RESEARCH AND DEVELOPMENT OF EDDY CURRENT BRAKING SYSTEM IN AUTOMOBILE

Submitted in partial fulfilment of the requirements for the completion of

INTERDISCIPLINARY PROJECT

By

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of VYSHNAVI KARROTHU (Reg. No. 40140037), PULI PRIYANKA (Reg. No. 40140027), and AKULA LAXMI PRASANNA (Reg.No.40140003) who carried out the Interdisciplinary Project entitled “RESEARCH AND DEVELOPMENT OF EDDY CURRENT BRAKING SYSTEM IN AUTOMOBILE” under our supervision from February 2023 to April 2023.

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27/4/23
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We KARROTHU VYSHNAVI(Reg. No. 40140037) , PULI PRIYANKA (Reg. No. 40140027), AKULA LAXMI PRASANNA (Reg. No. 40140003) hereby declare that the Project Report entitled "RESEARCH AND DEVELOPMENT OF EDDY CURRENT BRAKING SYSTEM IN AUTOMOBILE"

done by us under the guidance of DR. V. SENTHIL NAYAGAM is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

DATE: 20/04/2023
PLACE: CHENNAI

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SIGNATURE OF THE CANDIDATES

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ABSTRACT

Majority of braking systems work on the principle of dissipation of kinetic energy to heat energy. This method has its own drawbacks and must be replaced with a more reliable braking system that is quick in response, doesn’t heat up and in maintenancefree.

Eddy current is one of the most outstanding of electromagnetic inductionphenomena. Even though it appears many technical problems because dissipative nature it has some valuable contributions. It is a frictionless method for braking of vehicles including trains. As it is a frictionless brake, periodic change of braking components arc reduced. Embedded Eddy Current brake is employed in automobiles, the braking would be more efficient than the present friction basedbrake and braking cost in automobiles could be reduced to a larger extend[3]. Also toxic smell caused by friction brakes duringvehicle motion can be reduced.

The basic design of the eddy current braking system includes a conductor (usually made of copper and metal and aluminium) that is placed in close proximity to a magnetic field. When the conductor moves through the magnetic field, eddy currents are induced in the conductor, generating a magnetic field that opposes the original field. This creates a drag force that opposes the motion of the object, resulting in a reduction in speed. The eddy current braking system offers several advantages over traditional braking systems, including reduced wear and tear, improved safety, and higher energy efficiency. As a result, this technology is becoming increasingly popular in a wide range of applications where precise and efficientbraking is essential. This braking can be applied for heavy vehicles, railway transportby altering some changes. The motive of this project to enhance the modern technology braking system that is cost effective and time saving. The electromagnetsare being placed onthe either side of the conductor which is mounted on the axle of wheel. The electromagnets which help to take quick action to stop the vehicle from moving.

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3. Total moment of inertia = Moment of inertia of disc + Moment of Inertia of rod
4. Angular velocity, ω = 2 * π * f
5. Frictional torque = (final angular momentum-initial angular momentum)/time taken
6. Total torque = (final angular momentum-initial angular momentum)/time taken
7. Braking torque =Total negative torque -(-20.2)

CHAPTER 1

INTRODUCTION

1.1 GENERAL

In the operation of any machinery the most primary safety system is the braking system. The most basic designs of the braking system involve the conversion of kinetic energy to heat energy by friction. This is accomplished by friction between two rubbing surfaces. These brakes pose several problems i.e. significant wear, fading, complex and slow actuation, lack of fail-safe features, increased fuel consumption due to power assistance, and requirement for anti-lock controls. To solve these problems, a contactless magnetic brake has been developed.

Towards green technology, which focused on the importance of environment conservation, a move to a new braking system is needed. A new braking system to replace the current braking system which used the brake pad will help to reduce the air pollution that actually happen when we do braking using the conventional system. Brake wear debris represent obviously potential hazard to environment. Wear debris contains several hazardous elements that may interact with DNA of living organisms and cause carcinogenesis. Eddy current braking has a lot of advantages compared to conventional braking system.The advantages such as it can reduce the wear of brake pad, vibration and it is environmental friendly. Eddy current braking was said as environmental friendly because it can reduce the pollution of wear debris from brake pad itself. Realizing the importance of a new braking system that could lead into environmental friendly and reduce common problems mentioned above, this experiment was conducted to study the behaviour of eddy current braking system which uses an electromagnet and aluminium as the brake disc material. In electromagnetic induction, eddy current is one of the most important phenomena which can be applied in various kinds of research and application. This eddy current braking occurred when a magnetic drag force is produced to slow down the motion when a conducting material is moving through a stationary magnetic field. The changing magnetic flux induces eddy currents in the conductor and these currents dissipate energy and generate drag force.

CHAPTER 2

LITERATURE SURVEY

2.1 MAJOR FINDINDS FROM LITERATURE SURVEY

Y Ghayal – 2019, this study says, Electromagnet is the temporary magnet which when supplied by an electric current , it induces magnetic field and Eddy current is generated that retards the vehicle without friction. Although brakes are primarily based on the friction principle, particularly conversion of Kineticenergy into heat energy, but electromagnetic system is a quite steady system that prevents the Disk from heating. So, it don't need any kind of cooling system for dissipation of heat. This paper presents the Application of Lenz law as Electromagnetic Disk Braking, its design, Disk from heating. So, it don't need any kind of cooling system for dissipation of heat. This paper presents the Application of Lenz law as Electromagnetic Disk Braking, its design, Experimental setup, fabrication and scope in the future.

KW Berger 2010, this study says that, Eddy current braking has long held the promise of frictionless braking of railroad trains. Tests over the last decade have identified a number of controllable challenges to implementing eddy current brakes involving the vehicle, track, and wayside equipment. High speed trains equipped with eddy current brakes are in service in Europe and under consideration worldwide. This paper illustrates the fundamental characteristics of eddy current braking, locates the technology with respect to other braking systems technologies, and highlights wayside compatibility issues involved in deploying high speed trains with eddy current braking.O Rodrigues, O Taskar, S Sawardekar2016, the author says, Majority of braking systems work on the principle of dissipation of kinetic energy to heat energy. This method has its own drawbacks and must be replaced with a more reliable braking system that is quick in response, doesn't heat up and is maintenance free. In this project the design and braking system and optimization for various operational parameters has been done. These parameters have been previously iterated in cited projects and papers and also in the simulation models and are to be cross-checked with the experimental setup.

2.2 PROBLEM IDENTIFICATION

There are various types of conventional braking system such as Drum brake, Disc brake, Hydraulic brake etc. Brakes could be the crucial parts in most of the moving system that are generally used to slow down or stop the motion of the any moving system. Braking system uses the friction force to transform the kinetic energy of a moving part into heat by the use of the brake pads. Frequently using of these type of friction braking leads to rise in temperature of brake pads, these leads to effecting the effectiveness of the braking system. These braking systems produce higher amount of friction which produce heat wear and tear of braking parts.

2.3 SCOPE OF THE PROJECT

Electromagnet of higher magnetic flux density can be used to minimize thebraking time. Also, electromagnets can be positioned at different locations around the disc in radial arrangement to get better braking torque distribution.Electromagnetic and eddy current (magnetic) braking is superior to conventional frictional braking as there is no friction and heat in electromagnetic braking. So,the Conventional disc and drum brakes can be replaced with electromagnetic and magnetic brakes. In addition, it is found that ,electromagnetic brakes make up approximately 80% of all of the power applied brake applications.

2.4 OBJECTIVE

The objective of eddy current braking system is to slow down or stop a moving object by generating eddy currents in a conductive material, such as a metal disc or rail, which creates a magnetic field that opposes the motion of the object. This braking system is commonly used in trains, roller coasters, and other applications where high speeds need to be reduced efficiently and safely. The eddy current braking system is effective, reliable, and requires minimal maintenance, making it a popular choice for transportation and industrial applications.

2.5 METHODOLOGY

The frictionless magnetic braking system is proposed using eddy current phenomenon. This phenomenon is governed by faraday law of electromagnetic induction and lenz's law. Eddy current is created by relative motion between the magnet and metal conductor. The current induces magnetic field in conductor which oppose the actual magnetic field of magnet and result in deceleration of motion. In this project, by using this eddy current braking system we made a prototype to stop the vehicle by non-contracting type. This braking system is friction-less, it has an Advantages over the ordinary braking system in the performance and maintenance.

2.6 APPLICATIONS

Some of the major applications of eddy current braking systems are

1.Gym equipment

2.Rider and roller coasters

3.High speed trains

4.Industrial equipment

5.Recreation equipment

CHAPTER 3

HARDWARE AND PROJECT DESCRIPTION

3.1 BLOCK DIAGRAM

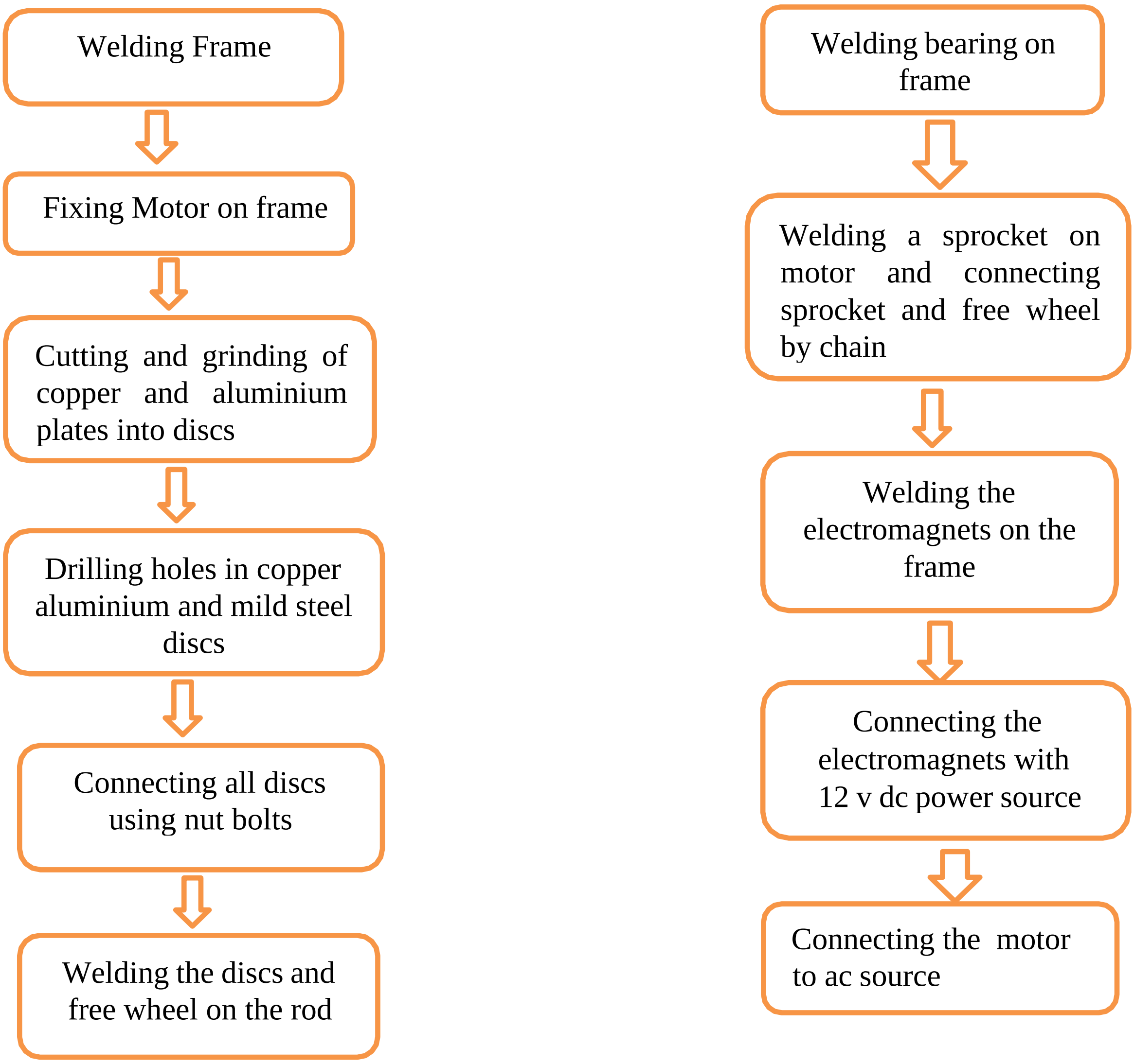


Figure 3.1 Existing Block Diagram

When a conductor in the form of disc rotating at a high speed, is placed in a magnetic field it breaks the magnetic flux lines, hence an electromotive force (emf) will be induced in the disc by Faraday's law of electromagnetic induction. Due to this emf eddy currents are generated in the disc. These eddy currents are generated in loops. These Eddy current generates a magnetic field on its own due to self-induction which opposes the source magnetic field. Due to this a drag force is created which convert kinetic energy of rotating disc to heat energy. This heat energy is then dissipated out by convection. Braking force is proportional tochange in magnetic flux. Hence braking force obtained is proportional to strength of magnetic field and rate of change at which the disc is cutting the magnetic field that is velocity of disc.

3.2 CONVENTIONAL BRAKING SYSTEM

A Conventional brake is a mechanical device that inhibits motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction. Most brakes commonly 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.

Brakes are most common and can be divided broadly into "shoe" or "pad" brakes, Braking forms an important part of motion of any automobile or locomotive. Effective braking ensures the safety of the passengers and goods an automobile or a locomotive is carrying. The most basic designs of the braking system involve the conversion of kinetic energy to heat energy by friction. This is accomplished by friction between two rubbing surfaces. These brakes pose several problems i.e. significant wear, fading, complex and slow actuation, lack of fail-safe features, increased fuel consumption due to power assistance, and requirement for anti-lock controls. The conventional type brake system which usesa hydraulic system has many problems such as time delay response due to pressure build-up, Brake discs and brake pads are subject to wear over the course of time, as they convert kinetic energy into thermal energy through friction. disc brakes can become red hot and set on fire.

3.3 EDDY CURRENT

Eddy currents are loops of electrical current induced withinconductors 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. When the magnetic flux linked with a metallic conductor changes, induced currents are developed in a conductor in the form of closed loops figure 1. These currents are known as eddy current. When there is a conductive material, which breaks through a time varying magnetic flux, eddy current are developed in the conductor. 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 change in the magnetic field that created it, and thus eddy currents react back on the source of the magnetic field. These eddy current flow inside the conductor developing a magnetic field ofopposite polarity as the applied magnetic field. 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. The interaction of two magnetic fields causes a force that resists the change in magnetic flux. 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.

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. Under certain assumptions (uniform material, uniform magnetic field, no skin effect, etc.) the power lost due to eddy currents per unit mass for a thin sheet or wire can be calculated from the following equation

3.4 VOLUMES

$$P = \frac{\pi^2 B_p^2 d^2 f^2}{6k\rho D},$$

Equation 3.1

Where, 1. P is the power lost per unit mass (W/kg),

2. Bp is the peak magnetic field (T),
3. d is the thickness of the sheet or diameter of the wire (m),
4. f is the frequency (Hz),
5. k is a constant equal to 1 for a thin sheet and 2 for a thin wire,
6. ρ is the resistivity of the material (Ω m), and
7. D is the density of the material (kg/m3).

This equation is valid only under the so-called quasi-static conditions

3.5 ADVANTAGES

1. No contact, therefore no wear or tear.
2. No noise or smell. Adjustable brake force.
3. High brake forces at high speeds.
4. Also used as service brake.
5. Can be activated at will via electrical signal
6. Low maintenance
7. Light weight
8. Less wear of segments.
9. Fully electronically controlled.
10. Great braking proficiency potential to recover vitality lost in braking.
11. Potential to recapture vitality lost in braking.
12. No need to change brake oils consistently.
13. No oil spillage.

CHAPTER 4

ASSEMBLING

4.1 MATERIALS REQUIRED FOR THIS PROJECT

1. ¼ HP 220V AC motor
2. Square pipe (frame)
3. Chain
4. Sprocket
5. MS disc
6. Bearings
7. Screws and bolts
8. Chain and Chain sprocket
9. Aluminium6202 disc (brake disc)
10. Copper disc (copper disc)
11. v dc electromagnets

4.1.1 ¼ HP 220V AC MOTOR

Figure 4.1 1/4HP 220V AC motor

Figure 4.1 shows that, An AC motor is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside 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 common, AC linearmotors 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

4.1.2 SQUARE PIPE (FRAME)

Figure 4.2 square pipe

Figure 4.2 shows that, the Mild Steel Square Tube is measured by taking the outer walls (which are the same size) and then the wall thickne**ss**. Applications includes trailers, barriers, bike racks, home construction and many more. Mild Steel Square Tube is used in general fabrication where strength is a requirement.

4.1.3 CHAIN

Figure 4.3 Chain

Figure 4.3 shows that, the 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, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles. Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, United States. Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotate once, it causes the gear that drivesthe wheels to rotate more than one revolution. Duplex chains are another type of chain which are essentially two chains joined side by side which allow for more power and torque to be transmitted.

4.1.4 SPROCKET

Figure 4.4 Sprocket

Figure 1.4 shows that, A sprocket, sprocket-wheel or chainwheel is a profiled wheel with teeth 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. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth except for timing pulleys used with toothed belts. Sprockets are used in bicycles, motorcycles, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc. Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel,which drives a chain, which, in turn, drives a small sprocket on the axle of the rear wheel. Early automobiles were also largely driven by sprocket and chainmechanism, a practice largely copied from bicycles.

4.1.5 MS ROD

Figure 4.2 Ms rod

Figure 4.5 shows that, Mild steel is a ferrous metal made from iron and carbon. It is a low-priced material with properties that are suitable for most general engineering applications. Low carbon mild steel has good magnetic properties due to its high iron content, it is therefore defined as being 'ferromagnetic'.

4.1 .6 MS DISC

Figure 4.6 MS Disc

Figure 4.6 shows that, Mild Steel Plate is a piece of flattened steel that is thicker than 1/4' (0.250). It has many applications in the manufacturing, industrial and construction industries where it is used structurally (not aesthetically). Mild Steel Plate is measured by its thickness in inches.

4.1.7 BEARINGS

Figure 4.7 Bearings

Figure 4.7 shows that, a bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the plain bearing, consists of a shaft rotating in a hole. In the ball bearing and roller bearing, to reduce sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. A wide variety of bearing designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance. a bearing being a machine element that allows one part to bear (i.e., to support) another. The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness, and location of the surface. Other bearings are separate devices installed into a machine or machine part.

4.1.8 SCREWS AND BOLTS

Figure 4.8 Screws and Bolts

Figure 4.8 shows that, Screws and bolts are used to fasten materials by the engagement of the screw thread with a similar female thread (internal thread) in a matching part. Screws are often self-threading (also known as self-tapping) where the thread cuts into the material when the screw is turned, creating an internal thread that helps pull fastened materials together and prevents pull-out. There are many screws for a variety of materials; materials commonly fastened by screws include wood, sheet metal, and plastic. A bolt is a form of threaded fastener withan external male thread requiring a matching preformed female thread such as a nut. Bolts are very closely related to screws

4.1.9 CHAIN AND CHAIN SPROCKET

Figure 4.9 Chain Sprocket Set

Figure 4.9 shows that, a chain and sprocket drive is a type of power transmission in which a roller chain engages with two or more toothed wheels or sprockets, used in engines as a drive from crankshaft to camshaft.

4.2 BRAKE DISC(ALUMINIUN)

Aluminium is the best material compared to copper and zinc to be use as the disc brake for eddy current braking using electromagnetic induction. Aluminium reacts better and faster compared to the other two materials. Besides that, increasing the current induced will increase the drag force that been produced and will slow down the motion better. The grade of aluminium used in this project is aluminium 6202.

While being praised for its malleable qualities, this particular property of aluminium can also act as a disadvantage. It can be more easily dented and scratched in comparison to steel. Steel is strong and less likely to warp, deform or bend under any weight, force or heat.

4.3 COPPER

Copper also can be used as the disc brake for eddy current braking but quite less effective than aluminium. Copper has some advantages over aluminium like, Copper is stronger than aluminium, It expands less, it has higher thermal conductivity than aluminium. As the thickness of disc increases the generation of eddy current increase and hence higher breaking torque to stop the rotating disc canbe achieved.

Copper is significantly more expensive than aluminium. Copper has less braking effective than aluminium. It is also much heavier than its aluminium counterpart which can add to the complexity of the installation. Now both metals have their own advantages and disadvantages so if both metals used as the disc at the same time it cancels out their disadvantages. So, both metals are used in this experiment

4.4 ELECTROMAGNETS (12V DC)

Electromagnets usually consist of wire wound into a coil. A current through the wire creates a magnetic field which is concentrated in the hole, denoting the center of the coil. The magnetic field disappears when the current is turned off. The wire turns are often wound around a magnetic core made from a ferromagnetic or ferrimagnetic material such as iron; the magnetic core concentrates the magnetic flux and makes a more powerful magnet. The main advantage of an electromagnet over a permanent magnet is that the magnetic field can be quickly changed by controlling the amount of electric current in the winding. However, unlike a permanent magnet that needs no power, an electromagnet requires a continuous supply of current to maintain the magnetic field.

Electromagnets are DC type that can be powered by battery. Electromagnets are selected instead of permanent magnet as electrical actuation is faster than mechanical actuation with lower losses. Also magnetic field can be created at the time when it is needed only unlike permanent magnet. The strength ofmagnetic field can be increased by increasing the current flowing through the coil or increasing the number of turns of winding. For high magnetic field, permanentmagnet is very bulky and installation is very difficult. Electromagnet is light and can be installed anywhere and does not interfere with other methods.

4.5 ARC WELDING

Figure 4.10 Arc welding

Figure 4.10 shows that, arc welding is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the join between two work pieces. The arc can be either manually or mechanically guided along the line of the join, while the electrode either simply carries the current or conducts the current and melts into the weld pool at the same time to supply filler metal to the join. Because the metals react chemically to oxygen and nitrogen in the air when heated to high temperatures by the arc, a protective shielding gas or slag is used to minimise the contact of the molten metal with the air.

4.6 COPPER AND ALUMINIUM CUTTING

Figure 4.11 Copper and Aluminium Cutting

Figure 4.11 shows that, a disc cutter is a specialised, often hand-held, power tool used for cutting hard materials, ceramic tile, metal, concrete, and stone for example. This tool is very similar to an angle grinder, chop saw, or even a die grinder, with the main difference being the cutting disc itself (a circular diamond blade, or resin- bonded abrasive cutting wheel for a disc cutter vs. an abrasive grinding wheel for an angle grinder). This tool is highly efficient at cutting very hard materials, especially when compared to hand tools

4.6.1 DISCS

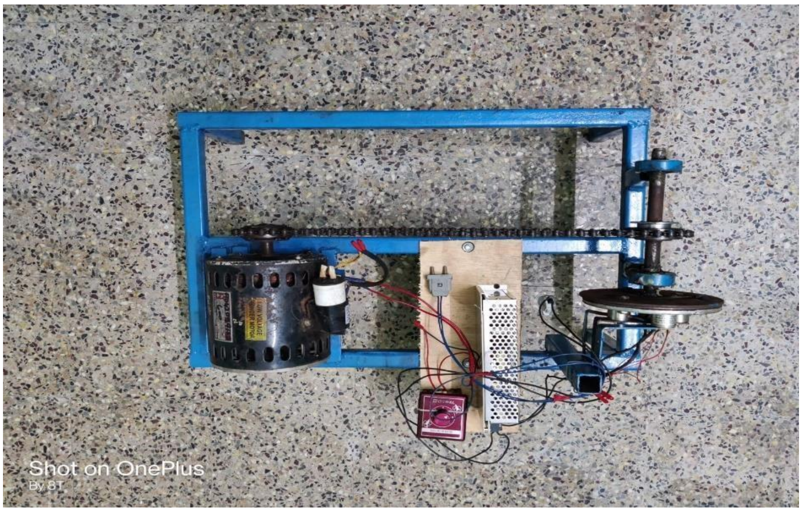
Often cutting discs, also known as cut-off wheels, are made from a solid abrasive disc. These discs are often used for cutting metal; they are composed of an abrasive mix of grit and adhesive that is formed into a thin, rigid disc with fiber webbing running through it for strength. Some discs used for cutting ceramic tile or stone are made from a solid disc with an edge coated with diamond grit. The most common size for these cutting wheels is 4-1/2 inches in diameter; however they can range from 2 to 16 inches in diameter with a thickness range from .045 in. to .125 in. Type 1 discs are flat, and type 27 discs have a raised hub. These wheels are strong but are not immune to breaking. If a cutting wheel breaks while in use, fragments could injure the operator or nearby co-workers. To avoid breaking cutting discs, never exceed the maximum speed (RPM) specified on the disc, and do not overload the disc by cutting with excess force or jamming the wheel into your workpiece.

4.7 COPPER AND ALUMINIUM PLATE DRILLING

Figure 4.12 Copper and Aluminium Plate

Figure (4.5) shows that, Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multi-point. The bit is pressed against the work-piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edgeagainst the work-piece, cutting off chips (swarf) from the hole as it is drilled. In rock drilling, the hole is usually not made through a circular cutting motion, though the bit is usually rotated. Instead, the hole is usually made by hammering a drill bit into the hole with quickly repeated short movements.

4.8 PROJECT PROTOTYPE FABRICATION



4.13 Top view of prototype

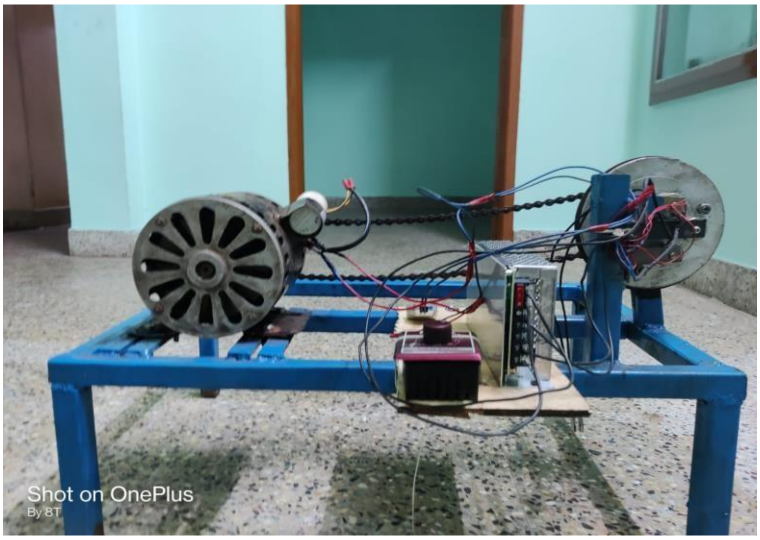


Figure 4.14 Side view of prototype

4.9 DIMMENSIONS

Table 4.1 dimensions

Raw Materials	Thickness	Diameter	weight	Length
Aluminium	5mm	160mm	0.273kg	-
Steel	-	160mm	-	-
Copper	2mm	-	0.361kg	-
Rod	-	160mm	0.493kg	200mm
Mild steel	4mm	160mm	0.631kg	-

4.10 CALCULATIONS:

CALCULATION OF NEGATIVE TORQUE PRODUCED BY BRAKE

Total negative torque= (braking torque + frictional torque)

Torque = rate of change of angular momentum

Torque = (final angular momentum-initial angular momentum)/time taken

To find, 1.Angular Momentum 3.Total Torque

2.Frictional torque 4. Braking Torque

(1) CALCULATION OF ANGULAR MOMENTUM

Angular momentum = Moment of inertia x angular velocity

(1.1) CALCULATING THE MOMENT OF INERTIA OF DISC SETUP

(A)CALCULTION OF ROD

Moment of inertia I = 1/2MR^2

Mass of rod M =0.631 kg

Radius of rod R =0.02m

Moment of inertia I = 1/2 0.631x0.02 = 0.00631 kgm2

(B) CALCULATION OF MOMENT OF INERTIA

Moment of inertia I = 1/2MR^2

Mass of the discs = 1.127 kg

Radius of discs = 0.16m

Moment of inertia I = 1/2 x 1.127 x0.16 =0.09016

Total moment of inertia = Moment of inertia of disc + Moment of inertia of rod

Total Moment of inertia =0.9647

(1.2) CALCULATION OF ANGULAR VELOCITY

Rpm = 1000

Angular velocity

1 revolution per minute (60 seconds) as a frequency, f, is 1/60 Hertz.

So, 1000 rpm gives f = 1000 / 60 = 16.67 Hz

Angular velocity, ω = 2 * π * f = 2 * π * 1000 / 60

So ω = 104.7 rads s^-1

Angular momentum = 0.9647x 104.7

Angular momentum gained is 101 kgm^2/s

(2) FRICTIONAL TORQUE

In order to calculate frictional torque due to friction allow rotation without applying brake

Frictional torque = (final angular momentum-initial angular momentum)/time

Time taken without applying brake = 5sec

Frictional torque = (0- 101)/5

Frictional torque produced is -20.2 Nm

(3) TOTAL TORQUE

In order to calculate Total torque due to friction allow rotation with applying brake Time taken for applying brake = 3sec

Total torque = (final angular momentum-initial angular momentum)/time taken

Total torque = (0-101)/3

Total torque is = -33.3 Nm/sec

Total negative torque = (braking torque + frictional torque)

Total negative torque = (-20.2 braking force)

(4) BRAKING TORQUE

Braking torque =Total negative torque -(-20.2)

Braking torque = -33.3 + 20.2

Braking torque = -13.1 Nm

Braking torque produced by the eddy current brake is 13.1 Nm

4.11 PROCESS

Square pipes are cut in a certain way so that it can be welded together to a frame.

1. Once the whole frame completed 1/4 hp 220 v AC motor is mounted on frame by using bolt and nuts
2. Circle is drawn on copper plate, using cutter its cut down into disc shape
3. Grinding process is done on copper plate to smooth out the edges of the disc using grinding machine

4. A centre hole (for shaft) and 3 holes drilled (for connecting discs) on copper disc using drilling machine
5. Circle is drawn on aluminium plate, using cutter Its cut down into disc shape
6. Grinding process is done on aluminium plate to smooth out the edges of the disc using grinding machine
7. A centre hole (for shaft) and 3 holes drilled (for connecting discs) on aluminium disc using drilling machine
8. A centre hole (for shaft) and 3 holes drilled (for connecting discs) on mild steel disc using drilling machine
9. All the discs are joined together in their order Mild Steel, Copper, Aluminium by nuts and bolts
10. The plates are inserted on a rod (MS) and the rod is welded to the MS disc
11. A freewheel also welded to the rod to have a free movement even after stopping the motor
12. Bearings are inserted on the rod and welded on the frame
13. Electromagnets are placed as near as possible to the disc to achieve effective braking and welded on the frame
14. The electromagnets are connected to a 12v dc supply
15. A sprocket is welded on the shaft of the motor
16. A chain is used to connect the sprocket and freewheel

4.12 IEEE STANDARDS FOLLOWED

IEEE (Institute of Electrical and Electronics Engineers) Standards are a set of guidelines and protocols that help ensure the safety, reliability, and interoperability of technologies used in various industries. In the case of eddy current braking systems, the following IEEE standards may be relevant:

1. IEEE 1596.1-1996 Eddy braking can be relevant for the communication protocol between Disc and the eddy current brake with other components of the prototype

2. IEEE 1068-1998 - Standard for Portable Electric Tools: This standard provides guidelines for the safe use of portable electric tools, which may also be applicable to a prototype using a motor and conductor.

3. IEEE 1652-2018 - Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications: This standard provides guidelines for the design, installation, and maintenance of electrical resistance trace heating systems, which may be useful for designing and testing the conductor used in the eddy current braking system prototype.

4. IEEE 117-1974: This standard specifies the methods and equipment to be used for testing the electrical performance of electromagnetic brakes.

5. IEEE 1415-2006: This standard specifies the methods for testing and evaluating the performance of eddy current brakes used in aviation.

These standards provide guidelines for the design, testing, and operation of eddy current braking systems, ensuring that they meet certain performance, safety, and reliability standards. Adhering to these standards helps to ensure that eddy current braking systems are safe, efficient, and effective in their intended applications.

4.13 CONSTRAINTS

There are several constraints that may affect the implementation of the "Development of eddy current braking system in automotive" project. Some of these constraints are:

1. Power supply: The power supply to the electromagnets should be spontaneous. In locations where there are frequent power outages, a backup power supplymay be needed.
2. Speed: The system speed should not exceed the level 4 of the speed regulator as it may result in misplacement of chain.
3. Cost: The cost of the system components, such as the copper disc,motor, may be a constraint, especially in low-income areas.
4. Maintenance: The system does not require any regular maintenance but in case of inappropriate function of electromagnets must be changed.

CHAPTER 5

SUMMARY AND CONCLUSION

5.1 SUMMARY

Eddy current braking is a non-contact braking system and eddy current braking system is successfully implemented and tested hence there is no friction and low wear and tear.

Thus the debris produced in braking is very low and be incorporated along with the conventional hence is eco-friendly. Eddy current braking is a braking system as eddy current embedded cleaner way of braking. Wheel skidding is avoided conventional braking system. Eddy current braking as the wheel does not get locked. It works on can be successfully used as an auxiliary brake.as the wheel does not get locked. It works on can be successfully used as an auxiliary brake.

This is particularly useful to heavy and long power for a tiny time period. It only consumes distance vehicle. In the cases of heavy vehicles the small space therefore installation is easy. Due to normal brakes get heated up and become less non-contact between the disc and the efficient on continuous usage. In the case of eddy electromagnet it does not emits heat, so the life current braking system can be used efficiently. time of the brake is high. In conclusion, that Also eddy current braking is used as a safety brake frictionless electromagnet brake is more effective, in automobiles. Eddy current braking also find eco-friendly when compare to the ordinary braking application on the highspeed vehicle as braking system. force is proportional to the speed of the vehicle.

5.2 CONCLUSION

Eddy current braking produce effective braking with low wear and tear. The maintenance cost of this braking system is very low. Eddy current braking is a non-contact braking system and hence there is no friction and low wear and tear. Thus debris produced in braking is very low and hence is eco-friendly. Eddy current braking is a cleaner way of braking. Wheel skidding is avoided as the wheel does notget locked. It is highly suitable at high speed. It works on electricity and consumes very small amount of power for a tiny time period. It only Consumes small space therefore installation is easy.

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