A

Capstone Project Planning Report

On

FRICTIONLESS BRAKING SYSTEM

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In a partial fulfilment for the award

Of

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CERTIFICATE

This is to certify that the Capstone Project Planning entitled "Frictionless Magnetic Braking System " being submitted by following students is worthy of consideration for finalization of project title and is a record of original bonafide work carried out under our guidance and supervision.

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Declaration

I declare that this project report entitled **“ Frictionless Magnetic Braking System ”** represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any data/fact in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date:

ABSTRACT

The main perspective about our project which is “ Frictionless Magnetic Braking System ’’ is to reduce the wear and tear of the brake pads. Our project will not only reduce the wear and tear it will also reduce the cost as we have to change the brake pads after a particular use for the working of the brakes. As the term itself says frictionless which means there will no engagement with the disc.

Our project work on the principle of ‘ Eddy Current ’. Eddy currents (also called Foucault's currents) are loops of electrical current induced within conductors by a changing magnetic field in the conductor according to Faraday's law of induction. Eddy currents flow in closed loops within conductors, in planes perpendicular to the magnetic field.

For this project to work we need a circuit which make this project work. The circuit include (Electro Magnet lifting capacity 15 kg, Boost Convertor, Protecting Diode, Battery 12v, electric motor and Switch) and also a iron disc fixed with a wheel of 14 inch . The circuit would be assembled in a frame which is made up of mild steel. For the welding of the frame Shielded Metal Arc Welding is done for stiff and durable support for the circuit and other assemblies.

As moving further to the working of our project. As soon as the brake lever is engage the electro magnets will charge up it will produce magnetic filled which will react with the iron disc due to eddy current loses and stop the wheel.

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Abbreviations and Notations

SrNo.	Abbreviation	Full Form
1.	AC	Alternating Current
2.	DC	Direct Current
3.	12V	12 volts
4.	rpm	Rotation per minute
5.	ft	Feet
6.	kg	Kilogram
7.	mm	Millimetre
8.	AC Motor	Alternating Current Motor
9.	3R10	3-Construction type R- Radial Construction 10-Size of tyre

CHAPTER 1

I. Introduction

The introduction part consist all the introduction and problem definition of our project which is “Frictionless Magnetic Braking System”. So first we need to know about the types of brakes which are current used in automotive. The electromagnetic braking is already used in the locomotives overcoming to this we need to make a compact system for the automotive due to less space available.

1.1 Need of a Braking System

In an automobile vehicle braking system is needed –

To stop the moving vehicle.

To de accelerate the moving vehicle.

For stable parking of a vehicle either on a flat surface or on a slope.

As a precaution for accidents.

To prevent the vehicle from any damage due to road conditions.

1.2 Classification of Braking System

As we have already discussed the evolution of braking system from vintage carts to modern cars, from vintage carriages to modern trucks has given us various different purpose braking systems which are classified on the basis of various needs and purposes of an automobile vehicle.

1. On the Basis of Power Source

The power source which carries the pedal force applied by the driver on brake pedal to the final brake drum or brake disc in order to de accelerate or stop the vehicle the braking systems are of 6 types-

- Mechanical braking system
- Hydraulic braking system
- Air or pneumatic braking system
- Vacuum braking system
- Magnetic braking system
- Electric braking system

2. On the Basis of Frictional Braking Contact

On the basis of the final friction contact made between the rotating brake components i.e., brake drum or disc rotor and the brake shoe the braking systems are of 2 types-

(i) Internal expanding brakes (e.g.- drum brakes)

(ii) External contracting brakes (e.g., disc brakes)

3. On the Basis of Application-

On the basis of method of applying brakes, braking systems are of 2 types-

(i) Foot or service brakes

(ii) Hand or parking brakes

4. On the Basis of Brake Force Distribution

(i) Single acting brakes

(ii) Dual acting brakes

1.3 Eddy Current:

Eddy currents (also called Foucault's currents) are loops of electrical current induced within conductors by a changing magnetic field in the conductor according to Faraday's law of induction. Eddy currents flow in closed loops within conductors, in planes perpendicular to the magnetic

field. They can be induced within nearby stationary conductors by a time-varying magnetic field created by an AC electromagnet or transformer, for example, or by relative motion between a magnet and a nearby conductor. The magnitude of the current in a given loop is proportional to the strength of the magnetic field, the area of the loop, and the rate of change of flux, and inversely proportional to the resistivity of the material. When graphed, these circular currents within a piece of metal look vaguely like eddies or whirlpools in a liquid.

By Lenz's law, an eddy current creates a magnetic field that opposes the change in the magnetic field that created it, and thus eddy currents react back on the source of the magnetic field. For example, a nearby conductive surface will exert a drag force on a moving magnet that opposes its motion, due to eddy currents induced in the surface by the moving magnetic field. This effect is employed in eddy current brakes which are used to stop rotating power tools quickly when they are turned off. The current flowing through the resistance of the conductor also dissipates energy as heat in the material. Thus eddy currents are a cause of energy loss in alternating current (AC) inductors, transformers, electric motors and generators, and other AC machinery, requiring special construction such as laminated magnetic cores or ferrite cores to minimize them. Eddy currents are also used to heat objects in induction heating furnaces and equipment, and to detect cracks and flaws in metal parts using eddy-current testing instruments.

1.4 Types of brakes:

A. Brake

A vehicle brake is used to slow down a vehicle by converting its kinetic energy into heat. Most commonly brakes use friction between two surfaces pressed together to convert the kinetic energy of the moving

object into heat, though other methods of energy conversion may be employed. For example regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel.

- Types of Brake

1)Friction Brake .

A friction brake is a type of automotive brake that slows or stops a vehicle by converting kinetic energy into heat energy, via friction. The heat energy is then dissipated into the atmosphere. In most systems, the brake acts on the vehicle's wheel hubs, but some vehicles use brakes which act on the axles or transmission.

Friction brakes may be

i)Drum Type.

ii)Disc Type.

i) Drum Brake

A drum brake is a vehicle brake in which the friction is caused by a set of brake shoes that press against the inner surface of a rotating drum. The drum is connected to the rotating roadwheel hub

ii)Disc Brake.

The disc brake is a device for slowing or stopping the rotation of a road wheel. A brake disc (or rotor in U.S. English), usually made of cast iron or ceramic, is connected to the wheel or the axle. To stop the wheel, friction material in the form of brake pads (mounted in a device called a

brake callipers) is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

2)Electromagnetic Brake:

i) Electromagnetic brakes slow an object through electromagnetic induction, which creates resistance and in turn either heat or electricity. Friction brakes apply pressure on two separate objects to slow the vehicle in a controlled manner.

ii) In locomotives, a mechanical linkage transmits torque to an electromagnetic braking component.

iii) Trams and trains use electromagnetic track brakes where the braking element is pressed by magnetic force to the rail. They are distinguished from mechanical track brakes, where the braking element is mechanically pressed on the rail.

iv) Electric motors in industrial and robotic applications also employ electromagnetic brakes.

v) Recent design innovations have led to the application of electromagnetic brakes to aircraft applications. In this application, a combination motor/generator is used first as a motor to spin the tires up to speed prior to touchdown, thus reducing wear on the tires, and then as a generator to provide regenerative braking.

3) Mechanical Brakes-

It is the type of braking system in which the brake force applied by the driver on the brake pedal is transferred to the final brake drum or disc rotor through the various mechanical linkages like cylindrical rods, fulcrums, springs etc. In order to de accelerate or stop the vehicle.

Mechanical brakes were used in various old automobile vehicles but they are obsolete now days due to their less effectiveness.

4) Hydraulic Brakes-

It is the type of braking system in which the brake force applied by the driver on brake pedal is first converted into hydraulic pressure by master cylinder (for reference read article on master cylinder) than this hydraulic pressure from master cylinder is transferred to the final brake drum or disc rotor through brake lines.

Instead of mechanical linkages, brake fluid is used in hydraulic brakes for the transmission of brake pedal force in order to stop or de accelerates the vehicle.

Almost all the bikes and cars on the road today are equipped with the hydraulic braking system due to it high effectiveness and high brake force generating capability.

5) Air or Pneumatic Brakes-

It is the types of braking system in which atmospheric air through compressors and valves is used to transmit brake pedal force from brake pedal to the final drum or disc rotor.

Air brakes are mainly used in heavy vehicles like busses and trucks because hydraulic brakes fails to transmit high brake force through greater distance and also pneumatic brakes generates higher brake force than hydraulic brake which is the need of the heavy vehicle.

The chances of brake failure is less in case of pneumatic brakes as they are usually equipped with a reserve air tank which comes in action when there is a brake failure due to leakage in brake lines.

High end cars these days are using air brakes system due to its effectiveness and fail proof ability.

6) Vacuum Brakes-

It is the conventional type of braking system in which vacuum inside the brake lines causes brake pads to move which in turn finally stops or de accelerate the vehicle.

Exhauster , main cylinder , brake lines , valves along with disc rotor or drum are the main components that combines together to make a vacuum braking system

Vacuum brakes were used in old or conventional trains and are replaced with air brakes now days because of its less effectiveness and slow braking.

Vacuum brakes are cheaper than air brakes but are less safe than air brakes.

Disc Eddy Current Brake:

Disk electromagnetic brakes are used on vehicles such as trains, and power tools such as circular saws, to stop the blade quickly when the power is turned off. A disk eddy current brake consists of a conductive non-ferromagnetic metal disc (rotor) attached to the axle of the vehicle's wheel, with an electromagnet located with its poles on each side of the disk, so the magnetic field passes through the disk. The electromagnet allows the braking force to be varied. When no current is passed through the electromagnet's winding, there is no braking force. When the driver steps on the brake pedal, current is passed through the electromagnet windings, creating a magnetic field. The greater the current in the winding, the greater the eddy currents and the stronger the braking force. Power tool brakes use permanent magnets, which are moved adjacent to the disk by a linkage when the power is turned off. The kinetic energy of the vehicle's motion is dissipated in Joule heating by the eddy currents passing through the disk's resistance, so like conventional friction disk

brakes, the disk becomes hot. Unlike in the linear brake below, the metal of the disk passes repeatedly through the magnetic field, so disk eddy current brakes get hotter than linear eddy current brakes.

Fig 1.4: Disk eddy current brake

1.5 Problem Definition:

The main aim of our project is that there should be no contact between the disc and the calliper. The disc provide efficient amount of baking force which is required but as there is contact with the disc the brake pads fades away after time due to excessive usage of the brake pads. Sometimes the disc also gets rusted and the chips start form which led to brake failure. To overcome this situation we are using electromagnet with eddy current principle for contactless braking

CHAPTER 2

2. Literature Overview:

A literature review is an overview of the previously published works on a specific topic. The term can refer to a full scholarly paper or a section of a scholarly work such as a book, or an article. Either way, a literature review is supposed to provide the researcher/author and the audiences with a general image of the existing knowledge on the topic under question. A good literature review can ensure that a proper research question has been asked and a proper theoretical framework and/or research methodology have been chosen. In other words, a literature review serves to situate the current study within the body of the relevant literature and to provide context for the reader. In such a case, the review usually precedes the methodology and results sections of the work.

Producing a literature review is often a part of graduate and post-graduate student work, including in the preparation of a thesis, dissertation, or a journal article. Literature reviews are also common in a research proposal or prospectus (the document that is approved before a student formally begins a dissertation or thesis).The following research papers are as follows:

2.1 General:

The importance of making this project is for the automotive sector. This type of braking system is usually used in the locomotive as per research it has performed at it best level. But there is no such system in the automotive sector. As we are in the phase of transforming the fuel engine vehicles into electric vehicle there is also a need of improvement in the breaking system. An electromagnetic braking system is the best as compared to other braking system in automotive sector. As the there is no friction which means there will not be any wear and tear of the brake pads which will indirectly cause decrease in the debris.

2.2 Overview of literature:

Magnetic braking system is the combination of disc brake and eddy current principle. Our project will not only reduce the wear and tear it will also reduce the cost as we have to change the brake pads after a particular use for the working of the brakes. As the term itself says frictionless which means there will no engagement with the disc.

2.3 Summary:

Stephen Z. Oldakowski, Bedford, Ohio A magnetic brake provides braking or locking capability and is remotely controlled by electric power. The magnetic brake comprises a rotatable shaft and a brake disc mounted on the shaft. A non-rotating core housing assembly located around the shaft includes a permanent magnet and a bipolar solenoid. A magnetic armature adjacent to the core housing assembly is capable of movement toward the core housing assembly and toward and into engagement with a brake disc to prevent rotation of the shaft. A spring urges the armature away from the core housing assembly and into engagement with the brake disc. The brake does not use any electric power to maintain the brake in the set mode with the rotating shaft fully locked or in the released mode with the rotating shaft fully released. The permanent magnet is of sufficient strength to hold the armature against urging of the spring until an opposite polarity is supplied by the solenoid.

Karl Erny, Holzhausem An elevator drive has a brake device with compression springs to actuate brake levers, and brake linings on a brake drum creating a braking force. A sensor is provided to detect the movement of a brake magnet armature tappet. A bracket is attached to the brake magnet tappet on one end and a distance piece carrying the sensor housing is arranged on the other end. A restoring lug is attached to the existing mechanical indicator. A monitor evaluates the sensor signal and turns off the elevator drive in the event of

dangerous operational states via a safety circuit. The system allows the state of the brake device to be monitored. The more the brake linings wear off due to abrasion, the smaller the distance between the armature and the brake magnet housing. If the armature is in contact with the brake magnet housing, the braking ability of the brake linings is completely void.

M.Z. Baharom, M.Z. Nuawi, G. Priyandoko, S.M. Haris, From two stages of the experiment that has been conducted, it can be concluded that aluminium is the best material compared to copper and zinc to be use as the disc brake for eddy current braking using electromagnetic. Thicker disc will generate high torque which will approach the motor torque in order to stop the disc rotation which in this study disc of 5 mm is better than 4 mm of thickness. Smaller air-gap will produce high braking torque and give better performance to the electromagnetic braking which air-gap of 1 mm shows the best result compared to 3 mm and 5 mm gap.

Ihsan Uluocak, Hakan Yavuz, Mehmet Gürsul, An experiment rig is built and torque performance of different rotor materials on eddy current brake. These materials are low carbon steel, Cr alloy steel and Zinc galvanized steel. Experiments are done at 200 rpm with 0.9 mm air gap between rotor and coils. Results shows that Low carbon steel has the most generated torque and galvanized steel has the lowest generated torque.

CHAPTER 3

3. Methodology

A methodology is the main part where the actual project information starts. In this chapter we are dealing with the detailed information about the working principle, components used, operation performed like fabrication process, soldering process and further the advantages and disadvantages.

3.1 Working principle :

A. Electromagnetism:

Electromagnetism is one of the four fundamental interactions in nature. The other three are the strong interaction, the weak interaction and gravitation. Electromagnetism is the force that causes the interaction between electrically charged particles; the areas in which this happens are called electromagnetic fields.

B. Magnetic Effect of Current:

The term "Magnetic effect of current" means that "a current flowing in a wire produces a magnetic field around it". The magnetic effect of current was discovered by Oersted in 1820. Oersted found that a wire carrying a current was able to deflect a magnetic needle.

C. Electromagnet:

An electric current can be used for making temporary magnets known as electromagnets. An electromagnet works on the magnetic effect of current. It has been found that if a soft iron rod called core is placed inside a solenoid, then the strength of the magnetic field becomes very large because the iron ore is magnetized by induction.

D. Factors Affecting Strength of an Electromagnet:

The strength of an electromagnet is:

i) Directly proportional to the number of turns in the coil.

ii) Directly proportional to the current flowing in the coil.

iii) Inversely proportional to the length of air gap between the poles.

In general, an electromagnet is often considered better than a permanent magnet because it can produce very strong magnetic fields and its strength can be controlled by varying the number of turns in its coil or by changing the current flowing through the coil.

E. Eddy Current:

Eddy currents are circular electric currents induced within conductors by a changing magnetic field in the conductor, due to Faraday's law of induction. Eddy currents flow in closed loops within conductors, in planes perpendicular to the magnetic field. By Lenz's law, an eddy current creates a magnetic field that opposes the magnetic field that created it, and thus eddy currents react back on the source of the magnetic field. This effect is employed in eddy current brakes which are used to stop rotating power tools quickly when they are turned off. The current flowing through the resistance of the conductor also dissipates energy as heat in the material.

3.2 Parts used:

A. AC Motor

An AC motor is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second

rotating magnetic field. The rotor magnetic field may be produced by permanent magnets, reluctance saliency, or DC or AC electrical windings.

Less commonly, linear AC motors operate on similar principles as rotating motors but have their stationary and moving parts arranged in a straight line configuration, producing linear motion instead of rotation.

Fig 3.2 A : Starter Motor

B. Iron Disk

1) The iron disk is the make from the iron.

2) This disk is mounted on the shaft.

3) And the shaft is connected to the ac motor so that the iron disk is rotates as the same speed of the motor.

4) There is one electro magnet provided on the left side of the disk.

5) So that when the iron disk cuts the magnetic field created by the electromagnet it is produce eddy current in it.

C. Frame

In any model the frame plays an important role as it shows the as the basic structure of the project. It the main unknit in which all the components are need to be placed. Without making the of the frame the project won't run. For our project we have selected slotted angle which provide proper structural strength.

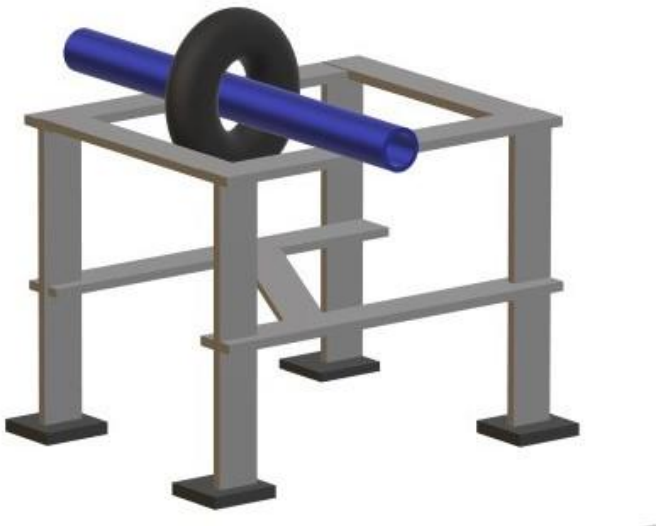

Fig 3.2 C : Metal Frame Design

D. Shaft

1) The shaft is the life line of the any equipment.

2) In this project there is the use the 8mm cast iron shaft for the mounting the disk and electric motor.

3) The shaft is attached to the motor and iron disk with help of the flange coupling.

4) The shaft is supported on the frame by the bearing and bearing blocks.

E. Bearing

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft). As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

The most common standardized ball bearing size is the 608 series. In the 608 series, the ball bearing typically consists of optional closures, inner race, outer race, balls, and ball retainer. It is characterized by an 8mm inner diameter (the bore of the ball bearings), a 22mm outer diameter, and a width of 7mm.

F. Bearing Block

The fundamental application of both types is the same which is to mount bearings safely enabling their outer ring to be stationary while allowing rotation of the inner ring. The housing is bolted to a foundation through the holes in the base. Bearing housings are either split type or unsplit type. Split type housings are usually two piece housings where the cap and base can be detached, while certain series are one single piece housings. Various seals are provided to prevent dust and other contaminants from entering the housing. Thus the housing provides a clean environment for the expensive bearings to freely rotate, hence increasing their performance and duty cycle.

Bearing housings are usually made of grey cast iron. However various grades of metals can be used to manufacture the same.

G. Flange Coupling

A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. Couplings do not normally allow disconnection of shafts during operation, however there are torque limiting couplings which can slip or disconnect when some torque limit is exceeded.

The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both. By careful selection, installation and maintenance of couplings, substantial savings can be made in reduced maintenance costs and downtime.

This coupling has two separate cast iron flanges. Each flange is mounted on the shaft end and keyed to it. The two flanges are coupled together with the help of bolts and nuts. The projected portion of one of the flanges and corresponding recess on the other flange help to bring the shaft into line and to maintain

alignment. A flange which is provided with a shroud which shelters the bolts heads and nuts is called protected type flange coupling.

H. Electromagnet

This DC 12V KK-P30/25 15KG Lifting Solenoid Electromagnet consists of an iron core and a coil to attract magnetic substances, using the magnetic action induced by electric current, only while the current is applied. This compact functional device offers high power with high reliability. The structure and design to release the residual magnetism left after de-energization is also one of its unique features.

OVERVIEW

- Operating Voltage: 12V DC
- Lifting Capacity: 15KG
- Size (D x L): 30 x 25 mm
- Electric lifting magnet.
- Powerful and compact.
- Smooth and flat surface.
- Low consumption and reliable.
- Ambient temperature within 130 degrees.

Fig 3.2 H : Electromagnet

I. Boost Converter:

A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element: a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).

Fig 3.2 I: Boost Converter (6 to 12 Volts)

J. Protecting Diode:

A protection diode (also called a safety diode) is a diode that is used in a circuit to protect the circuit from reverse voltage and current. Reverse voltage and current is power that flows in the opposite direction of the usual or conventional way; instead of current travelling from the positive side of the voltage source to ground and then to the negative side of the voltage source, it travels from the

negative side of the voltage source, through ground, and to the positive side of the voltage source, so, in essence, reverse. A protection diode is used to block this reverse current flow; this helps to protect components in circuitry that can be damaged from reverse current.

Fig 3.2 J : Protecting Diode

K. Chain:

Chain transfers power from the motor to the drive-wheel, thus propelling it. Most chains are made from plain carbon or alloy steel, but some are nickel-plated to prevent rust, or simply for aesthetics.

Fig 3.2 K: Chain

L. Sprocket:

A sprocket, sprocket-wheel or chainwheel is a profiled wheel with teeth, or cogs, that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it.

Fig 3.2 L: Sprocket

M. Wheel:

In its primitive form, a wheel is a circular block of a hard and durable material at whose centre has been bored a hole through which is placed an axle bearing about which the wheel rotates when torque is applied to the wheel about its axis. The tyre which we are using is of TVS Pep, which is 3R10 tyre rating.

N. Nut

A nut is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten multiple 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. For our project we have selected the size 12 nut.

Fig 3.2 N : Nut

O. Bolt

The distinction between a bolt and a screw is poorly-defined. The academic distinction, per Machinery's Handbook is in their intended design: bolts are designed to pass through an unthreaded hole in a component and be fastened with the aid of a nut, although such a fastener can be used without a nut to tighten into a threaded component such as a nut-plate or tapped housing. Screws in contrast are used in components which contain their own thread, or to cut its own internal thread into them. This definition allows ambiguity in the description of a fastener depending on the application it is actually used for, and the terms screw and bolt are widely used by different people or in different countries to apply to the same or varying fastener. For our project we have selected the size 12 bolt.

Fig 3.2 O : Bolt

P. Washer

A washer is a thin plate (typically disk-shaped, but sometimes square) with a hole (typically in the middle) that is normally used to distribute the load of a threaded fastener, such as a bolt or nut. Other uses are as a spacer, spring (Belleville washer, wave washer), wear pad, preload indicating device, locking device, and to reduce vibration (rubber washer). Washers often have an outer diameter (OD) about twice their inner diameter (ID), but this can vary quite widely.

Washers are usually metal or plastic. High-quality bolted joints require hardened steel washers to prevent the loss of pre-load due to brinelling after the torque is applied. Washers are also important for preventing galvanic corrosion, particularly by insulating steel screws from aluminium surfaces. They may also be used in rotating applications, as a bearing. A thrust washer is used when a rolling element bearing is not needed either from a cost-performance perspective or due to space restraints. Coatings can be used in attempt to reduce wear and friction either by hardening their surface, or providing a solid lubricant (i.e. a self-lubricating surface). For our project we have selected the size 12 Washer.

Fig 3.2 P : Washer

Q. Slotted Angles

Slotted angle (also sometimes referred to as slotted angle iron) is a system of reusable metal strips used to construct shelving, frames, work benches, equipment stands and other structures. The name derives, first, from the use of elongated slots punched into the metal at uniform intervals to enable assembly of structures fixed with nuts and bolts, and second, from the longitudinal folding of the metal strips to form a right angle.

Fig 3.2 Q : Slotted Angle

3.3 Operations:

A. Turning of shaft

Turning is the machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical tool path by moving more or less linearly while the workpiece rotates. In this operation reduce the diameter of the shaft. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear.

B. Cutting of the Slotted Angles

The slotted angles plays an important role in the project. It acts as a main purpose of slotted angle is to act as a supporting agent in which all the components are placed. For our project frame we have purchased the in total 32 feet. And cut the angles as 4 feet = 4 pieces, 2 feet = 8 pieces.

C. Welding

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material that cools to become a strong joint with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. In this operation, fix the sprocket on the shaft.

D. Fix bearing supports

i) Bearing is use for smooth rotation of shaft on which disk is mounted.

ii) Bearing fix at both side of disk on support which mount over the frame.

iii) When disk start rotational motion, due to bearing support it easy to operate disk.

iv) By screwing of bearing support, fix over frame at both side of disk.

v) Due to that starting of disk motion is quick and frictionless.

E. Coupling of Motor Shaft and Disk Shaft

i) For coupling of motor shaft and disk shaft two clamps are use.

ii) Both this clamp has same dimensions and hole for coupling.

iii) By nut and bolt this both shaft mount separately on motor shaft and disk shaft.

iv) When separate mount of clamp is done then this both clamp coupled together by nut and bolt.

G. Soldering of the electric components

Soldering is a process in which two or more items are joined together by melting and putting a filler metal (solder) into the joint, the filler metal having a lower melting point than the adjoining metal. Unlike welding, soldering does not involve melting the work pieces. In brazing, the work piece metal also does not melt, but the filler metal is one that melts at a higher temperature than in soldering. In the past, nearly all solders contained lead, but environmental and health concerns have increasingly dictated use of lead-free alloys for electronics and plumbing purposes.

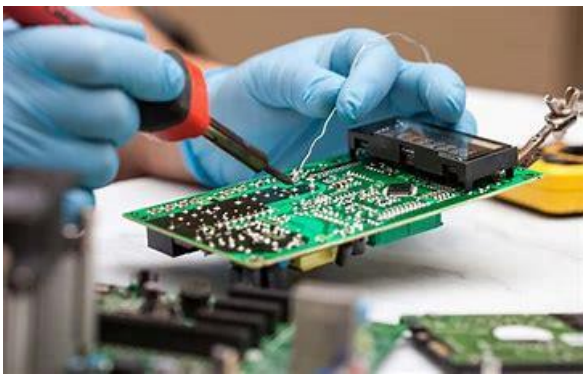

Fig 3.3 G : Soldering process

H. Fabrication process:

Metal fabrication is the creation of metal structures by cutting, bending and assembling processes. It is a value-added process involving the creation of machines, parts, and structures from various raw materials.

Typically, a fabrication shop bids on a job, usually based on engineering drawings, and if awarded the contract, builds the product. Large fab shops employ a multitude of value-added processes, including welding, cutting, forming and machining.

As with other manufacturing processes, both human labor and automation are commonly used. A fabricated product may be called a fabrication, and shops specializing in this type of work are called fab shops. The end products of other common types of metalworking, such as machining, metal stamping, forging, and casting, may be similar in shape and function, but those processes are not classified as fabrication.

Processes involved in the fabrication process:

- Cutting is done by sawing,[2] shearing, or chiselling (all with manual and powered variants); torching with handheld torches (such as oxy-fuel torches or plasma torches); and via numerical control (CNC) cutters (using a laser, mill bits, torch, or water jet).[3]
- Bending is done by hammering (manual or powered) or via press brakes, tube benders and similar tools. Modern metal fabricators use press brakes to coin or air-bend metal sheet into form. CNC-controlled back gauges use hard stops to position cut parts to place bend lines in specific positions.
- Assembling (joining of pieces) is done by welding, binding with adhesives, riveting, threaded fasteners, or further bending in the form of crimped seams. Structural steel and sheet metal are the usual

materials for fabrication; welding wire, flux and/or fasteners are used to join the cut pieces.

Fabrication comprises or overlaps with various metalworking specialties:

- Fabrication shops and machine shops have overlapping capabilities, but fabrication shops generally concentrate on metal preparation and assembly (as described above). Machine shops cut metal, but focus primarily on the machining of parts on machine tools. Some firms do both fab work and machining.
- Blacksmithing has always involved fabrication, although that term has not always been used.
- Welder-produced products, often referred to as weldments, are examples of fabrication.
- Boilermakers originally specialized in fabricating boilers, but the term is now used more broadly.
- Millwrights originally specialized in setting up grain mills and saw mills, but now perform a wide range of fabrication.
- Ironworkers, also known as steel erectors, also engage in fabrication. They often work with prefabricated segments, produced in fab shops, that are delivered to the site.

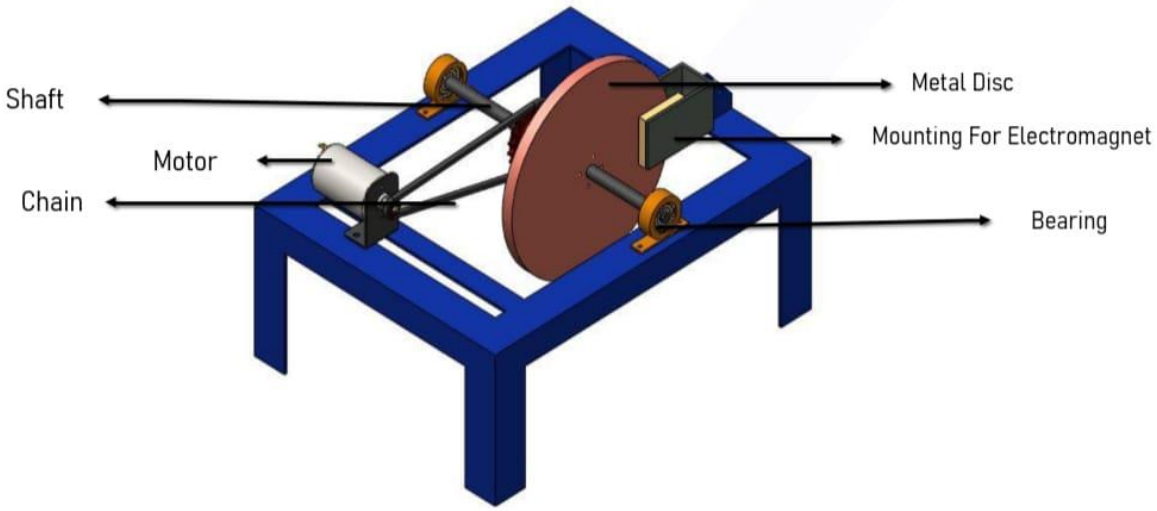

Fig 3.3 H : Basic layout of the project

The above figure shows the basic layout of our project which is followed by the following :

1] After selecting the material for the frame which is slotted angle. Then we calculated in total we bought about 32 feet of slotted angle. Further we started to cut the slotted angle in 4 feet and 2 feet pieces.

2] As we have cut the pieces in 4 and 2 feet pieces in total 4 feet piece were 5 pieces and 2 feet were 6 pieces. For assembling the slotted angle nut, bolts and washer were used to join the slotted angles.

3] We used 12 number size of nut, bolt and washer. With respect to the figure the vertical section which are the legs of the frame 2 feet size of angles were used. For keeping it stable we bolted 4 feet size of angle on right and left side horizontally.

4] Further moving towards base side were the disc, motor and electromagnets will be placed. 4 feet size slotted angles were horizontally place on right and left side. This were further bolted on the legs.

5] After this place 2 feet size angles were the electromagnets and motor is placed with respect to the figure. In total around 20 nut, bolt and washer were used to fix the slotted angles

6] Therefore we completed the frame on which the main project was going to take place. Thus we further moved to assembly of the electrical components with respect to circuit diagram.

I. Assembly of All Components

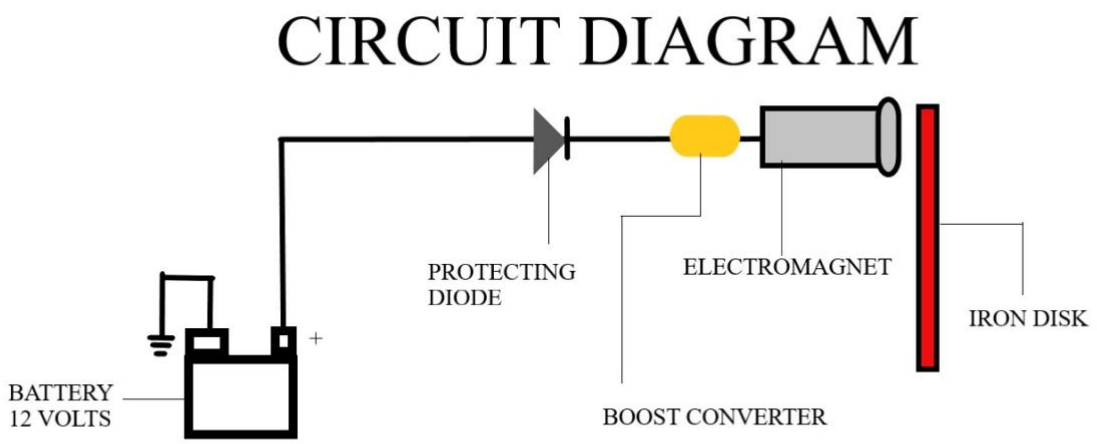

Fig 3.3 I : Circuit Diagram

With respect to the circuit diagram we have soldered the electrical components.

i) At last the assembly of all parts is done on suitable space on frame.

ii) Disk is mounting over shaft which in bearing support at both side.

iii) Motor shaft and disk shaft is coupled by clamping method.

iv) Then after electromagnet are mount at one side of disk but in opposite side.

v) For rotational motion of disk there is 2000 rpm motor mount with clamping.

vi) For proper way for electricity process switch are provide.

3.4 List Of Components purchased:

SRNO.	COMPONENTS PURCHASED	PRICE (rs.)
1.	Slotted Angles	900
2.	Battery (12V)	1200
3.	Nut and Bolt	200
4.	Wire	100
5.	Iron disk	500
6.	Bearings	500
7.	Shaft	300
8.	Boost Converter	60
9.	Electromagnet	355
10.	Protecting Diode	230
11.	Chain and sprocket set	200
12.	Tyre	250
13.	Stater Motor	300
14.	Misillineous	500
	TOTAL	7,665

3.5 Result Analysis

There are the result of the project are as shown in table

The reading are taken as the rotation speed of the iron disk with the motor and stopping time when the electromagnet are in action and motor power supply cut-off.

The results are as shown in table.

SR NO.	ROTATING SPEED (RPM)	STOPPING TIME (SEC)
1.	500	1.10
2.	1000	1.40
3.	1500	2.10
4.	1700	2.50
5.	2000	3

3.5 Advantages and Disadvantages

A. Advantages

i) Problems of drum distortion at widely varying temperatures. Which is common for friction-brake drums to exceed 500 °C surface temperatures when subject to heavy braking demands, and at temperatures of this order, a reduction in the coefficient of friction („brake fade“) suddenly occurs.

ii) This is reduced significantly in electromagnetic disk brake systems.

iii) Potential hazard of tire deterioration and bursts due to friction is eliminated.

iv) There is no need to change brake oils regularly.

v) There is no oil leakage

vi) The practical location of the retarder within the vehicle prevents the direct impingement of air on the retarder Caused by the motion of the vehicle.

vii) The retarders help to extend the life span of the regular brakes and keep the regular brakes cool for emergency situation.

viii) The electromagnetic brakes have excellent heat dissipation efficiency owing to the high temperature of the surface of the disc which is being cooled.

ix) Due to its special mounting location and heat dissipation mechanism, electromagnetic brakes have better thermal dynamic performance than regular friction brakes.

x) Burnishing is the wearing or mating of opposing surfaces .This is reduced significantly here.

xi) In the future, there may be shortage of crude oil; hence by-products such as brake oils will be in much demand. EMBs will overcome this problem.

xii) Electromagnetic brake systems will reduce maintenance cost.

xiii) The problem of brake fluid vaporization and freezing is eliminated.

xiv) Electric actuation, no fluid.

xv) Easier integration with anti-lock, traction, and dynamic stability controls.

xvi) Easy individual wheel braking control.

B. Disadvantage

i) Dependence on battery power to energize the brake system drains down the battery much faster.

ii) Due to residual magnetism present in electromagnets, metal fillings may get stuck.

Conclusion

Electromagnetic braking system is found to be more reliable as compared to other braking systems. In oil braking system or air braking system even a small leakage may lead to complete failure of brakes. While in electromagnetic braking system as four disc plates, coils and firing circuits are attached individually on each wheel, even any coil fails the brake does not completely fails remaining three coil works properly. And this system needs very little of maintenance. In addition, it is found that electromagnetic brakes make up approximately 80% of all of the power applied brake applications. Electromagnetic brakes have been used as supplementary retardation equipment in addition to the regular friction brakes on heavy vehicles. The frictions brakes can be used less frequently and therefore practically never reach high temperatures. The brake linings would last considerably longer before requiring maintenance and the potentially “brake fade” problem could be avoided. This enhanced braking system not only helps in effective braking but also helps in avoiding the accidents and reducing the frequency of accidents to a minimum. Furthermore the electromagnetic brakes prevent the danger that can arise from the prolonged use of brake beyond their capability to dissipate heat.

With all the advantages of electromagnetic brakes over friction brakes, they have been widely used on heavy vehicles where the „brake fading‟ problem exists. The same concept is being developed for application on lighter vehicles. The concept designed by us is just a prototype and needs to be developed more because of the above mentioned disadvantages. These electromagnetic brakes can be used as an auxiliary braking system along with the friction braking system to avoid overheating and brake failure. ABS usage can be neglected by simply using a micro controlled electromagnetic disk brake system .These find vast applications in heavy vehicles where high heat dissipation is required. In rail coaches it can used in combination of disc brake to bring the trains moving

in high speed. When these brakes are combined it increases the life of brake and act like fully loaded brakes. These electromagnetic brakes can be used in wet conditions which eliminate the anti-skidding equipment, and cost of these brake are cheaper than the other types. Hence the braking force produced in this is less than the disc brakes if can be used as a secondary or emergency braking system in the automobiles.

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