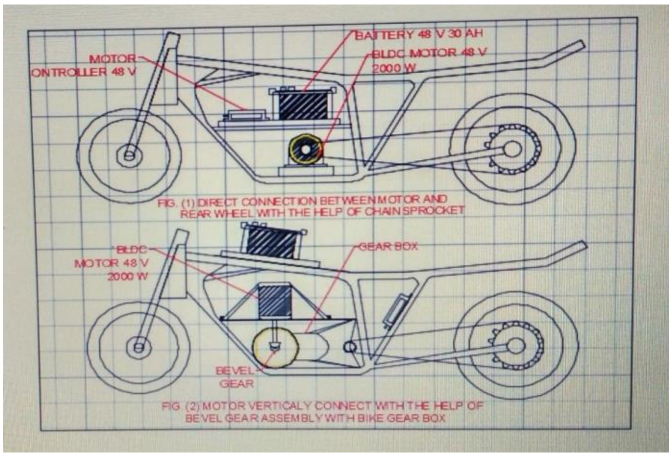

Figure-8 E-bike design

5. DESIGN CALCULATIONS FOR E-BIKE [11]

Considering net loading capacity of bike 150 kg (two person)
The design of e-bike is categorized into two ways-

1. Power transmitted by means of chain drive
2. Power transmitted by means of gear system

<u>Design for chain drive:-</u>

Here we have used a motor with 2000 watts and a speed of 4300 revolutions per minute. The motor has 48 volts and 33 amps of power. The power developed by a motor is equal to the speed of the motor multiplied by the torque developed by the motor.

<u>Notations:</u>
P = Power developed by motor
N = Speed of motor in rpm
T =Torque developed by motor

Given,
Motor Power = 2000 W
Motor Speed = 4300 rpm

$$P = 2 \times 3.14 \times N \times T / 60$$

$$2000 = 2 \times 3.14 \times 4300 \times T/60$$

$$\mathbf{T = 4.44\ N\ m = 4441\ N\text{-}mm}$$

<u>Dimension of sprockets-</u>

Idler sprocket,
No. of Teeth Z1 = 13
Diameter, D1 = 60 mm
Wheel sprocket,
No. of Teeth Z2 = 44
Diameter, D2 = 180 mm
Transmission ratio,

$$i = Z2/Z1 = 44/13 = 3.38$$

$$i = n1/n2 = 4300/n2 = 3.38$$

$$\mathbf{n2 = 1272\ rpm}$$

Selection of pitch, (PSG DDB PG7.74)

$$a = (30 \text{ to } 50)\ p$$

Center distance a = 720 mm

$p = a/30 = 720/30 = 24$ mm

$p = a/30 = 720/50 = 14.4$ mm

Pitch p = 19 mm.

Length of chain,

(PSG DDB PG 7.75)

$L = L_P * p$

$L_P = 2a_p + (Z1+Z2)/2 + ((Z1-Z2)/2\pi)^2 / a_p$

$a_p = a_o/p = 720/19 = 38$ mm

$L_p = 105$ mm

L = 105*19 =1998 mm

Final center distance,

$a = ((e+(e^2 - 8m))/4) * p$

a = 721 mm

$v1 = \pi * D1 * n1/60 =$ **13.33 m/s**

Assuming service factor $k_s = 1$,

Power transmitted on the basis of breaking load,

(PSG DDB PG 7.77)

$N = Q*v/102*n*K_S$ in KW

$2 = Q*13.33/102*26*1$

Q = 397.88 kgf

Power transmitted on the basis of allowable bearing stress,

$N = \sigma * A * v/102 * K_S$

$2 = 0.7*A*13.33/102*1$

A = 21.86 kgf/cm²

Load on shafts,

$Q_O = K * p_t$

$P_t = 102*N/v = 102*2/13.33 = 15.3$ kgf

Q_O = 15.3 kgf

Torque on wheel sprocket,

$P = 2\Pi * n2 * T2/60$

$2000 = 2*3.14*1272*T2/60$

T2 = 15 Nm =15000 N-mm

Hence output on the wheel sprocket will be:

$T_2 = 15$ Nm and $N_2 = 1272$ rpm

<u>Design for Bevel Gear:</u>

Given,

POWER=2000W,

SPEED=4300RPM,

GEAR RATIO=3

Material Selection:

Material C45 surface hardened.

Life of gear 10,000 to 25,000 hours (Let take 20,000)

(PSG Design data book-8.5)

Name	Material	$[\sigma_c]$	$[\sigma_b]$
Pinion	C45	500N/mm²	140N/mm²
Gear	C45	500N/mm²	140N/mm²

Minimum center distance,

$$R \geq \Psi_Y \sqrt{i^2+1}\sqrt{\left[\frac{0.72}{(\varphi_Y - 0.5)[\sigma_2]}\right]^2 \frac{E[M_t]}{i}}$$

(PSG Design data book-8.13)

$\Psi_Y = \frac{R}{b} = 3$, $i = 3$

$E = 2.15 \times 10^5$ N/mm²

$[M_t] = M_t \times K_d \times K$

(PSG Design data book-8.15)

$$M_t = \frac{60 \times 10^6 (KW)}{2\pi N}$$

$M_t = 2220.76$ N-mm

$[M_t] = 2220.76 \times 1.5 = 3331.14$N-m

R ≥ 84.43 mm

Average module,

$$M_{av} \geq 1.28 \sqrt[3]{\frac{[M_t]}{Y_V\ [\sigma_b]\ \varphi_m\ z_1}} \geq 1.28 \sqrt[3]{\frac{3331.14}{0.395 \times [140] \times 10 \times 17}}$$

(PSG Design data book-8.13A)

M_{av} ≥ 0.905 mm

Transverse module,

$$m_t = \left[\frac{\varphi_Y}{\varphi_Y - 0.5}\right] \times M_{av} = \left[\frac{3}{3-0.5}\right] \times 0.905$$

(PSG Design data book-8.38)

$m_t = 2$ mm, (Consider as standard module)

$$\text{Number of teeth} = \frac{R}{0.5\, m_t \sqrt{i^2+1}} = \frac{84.43}{0.5 \times 2 \times \sqrt{10}} = 27 \text{ teeth}$$

(PSG Design data book-8.38)

$\text{Cone distance} = 0.5 \times m_t \times \sqrt{i^2+1} \times Z_1$

(PSG Design data book-8.38)

R = 85.38 mm, (Design is safe)

Compression strength,

$$\sigma_c = \frac{0.72}{(R-0.5b)}\sqrt{\left[\frac{\sqrt{(i^2+1)^3}}{i \times b}\right] E[M_t]}$$

(PSG Design data book-8.13)

$\frac{R}{b} = 3$, $b = 28.46$ mm

σ_c = 458.87 N/**mm²**, (Design is safe)

Bending strength,

$$\sigma_b = \frac{R\sqrt{i^2+1}[M_t]}{(R-0.5b)^2 \times b \times m \times Y_V} \times \frac{1}{\cos\alpha}$$

(PSG Design data book-8.13A)

σ_b = 8.40 N/mm² ≤ [σ_b], (Design is safe)

Pitch circle diameter,

$d_1 = 2\times27 = 54$ mm

$d_2 = 2\times2\times27 = 108$ mm

Tip Circle Diameter,

$D_{a1} = m_t (Z_1+2\cos\delta_1) = 57.79$ mm

$D_{a2} = m_t (Z_2+2\cos\delta_2) = 57.79$ mm

Face width (b) = 0.3 ≈ R

Or $10\times m_t = 20$ mm

Pressure angle (α) = 20

Height factor (f_0) = 1, (Standard value)

Clearance(C) = 0.2

Addendum (h_w) = m_t = 2 mm

Deddendum (h_f) = $1.126\times m_t$ = 2.52 mm

Tooth height = $h_w + h_f$ = 4.52 mm

OUTPUT POWER,

Power = 2 KW, Speed = 4300 RPM, m = 2 mm, FOS = 2.5,

C45 $S_{ut} = 520$ N/mm^2

$\tan\gamma = \frac{z_g}{z_p} = \frac{54}{27} = 2$

$\gamma = 63.43°$

Beam strength,

$S_b = m \times b \times \sigma_b \times Y\left[1 - \frac{b}{A_0}\right]$; $Z_Y = \frac{27}{\cos\alpha} = 60$

Y = 0.421

(PSG Design data book-8.53)

$A_0 = \sqrt{\left(\frac{mZ_p}{2}\right)^2 + \left(\frac{mZ_g}{2}\right)^2}$

A_0 = 60.37 mm

$S_b = 2 \times 20 \times \frac{520}{3} \times 0.421\left[1 - \frac{20}{60.37}\right]$

S_b = 1951.91 N

Static load,

$P_{eff} = \frac{C_s P_t}{C_v}$

$C_v = \frac{5.6}{5.6+\sqrt{V}}$

$V = \frac{\pi DN}{60\times10^3} = 12.15$ m/s

$C_v = 0.61$ m/s ; $C_s = 1.5$

$P_{eff} = \frac{S_b}{FOS} = \frac{1451.91}{2.5}$

P_{eff} = 780.76 N

$780.76 = \frac{1.5\times P_t}{0.61}$

P_t = 317.50 N

Power,

$P_t = \frac{2M_t}{D}$ => $317.50 = \frac{2\times M_t}{54}$

$M_t = 8572.5$ N-mm

$P = \frac{60\times10^6\,(Power)}{2\pi\times4300}$ = **3.86 KW**

Hence power developed by bevel gear is 3.86 KW to the transmission gear system.

Comparative analysis with e-bikes-

Table: 5.1

Below mentioned are the e- bikes which are available in market:

S. No.	E- -bike	Load Capa- -city (kg)	Range (KM /charge)	Battery (kwh)	Max. Speed (kmph)	Motor (W)	Trans- - mission gearbox	On road Price (Rs)
1	Revolt 300	150	120	2.7	65	1500	NA	1,11,000
2	Revolt 400	110	150	3.24	100	3000	NA	1,30,000

Table: 5.2

Below mentioned are the e- scooter which are available in market

S. No.	E- Scoo--ter	Load Capacity (kg)	Range (KM/ charge)	Battery (kwh)	Max. Speed (kmph)	Motor (W)	Trans--mission gearbox	On road Price (Rs)
1	Bajaj Chetek	120	95	3.6	70	4080	NA	1,15,000
2	Okinawa I Praise	150	170	2.9	85	1000	NA	1,16,000
3	Okinawa Praise	150	200	2.9	75	1000	NA	72,000

Table: 5.3 E- Bike to be designed for the purpose of project:

Load Capa -city (kg)	Range (KM/ charge)	Battery (kwh)	Max. Speed (kmph)	Motor (W)	Charg- -ing Time (hrs)	Trans- -mission gearbox
150	60	1.44	55	2000	3-4	Available
	130	2.88	70			
	170	4.22	90			

Result:

The gear drive connected to the motor of the electric bicycle is more efficient than the chain drive to cause mechanical loss. Electric bikes produce slightly less power than traditional bikes, but they still have their advantages. The bicycle can provide a net performance output of 80-100 meters per second (m/s), and a one-way travel distance of up to 120-150 kilometers, depending on the battery capacity, can carry a person of 120 kilograms (kg). The battery takes four to five hours to charge, which is more than a smartphone. The addition of more charging systems can improve performance. There are fewer problems related to battery consumption.

Discussions:

In this article, we analyzed the usage and battery charge data of the electric bicycle from the field test. Electric bicycles are designed for commuting and can replace the use of cars and public transport. Over 150GB of data over the last three years shows that: [12]

- • Some participants ride their bikes all year round, but most rides take less than 20 minutes and take place in the spring, summer and fall. Most of the charging process takes place on a low charge, so there are no signs of fear for kilometers. Participants commute to work in the morning and recharge the batteries shortly after returning home in the afternoon.
- • No significant correlation was found between the participants' actual and expected use of the electric bike (estimated by some studies).
- Participating in field trials of electric bicycles did not significantly change participants' views on various modes of transportation. Electric bikes are a great addition for independence, reliability, stress-free travel, and the environment. However, electric bicycles are more highly regarded than automobiles in every respect. In addition to independence and comfort, electric bicycles are rated higher than automobiles in terms of safety, environmental friendliness, and cost.
- I found that the use of electric bicycles did not stop even in winter. Therefore, manufacturers of electric bikes in countries with winter weather need to provide integrated mudguards and lighting to make winter driving safer.

6. CONCLUSIONS

The most important feature of electric bicycles is that they do not consume fossil fuels, which saves the forex core. If solar panels are provided, solar energy can also be used, increasing energy production. Because of its energy saving, electric bicycles are cheap and affordable for everyone. In the event of a power outage, you can use the adapter to charge your bike. Operating costs per kilometer are very low and can be further reduced with the help of solar panels.

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