International Journal of Enhanced Research in Science, Technology & Engineering
ISSN: 2319-7463, Vol. 12 Issue 4, April-2023, Impact Factor: 7.957

Design & Fabrication of Foldable E-Bicycle

Penke Devi Prasad[1], Sakamuri Ravindra Naga Prasad[2], Sk Jafeer Ahmed[3], G Satya Chandra Naga Sai Ram[4], B Karteek Damodhar Rao[5], M. Rambabu[6]

[1,2,3,4,5]B.Tech, Aditya College of Engineering & Technology, Surampalem, A.P, India, 533437
[6]Assistant Professor, Aditya College of Engineering & Technology, Surampalem, A.P, India, 533437

ABSTRACT

In the present-day lifestyle man is not able to dedicate specific time for his health, importance is least given to exercise and body fitness due to time shortage and stressful life. To cope with time deficit, we can utilize 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, are not easy to carry around and are probable to theft. Transport has been one of the most important issues to be dealt within the present-day situation as commuting from place to place within the city has become a tedious and an expensive task. It is very difficult to reach the nearest public transport facility and in many cases the destination will be very far from the main roads where the public transport might not be able to commute, or it might be very expensive.

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 is very easy to be carried around. The main objective is to design and develop a foldable bicycle which is comfortable to ride and economical.

Key words: Transport, Bicycle, Foldable, Electric, Pollution, etc.

INTRODUCTION

On December 31, 1895, American inventor Ogden Bolton Jr. was granted what appears to be the very first patent for a battery-powered bicycle. It featured a rear wheel hub motor, with a 10-volt battery, and appears to have had a rear brake, which looks so much like the modern road bikes. Some modern e-bike manufacturers have taken a step back to their traditional roots.

A foldable e-bicycle vehicle is one which uses more (can one source of power. An electric system combined with the traditional pedal system gives us our Hybrid Bicycle. An electric bicycle, also known as an e-bike, power bike or booster bike, is a bicycle with an integrated electric motor which can be used for propulsion. A folding bicycle is a bicycle designed to fold into a compact form, facilitating transport and storage

Figure 1.1 Foldable Electric Bicycles

An e-bicycle is one with electric motor that assists the rider with pedaling. This means that will you're still getting a workout and enjoying the scenery you don't need to pedal nearly as heard, especially up hills. An electric bicycle (e-bike, e-bike, etc.) is a motorized bicycle with an integrated electric motor used to assist propulsion. Many kinds of e-bikes are available worldwide, but they generally fall into two broad categories: bikes that assist the rider's pedal- power (i.e peddles) and bikes that add a throttle, integrating moped-style functionality. Both retain the ability to be pedaled by the rider and are therefore not electric motorcycles.

Foldable Bicycle

A folding bicycle is a bicycle designed to fold into a compact form, facilitating transport and storage. When folded, the bikes can be more easily carried into buildings, on public transportation (facilitating mixed-mode commuting and bicycle commuting), and more easily stored in compact living quarters or aboard a car, boat or plane.

Folding mechanisms vary, with each offering a distinct combination of folding speed, folding ease, compactness, ride, weight, durability, and price. Distinguished by the complexities of their folding mechanism, more demanding structural requirements, greater number of parts, and more specialized market appeal, folding bikes may be more expensive than comparable non-folding models. The choice of model, apart from cost considerations, is a matter of resolving the various practical requirements: a quick, easy fold, a compact folded size, or a faster but less compact model.

There are also bicycles that provide similar advantages by separating into pieces rather than folding.

History

Military interest in bicycles arose in the 1890s, and the French army and others deployed folding bikes for bicycle infantry use. In 1900, Mikael Pedersen developed for the British army a folding version of his Pedersen bicycle that weighed 15 pounds and had 24inch wheels. It included a rifle rack and was used in the Second Boer War.

In 1941, during the Second World War, the British War Office called for a machine that weighed less than 23 lb (this was not achieved - the final weight was about 32 pounds) and would withstand being dropped by parachute. In response, the Birmingham Small Arms Company (BSA) developed a folding bicycle small enough to be taken in small gliders or on parachute jumps from aircraft.

This British WW Airborne BSA folding bicycle was rigged so that, when parachuted, the handlebars and seat were the first parts to hit the ground (as bent wheels would disable the bike). BSA abandoned the traditional diamond bicycle design as too weak for the shock and instead made an elliptical frame of twin parallel tubes, one forming the top tube and seat stays, and the other the chain stay and down tube. The hinges were in front of the bottom bracket and in the corresponding position in front of the saddle, fastened by wing nuts. The peg pedals could be pushed in to avoid snagging and further reduce the space occupied during transit. From 1942 to 1945, the British WWII Airborne BSA folding bicycle was used by British & Commonwealth airborne troops, Commandos, and some infantry regiments; some were also used as run-abouts on military bases. The bicycle was used by British paratroopers, Commandos, and second-wave infantry units on the D-Day landings and at the Battle of Arnhem.

Electric Bicycle

Electric bikes use a motor to assist the movement of the pedals, making riding the bicycle less taxing. Some designs allow the bike to move forward under its own power from the motor while others require your assistance to pedal. An electric bicycle (e-bike, etc.) is a motorized bicycle with an integrated electric motor used to assist propulsion. Many kinds of e-bikes are available worldwide, but they generally fall into two broad categories: bikes that assist the rider's pedal-power (i.epeddles) and bikes that add a throttle, integrating moped-style functionality. Both retain the ability to be pedaled by the rider and are therefore not electric motorcycles. E-bikes use rechargeable batteries and typically travel up to 25 to 32 km/h (16 to 20 mph). Depending up on the laws of their country. High-powered varieties can often travel more than 45 km/h (28 mph). In some markets, such as Germany as of 2013, they are gaining in popularity and taking some market share away from conventional bicycles, while in others, such as China as of 2010, they are replacing fossil fuel- powered mopeds and small motorcycles Depending on local laws, many c- bikes (e.g., peddles) are legally classified as bicycles rather than mopeds or motorcycles, so they are not subject to the more stringent laws regarding their certification and operation, unlike the more powerful two-wheelers which are often classed ns electric motorcycles, e-bikes can also be defined separately and treated as a specific vehicle type in many areas of legal jurisdiction. E- bikes arc the electric motor-powered versions of motorized bicycles, which have been around since the late 19th century. Some bicycle-sharing systems use them.

LITERATURE SURVEY

Department of Manufacturing and Materials Engineering, International Islamic University, Malaysia's view on Folding Bicycle Design.

The study on the aspects of materials, properties and design of folding bicycle frame was performed. Folding bicycle is an important design in human history; thus, it brings benefits to make life easier than before. Thefatigue problem (which might extend the life cycle of the folding bicycle frame) is always considered as main problem regarding the properties of the materials. The relationship between materials properties and design is not straight-forward because the behavior of the material in the finished product could be different from that of the raw material. Additionally, the properties like fatigue and tensile strength are the important properties for the better performance of the frame. The coated swing hinge in folding bicycle is considered as a better joint technique in the design and carries benefits to the user to fold the bicycle since it overcome the limited lifecycle and moreover is simple and cost-effective.

R. S Jadon& Sushil Kumar [2] Choudhary focused on "Design and fabrication of dual chargeable bicycle "Topic. We get Idea of Self Chargeable Concept. When the battery is fully charged a speed of 10-15km/hr is obtained. When coming down the hill the charging can be achieved in 1hr. Because of friction driven mechanism wheel wear at a faster rate.(PDF) Self Rechargeable Electric Folding Bicycle.

MD Saquib Gadkari et al. [3] Fans are the most used items in India despite the widespread availability of Cooler's and air conditioners. Since the initial capital cost of solar systems is still quite high when it comes to generate power for a domestic use and energy are saving and energy generating is a major issue for mankind. This paper presents method of generating power by a ceiling fan. The generated power can be either used or can be stored in a battery for powering some other devices. By it we use Dynamo to Convert Kinetic Energy of Its chainwheel we are meshing Gear tooth with small gear by it we Generate Power. It Fan's concept we use in our Project.

J. Sandhu et al. [4] considered the possibility of power generation, using a bicycle dynamo, to recharge a mobile phone.

FOLDABLE ELECTRIC BICYCLE

Bicycle Frame

A chassis consists of an internal vehicle frame that supports an artificial object in its construction and use, can also provide protection for some internal parts. An example of a chassis is the underpart of a motor vehicle, consisting of the frame.

A bicycle frame is the main component of a bicycle, onto which wheels and other components are fitted. The modem and most common frame design for an upright bicycle is based on the safety bicycle and consists of two triangles: a main triangle and a paired rear triangle. This is known as the diamond frame. Frames are required to be strong, stiff and light, which they do by combining different materials and shapes. A frameset consists of the frame and front fork of a bicycle and sometimes includes the headset and seat post. Frame builders will often produce the frame and fork together as a paired set.

Types of Bicycle Frames:

Dimond

In the diamond frame, the main "triangle" is not actually a triangle because it consists of four tubes: the head tube, top tube, down tube, and seat tube. The rear triangle consists of the seat tube joined by paired chain stays and seat stays.The head tube contains the headset, the interface with the fork. The top tube connects the head tube to the seat tube at the top. The top tube may be positioned horizontally (parallel to the ground), or it may slope downwards towards the seat tube for additional stand-over clearance. The down tube connects the head tube to the bottom bracket shell.

The rear triangle connects to the rear fork ends, where the rear wheel is attached. It consists of the seat tube and paired chain stays and seat stays. The chain stays run connecting the bottom bracket to the rear fork ends. The seat stays connect the top of the seat tube to the rear fork ends.

Step-Through

Historically, women's bicycle frames had a top tube that connected in the middle of the seat tube instead of the top, resulting in a lower stand over height. This was to allow the rider to dismount while wearing a skirt or dress. The design has since been used in unisex utility bikes to facilitate easy mounting and dismounting, and is also known as a step-through frame or an open frame.

Cantilever

In a cantilever bicycle frame the seat stays continue past the seat post and curve downwards to meet with the down tube. Cantilever frames are popular on the cruiser bicycle, the lowrider bicycle, and the wheelie bike. In many cantilevers frames the only straight tubes are the seat tube and the head tube.

Recumbent

The recumbent bicycle moves the cranks to a position forward of the rider instead of underneath, generally improving the slipstream around the rider without the characteristic sharp bend at the waist used by racers of Diamond frame bicycles.

Prone

The uncommon prone bike moves the cranks to the rear of the rider, resulting in a head-forward, chest-down riding position.

Cross or Girder

A cross frame consists mainly of two tubes that form a cross: a seat tube from the bottom bracket to the saddle, and a backbone from the head tube to the rear hub.

Truss

A truss frame uses additional tubes to form a truss. Examples include Pedersen's, Pedersen's, and the one pictured.

Monocoque

A monocoque frame consists only of a hollow shell with no internal structure.

Folding

Folding bicycle frames are characterized by the ability to fold into a compact shape for transportation or storage.

Penny-Farthing

Penny-farthing frames are characterized by a large front wheel and a small rear wheel.

Tandem and Sociable

Tandem and sociable frames support multiple riders.

Frame tubes

The diamond frame consists of two triangles, a main triangle and a paired rear triangle. The main triangle consists of the head tube, top tube, down tube and seat tube. The rear triangle consists of the seat tube, and paired chain stays and seat stays.

Head tube

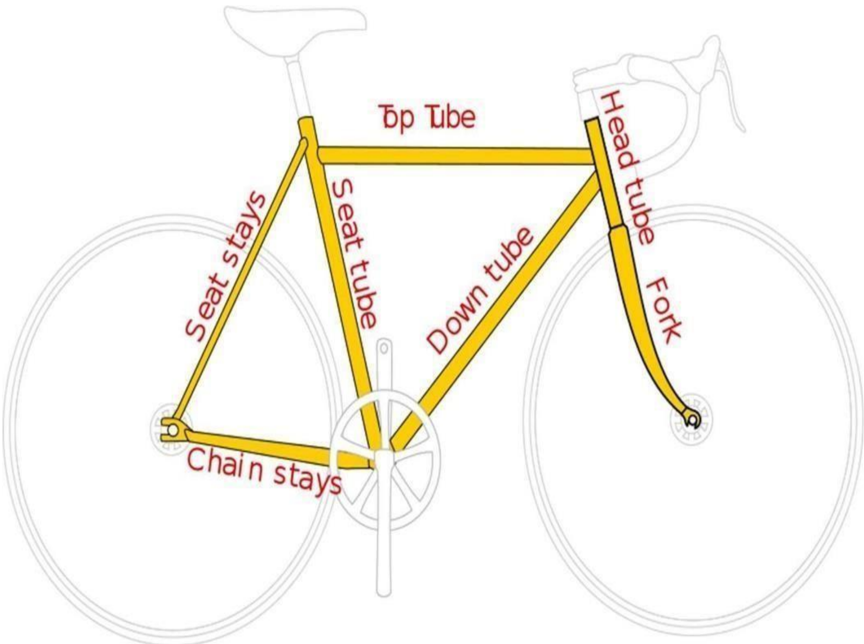

Figure 3.1 Head Tube

The head tube contains the headset, the bearings for the fork via its steerer tube. In an integrated headset, cartridge bearings interface directly with the surface on the inside of the head tube, on non-integrated headsets the bearings (in a cartridge or not) interface with "cups" pressed into the head tube.

Top Tube: -

Bicycle frameset (frame and fork) schematic The top tube, or cross-bar, connects the top of the head tube to the top of the seat tube.

In a traditional-geometry diamond frame, the top tube is horizontal (parallel to the ground). In a compact-geometry frame, the top tube is normally sloped downward toward the seat tube for additional stand over clearance. In as mountain bike frame, the top tube is almost always sloped downward toward the seat tube. Radically sloped top tubes that compromise the integrity of the traditional diamond frame may require additional gusseting tubes, alternative frame construction, or different materials for equivalent strength. (See Road and triathlon bicycles for more information on geometries.) Step-through frames usually have a top tube that slopes down steeply to allow the rider to mount and dismount the bicycle more easily. Alternative step through designs may include leaving out the top tube out completely, as in monocoque mainframe designs using a separated or hinged seat tube, and twin top tubes that continue to the rear fork ends as with the Maxterm. These alternatives to the diamond frame provide greater versatility, though at the expense of added weight to achieve equivalent strength and rigidity.

Seat Tube: -
The seat tube contains the seat post of the bike, which connects to the saddle. The saddle height is adjustable by changing how far the seat post is inserted into the seat tube. On some bikes, this is achieved using a quick release lever. The seat post must be inserted at least a certain length; this is marked with a minimum insertion mark.
The seat tube also may have braze-on mounts for a bottle cage or front derailleur.

Chain stays: -
The chain stays run parallel to the chain, connecting the bottom bracket shell (which holds the axis around which the pedals and cranks rotate) to the rear fork ends or dropouts. A shorter chain stay generally means that the bike will accelerate faster and be easier to ride uphill, at least while the rider can avoid the front wheel losing contact with the ground. When the rear derailleur cable is routed partially along the down tube, it is also routed along the chain stay.

Seat Stays: -
Example of a dual-stay seat stays system the seat stays connects the top of the seat tube (often at or near the same point as the top tube) to the rear fork dropouts. A traditional frame uses a simple set of paralleled tubes connected by a bridge above the rear wheel. When the rear derailleur cable is routed partially along the top tube, it is also usually routed along the seat stay.

Many alternatives to the traditional seat stay design have been introduced over the years. A style of seat stay that extends forward of the seat tube, below the rear end of the top tube and connects to the top tube in front of the seat tube, creating a small triangle, is called a Hellenic stay after the British frame builder Fred Helens, who introduced them in 1923. Hellenic seat stays add aesthetic appeal at the expense of added weight. This style of seat stay was popularized again in the late 20th century by GT Bicycles (under the moniker "triple triangle"), who had incorporated the design element into their BMX frames, as it also made for a much stiffer rear triangle (an advantage in races); this design element has also been used on their mountain bike frames for similar reasons. In 2012, a variation of the traditional seat stay that bypasses the seat tube and connects further into the top tube was patented by Volagi Cycles. This frame element added length to the traditional design of seat stays, making a softer ride at the sacrifice of frame stiffness.

Bottom Bracket Shell
The bottom bracket shell is a short and large diameter tube, relative to the other tubes in the frame that runs side to side and holds the bottom bracket. It is usually threaded, often left-hand threaded on the right (drive) side of the bike to prevent loosening by fretting induced precession, and right-hand threaded on the left (non-drive) side. There are many variations, such as an eccentric bottom bracket, which allows for adjustment in tension of the bicycle's chain. It is typically larger, unthreaded, and sometimes split. The chain stays, seat tube, and down tube all typically connect to the bottom bracket shell.There are a few traditional standard shell widths (68, 70 or 73 mm).[28] Road bikes usually use 68 mm; Italian road bikes use 70 mm; Early model mountain bikes use 73 mm; later models (1995 and newer) use 68 mm more commonly. Some modern bicycles have shell widths of 83 or 100 mm and these are for specialized downhill mountain biking or snow biking applications. The shell width influences the Q factor or tread of the bike. There are a few standard shell diameters (34.798 – 36 mm) with associated thread pitches (24 - 28 tpi). On some gearbox bicycles, the bottom bracket shell may be replaced by an integrated gearbox or a mounting location for a detachable gearbox.

Frame Geometry
The length of the tubes and the angles at which they are attached define frame geometry. In comparing different frame geometries, designers often compare the seat tube angle, head tube angle, (virtual) top tube length, and seat tube length. To complete the specification of a bicycle for use, the rider adjusts the relative positions of the saddle, pedals, and handlebars: saddle height, the distance from the canter of the bottom bracket to the point of reference on top of the middle of the saddle. Stack, the vertical distance from the center of the bottom bracket to the top of the head tube. reach, the horizontal distance from the canter of the bottom bracket to the top of the head tube. Bottom bracket drop, the distance by which the center of the bottom bracket lies below the level of the rear hub. Handle bar drop, the vertical distance between the reference at the top of the saddle to thehandlebar. Setback

Frame Size:

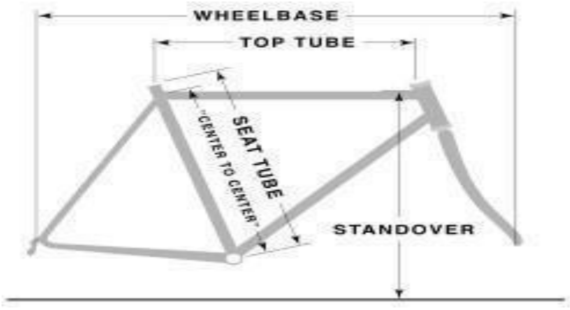

Figure3.2 Frame Size

Commonly Used Measurements
Frame size was traditionally measured along the seat tube from the centre of the bottom bracket to the center of the top tube. Typical "medium" sizes are 54 or 56 cm (approximately 21.2 or 22 inches) for a European men's racing bicycle or 46 cm (about 18.5 inches) for a men's mountain bike. The wider range of frame geometries that now exist has also led to other methods of measuring frame size. Touring frames tend to be longer, while racing framesare more compact.

Frame Materials
Historically, the most common material for the tubes of a bicycle frame has been steel. Steel frames can be made of varying grades of steel, from very inexpensive carbon steel to more costly and higher quality chromium molybdenum steel alloys. Frames can also be made from aluminum alloys, titanium, carbon fiber, and even bamboo and cardboard. Occasionally, diamond (shaped) frames have been formed from sections other than tubes. These include I-beams and monocoque. Materials that have been used in these frames include wood (solid or laminate), magnesium (cast I beams), and thermoplastic. Several properties of a material help decide whether it is appropriate in the construction of a bicycle frame:

- Density (or specific gravity) is a measure of how light or heavy the material per unit volume.
- Stiffness (or elastic modulus) can in theory affect the ride comfort and power transmission efficiency. In practice, because even a very flexible frame is much stiffer than the tires and saddle, ride comfort is ultimately more a factor of saddle choice, frame geometry, tire choice, and bicycle fit
- Yield strength determines how much force is needed to permanently deform the material (for crashworthiness).
- Elongation determines how much deformity the materialallows before cracking.
- Fatigue limit and Endurance limit determines the durability of the frame when subjected to cyclical stress from pedalling or ride bumps.

Steel:
Steel frames are often built using various types of steel alloys including chromoly. They are strong, easy to work, and relatively inexpensive. However, they are denser (and thus generally heavier) than many other structural materials. Compared to aluminum -based frames, steel frames generally offer a smoother riding experience. It is common (as of 2018, in hybrid commuter bikes) to use steel for the fork blades even when the rest of the frame is made of a different material, because steel offers better vibration dampening.
Main article: Lugged steel frame construction

Aluminum
Aluminum alloys have a lower density and lower strength compared with steel alloys; however, they possess a better strength-to-weight ratio, giving them notable weight advantages over steel. Early aluminum structures have shown to be more vulnerable to fatigue, either due to ineffective alloys, or imperfect welding technique being used. This contrasts with some steel and titanium alloys, which have clear fatigue limits and are easier to weld or braze together. However, some of these disadvantages have since been mitigated with more skilled labor capable of producing better quality welds, automation, and the greater accessibility to modern aluminum alloys. Aluminum ‘s attractive strength to weight ratio as compared to steel, and certain mechanical properties, assure it a place among the favored frame building materials. Popular alloys for bicycle frames are 6061 aluminum and 7005 aluminums.

Titanium
Titanium is a relatively niche material for bicycle frames. It has many desirable characteristics, including a high specific strength, high fatigue limit, and excellent corrosion resistance. While not as light as carbon fiber frames, titanium's properties and reasonable stiffness lend to a more pleasant ride quality, making the material popular among cyclists

seeking comfort over performance. However, titanium has a high material cost and is more difficult to machine than steel or aluminum, which translates to relatively expensive frames compared to steel, aluminum, and carbon fiber.

Carbon Fibre

Composite is a popular non-metallic material commonly used for bicycle frames Although expensive, it is light-weight, corrosion-resistant and strong, and can be formed into almost any shape desired. The result is a frame that can be fine-tuned for specific strength where it is needed (to with stand pedaling forces), while allowing flexibility in other frame sections (for comfort). Custom carbon fiber bicycle frames may even be designed with individual tubes that are strong in one direction (such as laterally), while compliant in another direction (such as vertically). The ability to design an individual composite tube with properties that vary by orientation cannot be accomplished with any metal frame construction commonly in production. Some carbon fiber frames use cylindrical tubes that are joined with adhesives and lugs, in a method analogous to a lugged steel frame. Another type of carbon fiber frames is manufactured in a single piece, called monocoque construction.

Thermoplastic: -

Figure 3.3 Therma plastic

Thermoplastics are a category of polymers that can be reheated and reshaped, and there are several ways that they can be used to create a bicycle frame. One implementation of thermoplastic bicycle frames are essentially carbon fiber frames with the fibers embedded in a thermoplastic material rather than the more common thermosetting epoxy materials. GT Bicycles was one of the first major manufacturers to produce a thermoplastic frame with their STS System frames in the mid-1990s. The carbon fibers were loosely woven into a tube along with fibers of thermoplastic

Magnesium

A handful of bicycle frames are made from magnesium, which has around 64% the density of aluminum. In the 1980s, an engineer, Frank Kirk, devi-seda novel form of frame that was die cast in one piece and composed of I beams rather than tubes. A company, Kirk Precision Ltd, was established in Britain to manufacture both road bike and mountain bike frames with this technology.

Scandium Aluminum Alloy

Some manufacturers of bikes make frames out of aluminum alloys containing cadmium, usually referred to simply as scandium for marketing purposes although the Sc content is less than 0.5%. Scandium improves the welding characteristics of some aluminum alloys with superior fatigue resistance permitting the use of smaller diameter tubing, allowing for more frame design flexibility.

Beryllium

American Bicycle Manufacturing of St. Cloud, Minnesota, briefly offered a frameset made of beryllium tubes (bonded to aluminum lugs), priced at$26,000. Reports were that the ride was very harsh, but the frame was also very laterally flexible.

Bamboo

Several bicycle frames have been made of bamboo tubes connected with metal or composite joinery. Aesthetic appeal has often been as much of a motivator as mechanical characteristics.

Wood

Several bicycle frames have been made of wood, either solid or laminate. Although one survived 265 grueling kilometers of the Paris–Roubaix race, aesthetic appeal has often been as much of a motivator as ride characteristics. Wood is used to fashion bicycles in East Africa. Cardboard has also been used for bicycle frames.

Combinations

Combining different materials can provide the desired stiffness, compliance, or damping in different areas better than can be accomplished with a single material. The combined materials are usually carbon fibered a metal, either steel, aluminum, or titanium. One implementation of this approach includes a metal down tube and chain stays with carbon top tube, seat tube, and seat stays. Another is a metal main triangle and chain stays with just carbon seat stays. Carbon forks have become very common on racing bicycles of all frame materials.

Calculation

Resistance Torque (R.T): -

R. T= T. R × R × Fl

Where, T.R = Total resistance R = radius of type, Fl=dynamic radiusof tier

R. T= T. R × R × Fl =107.005×0.33×0.97 =34.25 N

Speed without any reduction Rated rpm = 400 Linear

speed (V)= πDN= (3.14×0.66×400) =49.71 Km/h

Speed after reduction (N2) = T1

N1

Were

No. of teeth in motor gear (T1) =9

No. of teeth in sprocket gear (T2) = 16 N1=400 rpm

N2= × =28 Km/hr.

Battery charging time= Battery current / Charger output current

$= \frac{22}{7}$ Total charge time to get full charge =3.14 Hrs

Fabrication of Foldable E-Bicycle

Methodology

In this chapter we focus on the methodology required for the fabrication or construction of the inexpensive electric bicycle. The step-by-step procedure is preferred to make a complex design easier and simple for both understanding and construction purpose. Firstly, we have to search and gather all the components of an electric bicycle like D.C motor, Batteries, controller, throttle, brakes etc. once we have finished with the purchasing of components, make a chart of the raw materials available to you as mentioned below.

List of Components Required

Table 4.9

SI NO	COMPONENT NAME	QUANTITY
1.	HUB MOTAR	1
2.	BATTERY	1
3.	BRAKES	2
4.	CONTROLLER	1
5.	CHARGER	1

6.	THROTTEL	2
7.	CHASIS	1
8.	RIM	2
9.	TYRES	2
10.	DIGITAL SPEEDOMETER	1

This chart will help to know about the resources available to us and having the brief detailed about those in mind. Now it's time to kick out the potential of knowledge and ideas to solve the upcoming hurdles in the fabrication methodology.

Figure 5.0 Foldable frame

We had followed the step wise construction as mentioned below:-

Fabrication Process

Step 1: - selection of bicycle
Step 2: - rigid mounting of sprocket on the rear wheel hub
Step 3: - mounting of motor in proper alignment & position
Step 4: - fabrication of carriage
Step 5: -Rigid mounting of batteries and controller on carriage
Step 6: - Mounting of brakes
Step 7: - Other components mountings
Step 8: -Electric circuits to controller

TESTING & RESULTS

Performance Evolution:
The combined center of mass of a bicycle and its rider must lean into a turn to successful navigate it. This lean is induced by a method known as counter steering, which can be performed by the rider turning the handlebars directly with the hands or indirectly.

Average Speed: -
The average speed of any object is the total distance travelled by that object divided by total time elapsed to cover the said distance. Object has a speed of 15km/hour.

Maximum Speed: -
The maximum speed is defined as the top speed attained by the bicycle when we have given the maximum power input to the hub motor when it is traveling 25kmph

Travel Range: -
The travel range is defined as the approximate distance traveled by the bicycle with full charge. The total travel range of the bicycle was 50-60km.

Battery Charging Time: -
The battery charging time is nothing, but the total time taken for full charge it can be calculated by using battery range by charging current. The total charging time for the battery was 3-4 hr.

Power Consumption Range: -
The units of electric power are watt-hours, which is how many watts can be delivered for an hour by the battery. The power consumption range for our e-bicyclewas 150-336WH

Battery Voltage: -
The voltage of a battery is a fundamental characteristic of a battery, which is determined by the chemical reactions in the battery, the concentrations of the battery components, and the polarization of the battery. The voltage calculated from equilibrium conditions is typically known as the nominal battery voltage. The total voltage of it is 24v/12ah

Maximum Torque: -
Max. Torque is the maximum power at low speed (in rpm) Suppose if we are going on uphill, we will need some extra power than a power is needed to vehicle on a flat road at low rpm. Max power is the power generated at high speed. The maximum torque produced in the bicycle was 39.1Nm

Braking Distance: -
Braking distance refers to the distance a vehicle will travel from the point when its brakes are fully applied to when it comes to a complete stop. The distance taken for applying break was 2m.

Kerb Weight: -
The kerb weights nothing but the total weight of the bicycle without including the driver weight. The total kerb weight of the vehicle was 27kg.

CONCLUSION

The foldable portable electric bicycle was created using industry-standard data. The fabrication was done with materials that were readily available in the area. The project's goal was to design and develop a portable foldable bicycle that would take up less space in parking and could be taken around. It can be used to reduce walking distance on college campuses and in industrial regions. The vehicle is small, lightweight, and has a simple design, making it portable. Manufacturing costs are moderate.

The new vehicle is compact in size and lighter in weight and is accessible to remote places. The design efforts on a new e-bicycle are successful and produce highly portable product. The e-bicycle is the mobility vehicle in die near future. e-bicycle is an Electric vehicle with all necessary requirements.

E-Bikes are zero-emissions vehicles, as they emit no combustion byproducts. However, the environmental effects of electricity generation and power distribution and of manufacturing and disposing of (limited life) high storage density batteries must be considered. Even with these issues considered, e- bikes will have significantly lower environmental impact than conventional automobiles and are generally seen as environmentally desirable in an urban environment.

The bicycle's seat and handle locations are adjustable, allowing it to be used by both youngsters and adults. Though the bicycle is foldable, sleek, and has small wheels, complete justice is given to the rider's ergonomics, making it comfortable. The idea of providing a foldable bicycle that is light and sleek yet rigid and safe, easy to handle, and easy to maintain was inspired by the idea of providing a foldable bicycle that is light and sleek yet rigid and safe, easy to handle, and easy to maintain.

Future Scope

E-bikes, as you might be aware, have exploded in popularity over the past half a decade or so. Some thought the pandemic would hamper this progress, but it seems that it has only accelerated it; whilst throwing a few spanners in there along the way.

Acceptance - As e-bikes have grown so has the level of acceptance -some would say tolerance of e-bikes throughout cycling circles and wider society. As the well-known saying goes:

Cycling and cyclists have been part of the planning in cities across both Asia and Europe for decades, but this has never been the case in the USA, however, it is starting to happen. With the growth of cycling as an acceptable and more and more common mode of transportation -for pleasure, work, and fitness- except cycling lanes and bicycle-friendly areas and facilities to grow in abundance throughout our current, car-centric society.

High Growth - Many are predicting a high level of growth for the e-bike sector. Over the next five years, it is predicted that the e-bike industry will grow by 11.86% each year, resulting in an overall estimated growth rate of over 75% in 5 years! This all means an increase in ownership and an increase in the number of e-bikes on our streets and trails.

Climate Change - The common train of thought is that the electric car will replace the car as the mode of transport for everyone; allowing everyone to do their bit and solve the looming doom of climate change. Sadly, this isn't the case. It's going to take much more than just electric cars to solve climate change, and many see e-bikes as an integral part of our shift to greener transportation.

REFERENCES

[1]. Shishir S and Manjunath P, Design and Fabrication of Foldable Bicycle, SSRG International Journal of Mechanical Engineering (SSRG-IJME), June 2015, Vol.2.
[2]. Morteza Hanifezade and Arian Ashrafi, Folding and Self-Propelling Bicycle, International Journal of Innovation, Management and Technology, April 2014, Vol.5, page no.2
[3]. Nguyen Ba Hung, A Study of the effects of input parameters on the dynamics and required power of an electric bicycle, Applied Energy xxx, 2017.
[4]. Bjarni Freyer Gudmundsson, Integration of a Folding Electric Two Wheeler Vehicle for a Future Commuting Transportation, World Electric Vehicle Journal, 2012, Vol.5, page no.0276.
[5]. https://circuitglobe.com/lead-acid-battery.
[6]. http://hades.mech.northwestern.edu/index.php/Gear_Motor
[7]. V. B. Bhandari, Design of Machine Elements, Third Edition, page no. 23-30