E-Scooter for Campus Mobility

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ABSTRACT

In today's world, the infrastructure of College and Industries are becoming large so if one has to travel or visit from one place to another we have to walk a long distance and sometimes it becomes very hasty and inconvenient. Sometimes after too many travelling on campus, it causes strain and pain in the body. So to travel these distances two-wheeled like Segway PT, were introduced. We developed whole newly designed product and this is Reliable, Eco-friendly, a Compact vehicle for the campus. Its utilities are college campus, Airports, Industries, Recreational Parks, Sanctuaries, Museums, Palaces, Villas etc. So our project is on design and fabrication of two-wheel vehicle and also its multipurpose utility among the society. The concept of the model taken from children's scooter bicycle. The complete body looks like a scooter bicycle in which platform is provided for standing and driving the powered scooter. This product is a battery powered and motor-driven vehicle.

Chapter- 1

INTRODUCTION

As the population is increasing there is increase in demand of automobiles. Due to increase in automobiles, people will require space for driving and also for parking. As we know there is limited space available and due to increase in the number of scooters on roads, they are causing traffic congestion and with that they require a place for parking. In addition to this pollution is also a priority nowadays. The pollution is reaching new limits day by day. So the idea of a foldable andportable vehicle comes into concept.

The Foldable scooter which can be folded to make it compact; hence it does not require the parking place. Due to its compactness, it can be used in various shopping malls, industries, college campuses etc. Portable scooter can be used to cover short distance at many instances. It can be used for travelling purpose on the roads.

In order to overcome above mentioned disadvantages in the present invention, we can replace engine with motor and battery. But it will add more weight to vehicle. Portable vehicle can be assembled and dissembled whenever required as well as we can carry anywhere. If required we can assemble it in just less than ten minutes and drive it. In this portable vehicle we used two wheels, out of that the power is given to rear wheels via shaft and steering of the vehicle is done by front wheel. Power is produced in vehicle using a DC electric motor. If there is no use of vehicle then we can just simply fould using dc motors. This portable vehicle can scooter weight up to 90kgand it has Maximum speed of 20 km/hr.

Chapter-2

Objective

SCOPE AND OBJECTIVE

- To build a suitcase vehicle to overcome problems arising due to shortage in space.
- Time required for assembly and disassembly should be as less as possible.
- Driver comfort is also important factor, so it must not be compromised.
- Folding ease: Folding should be easy, stress-free, and take no more than 10 minutes after user becomes familiar with the tri-scooter.
- Portability: It should be easily transportable for both women and men. It should be easy to handle and should be portable.
- Reliability: It should have a stable ride, confident feel, and similar performance to a conventional bike. Fit various sized people, should be easy to maintain and reliable.
- Retailer Network: Program should offer two to three price points such as a good, better and best‟ philosophy. Sales and service should be very convenient and available to users via local retailer networks.

Scope

- Designing and fabrication of foldable vehicle: The designing of the vehicle had been done and fabrication of vehicle will be achieved with respect to designing procedure.
- Selection of propulsion mechanism: a motor with battery arrangement, we had decided to go with electric motor for propulsion mechanism for the vehicle and which is ecofriendly.
- Testing of vehicle: Virtually, analysis on chassis was done to ensure driver safety. After fabrication test were performed on vehicle to check its stability, velocity and acceleration and deceleration capabilities

Chapter- 3

LITERATURE SURVEY

[1] Bjarni Freyr Gudmundson and Mr. Esben Larsen: In their research paper have discussed about various techniques in which the foldable electric motorbike can be developed. They made a conceptual design and did detailed analysis on specification, material selection, design and structural analysis, component selection, test drive. Their basic idea behind manufacturing this type of design was to give the comfort and compact ability to the driver, so that driver can feel safe and comfortable to enjoy every ride of kart. For making a vehicle the following subsystems such as chassis subsystem handling subsystem, wheel and tire subsystem, brake subsystem and power train subsystem should be designed and fabricated. They worked on the power train for the vehicle and also initiated work on developing powerful, light weight motorbike. They thought about the cost and efficiency of vehicle. To minimize the cost of the vehicle, they used electric arc welding as it is cheap and reliable option available. They also made a foldable electric bike, providing with their all details and procedure. They also discussed about various future works that can be done on their project.

[2] **Mr. Sachin Achari**: With his team has discussed the feasibility, use and design procedure of the foldable tri scooter. They made effort in the experimental analysis as well as in design part of the project. Their main aim was to design a portable automobile which should be very easy to scooter as well as easy to handle by both the sexes with equal ease. The aim was also that it should be environmentally friendly and should be non-polluting. They used D.C motor as their main power source due to which there is no emission at all and also the problem of fuel consumption can be solved. Also keeping in mind, the parking problems, they made a triscooter which can be folded easily, so after the use one can fold the triscooter and can scooter it along with him/her. Their design allows users to easily transport the triscooter using less space when it is "folded" into a compact size. They were the first to offer foldable triscooter in the market. While designing they concentrated on power, economy, ease and comfort of riding and low maintenance cost. Also, they concentrated on ergonomics factor to give the user a comfortable ride. Their objectives included folding ease, Portability, Reliability and retailer network. They used mild steel as the frame material welded in suitcase shape which serves as the base to hold all the accessories such as motor, weight of the load to be conveyed and the weight of the person driving the unit. They also discussed about advantages of the foldable tri scooter.

[3] **Mr. Akash Chaudhary Raghuvanshi:** With his team had made effort in developing foldable kart chassis. They understood the thing that the world is going towards the compactness, where the all things are going to compact and its time is to think about vehicle which can be folded easily and can be taken everywhere as a luggage. By this innovative idea, he conducted the structural analysis on the frame of their kart vehicle and developed a GO KART named as "ASHVA" which can be folded by its mid with the help of a joint that connected between its two chassis front chassis-rear chassis. They knew that Karts are used to just take the experience of racing scooters. Mostly they are very entertaining vehicles in the markets. Taking this into consideration they manufactured an automobile that would be something really out of the box. As the speed of kart varies on the power of engine and how much fuel it takes. The chassis of kart was made up from the mild steel and the joint of kart had been made up of mild steel. This joint gave more power and stability to their vehicle. They used mechanical chain to transmit the power from the engine to the axle of kart. For a better karting experience, rack and pinion system was used by them. A fish body is a perfect aerodynamic natural structure, one can get inspired with hence the chassis of the kart was developed with an igniting idea of a fish body. Selection of material plays an important role on strength and safety of the product that was the reason they chose AS-202 stainless steel round tubes as a chassis material. Also, they chose the material for shaft so that it can bear all the stresses. They discussed about the material selection procedure. They made an effort in describing the jointsthat can be used in foldable vehicle chassis.

[4] Researchers at MIT: With backing from General Motors Corp. are building a prototype of a lightweight electric vehicle that can be cheaply mass-produced, rented by commuters under a shared-use business model, & folded & arranged like grocery scooters at subway stations or other central sites. It's called the City Scooter, and the key to the concept lies in the design of its wheels.

<u>Other Researches</u>

Karts are used just to take the experience of racing scooters. Mostly they are very entertaining vehicles in the markets. Karts are likely the basic concepts of scooter nothing else. As the speed of kart just varies on the power of engine and how much fuel it takes, the chassis of kart is made up from the mild steel and the joint of kart had been made up of mild steel. This joint gives more power and stability to the vehicle. Student competition based on the product they designed and fabricated is a good activity scooter out by university students. Here mechanical chain is used to transmit the power from the engine to the axel of kart.

Generally, karts speed varies from 45 Km/Hr. – 65 Km/Hr. and this kart also had a speed of 52 Km/Hr. As joint gives the support to the both chassis front as well as it also helps to bears maximum force on it so that chassis have good strength and can bear maximum weight in comparing of other karts. For less turning radius we used simple rack and pinion. National Go- Kart championship is a platform where nation comes together with bringing new ideas of their minds in automobile field. This completion gives the basic knowledge of scooter and increases manufacturing skills of students. There is not much research about go-kart design. Most of the research is about the safety and injury. Risk compensation theories hypothesize that if individuals use safety belts, they will drive in a more risky manner than if they do not use safety belts due to an increased perception of safety.

Chapter- 4

QUALITIES REQUIRED FOR A DESIGNER

i. LOGICAL THINKING:

- A designer must possess highly developed intellectual powers.

ii. GOOD MEMORY:

- Good memory is essential for a designer in order to have fast amounts or facts and figures at his fingertips.

iii. CONSCIENTIOUSNESS:

- The ability to work thoroughly and conscientiously, so that no mistakes are made.

iv. INTEGRITY:

- A designer should not feel disappointed if corrections and suggestions for improvements are pointed in his work; at the same time, he should not criticize the work of others, instead he should offer better solutions if possible.

- Harmonious and balanced temperament, ability to work with people stimulation skill and skill in experimentation and measurement are the pre-requisites of a good designer.

v. ENVIRONMENT CONSCIOUSNESS:

- A designer must be above of his responsibility to the environment.

vi. REPORTING DESIGN:

- Technical reports giving detailed calculations and reasons for design decisions must be written and maintained properly.

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Chapter- 5

METHODOLOGY

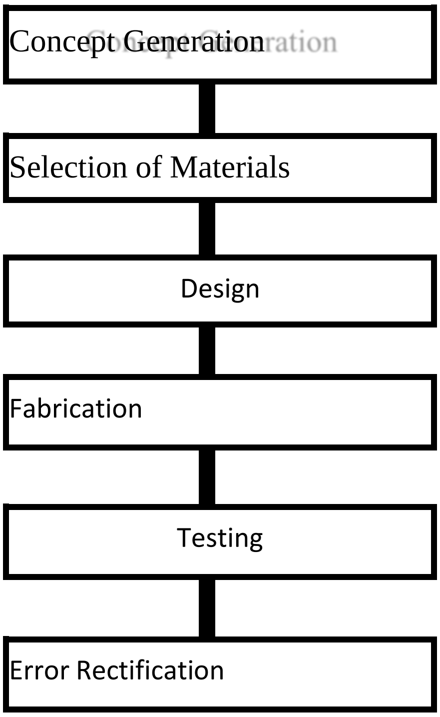

Fig 5.1 methodology

I. Literature study Make review on other model and focusing on how to make it simple and relevance to the project title.

II. Conceptual design Sketching several types of design based on concept that being choose. Statethe dimension for all part.

III. Materials Selection Selected the true material based on model design and criteria. Light, easyto joining and easy to manufacture. Assemble all the part to the design.

IV. Fabrication model refinement. Fabricate according to the main frame and design. Refinementat several part of joining and sharp edge.

V. Performance testing.

VI. Documentation Preparing a report for the project.

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The Choice of material for engineering purposes depends upon the following factors:

- Availability of the materials.
- Suitability of materials for the working condition in service.
- The cost of materials.
- Physical and chemical properties of material.

Mechanical properties of material. The mechanical properties of the metals are those, which are associated with the ability of the material to resist mechanical forces and load. We shall now discuss these properties as follows:

- Strength: It is the ability of a material to resist the externally applied forces
- Stress: Without breaking or yielding. The internal resistance offered by a part to an externally applied force is called stress.

Stiffness: It is the ability of material to resist deformation under stresses. The modules of elasticity of the measure of stiffness.

Chapter- 6

COMPONENTS AND DESCRIPTION

6.1 COMPONENTS AND DESCRIPTION

The major components of the wall painting crane are,

- BATTERY
- BLDC MOTOR
- BALL BEARINGS
- CHAIN AND SPROCKET
- FRAME WORK
- TOGGLE SWITCH

1. BATTERY:

6.1.1 INTRODUCTION:

In isolated systems away from the grid, batteries are used for storage of excess solar energy converted into electrical energy. The only exceptions are isolated sunshine load such as irrigation pumps or drinking water supplies for storage. In fact for small units with output less than one kilowatt. Batteries seem to be the only technically and economically available storage means. Since both the photo-voltaic system and batteries are high in capital costs.

It is necessary that the overall system be optimized with respect to available energy and local demand pattern. To be economically attractive the storage of solar electricity requires a battery with a particular combination of properties:

(1) Low cost
(2) Long life
(3) High reliability
(4) High overall efficiency
(5) Low discharge
(6) Minimum maintenance

- Ampere hour efficiency
- Watt hour efficiency

We use lead acid battery for storing the electrical energy from the solar panel for lighting the street and so about the lead acid cells are explained below.

6.1.2 LEAD-ACID WET CELL:

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2SO_4).

In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A. One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery.

The lead acid cell type is a secondary cell or storage cell, which can be recharged. The charge and discharge cycle can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, heat with excessive charge and discharge currents shortends the useful life to about 3 to 5 years for an automobile battery. Of the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells for a specified battery voltage.

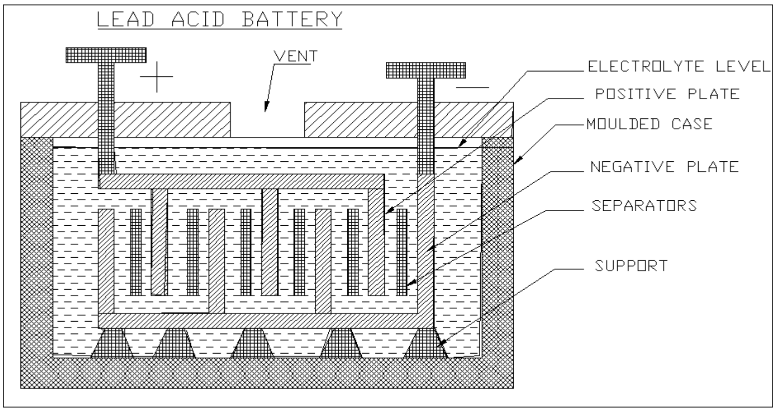

Fig 6.1: Lead Acid Battery

6.1.3 CONSTRUCTION:

Inside a lead-acid battery, the positive and negative electrodes consist of a group of plates welded to a connecting strap. The plates are immersed in the electrolyte, consisting of 8 parts of water to 3 parts of concentrated sulfuric acid. Each plate is a grid or framework, made of a lead- antimony alloy. This construction enables the active material, which is lead oxide, to be pasted into the grid. In manufacture of the cell, a forming charge produces the positive and negative electrodes. In the forming process, the active material in the positive plate is changed to lead peroxide (pbo_2). The negative electrode is spongy lead (pb)

Automobile batteries are usually shipped dry from the manufacturer. The electrolyte is put in at the time of installation, and then the battery is charged to from the plates. With maintenance- free batteries, little or no water need be added in normal service. Some types are sealed, except for a pressure vent, without provision for adding water.

6.1.4 CHEMICAL ACTION:

Sulfuric acid is a combination of hydrogen and sulfate ions. When the cell discharges, lead peroxide from the positive electrode combines with hydrogen ions to form water and with sulfate ions to form lead sulfate. Combining lead on the negative plate with sulfate ions also produces he sulfate. Therefore, the net result of discharge is to produce more water, which dilutes the electrolyte, and to form lead sulfate on the plates.

As the discharge continues, the sulfate fills the pores of the grids, retarding circulation of acid in the active material. Lead sulfate is the powder often seen on the outside terminals of old batteries. When the combination of weak electrolyte and sulfating on the plate lowers the output of the battery, charging is necessary.

On charge, the external D.C. source reverses the current in the battery. The reversed direction of ions flows in the electrolyte result in a reversal of the chemical reactions. Now the lead sulfates on the positive plate reactive with the water and sulfate ions to produce lead peroxide and sulfuric acid. This action re-forms the positive plates and makes the electrolyte stronger by adding sulfuric acid.

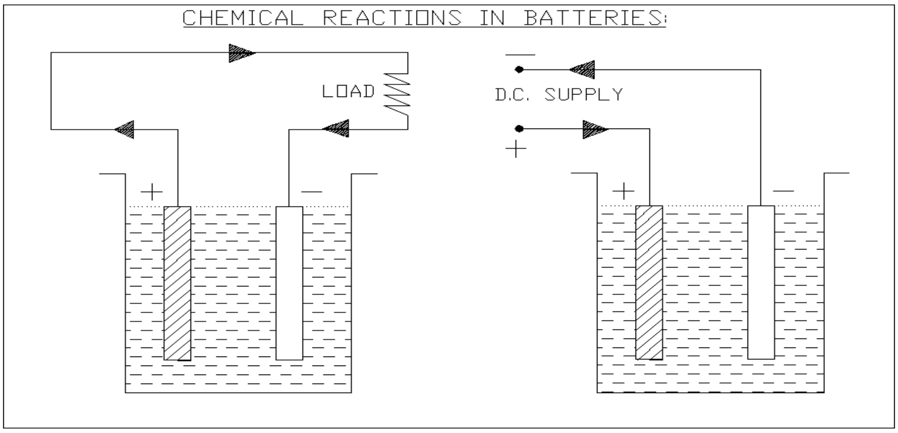

Fig 6.2: Chemical Reaction In Batteries

At the same time, charging enables the lead sulfate on the negative plate to react with hydrogenions; this also forms sulfuric acid while reforming lead on the negative plate to react with hydrogen ions; this also forms currents can restore the cell to full output, with lead peroxide onthe positive plates, spongy lead on the negative plate, and the required concentration of sulfuricacid in the electrolyte.

The chemical equation for the lead-acid cell is

$$Pb + pbO_2 + 2H_2SO_4 \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftarrows}} 2pbSO_4 + 2H_2O$$

On discharge, the pb and pbo_2 combine with the SO_4 ions at the left side of the equation to form lead sulfate

($pbSO_4$) and water (H_2O) at the right side of the equation.

One battery consists of 6 cell, each have an output voltage of 2.1V, which are connected in series to get an voltage of 12V and the same 12V battery is connected in series, to get an 24 V battery. They are placed in the water proof iron casing box.

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6.1.5 SCOOTERING FOR LEAD-ACID BATTERIES:

Always use extreme caution when handling batteries and electrolyte. Wear gloves, goggles and old clothes. “Battery acid” will burn skin and eyes and destroy cotton and wool clothing.

The quickest way of ruin lead-acid batteries is to discharge them deeply and leave them stand “dead” for an extended period of time. When they discharge, there is a chemical change in the positive plates of the battery. They change from lead oxide when charge out lead sulfate when discharged. If they remain in the lead

Sulfate State for a few days, some part of the plate dose not returns to lead oxide when the battery is recharged. If the battery remains discharge longer, a greater amount of the positive plate will remain lead sulfate. The parts of the plates that become "sulfate" no longer store energy. Batteries that are deeply discharged, and then charged partially on a regular basis can fail in less then one year.

Check your batteries on a regular basis to be sure they are getting charged. Use a hydrometer to check the specific gravity of your lead acid batteries. If batteries are cycled very deeply and then recharged quickly, the specific gravity reading will be lower than it should because the electrolyte at the top of the battery may not have mixed with the "charged" electrolyte.

Check the electrolyte level in the wet-cell batteries at the least four times a year and top each cell of with distilled water. Do not add water to discharged batteries. Electrolyte is absorbed when batteries are very discharged. If you add water at this time, and then recharge the battery, electrolyte will overflow and make a mess.

Keep the top of your batteries clean and check that cables are tight. Do not tighten or remove cables while charging or discharging. Any spark around batteries can cause a hydrogen explosion inside, and ruin one of the cells, and you.

On charge, with reverse current through the electrolyte, the chemical action is reversed. Then the pb ions from the lead sulfate on the right side of the equation re-form the lead and lead peroxide electrodes. Also the SO_4 ions combine with H_2 ions from the water to produce more sulfuric acid at the left side of the equation.

6.1.6 CURRENT RATINGS:

Lead-acid batteries are generally rated in terms of how much discharge currents they can supply for a specified period of time; the output voltage must be maintained above a minimum level, which is 1.5 to 1.8V per cell. A common rating is ampere-hours (A.h.) based on a specific discharge time, which is often 8h. Typical values for automobile batteries are 100 to 300 A.h.

As an example, a 200 A.h battery can supply a load current of 200/8 or 25A, used on 8h discharge. The battery can supply less current for a longer time or more current for a shorter time. Automobile batteries may be rated for "cold cranking power", which is related to the job of starting the engine. A typical rating is 450A for 30s at a temperature of 0 degree F.

Note that the ampere-hour unit specifies coulombs of charge. For instance, 200 A.h. corresponds to

200A*3600s (1h=3600s). the equals 720,000 A.S, or coulombs. One ampere- second is equal to one coulomb. Then the charge equals 720,000 or 7.2*10^5ºC. To put this much charge back into the battery would require 20 hours with a charging current of 10A.

The ratings for lead-acid batteries are given for a temperature range of 77 to 80ºF. Higher temperature increase the chemical reaction, but operation above 110ºF shortens the battery life. Low temperatures reduce the current capacity and voltage output. The ampere-hour capacity is reduced approximately 0.75% for each decreases of 1º F below normal temperature rating. At 0ºF the available output is only 60 % of the ampere-hour battery rating. In cold weather, therefore, it is very important to have an automobile battery unto full charge. In addition, the electrolyte freezesmore easily when diluted by water in the discharged condition.

6.1.7 SPECIFIC GRAVITY:

Measuring the specific gravity of the electrolyte generally checks the state of discharge for a lead-acid cell. Specific gravity is a ratio comparing the weight of a substance with the weight of a substance with the weight of water. For instance, concentrated sulfuric acid is 1.835 times as heavy as water for the same volume. Therefore, its specific gravity equals 1.835. The specific gravity of water is 1, since it is the reference.

In a fully charged automotive cell, mixture of sulfuric acid and water results in a specific gravity of 1.280 at room temperatures of 70 to 80ºF. as the cell discharges, more water is formed, lowering the specific gravity. When it is down to about 1.150, the cell is completely discharged.

Specific-gravity readings are taken with a battery hydrometer. Note that the calibrated float with the specific gravity marks will rest higher in an electrolyte of higher specific gravity.

The decimal point is often omitted for convenience. For example, the value of 1.220 is simply read “twelve twenty”. A hydrometer reading of 1260 to 1280 indicates full charge, approximately 12.50 are half charge, and 1150 to 1200 indicates complete discharge.

The importance of the specific gravity can be seen from the fact that the open-circuit voltage of the lead-acid cell is approximately equal to

$$V = \text{Specific gravity} + 0.84$$

For the specific gravity of 1.280, the voltage is 1.280 = 0.84 = 2.12V, as an example. These values are for a fully charged battery.

6.1.8 CHARGING THE LEAD-ACID BATERY:

The requirements are illustrated in figure. An external D.C. voltage source is necessary to produce current in one direction. Also, the charging voltage must be more than the battery e.m.f. Approximately 2.5 per cell are enough to over the cell e.m.f. so that the charging voltage can produce current opposite to the direction of discharge current.

Note that the reversal of current is obtained just by connecting the battery VB and charging source VG with + to + and –to-, as shown in figure. The charging current is reversed because the battery effectively becomes a load resistance for VG when it higher than VB. In this example, the net voltage available to produce charging currents is 15-12=3V.

A commercial charger for automobile batteries is essentially a D.C. power supply, rectifying input from the AC power line to provide D.C. output for charging batteries.

Float charging refers to a method in which the charger and the battery are always connected to each other for supplying current to the load. In figure the charger provides current for the load and the current necessary to keep the battery fully charged. The battery here is an auxiliary sourcefor D.C. power.

It may be of interest to note that an automobile battery is in a floating-charge circuit. The battery charger is an AC generator or alternator with rectifier diodes, driver by a belt from the engine. When you start the scooter, the battery supplies the cranking power. Once the engine is running, the alternator charges he battery. It is not necessary for the scooter to be moving. A voltage regulator is used in this system to maintain the output at approximately 13 to 15 V.

The constant voltage of 24V comes from the solar panel controlled by the charge controller so for storing this energy we need a 24V battery so two 12V battery are connected in series.

It is a good idea to do an equalizing charge when some cells show a variation of the 0.05 specific gravity from each other. This is a long steady overcharge, bringing the battery to a gassing or bubbling state. Do not equalize sealed or gel type batteries.

With proper scooter lead-acid batteries will have a long service life and work very well in almost any power system. Unfortunately, with poor treatment lead-acid battery life will be very short.

An electric motor is an instrument which converts electrical energy into mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy. General-purpose motors with highly standardized dimensions and characteristics provide convenient mechanical power for industrial use.

Motor consists of Rotor, Stator, Windings, Air Gap, and Commutator which works together to convert electrical energy into mechanical energy which may be linear or rotary depending upon motor. There are four types of brushed DC motors. The first type is the Permanent Magnet Brush DC Motor. Second, the shunt-wound brushed DC motor. Third is the series-wound DC motor and fourth is the compound-wound brushed DC motor which is a combination of both the shunt-and series-wound brushed DC motors.

Shunt-wound brushed DC motors have the field coil in parallel (shunt) with the rotor. The current in the field coil and in the rotor are independent of one another, thus, the total current of the motor is equal to the sum of the shunt current (or stator current) and the rotor current.

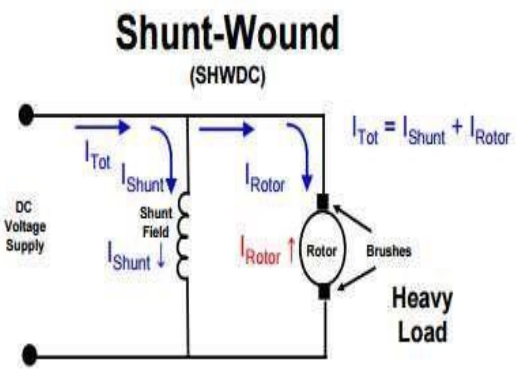

Fig6.3: Circuit diagram of Shunt DC Motors

The supplied voltage is increased the total current of the motor will increase causing the stator and rotor fields to increase. As total current increases motor speed will increase, thus motor torque will decrease. However, once you put a load on the motor the rotor current will increase causing the rotor field to increase. If the rotor current increases then the shunt current will decrease causing the stator field to decrease. This will cause the motor speed to decrease, thus the motor torque will increase.

Shunt-wound brushed DC motors have the performance characteristics of decreasing torque at high speeds and a high but more consistent torque at low speeds. The current in the field coil and in the rotor are independent of one another, thus, the total current of the motor is equal to the sum of the shunt current (or stator current) and the rotor current. As a result, these motors have excellent speed control characteristics. Shunt-wound brushed DC motors are typically used in applications that require 5 or more HP such as industrial and automotive applications. As compared to permanent magnet brushed DC motors, shunt wound brushed DC motors have no loss of magnetism and are more robust. Some drawbacks are that shunt wound brushed DC motors are more expensive than permanent magnet brushed DC motors and have the potential of motor runaway if the shunt current decreases to zero. This is a very dangerous condition that can lead the motor to literally break apart.

Principal of operation of DC Motor:

- When a current carrying conductor is placed in a magnetic field. It experiences a force.
- In case of DC motor, the magnetic field is developed by the field current i.e. the currentflowing in field winding.
- The armature winding is connected to an external dc source; hence it plays the role ofthe current carrying conductor placed in the magnetic field.
- Due to force exerted on it when placed in the magnetic field, it starts rotating and thearmature starts rotating.
- The direction of rotation depends on the direction of the magnetic field produced by thefield winding as well as the direction of magnetic field produced by the armature.

Effect of increase in load:

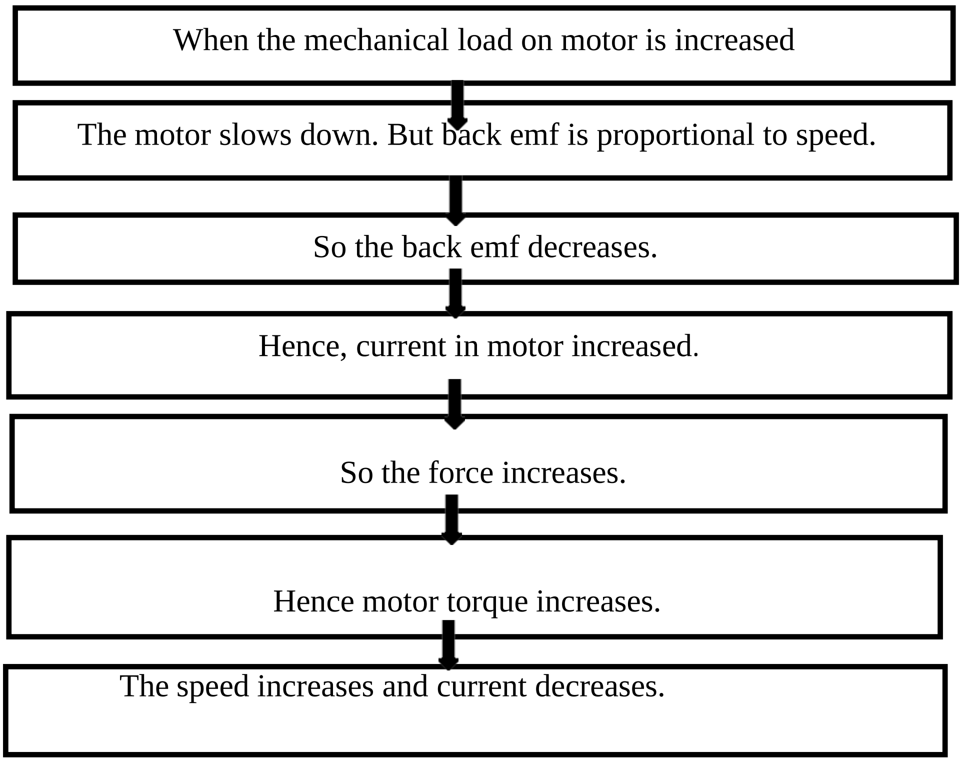

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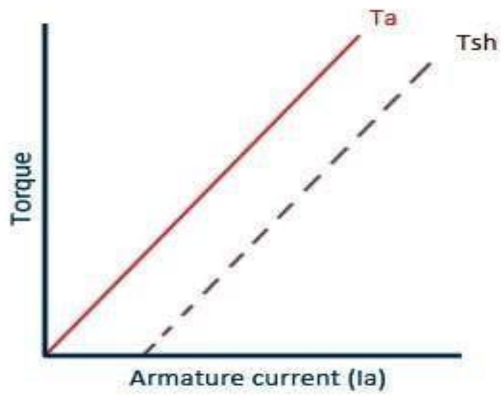
Table 6.1: Effects of load on motor

Characteristics of DC Motor:

Torque Armature Current characteristics:

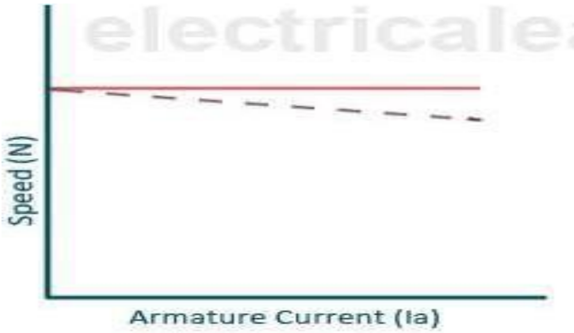


Graph 6.1: Torque Armature Current Characteristics

- The torque armature current characteristics of DC shunt motor shows that the startingtorque (at the time of starting the motor) is not very high.
- To generate higher starting, we have to increase armature current, to a very large valuebecause torque is directly proportional to armature current. This may damage the motor.
- So shunt motors should be used in those applications which demand amoderate starting torque.

Speed Armature current characteristics:

- As the load on the motor is increased, the torque demands increases. To generate highertorque the motor draws more armature current.
- As armature current increases, voltage also increases.
- As the value of resistance is small, the drop in voltage is small. Hence the reduction inspeed is not significantly large.
- So, the characteristic is slightly dropping as shown in figure, as we increase the loadfrom no load to full load.
- However, the reduction in speed is so negligible, that the DC shunt motors are consideredas constant speed motors.



Graph 6.2: Speed Armature current characteristics

Speed Torque characteristics:

Graph 6.3: Speed Torque characteristics

- At no load, torque produced by motor is less and rotates at constant speed.
- As the load is increased, the torque requirement also increases. To generate the required amount of torque, the motor has to draw more armature current and more armature current can be drawn if a speed decrease is more.
- Therefore, as load increases, torque will also increase and the speed decreases.

6.2 Electric Motor, Controller & Throttle

6.2.1 Electric Motor:

We have chosen electric motor instead of IC engine in our project. But due to space constraints, we opted for electric motor. Motor which we used is reduction electric DC motor which provides required torque. Also, reason behind choosing this motor is we did not want emission issues with our vehicle. Only disadvantage with this motor is increase in size of battery and decrement in RPM. Also, this reduction motor comes with controller and throttle control for handle. Specification for the electric motor is provided below:

Parameters	Specifications
Type	DC Motor
Voltage	24

RPM	4000
Rated Wattage	250w
Rated Current	14.7A
Torque	22 Nm
Reduction Ratio	5.78:1

Table 6.2: Motor Specifications

Fig 6.4: Electric Motor

6.2.2 Controller:

Controller is a device that serves to govern the performance of an electric motor. This may have automatic or manual means of starting and stopping the motor, selecting forward and reverse rotation, selecting and regulating or limiting the torque and protecting against overloads and faults. The given controller is of manual starting or stopping Direct on Line (DOL) type which is controlled by using throttle. This is pre-loaded with software to work for the given electric motor.This works for all functions given above.

Fig 6.5: Controller for 250W Electric Motor

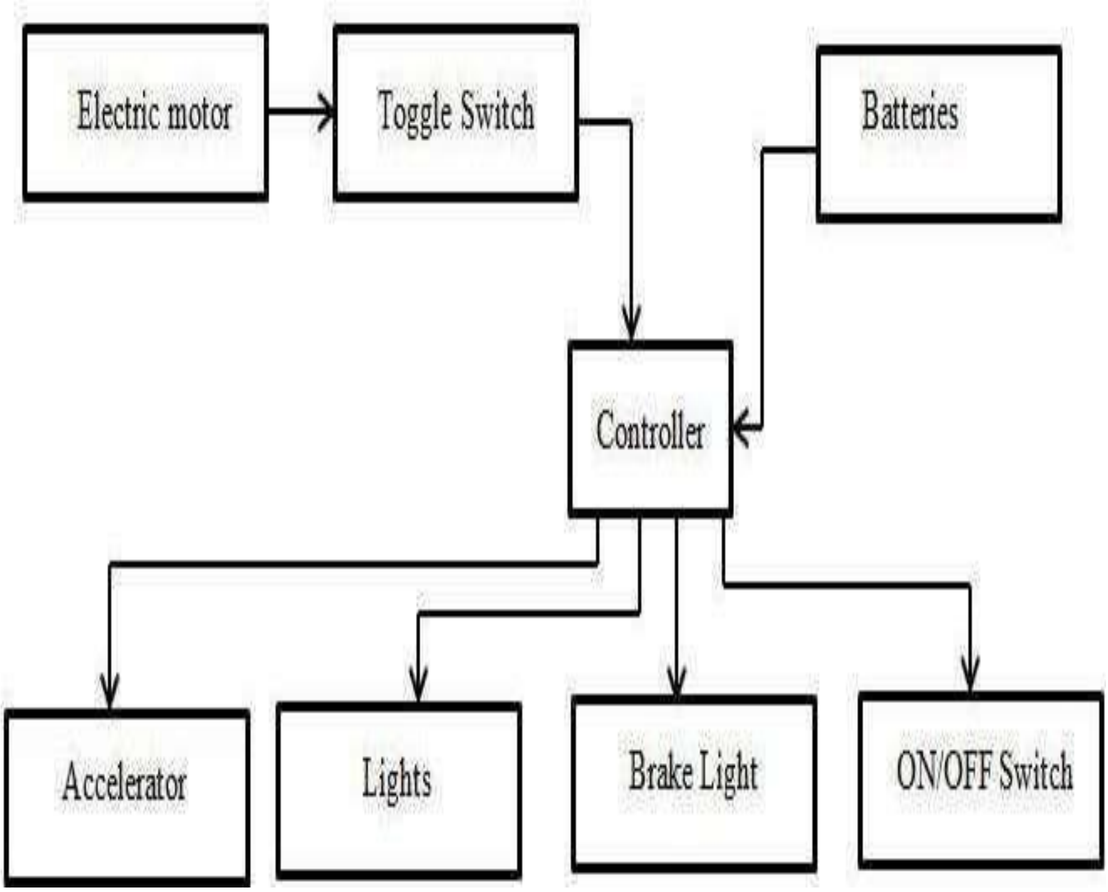


Fig 6.6: Block Diagram of controller connections

6.2.3 Throttle:

Electronic Throttle control (ETC) is an automobile technology which electronically connects the accelerator pedal to the throttle, replacing mechanical linkages. ETC consists of accelerator pedal module, ETB and ECM. There are throttle positions sensor embedded in ETB which helps in determining the required throttle. The given ETB works on potentiometer.

6.2.4 Wheel

Fig 6.7: Electronic Throttle Body

We have used three wheels for the vehicle. Out of these two wheels, one wheel at front steering handle and other wheel used with shafts at rear of the vehicle for propulsion purpose. These wheels are made up of hard rubber which will help in transferring weight to the roads. Due to their smaller size and high weight handling capacity they are best for use. Specifications for the used wheel are as follows:

Component	Parameters	Specifications
Front wheels		
	Quantity	1
	Size	8”
Rear Wheels		
	Quantity	1
	Size	8”

Table 6.3: Wheel Specifications

Fig 6.8: Wheel

6.2.5 Chassis

We have used perimeter type chassis frame which provides more space and area for mountings. It is also the internal part of vehicle. It also helps in distributing space equally over the vehicle. We have manufactured the chassis in two different parts which can be assembled by an intermediate member. We have compared many different materials such as AISI 4130, AISI 1020, AISI 1006 and ASTM A500 GRB. Comparisons of these materials are provided below.

Parameter	AISI 4130	AISI 1020	AISI 1006	ASTMA500
UTS (MPa)	1075	380	295	300
YTS (MPa)	986	205	165	210
Density (g/cc)	7.85	7.87	7.87	7.85
Poisson's ratio	0.29	0.29	0.29	0.26
Elasticit y Modulus(GPa)	205	200	205	205
Cost	₹ 550/ mtr	₹ 400/ mtr	₹ 250/mtr	₹ 350/ mtr

Table 6.4: Material Comparisons

Out of these materials ASTM A500 Gr B has used. The reason behind using this grade above all others was that it provides much strength and cost efficiency. The AISI 4130 is much good in strength but is costly and moreover we do not require this much strength for vehicle. Frame has made up of square pipe with following dimensions:

Parameter	Specifications
Dimension	1" & 3/4th " Pipe with 1.6 mm thickness
Material	ASTM A500 Gr B
Yield tensile strength	210 MPa
Ultimate tensile strength	300 MPa

Bulk Modulus	140 GPa
Shear modulus	80 GPa
Poisson's Ratio	0.26
Density	7.85 g/cc

Table 6.5: Chassis Material Specifications

6.2.6 Steering

The primary purpose of the steering system is to allow the driver to guide the vehicle. As the vehicle is not too heavy so we used a simple steering mechanism. Following things were mounted on steering handle.

- Handle Driven Single Wheels
- Brakes on handle
- Throttle on handle

6.2.7 Shaft

Fig 6.9: Steering handle

A solid shaft of circular cross section has used. As maximum bending force and torque wascoming on shaft so the solid shaft has opted. Brakes and rear sprocket has mounted on the shaft.

Parameter	Specification
Material	Stainless steel 302 (annealed)
SUT	620 MPa
Elastic modulus	193 GPa
Poisson Ratio	0.25

Table 6.6: Shaft Material Specification

6.2.7 Mild Steel Rod

- **Mild steel**

General purpose steel bars for machining, suitable for lightly stressed components including studs, bolts, gears and shafts. Often specified where weld ability is a requirement. can be case-hardened to improve wear resistance. Available in bright rounds, squares and flats, and hot rolled rounds. Can be supplied in sawn blanks, and bespoke size blocks

Fig 6.10: Mild Steel

Mild steel is a scooterbon steel typically with a maximum of 0.25% Scooterbon and 0.4%- 0.7% manganese, 0.1%-0.5% Silicon and some + traces of other elements such as phosphorous, it may also contain lead (free cutting mild steel) or sulphar (again free cutting steel called resulphurised mild steel) The stuff is used everywhere, looking out of my office window I can see diesel pump injector parts, loudspeaker pole pieces, Automated packing machinery parts and I haven't even got my glasses on. How its made and more info, depending upon the age of your son it's probably an idea he spends a Saturday morning at the local library researching his homework. Whilst the internet's good you still can't beat browsing through books at the library for homework.

- **Nut And Bolt**

Fig 6.11: Nut and Bolt

A nut is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten two or more parts together. The two partners are kept together by a combination of their threads' friction (with slight elastic deformation), a slight stretching of the bolt, and compression of the parts to be held together. In applications where vibration or rotation may work a nut loose, various locking mechanisms may be employed: lock washers, jam nuts, specialist adhesive thread-locking fluid such as Loctite, safety pins (split pins) or lockwire in conjunction with castellated nuts, nylon inserts (Nyloc nut), or slightly oval-shaped threads. The most common shape is hexagonal, for similar reasons as the bolt head - 6 sides give a good granularity of angles for a tool to approach from (good in tight spots), but more (and smaller) corners would be vulnerable to being rounded off. It takes only 1/6th of a rotation to obtain the next side of the hexagon and grip is optimal. However polygons with more than 6 sides do not give the requisite grip and polygons with fewer than 6 sides take more time to be given a complete rotation. Other specialized shapes exist for certain needs, such as wingnuts for finger adjustment and captive nuts (e.g. cage nuts) for inaccessible areas.

6.3 BALL BEARING

The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. Bearing is made upon steel material and bearing cap is mild steel.

6.3.1 INTRODUCTION

Ball and roller bearings are used widely in instruments and machines in order to minimize friction and power loss. While the concept of the ball bearing dates back at least to Leonardo da Vinci, their design and manufacture has become remarkably sophisticated. This technology was brought to its present state of perfection only after a long period of research and development. The benefits of such specialized research can be obtained when it is possible to use a standardized bearing of the proper size and type. However, such bearings cannot be used indiscriminately without a scooter study of the loads and operating conditions. In addition, the bearing must be provided with adequate mounting, lubrication and sealing. Design engineers have usually two possible sources for obtaining information which they can use to select a bearing for their particular application:

1. Textbooks

2. Manufacturers

Catalogs Textbooks are excellent sources; however, they tend to be overly detailed and aimed at the student of the subject matter rather than the practicing designer. They, in most cases, contain information on how to design rather than how to select a bearing for a particular application. Manufacturers' catalogs, in turn, are also excellent and contain a wealth of information which relates to the products of the particular manufacturer. These catalogs, however, fail to provide alternatives – which may divert the designer's interest to products not manufactured by them. Our Company, however, provides the broadest selection of many types of bearings made by different manufacturers.

For this reason, we are interested in providing a condensed overview of the subject matter in an objective manner, using data obtained from different texts, handbooks and manufacturers' literature. This information will enable the reader to select the proper bearing in an expeditious manner. If the designer's interest exceeds the scope of the presented material, a list of references is provided at the end of the Technical Section. At the same time, we are expressing our thanks and are providing credit to the sources which supplied the material presented here.

6.3.2 Construction and Types of Ball Bearings

A ball bearing usually consists of four parts: an inner ring, an outer ring, the balls and thecage or separator.

To increase the contact area and permit larger loads to be scooterried, the balls run in curvilinear grooves in the rings. The radius of the groove is slightly larger than the radius of the ball, and a very slight amount of radial play must be provided. The bearing is thus permitted to adjust itself to small amounts of angular misalignment between the assembled shaft and mounting. The separator keeps the balls evenly spaced and prevents them from touching each other on the sides where their relative velocities are the greatest. Ball bearings are made in a wide variety of types and sizes. Single-row radial bearings are made in four series, extra light, light, medium, and heavy, for each bore, as illustrated in Fig. 1-3(a), (b), and (c).

100 Series 200 Series 300 Series Axial Thrust Angular Contact Self-Aligning Bearing

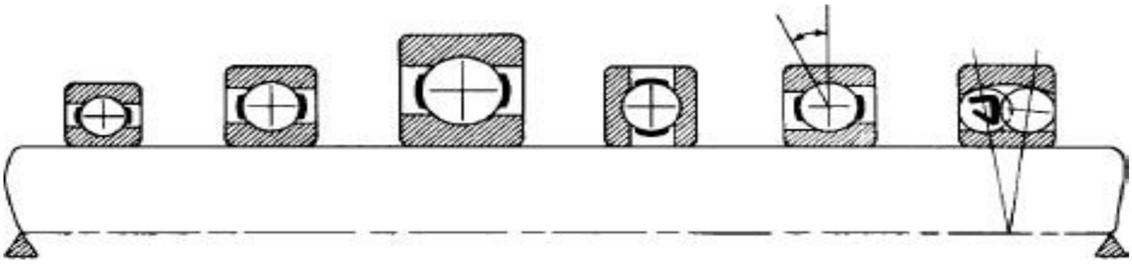


Fig 6.12: Types of Ball Bearings

The heavy series of bearings is designated by 400. Most, but not all, manufacturers use a numbering system so devised that if the last two digits are multiplied by 5, the result will be the bore in millimeters.

The digit in the third place from the right indicates the series number. Thus, bearing 307 signifies a medium-series bearing of 35-mm bore. For additional digits, which may be present in the catalog number of a bearing, refer to manufacturer's details.

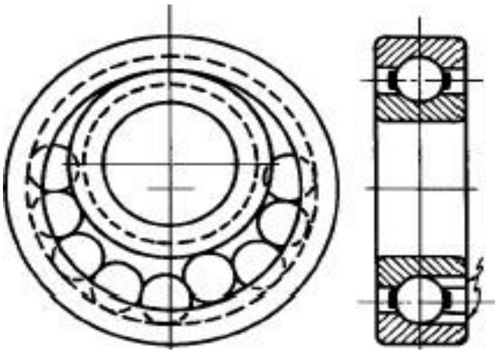


Fig 6.13: Groove Bearing

Some makers list deep groove bearings and bearings with two rows of balls. For bearing designations of Quality Bearings & Components (QBC), see special pages devoted to this purpose. The radial bearing is able to scooter considerable amount of axial thrust. However, when the load is directed entirely along the axis, the thrust type of bearing should be used. The angular contact bearing will take scooter of both radial and axial loads. The self-aligning ball bearing will take scooter of large amounts of angular misalignment. An increase in radial capacity may be secured by using rings with deep grooves, or by employing a double-row radial bearing. Radial bearings are divided into two general classes, depending on the method of assembly. These are the Conrad, or non filling-notch type, and the maximum, or filling-notch type. In the Conrad bearing, the balls are placed between the rings as shown in Fig. 1-4(a). Then they are evenly spaced and the separator is

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riveted in place. In the maximum-type bearing, the balls are a (a) (b) (c) (d) (e)

(f) 100 Series Extra Light 200 Series Light 300 Series Medium Axial Thrust Bearing Angular Contact Bearing Self-aligning Bearing Fig. 1-3 Types of Ball Bearings Fig. 1-4 Methods of Assembly for Ball Bearings (a) Conrad or non-filling notch type (b) Maximum or filling notch type.

6.4 SPROCKET AND CHAIN DRIVE

6.4.1 Drive

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle using a chain. Since there is a reduction gear mounted in electric motor, that's why we do not need different gear ratios and because of this we are using direct chain drive. Moreover, gearbox in vehicle will increase in weight; we are rejecting the use of gearbox. Motor sprocket has attached to motor and with its specification we have designed our shaft ratio. Since there was already reduction setup in motor, we were trying to achieve 1:1 ratio from motor output to shaft. Pinion details are as follows.

Parameters	Specifications
Type	Direct chain drive using clutch
Pinion	9 Teeth‟s
Module	2.75 mm
Pitch	9.2364
Gear Ratio	1.4
Center distance	200mm

Table 6.7: Chain Drive Specifications

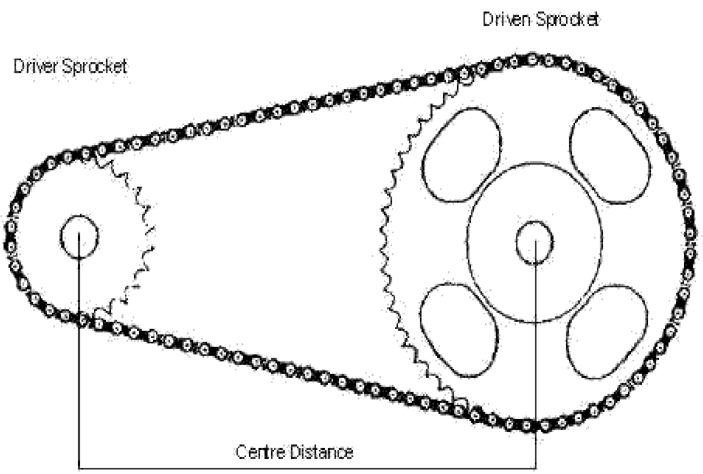

Fig 6.14: Chain Drive

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This is a cycle chain sprocket. The chain sprocket is coupled with another generator shaft. The chain converts rotational power to pulling power, or pulling power to rotational power, by engaging with the sprocket.

The sprocket looks like a gear but differs in three important ways:

1. Sprockets have many engaging teeth; gears usually have only one or two.
2. The teeth of a gear touch and slip against each other; there is basically no slippage in a sprocket.
3. The shape of the teeth is different in gears and sprockets.

Fig 6.15: Types of Sprockets

6.4.2 Engagement with Sprockets:

Although chains are sometimes pushed and pulled at either end by cylinders, chains are usually driven by wrapping them on sprockets. In the following section, we explain the relation between sprockets and chains when power is transmitted by sprockets.

1. **Back tension**

First, let us explain the relationship between flat belts and pulleys. Figure 2.5 shows a rendition of a flat belt drive. The circle at the top is a pulley, and the belt hangs down from each side. When the pulley is fixed and the left side of the belt is loaded with tension (T0), the force needed to pull the belt down to the right side will be: T1 = T0 3 eµu

For example, T0 = 100 N: the coefficient of friction between the belt and pulley, µ = 0.3; the wrap angle u = ¼ (180).

T1 = T0 3 2.566 = 256.6 N

In brief, when you use a flat belt in this situation, you can get 256.6 N of drive power only when there is 100 N of back tension.

For elements without teeth such as flat belts or ropes, the way to get more drive power is to increase the coefficient of friction or wrapping angle. If a substance, like grease or oil, which decreases the coefficient of friction, gets onto the contact surface, the belt cannot deliver the required tension.

In the chain's case, sprocket teeth hold the chain roller. If the sprocket tooth configuration is square, as in Figure 2.6, the direction of the tooth's reactive force is opposite the chain's tension, and only one tooth will receive all the chain's tension. Therefore, the chain will work without backtension.

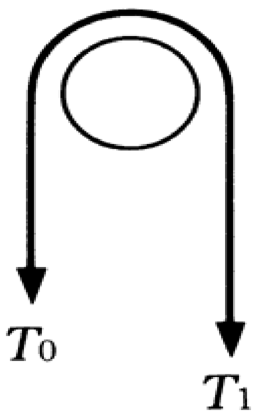

Fig 6.16: Flat Belt Drive

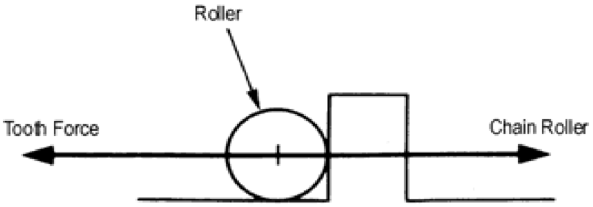

Fig 6.17: Simplified Roller/Tooth Forces

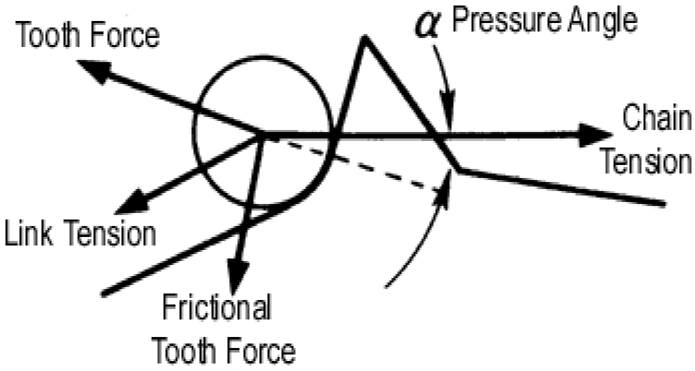

Fig 6.18: The Balance of Forces Around the Roller

But actually, sprocket teeth need some inclination so that the teeth can engage and slip off of the roller. The balances of forces that exist around the roller are shown in Figure 2.7, and it is easy to calculate the required back tension.

For example, assume a coefficient of friction μ = 0, and you can calculate the back tension (Tk)that is needed at sprocket tooth number k with this formula:

Tk = T0 3 sin ø k-1 sin(ø + 2b) Where:

Tk= back tension at tooth k

T0 = chain tension

ø = sprocket minimum pressure angle 17 64/N(š)

N = number of teeth

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2b = sprocket tooth angle (360/N)

k = the number of engaged teeth (angle of wrap 3 N/360); round down to the nearest whole number to be safe.

By this formula, if the chain is wrapped halfway around the sprocket, the back tension at sprocket tooth number six is only 0.96 N. This is 1 percent of the amount of a flat belt. Using chains and sprockets, the required back tension is much lower than a flat belt. Now let's compare chains and sprockets with a toothed-belt back tension. Although in toothed belts the allowable tension can differ with the number of pulley teeth and the revolutions per minute (rpm), the general recommendation is to use 1/3.5 of the allowable tension as the back tension (F). This is shown in below Figure 2.8. Therefore, our 257 N force will require 257/3.5 = 73 N of back tension.

Both toothed belts and chains engage by means of teeth, but chain's back tension is only 1/75 thatof toothed belts.

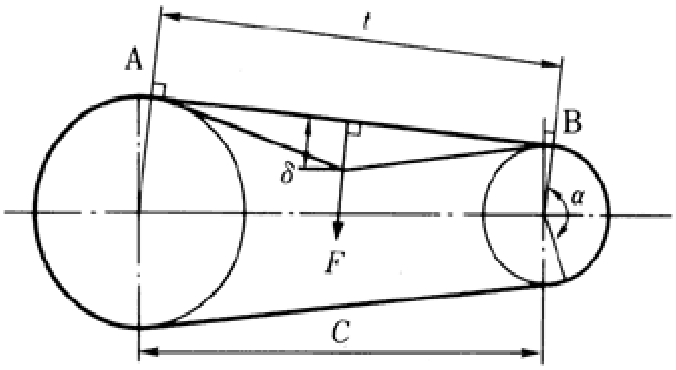


Fig 6.20: Back Tension on a Toothed Belt

6.4.3 Chain wear and jumping sprocket teeth

The key factor causing chain to jump sprocket teeth is chain wear elongation (see Basics Section 2.2.4). Because of wear elongation, the chain creeps up on the sprocket teeth until it starts jumping sprocket teeth and can no longer engage with the sprocket.

Figure 2.9 shows sprocket tooth shape and positions of engagement. Figure 2.10 shows the engagement of a sprocket with an elongated chain.

In Figure 2.9 there are three sections on the sprocket tooth face:

- Bottom curve of tooth, where the roller falls into place;
- Working curve, where the roller and the sprocket are working together;
- Where the tooth can guide the roller but can't transmit tension. If the roller, which should transmit tension, only engages with C, it causes jumped sprocket teeth.

The chain's wear elongation limit varies according to the number of sprocket teeth and their shape, as shown in Figure 2.11. Upon calculation, we see that sprockets with large numbers of teeth are very limited in stretch percentage. Smaller sprockets are limited by other harmful effects, such as high vibration and decreasing strength; therefore, in the case of less than 60 teeth, the stretch limit ratio is limited to 1.5 percent (in transmission chain).

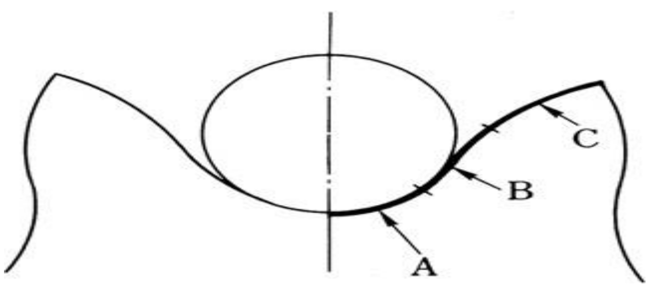


Fig 6.21: Sprocket Tooth Shape and Positions of Engagement

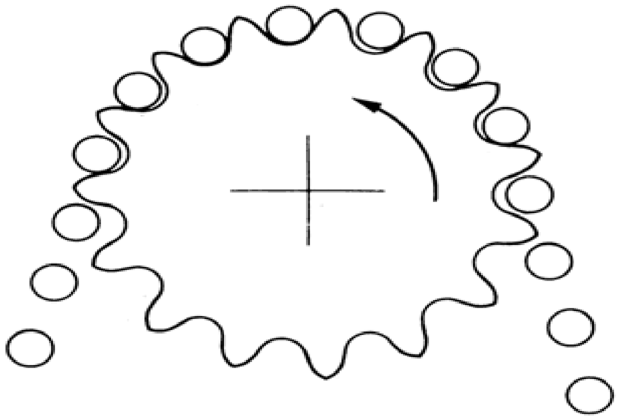
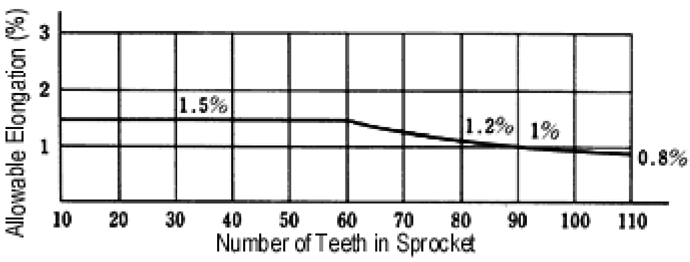


Fig 6.22: The Engagement Between a Sprocket and an Elongated Chain



Graph 6.4: Elongation Versus the Number of Sprocket Teeth

In conveyor chains, in which the number of working teeth in sprockets is less than transmission chains, the stretch ratio is limited to 2 percent. Large pitch conveyor chains use a straight line in place of curve B in the sprocket tooth face.

A chain is a reliable machine component, which transmits power by means of tensile forces, and is used primarily for power transmission and conveyance systems. The function and uses of chain are similar to a belt. There are many kinds of chain. It is convenient to sort types of chain by either material of composition or method of construction.

We can sort chains into five types:

- Cast iron chain.
- Cast steel chain.
- Forged chain.

- Steel chain.
- Plastic chain.

Demand for the first three chain types is now decreasing; they are only used in some special situations. For example, cast iron chain is part of water-treatment equipment; forged chain is used in overhead conveyors for automobile factories.

In this book, we are going to focus on the latter two: "steel chain," especially the type called "roller chain," which makes up the largest share of chains being produced, and "plastic chain." For the most part, we will refer to "roller chain" simply as "chain."

NOTE: Roller chain is a chain that has an inner plate, outer plate, pin, bushing, and roller.

In the following section of this book, we will sort chains according to their uses, which can be broadly divided into six types:

1. Power transmission chain.
2. Small pitch conveyor chain.
3. Precision conveyor chain.
4. Top chain.
5. Free flow chain.
6. Large pitch conveyor chain.

The first one is used for power transmission; the other five are used for conveyance. In the Applications section of this book, we will describe the uses and features of each chain type by following the above classification.

In the following section, we will explain the composition of power transmission chain, small pitch chain, and large pitch conveyor chain. Because there are special features in the composition of precision conveyor chain, top chain, and free flow chain, checks the appropriate pages in the Applications section about these features.

6.4.4 Basic Structure of Power Transmission Chain

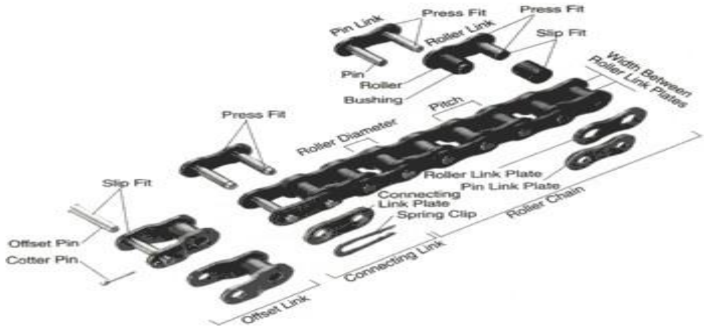


Fig 6.23: A Typical Configuration For RS60-Type Chain

Connecting Link

This is the ordinary type of connecting link. The pin and link plate are slip fit in the connecting link for ease of assembly. This type of connecting link is 20 percent lower in fatigue strength than the chain itself. There are also some special connecting links which have the same strength as the chain itself. (See Figure 1.2

6.4.5 Tap Fit Connecting Link

In this link, the pin and the tap fit connecting link plate are press fit. It has fatigue strength almost equal to that of the chain itself. (See Figure 1.2)

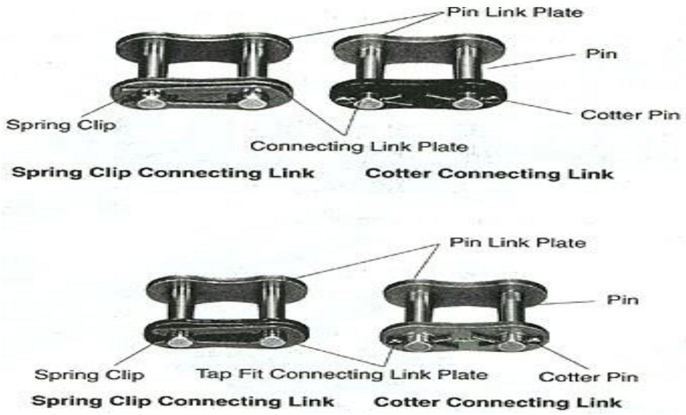
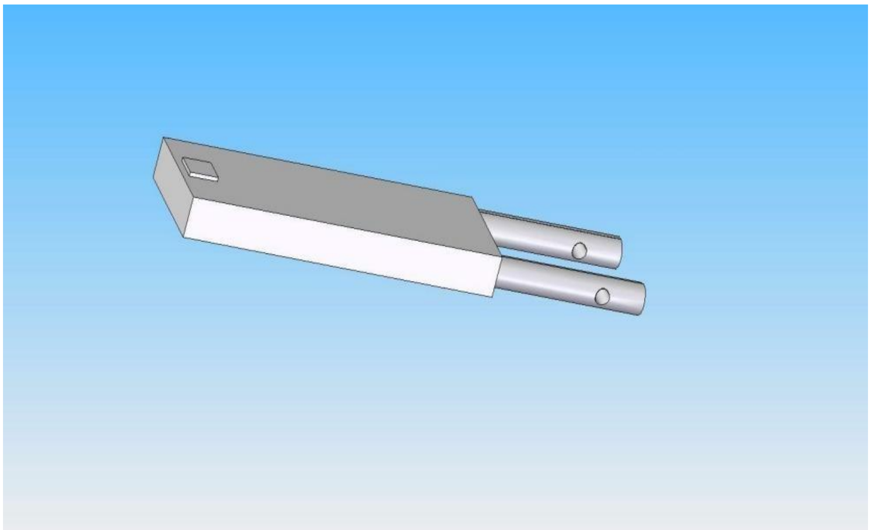


Fig 6.24: Standard connecting link(top) and tap fit connecting link (bottom)

Chapter -7

7.1 Base/Foot Rest

DESIGN & CALCULATION



7.2 Clamp Fig 7.1 Base

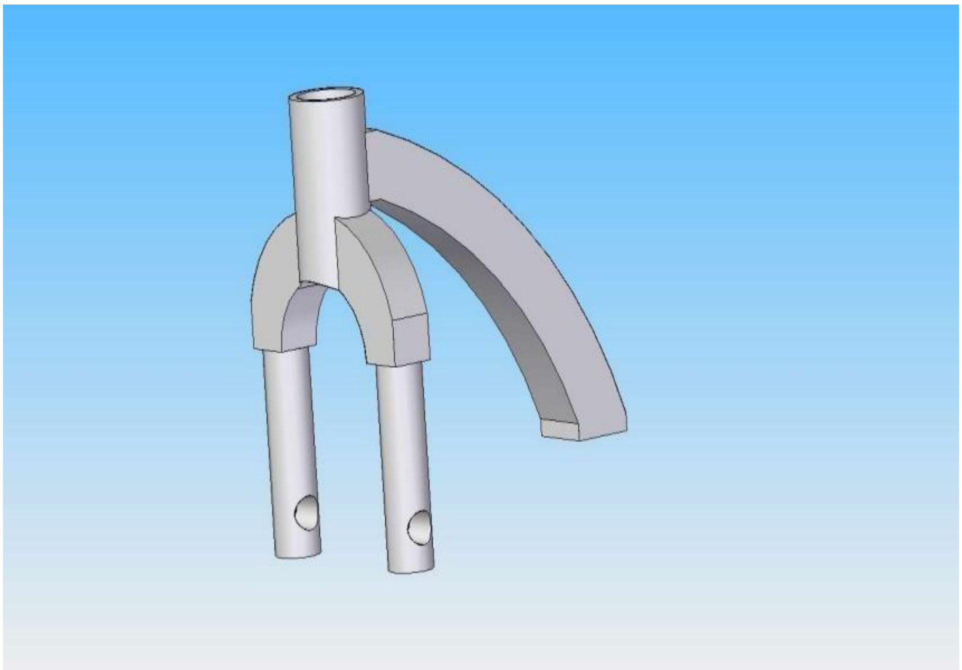


Fig 7.2 Clamp

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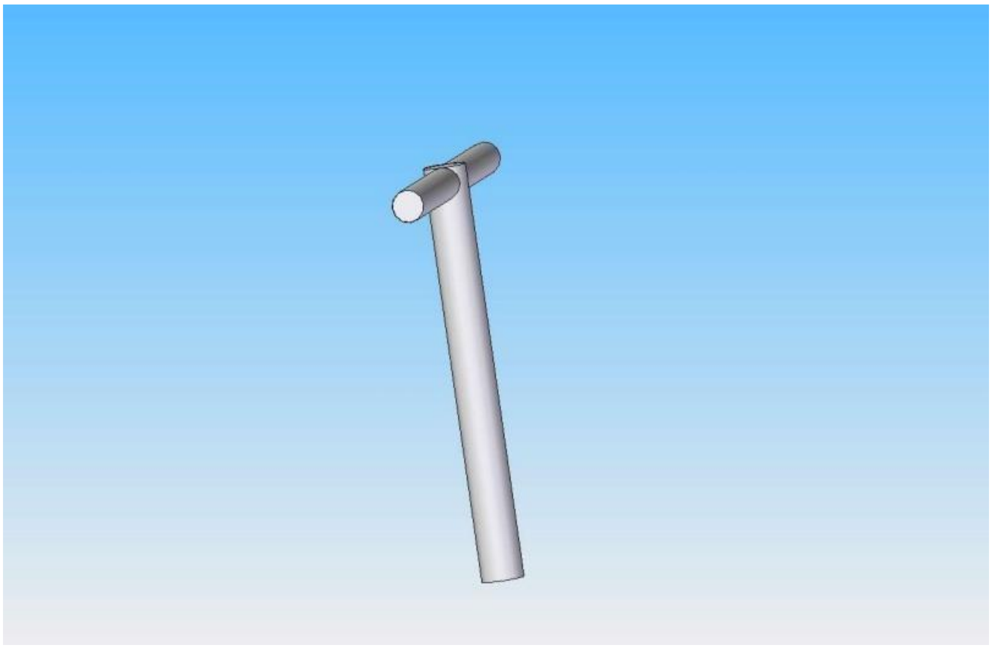
7.3 Handle



7.4 Wheel

Fig 7.3 Handle

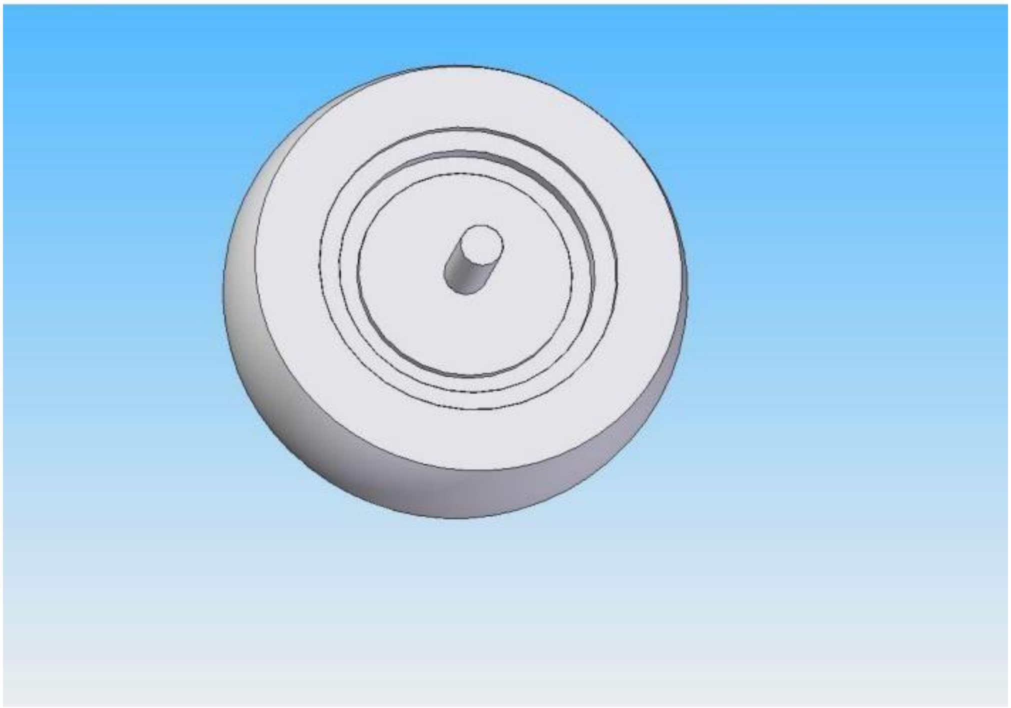


Fig 7.4 Wheel

7.5 Assembly View

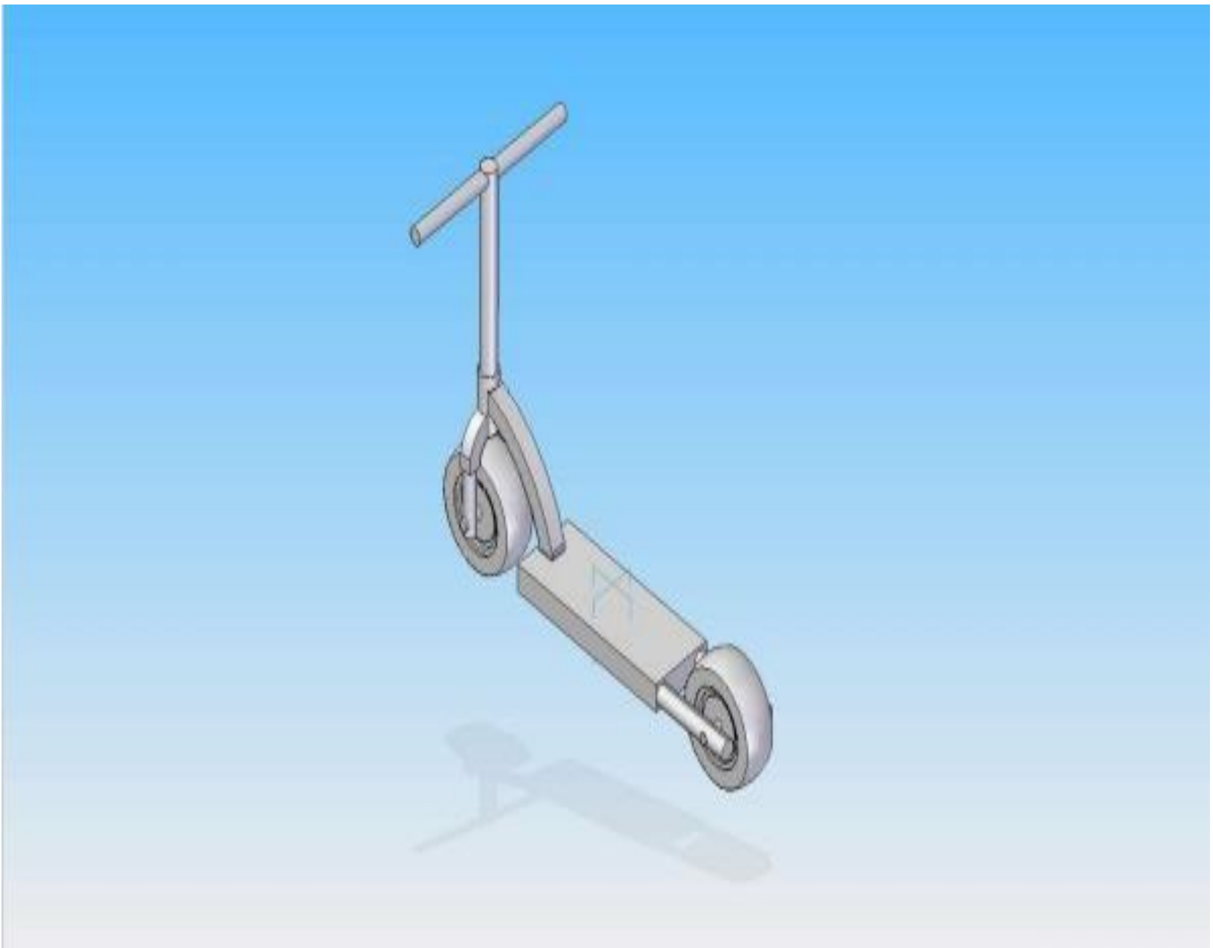


Fig 7.5 Assembly

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7.6. 2D Drawing

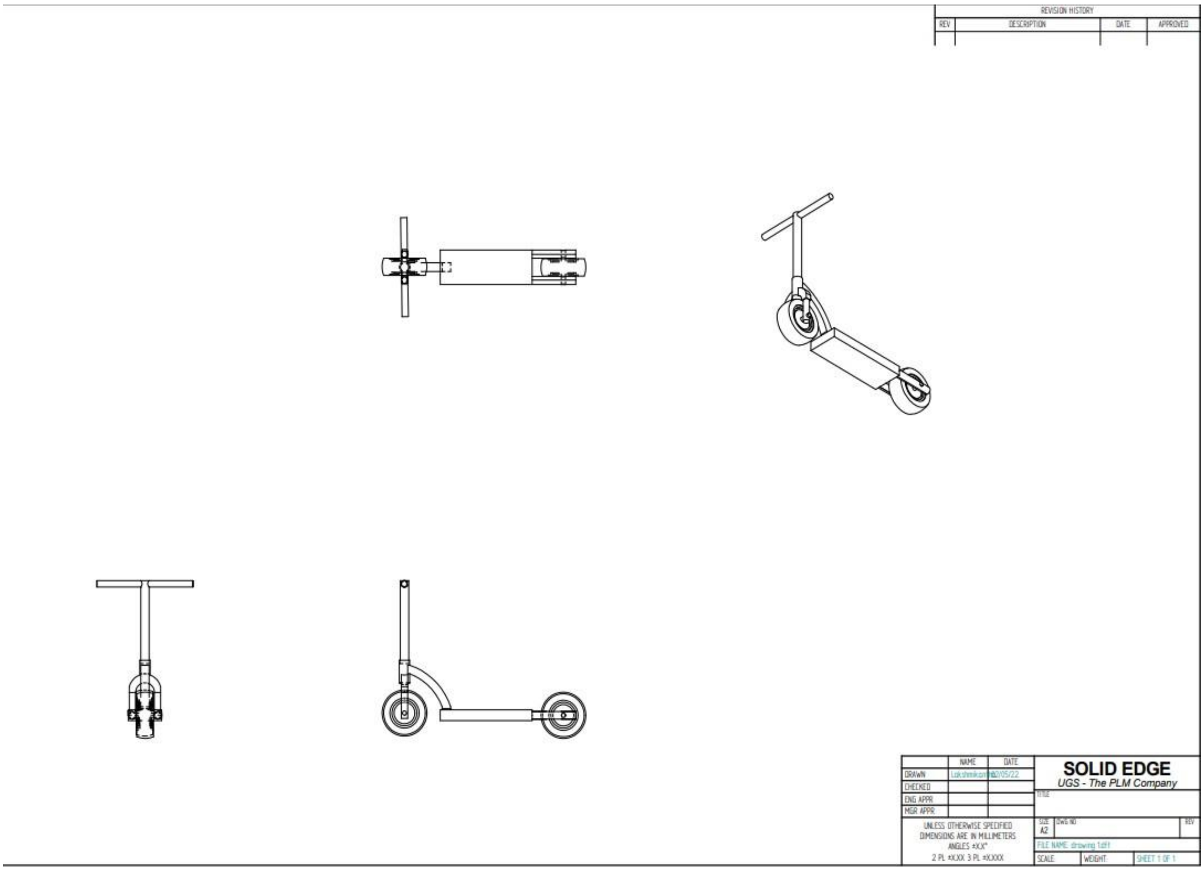
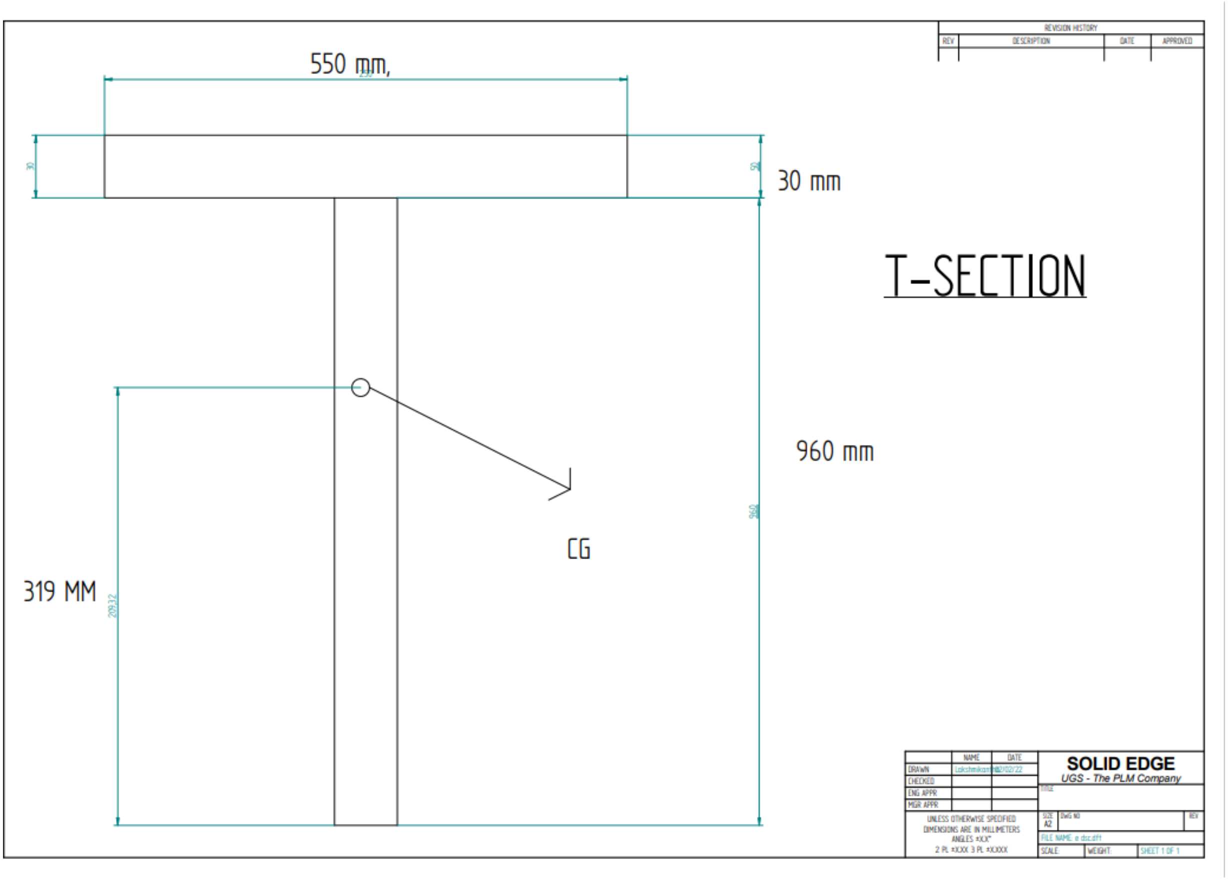


Fig 7.6 2d Drawing

7.7 Calculations

1. To find the centre of gravity for handle section (T - section)



1.1 To calculate moment of inertia I_{NA} and Y

$A_1 = l*b$

$= 55*3$

= 165 cm^2

$A_2 = l*b$

$= 96*3$

= 288 cm^2

$X_1 = l/2$

$= 55/2$

= 27.5 cm

$Y_2 = b/2$

$= 3/2$

= 1.5 cm

$X_2 = l/2$

$= 3/2$

= 1.5 cm

$Y_2 = l/2$

$= 96/2$

$= 48 + 3$

= 51 cm

1.2 To find the centroid of axis (CG)

$\bar{x} = \sum A_i * X_i / \sum A_i$

$= A_1X_1+A_2X_2/A_1+A_2$

$= 165*27.5+288*1.5/165+288$

= 1.5 cm

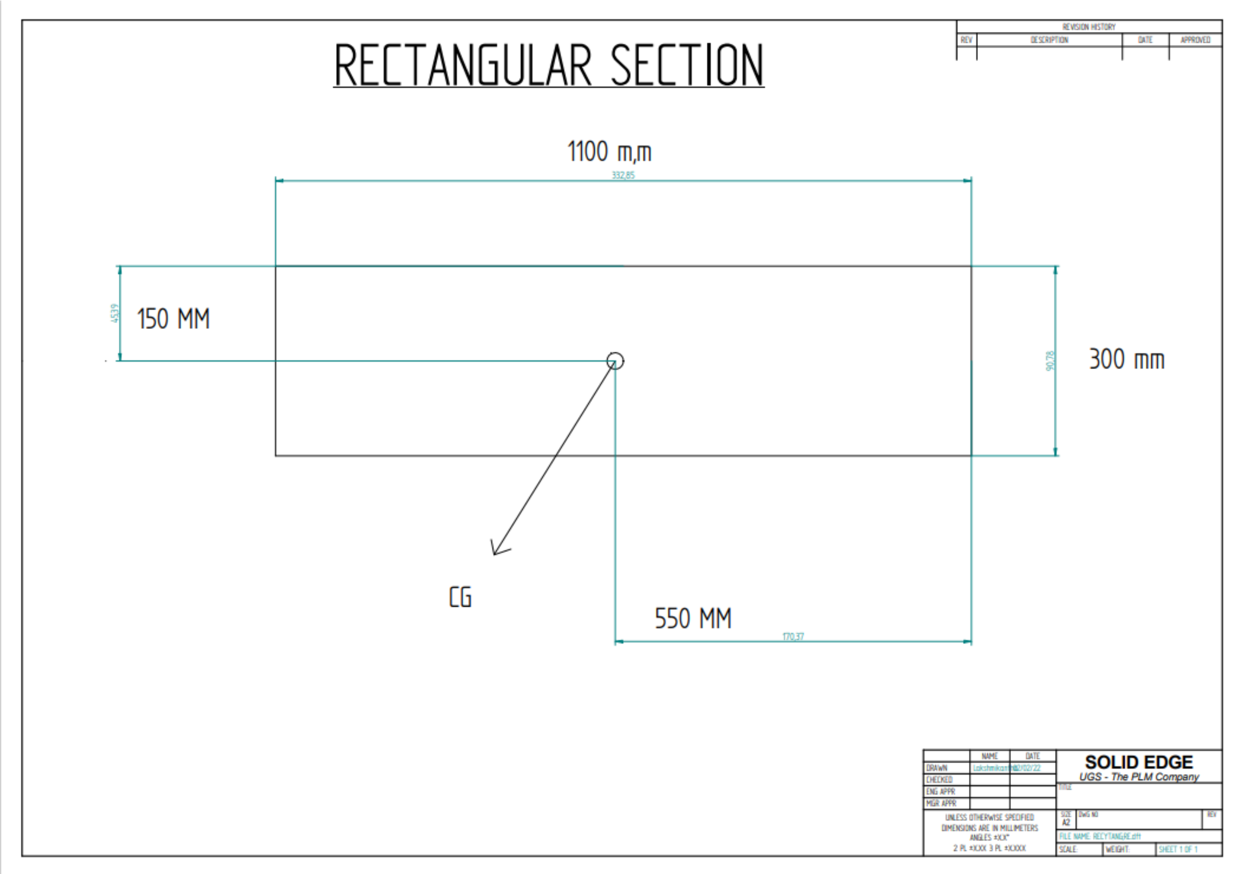
$\bar{Y} = \sum A_i * Y_i / \sum A_i$

$= A_1Y_1+A_2Y_2/A_1+A_2$

$= 165*1.5+288*51/165+288$

= 32.97 cm ≈ 33 c

2. To find the centre of gravity for base section <u>(Rectangular – section)</u>



$\bar{x}$ = l/2

= 110/2

= 55 cm

$\bar{Y}$ = b/2

= 30/2

= 15 cm

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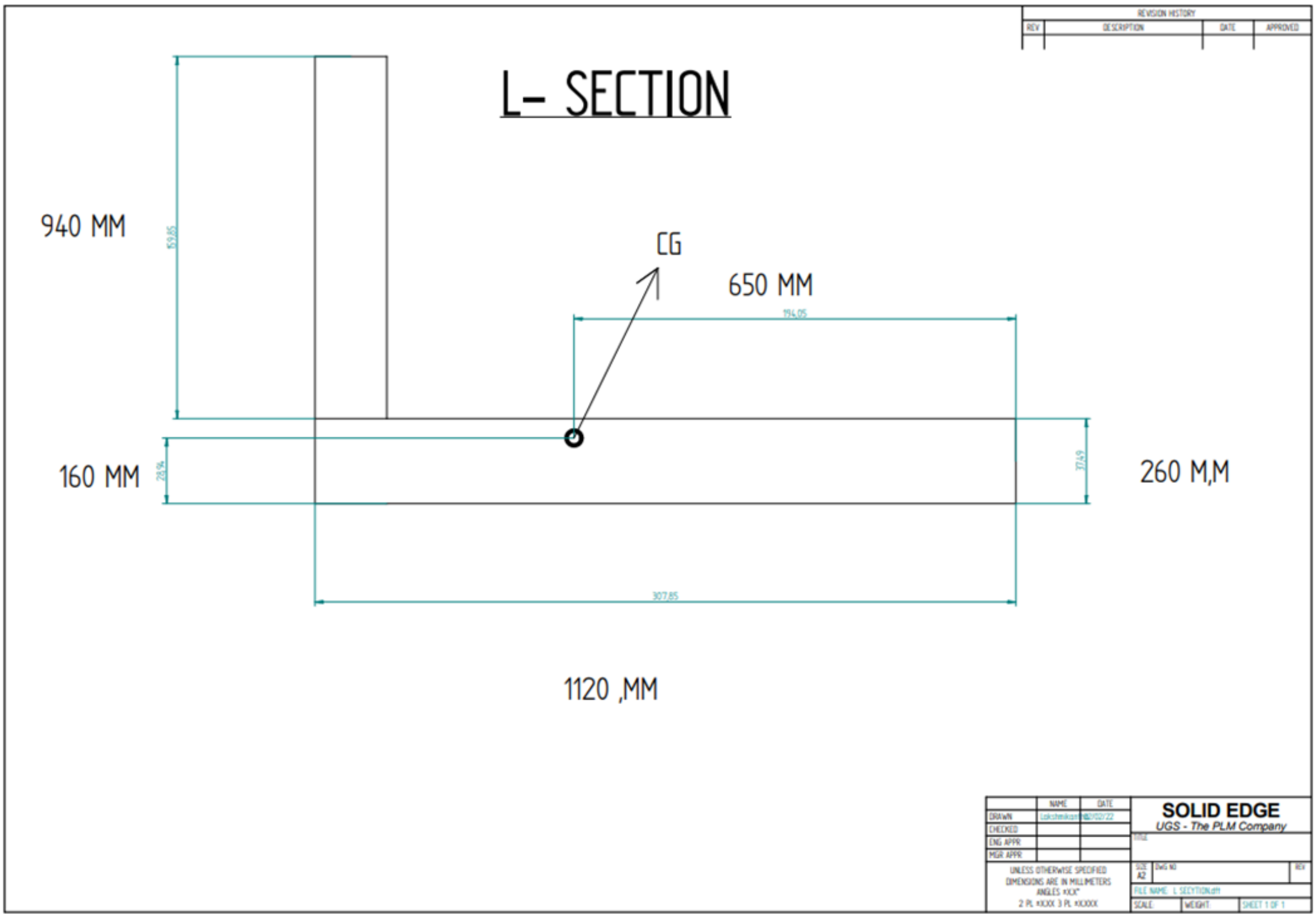
3. **To find cent of gravity for Model <u>(L-Section)</u>**



4. **3.1 Area of the section (A_1)**

$A_1 = l*b$

$= 112*26$

$= 2912\ cm^2$

3.2 Centroid distance

$X_1 = 56$ cm$Y_1 = 13$ cm

3.3 Area of the section (A_2)

$A_2 = l*b$

= 94*3

= 282 cm^2 +26 cm

= 308 cm2

3.4 Centroid distance

X_2 = 1.5 cmY_2 = 47 cm

3.5 To find the CG of the given section

$\bar{x} = \sum A_i X_i / \sum A_i$

$= A_1X_1+A_2X_2/A_1+A_2$

= 2912*56+308*1.5/2912+308

= 50.78 cm

$\bar{Y} = \sum A_i Y_i / \sum A_i$

$= A_1Y_1+A_2Y_2/A_1+A_2$

= 2912*13+308*47/2913+308

= 16.25 cm

Speed Calculations

Given value,

Radius of Tire = 13 cm

Center of Gravity = 50 cm

Weight of model = 20 kg

Weight of Passenger = 90 kg

Under Load condition

Motor rpm = 400 rpm

Rear Wheel rpm = 450 rpm

Speed of E – Scooter

4.1 Circumference = 2πr

= 2*π*0.15

= 0.942 m

4.2 Surface speed = circumference * rpm

= 0.942 * 450

= 423.9 m/min

4.3 Surface speed = 423.9/1000

= 0.423 Km/min

4.4 Surface speed = 0.423*60

= 25Km/Hrs

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7.8 Pictures of The Model

FIG 7.7.1 MODEL FRONT VIEW

FIG 7.7.2 MODEL SIDE VIEW

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FIG 7.7.3 GROUP PICTURE WITH MODEL

Chapter -8

COST ESTIMATION

SL. NO.	NAME OF THE PARTS	MATERIAL	QUANTITY	AMOUNT (RS)
1	Battery	Lead-Acid	3	5800/-
2	D.C. Motor (12 V)	Aluminium	1	2000/-
3	Chain and sprocket	Mild Steel	1	400/-
4	controller unit		1	1800/-
5	Ms shaft	M.S	1	200/-
6	Frame Work	SS	1	1500/-
7	Connecting Wire	Cu	-	400/-
8	Ball bearings	SS	4	250/-
9	wheels	rubber	2	1100/-

Total = 13450/-

LABOUR COST:

LATHE, DRILLING, WELDING, GRINDING, POWER HACKSAW, GAS CUTTING:

Cost = 1800/-

1. OVERHEAD CHARGES:

The overhead charges are arrived by "Manufacturing cost"Manufacturing Cost = Material Cost+

Labour cost

= 13450+1800

= 15250/-

Overhead Charges = 20% of the manufacturing cost

= 3050/-

TOTAL COST

Total cost = Material Cost + Labour cost + Overhead Charges

= 13450+1800+3050

= 18300/-

Total cost for this project= 18300/-

Chapter -9

APPLICATIONS, ADVANTAGES & LIMITATIONS

9.1 Applications

- Suitable for short-distance travels.
- Multiple users can use the same equipment without any adjustment.
- It can be used at the places where is the risk of contamination due to emission.
- Used where traffic intensity is high.
- Used in college Campus, airport, industries, museums, Railway Station etc.

9.2 Advantages

- It is Eco-Friendly.
- It can easily be used for short-distance travels i.e. College tours, factory tours etc.
- The Electric Scooter has a predictable surface that is much easier to negotiate than sidewalks, curbs or trails and the risk of tripping is reduced.
- Multiple users can use the same equipment without adjusting the structure.
- It can be used at the places where is the risk of contamination due to emission.

9.3 Limitations

- On sudden application of brakes jerking and accident can occur.
- Main disadvantage of Electric Scooter is its discharging battery. Due to sudden dischargeof battery in between of travelling many problems are faced.
- Not optimal for long distance.

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Chapter -10

CONCLUSION

Our project “Design and Fabrication of foldable vehicle” is the perfect application of theory and practical we have studied so far in engineering. The aim of this project was to design and build a coaxial, light weight vehicle which will consume less space for parking and can be scooter along. This aim has achieved and a foldable suitcase vehicle with electric motor has manufactured and successfully tested.

A comprehensive literature review has conducted, covering technical information relevant to the project. A formulated design approach was used to create the most efficient and robust configuration for fabrication of the foldable vehicle. The structural design was considered concurrently with component selection, aesthetics, and ergonomics to minimize mechanical, electrical and rider integration problems.

It can be used in college campuses and industrial areas to minimize the walking distance. As it is electric motor powered, it is easy to operate. The vehicle is compact, lightweight, has simple design and hence easily portable. Cost of manufacturing is moderate. Other vehicles can be manufactured having greater capacity as well as larger area for heavy duty works. Thus, our project “Design and fabrication of foldable vehicle” is a successful attempt to overcome traffic congestion and parking problems.

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