

DESIGN AND FABRICATION OF EDDY CURRENT BRAKING SYSTEM FOR BICYCLE

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Engineering in Mechanical Engineering.

By

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INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of BATHULA MANOJ (Reg. No. 39150704), SIRUMALLA GNANA PRAKASH (Reg. No. 39150708), who carried out the Final year Project entitled "**DESIGN AND FABRICATION OF EDDY CURRENT BRAKING SYSTEM FOR BICYCLE**" Under our supervision from December 2022 to APRIL 2023.

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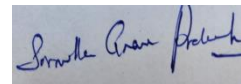
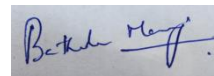
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DECLARATION

We BATHULA MANOJ (Reg.No. 39150704) and Sirumalla Gnana Prakash (Reg.No. 39150708) hereby declare that the Project Report entitled “**DESIGN AND FABRICATION OF EDDY CURRENT BRAKING SYSTEM FOR BICYCLE**” done by me under the guidance of **Dr. G. ARUNKUMAR, ME., Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering in Mechanical Engineering.



DATE:26/04/2023

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ABSTRACT

Most braking systems operate by converting kinetic energy into heat energy, which has some limitations and requires a more reliable, responsive, and low-maintenance braking system. One potential solution is the use of eddy current braking, which is an electromagnetic induction phenomenon that can provide frictionless braking for vehicles, including trains. Compared to traditional friction brakes, eddy current brakes can reduce the need for periodic replacement of braking components and lower braking costs. Additionally, this technology can help reduce toxic smells caused by friction brakes while the vehicle is in motion. A project has been carried out to design an eddy current braking system and optimize various operational parameters

The eddy current braking system operates on the principle of electromagnetic induction. It consists of a set of magnets fixed to the rim of the bicycle wheel and a conductive aluminium disc that is connected to the bicycle's frame. When the wheel rotates, the magnets create a magnetic field that induces eddy currents in the aluminium disc. The interaction between the eddy currents and the magnetic field generates a resistive force that slows down the wheel.

The project involves designing and fabricating the eddy current braking system for a standard bicycle. The first step is to select the appropriate magnets and aluminum disc for the system. The size and shape of the magnets must be compatible with the bicycle's rim, and the aluminium disc should be of sufficient thickness and conductivity to generate the desired braking force.

Once the design is finalized, the fabrication process begins. This involves machining the aluminium disc to the desired shape and size, as well as preparing the magnets and mechanical structure. The components are then assembled and tested to ensure that they function as intended.

The final step is to install the eddy current braking system on the bicycle and test its performance. The braking force generated by the system will depend on the strength of the magnets, the speed of the wheel, and the conductivity of the aluminium

disc. The system should be able to slow down and stop the bicycle smoothly and quickly without excessive wear or noise.

In conclusion, the design and fabrication of an eddy current braking system for a bicycle is a challenging but rewarding project that offers a more efficient and durable alternative to traditional braking systems. The project requires a combination of mechanical and electrical skills, and it provides an opportunity to apply principles of electromagnetic induction and magnetism to a real-world problem.

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LIST OF SYMBOLS AND ABBEREVIATIONS

V_c	Cutting speed (mm/sec)
N	Spindle speed (rpm)
V_c	Penetration rate (mm/sec)
F_n	Feed per revolution (mm/rev)
MRR	Metal Removal Rate (Q)
M_c	Torque (N/m)
T_c	Machining Time (sec)
A_e	Axial depth of cut (mm)
A_p	Radial depth of cut (mm)
R_a	surface roughness factor
L	length of cut (mm)
D	diameter (mm)
F_x	Tangential Force (N)
F_t	Thrust Force (N)

CHAPTER-1

INTRODUCTION

The concept of "x-by-wire" is a key area of focus for the automotive industry because of its potential to enhance vehicle performance, safety, and affordability. In the context of x-by-wire, the "x" refers to a technological wildcard that can apply to various automotive systems, including steering and braking. It involves replacing conventional mechanical components with electrical ones. Our objective is to create a brake-by-wire system that incorporates an electromechanical brake (EMB) utilizing magnetorheological (MR) fluid.

Brake-by-wire technology replaces the mechanical linkage between the brake pedal and each wheel's brake actuator with electronic components. During the first generation of brake-by-wire systems, all brake control functions are managed by a primary electronic control unit (ECU), and a conventional hydraulic brake (CHB) system can serve as a backup. The CHB backup mode is crucial for safety in the event of an ECU or electrical failure. However, the second generation of brake-by-wire systems, which are currently under development by the automotive industry for the upcoming generation of hybrid electric vehicles (HEVs), will no longer require a hydraulic backup mode thanks to advancements such as fault-tolerant system architecture and redundant fail-safe power management systems, such as the 42V system.

Furthermore, the addition of a sub-ECU to each wheel enables a multi-redundant, independent, wheel-specific braking system. There are numerous advantages to employing fully electronically controlled brake systems. By changing software parameters and electrical outputs, the brake's characteristics and behavior can be easily adjusted without needing to modify mechanical components. This facilitates the integration of existing and new control features, such as anti-lock braking system (ABS), electronic parking brake (EPB), vehicle stability control (VSC), vehicle chassis control (VCC), adaptive cruise control (ACC), and more. Diagnostic capabilities, the elimination of environmentally harmful brake fluids, a simplified wiring layout, and an optimized overall design with fewer components are additional benefits.

In this study, an electromechanical brake using magnetorheological (MR) fluid is proposed for each wheel. The brake actuator is composed of a rotating disk

immersed in MR fluid and enclosed in an electromagnet. By varying the DC current applied to the electromagnet, the brake torque can be controlled. MR fluid contains fine iron particles that stiffen in the presence of a magnetic field. MR fluids have two key properties: (i) they exhibit linear response, with the increase in stiffness proportional to the magnetic field's strength and (ii) they provide fast response, transforming from a fluid state to a near-solid state within milliseconds of exposure to a magnetic field. Conventional hydraulic brake (CHB) systems exhibit a delay of 200-300 ms between the driver pressing the brake pedal and the corresponding brake response due to pressure build-up within the hydraulic lines. By using an electric brake system with MR fluid, this time delay can be significantly reduced, resulting in a reduction in braking distance. Delphi has recently introduced an EMB that uses an electrical motor to actuate the brake pads instead of the hydraulic actuator, with performance similar to existing disk brakes.

The use of MR fluid in automotive applications has been a topic of interest for a while, but it's only recently that MR fluid-based electromechanical devices have started replacing all-mechanical or hydraulic counterparts. General Motors has introduced the Magnetic Ride Control, a suspension control system based on MR fluid, on vehicles such as the Corvette and Cadillac Seville STS and XLR, which is a significant advancement because it allows for real-time adjustments based on driving conditions. As a result, the limitations of traditional mechanical components, such as brakes, shocks, steering gear, and springs, are quickly becoming obsolete. MR actuators are a promising technology for the automotive industry with high commercial value. In our research, we considered two types of controllable fluids in the initial stage: electrorheological (ER) and MR fluids.

ER fluid is a type of viscous liquid that exhibits changes in its rheological properties when subjected to an electric field, as opposed to a magnetic field in the case of MR fluid. A comparison between ER and MR fluids is summarized in Table 1.

The comparison presented above reveals that MR fluids are more suitable for the proposed application compared to ER fluids, given their superior performance in terms of yield stress and energy dissipation per unit volume, as well as their compatibility with more common power supplies and higher tolerance to impurities. The only advantage of ER fluids over MR fluids is their lower density, which is not a major concern given the small amount of fluid needed in the brake. Braking systems

are the primary safety system in any machinery, where the most basic design involves the conversion of kinetic energy to heat energy by friction between two rubbing surfaces. However, these brakes are associated with various issues, such as significant wear, fading, slow and complex actuation, lack of fail-safe features, increased fuel consumption due to power assistance, and the need for anti-lock controls.

Considering the growing importance of environmentally friendly technology, there is a need to develop a new braking system to replace the current brake pad-based system. The latter produces air pollution and wear debris that pose potential hazards to the environment and living organisms. Eddy current braking offers many advantages over traditional braking systems, including reduced wear of the brake pad, vibration, and environmental pollution. This method relies on electromagnetic induction to generate eddy currents in a conductor moving through a stationary magnetic field, resulting in a magnetic drag force that slows down motion. This process dissipates energy and generates a drag force, reducing the need for contact between braking elements and, therefore, reducing wear debris and pollution. An experiment was conducted to investigate the behavior of eddy current braking using an electromagnet and aluminum as the brake disc material, with promising results.

The use of bicycles as a means of transportation has gained popularity over the years, owing to their cost-effectiveness, ease of use, and environment-friendly nature. However, the use of traditional braking systems such as rim brakes and disc brakes has some limitations, including the risk of overheating and reduced efficiency in wet conditions. These limitations have led to the development of new braking systems, such as the eddy current braking system.

The eddy current braking system uses the principle of electromagnetic induction to generate a braking force. When a magnet moves near a metal conductor, it creates a magnetic field that induces an electric current in the conductor, generating a resistive force that opposes the motion of the magnet. This principle is used to develop the eddy current braking system, where the braking force is generated by the interaction between the magnetic field generated by the system and the conductive material of the bicycle wheel.

The objective of this project is to design and fabricate an eddy current braking system for a bicycle that is cost-effective, efficient, and easy to use. The system will be designed to provide a smooth and consistent braking force, even in wet conditions, and will be easy to install on existing bicycles. The braking force will be adjustable, allowing the rider to control the amount of braking force applied.

This project will involve the design and fabrication of the eddy current braking system, as well as testing and optimization of the system to ensure its efficiency and safety. The project will also involve the development of a control mechanism that allows the rider to adjust the braking force applied to the wheel.

Overall, the eddy current braking system offers a promising alternative to traditional braking systems for bicycles. Its use can improve safety, reduce maintenance costs, and provide a smoother riding experience. This project aims to contribute to the development and advancement of this technology, making it more accessible and practical for everyday use.

CHAPTER-2

LITERATURE SURVEY

A brake is a mechanism that applies a force to the road to slow down or stop the movement of a wheeled vehicle, such as cars, trucks, and motorcycles. Brakes have been around since the advent of vehicles, and there are several types available, including drum brakes and disk brakes. However, the automotive industry is now actively developing new braking technologies that provide greater safety, better performance, and are more environmentally friendly. One of these technologies is the Magnetorheological Braking System (MRBS), which uses a special fluid called Magnetorheological (MR) fluid. This innovative braking-by-wire technology employs MR fluid that changes its viscosity in the presence of a magnetic field, offering superior control over traditional brake systems.

Eddy current braking systems are a type of regenerative braking system that uses electromagnetic induction to generate braking force. These systems are commonly used in high-speed trains, automobiles, and other vehicles. However, they have recently gained popularity in bicycles due to their ability to provide reliable and efficient braking without wearing out the brake pads or rims.

Several studies have been conducted on the design and fabrication of eddy current braking systems for bicycles. In one study published in the International Journal of Mechanical Engineering and Technology, researchers developed a prototype eddy current braking system for a bicycle. The system consisted of a magnet attached to the bike frame and an aluminium plate attached to the rear wheel. The magnet generated a magnetic field that induced eddy currents in the aluminium plate, producing a braking force.

Another study published in the International Journal of Innovative Research in Science, Engineering and Technology proposed a new design for an eddy current braking system for bicycles. The design involved using a solenoid coil mounted on the bicycle frame and a conductive plate attached to the rear wheel. The solenoid coil generated a magnetic field that induced eddy currents in the conductive plate, resulting in a braking force.

A more recent study published in the Journal of Advanced Research in Mechanical Engineering and Technology proposed an eddy current braking system for bicycles that used a neodymium magnet and a copper plate. The neodymium magnet was mounted on the bicycle frame, while the copper plate was attached to the rear wheel. When the wheel rotated, eddy currents were induced in the copper plate, generating a braking force.

Overall, these studies demonstrate the feasibility of using eddy current braking systems in bicycles and provide insights into the design and fabrication of such systems. Further research is needed to optimize the design and improve the efficiency of these braking systems.

In 1902, Ransom E. Olds arranged a brake system test on Riverside Drive in New York City. The test involved an Oldsmobile, a four-horse coach, and a Victoria horseless carriage, with each vehicle using a different brake system. The Oldsmobile's brake system used a single flexible stainless-steel band that wrapped around a drum on the rear axle. When the brake pedal was applied, the band contracted to grip the drum. In the test, the Oldsmobile was able to stop in just 21.5 ft, while the Victoria and coach, which used an expanding-shoe internal drum design and a tire brake system respectively, took 37 ft to stop with the same speed of 14 mph. By 1903, most other automotive manufacturers had adopted Oldsmobile's braking system, and by 1904, practically all car makers manufactured cars with an external brake on each rear wheel, making it the dominant brake system in the United States.

During the 1950s, the disk brake became a common feature on cars in Europe, especially in Great Britain. However, it took about 20 years for American car manufacturers to adopt this technology, around the year 1973.

In 1902, F.W. Lanchester was granted a patent for a non-electric spot disk braking system that was similar in principle to today's systems, but used copper linings that produced a loud screeching noise when they made contact with the metal disk. In 1907, Herbert Froad, another Englishman, came up with the idea of lining the pads with asbestos, which solved the noise problem when braking. Car manufacturers quickly adopted this technology for both drum and disk brakes.

Malcolm Lougheed invented the hydraulic braking system in 1918, in response to the need for more powerful brakes to handle faster driving. His system used cylinders and tubes to transmit fluid pressure to the brake shoes, pushing them against the drums. The Model A Duesenberg was the first passenger car to feature four-wheel

hydraulic brakes. In 1958, the Road Research Laboratories in Great Britain developed a new braking technology known as the antiskid braking system, which is now commonly referred to as the antilock braking system (ABS). The first car to be equipped with ABS was the Jensen FF sports sedan in 1966.

The development of braking technology is an ongoing process, with researchers constantly seeking to create more reliable and efficient braking systems. One such technology that is currently being actively developed is the braking-by-wire system, which is particularly relevant for electric and hybrid vehicles that rely on electric power. A Frost & Sullivan research study suggests that after 2010, the automotive industry may begin to shift away from the conventional hydraulic brake system towards brake-by-wire technology. With brake-by-wire, drivers will have better control over their vehicles, particularly in emergency situations

The history of automotive braking systems dates back to the late 19th century when the first practical automobile was developed. Initially, these vehicles were equipped with simple mechanical braking systems, which relied on friction to slow down or stop the vehicle. The mechanical brakes were later replaced by hydraulic brakes, which offered more efficient stopping power and greater reliability. In the 20th century, various types of brake systems, such as the disc brakes, anti-lock brakes, and electronic braking systems were developed, improving vehicle safety and performance.

In recent years, there has been an increasing focus on developing more environmentally friendly forms of transportation, such as bicycles. While bicycles are typically considered a safe mode of transportation, they still require effective braking systems to ensure rider safety. One promising technology for bicycle braking is the eddy current braking system, which uses magnetic fields to generate resistance and slow down the bicycle.

The design and fabrication of an eddy current braking system for a bicycle involves several key components. The system typically includes a magnetic field generator, a conductive metal disc, and a control mechanism to adjust the strength of the magnetic field. When the rider applies the brakes, the conductive metal disc passes through the magnetic field, generating eddy currents that create a braking force.

The design and fabrication of such a system requires expertise in electrical engineering, mechanical engineering, and materials science. The system must be carefully designed to ensure efficient power transfer and reliable operation, while also being lightweight and easy to use.

In recent years, several companies and research groups have developed and tested eddy current braking systems for bicycles. These systems have shown promise in reducing wear and tear on traditional mechanical brakes, improving overall braking performance, and reducing the environmental impact of transportation. As research and development continue, it is likely that eddy current braking systems will become increasingly common on bicycles and other forms of transportation in the years to come.

CHAPTER-3

Aim and Scope of the Present Investigation

- Designing and developing a frictionless braking system for automobiles is a complex task that requires a multidisciplinary approach. The following are some general steps that could be taken to achieve the goals outlined in the project:
- **Research:** Conduct thorough research on frictionless braking systems, including electromagnetic braking, to understand the principles and technologies involved. Study the advantages and disadvantages of different approaches, and identify the most suitable one for the specific application.
 - **Conceptual Design:** Based on the research findings, create a conceptual design of the frictionless braking system that meets the requirements and specifications of the project. Consider the use of materials, such as magnetic alloys, that can reduce wear and tear and improve efficiency.
 - **Simulation and Prototyping:** Utilize computer simulations and modeling software to validate the conceptual design and optimize its performance. Create a prototype of the system to test and evaluate its functionality, durability, and safety.
 - **Implementation:** Integrate the frictionless braking system into an actual automobile and conduct extensive testing to verify its performance under various conditions. Make any necessary adjustments and improvements based on the test results.
 - **Maintenance and Service:** Establish a maintenance and service plan for the frictionless braking system, considering its unique characteristics and requirements. Train technicians and mechanics on how to properly maintain and service the system to ensure its longevity and reliability.

By following these steps, it is possible to design and develop a frictionless braking system that is efficient, durable, safe, and cost-effective. Such a system can significantly reduce wear and tear on the braking system, improve overall performance, and pave the way for the use of electromagnetic braking in future automobiles.

- Based on the design and product development of the eddy current braking system, The benefits and advantages of this technology are the following key points:
- Use of high magnetic flux density electromagnets: The use of electromagnets with higher magnetic flux density can help to minimize the braking time and improve the overall efficiency of the braking system.
 - Radial arrangement of electromagnets: By positioning the electromagnets at different locations around the disc in a radial arrangement, we can achieve better braking torque distribution, which results in smoother and more controlled braking.
 - Superiority of electromagnetic and eddy current braking: The paper can highlight how electromagnetic and eddy current (magnetic) braking is superior to conventional frictional braking as there is no friction and heat generated, which reduces wear and tear and improves the overall durability and efficiency of the system.
 - Replacement of conventional disc and drum brakes: The paper can suggest that conventional disc and drum brakes can be replaced with electromagnetic and magnetic brakes, as these technologies offer better performance, improved efficiency, and reduced maintenance costs.
 - Wide range of applications: The paper can highlight the wide range of applications for electromagnetic and eddy current braking systems, such as in trains, roller coasters, industrial machinery, electric vehicles, and aerospace.

Overall, the paper can showcase the benefits and advantages of eddy current braking systems, highlighting the potential for this technology to transform the braking systems used in various industries.

- The aim of the present investigation is to design and fabricate an eddy current braking system for a bicycle. This braking system uses the principle of electromagnetic induction to generate a braking force that opposes the motion of the bicycle wheel.
- The scope of this project includes the design and fabrication of the eddy current braking system, as well as the testing and optimization of its performance. The

design phase involves selecting appropriate materials and components for the system, such as magnets and copper coils, and determining their placement and orientation.

- The fabrication phase involves the construction of the braking system according to the design specifications. This includes the assembly of the components, wiring of the coils, and installation of the magnets.
- Once the braking system is constructed, it will be tested for its braking performance under various conditions, such as different speeds and loads. The results of these tests will be used to optimize the design and make any necessary adjustments to improve its performance.
- The goal of this project is to develop an eddy current braking system that can be easily installed on bicycles and provide an effective and efficient means of braking. This could have significant implications for the safety and performance of bicycles, especially in situations where traditional braking systems may be ineffective or unreliable.

Aim:

The aim of the project "Design and Fabrication of Eddy Current Braking System for Bicycle" is to develop a braking system for bicycles that utilizes the principles of eddy currents to slow down or stop the bike. The eddy current braking system works by inducing electrical currents in a conductive metal disc (brake rotor) that is attached to the bicycle wheel, using a magnetic field generated by a coil. These currents generate heat, which slows down the rotor and, consequently, the bike.

The project will involve designing and fabricating a prototype of the eddy current braking system that can be installed on a bicycle. The system will consist of a brake rotor, a coil, a power source, and a controller that regulates the amount of current flowing through the coil.

The design phase will involve selecting the appropriate materials for the rotor and coil, determining the dimensions of the system components, and designing a mounting mechanism that will allow the system to be attached to a bicycle.

The fabrication phase will involve constructing the rotor and coil using techniques such as CNC machining and 3D printing, and assembling the components into a functional system. The power source for the system will be a battery, and the controller will be a microcontroller that will regulate the amount of current flowing through the coil.

Once the system has been fabricated, it will be tested to evaluate its performance in terms of braking force, power consumption, and durability. The results of the tests will be used to refine the design and optimize the system for use on bicycles.

Overall, the project aims to demonstrate the feasibility of using eddy current braking systems for bicycles and to develop a prototype that can be used as a basis for further research and development in this area. The benefits of such a system include reduced wear and tear on the traditional brake pads, improved braking efficiency, and reduced maintenance costs.

Scope:

The scope of the project, "Design and Fabrication of Eddy Current Braking System for Bicycle," is to develop a new braking system that can replace the conventional braking systems used in bicycles. The project aims to create a braking mechanism that is efficient, reliable, and safer than traditional braking systems.

The eddy current braking system uses the principles of electromagnetic induction to generate a braking force that opposes the motion of the bicycle. This system consists of a magnet and a conductive metal plate, which when brought in close proximity, creates eddy currents that generate the braking force.

The primary objective of this project is to design and develop an eddy current braking system that can be integrated with a bicycle. The system must be able to provide adequate braking force while maintaining a high level of safety and reliability.

The project's scope includes the following key activities:

- **Literature review:** A comprehensive literature review will be conducted to gain a thorough understanding of the principles and applications of eddy current braking systems in various fields.
- **Design and development of the eddy current braking system:** The system will be designed and developed using CAD software, and the prototype will be fabricated using standard manufacturing techniques.
- **Testing and evaluation:** The braking system will be tested under various conditions to determine its performance, efficiency, and safety. The system will be evaluated based on its braking force, braking distance, and stability.

- **Integration with a bicycle:** The final step in the project scope is to integrate the eddy current braking system with a bicycle. This involves retrofitting the system onto an existing bicycle frame and testing it under real-world conditions.

In conclusion, the design and fabrication of an eddy current braking system for bicycles project scope is aimed at developing a new and innovative braking system that can provide a safer and more reliable alternative to conventional braking systems. The project's outcome has the potential to revolutionize the cycling industry and improve the safety of cyclists on the road

CHAPTER-4

EXPERIMENTAL OR MATERIALS AND METHODS; ALGORITHMS USED

Components: Major components involved in the design and the fabrication of the viscous braking system using MR fluid are as follows.

- Electromagnets 12v
- MS Disc D200
- Battery 12v 7A
- Wires
- Square Rod
- Bolts and Nuts
- Press Switch 12v 7A
- Bicycle

ELECTROMAGNETS

An electromagnet is a magnet that relies on an electric current to produce a magnetic field. It is typically made up of a coil of wire wound around a ferromagnetic or ferrimagnetic material, such as iron, which concentrates the magnetic flux and creates a more powerful magnet. When a current flows through the wire, a magnetic field is generated, which is concentrated at the centre of the coil. Unlike a permanent magnet, an electromagnet can have its magnetic field quickly changed by varying the amount of electric current in the winding. However, it requires a continuous supply of current to maintain the magnetic field, while a permanent magnet does not. Electromagnets are often preferred over permanent magnets as electrical actuation is faster with lower losses. They are widely used in electrical devices such as motors, generators, relays, and loudspeakers, as well as in industrial applications for lifting and moving heavy objects. Increasing the current flowing through the coil or the number of turns of the winding can increase the strength of the magnetic field. Electromagnets are also favored over permanent magnets for creating high magnetic

fields, as they are lighter and more easily installed, and do not interfere with other metals.

SPECIFICATIONS

Voltage	12v
No of turns	500 tons
Force	8 kgf
Power	40 amps

MS DISC:

Mild Steel Plate in figure 4.1 is a type of flattened steel that has a thickness greater than 1/4 inch (0.250) and a diameter of 200mm. It finds application in various industries such as manufacturing, construction, and industrial sectors where it is primarily used for its structural properties rather than for aesthetic purposes. The thickness of the Mild Steel Plate is measured in inches.



Figure 4.1. MS DISC

BATTERY

In off-grid systems that are not connected to the electricity grid, batteries are commonly used to store excess solar energy that has been converted into electrical energy. This is typically the case except for isolated applications that have a low demand for energy, such as irrigation pumps or drinking water supplies, which may not require battery storage. For small units that have an output of less than one kilowatt, battery storage may not be necessary or may be impractical.

Batteries are currently the most practical and cost-effective means of storing excess solar energy for off-grid systems. However, both photovoltaic systems and batteries have high capital costs. Therefore, it is important to optimize the overall system in terms of available energy and local demand patterns. In order for solar electricity storage to be economically feasible, the battery must have specific properties that are suitable for the application.

- (1) Low cost
- (2) Long life
- (3) High reliability
- (4) High overall efficiency
- (5) Low discharge
- (6) Minimum maintenance
 - (A) Ampere hour efficiency
 - (B) Watt hour efficiency



Figure 4.2 Battery

Lead acid batteries in figure 4.2 are a type of rechargeable battery that are commonly used in solar power systems for storing electrical energy. They are made up of lead plates and sulfuric acid electrolyte, and typically have a nominal voltage of 2 volts per cell. The battery is charged by passing a current through it in the opposite direction to the discharge current. This reverses the chemical reactions that occur during discharge, and allows the battery to be reused. The capacity of a lead acid battery is measured in amp-hours, and depends on the size and number of cells in the battery. Lead acid batteries are relatively inexpensive and reliable, but they do have some disadvantages. They are heavy and have a relatively low energy density compared to other types of batteries, which makes them less suitable for applications where weight is a concern. They also require periodic maintenance, such as adding distilled water to the cells to replace water lost during charging. Despite these drawbacks, lead acid batteries remain a popular choice for solar power storage due to their low cost and availability.

LEAD-ACID WET CELL

Lead-acid cells are commonly used when high load currents are required. The electrolyte in these cells is a dilute solution of sulfuric acid (H_2SO_4). For example, in the application of battery power to start the engine in an automobile, the load current to the starter motor is typically between 200 to 400A. One cell provides a nominal output of 2.1V, but lead-acid cells are commonly used in series combinations of three for a 6-V battery and six for a 12-V battery to meet the required voltage.

The lead acid cell in figure 4.3 is a type of secondary or storage cell that can be recharged by a charge and discharge cycle that can be repeated many times to restore the output voltage, as long as the cell is in good physical condition. However, excessive charge and discharge currents and heat can shorten its useful life to about 3 to 5 years for an automobile battery. Among the different types of secondary cells, the lead-acid type has the highest output voltage, which allows fewer cells to be used for a specified battery voltage.

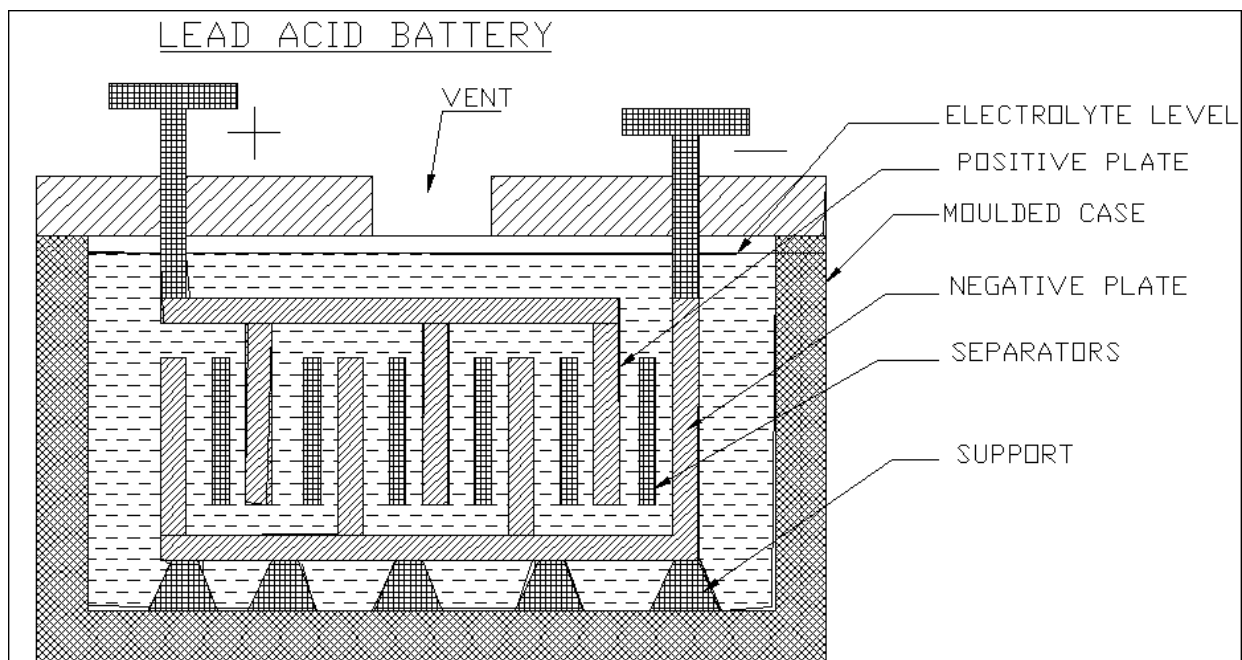


Figure 4.3. Lead Acid Battery

CONSTRUCTION

A lead-acid battery comprises positive and negative electrodes that are made up of plates connected by a strap. These plates are immersed in an electrolyte that is made by mixing 8 parts of water with 3 parts of concentrated sulfuric acid. Each plate is made of a lead-antimony alloy and has a grid-like structure that allows the active material, which is lead oxide, to be pasted into it. During the manufacture of the battery, a forming charge is applied to produce the positive and negative electrodes. The forming process changes the active material in the positive plate to lead peroxide (PbO_2), while the negative electrode is made of spongy lead (Pb).

Dry-shipping and installation of the electrolyte at the time of installation is a common practice for automobile batteries. Maintenance-free batteries require little to

no water addition during their normal service life, while sealed batteries come with a pressure vent and no provision for adding water.

The construction parts of battery are shown in figure 4.4.

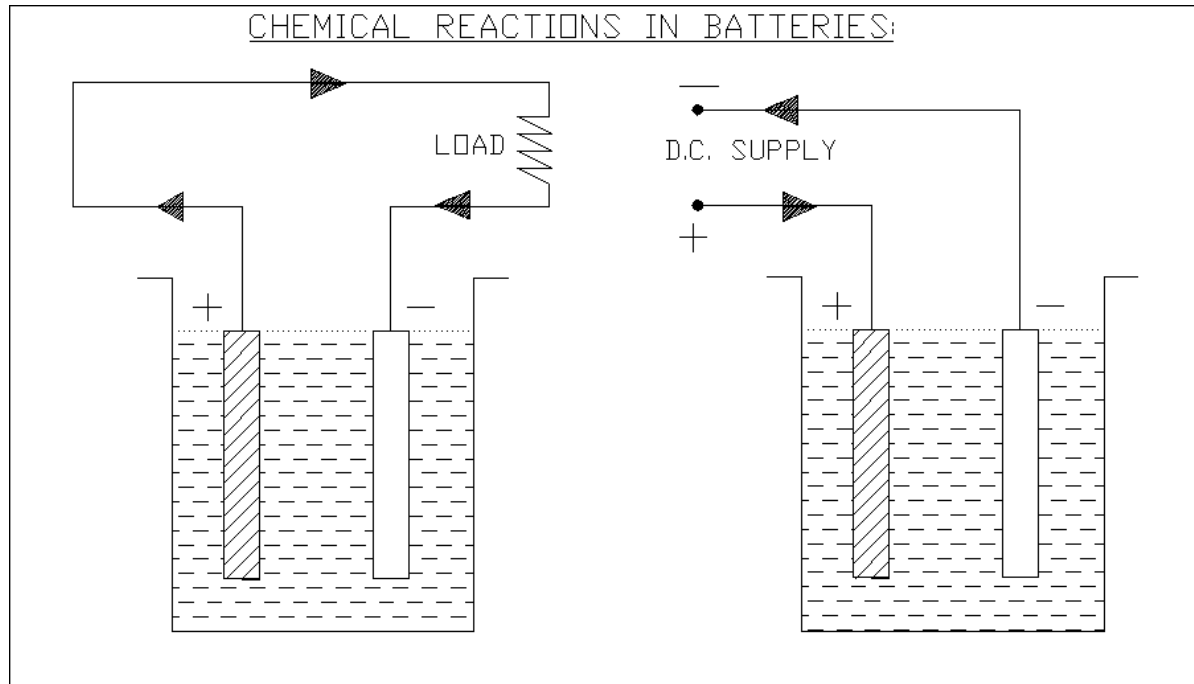


Figure 4.4 Chemical Reactions in Batteries.

CHEMICAL ACTION

Sulfuric acid consists of hydrogen and sulphate ions. During discharge, the lead peroxide on the positive electrode reacts with hydrogen ions to form water, and with sulphate ions to create lead sulphate. On the negative plate, lead reacts with sulphate ions to produce more sulphate. The overall effect of discharge is to increase the amount of water in the electrolyte, thereby diluting it, and to create lead sulphate on the plates.

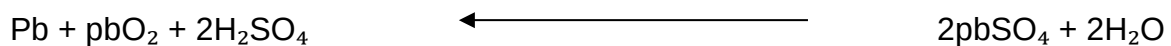
During the discharge process, the lead sulphate produced on the plates fills the pores of the grids, which slows down the flow of acid in the active material. This leads to a weak electrolyte, which is often visible as a powder of lead sulphate on the terminals of old batteries. As the combination of weak electrolyte and sulfation reduces the output of the battery, it becomes necessary to recharge it.

During charging, the external DC source causes the current in the battery to reverse. This reversal of the ion flow in the electrolyte leads to a reversal of the chemical reactions. The lead sulphates on the positive plate react with the water and sulphate ions to produce lead peroxide and sulfuric acid, which reforms the positive plates and strengthens the electrolyte by adding sulfuric acid.

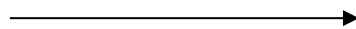
Charging the battery also enables the lead sulphate on the negative plate to react with hydrogen ions, forming sulfuric acid while reforming lead on the negative plate. This process restores the cell to full output, with lead peroxide on the positive plates, spongy lead on the negative plate, and the required concentration of sulfuric acid in the electrolyte. Thus, by reversing the chemical reactions that occur during discharge, charging the battery helps to restore it to its fully charged state.

The chemical equation for the lead-acid cell is

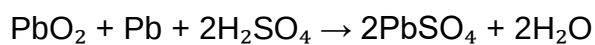
Charge



Discharge



The balanced chemical equation for the discharge reaction in a lead-acid battery is:



During discharge, the lead dioxide (PbO_2) on the positive electrode and the spongy lead (Pb) on the negative electrode react with the sulfuric acid (H_2SO_4) in the electrolyte to form lead sulfate (PbSO_4) and water (H_2O). This reaction generates electrons that flow through the external circuit and power the load.

A typical battery comprises six cells, each capable of producing an output voltage of 2.1V. To obtain a 12V battery, the six cells are connected in series. Similarly,

to obtain a 24V battery, two 12V batteries are connected in series. These batteries are usually placed inside a waterproof iron casing.

CARING FOR LEAD-ACID BATTERIES

It is crucial to exercise extreme caution when handling batteries and electrolyte. It is advisable to wear protective gear such as gloves, goggles, and old clothes. The electrolyte in batteries, also known as "battery acid," can cause severe burns on skin and eyes and ruin cotton and wool clothing.

Deeply discharging lead-acid batteries and leaving them unused for a prolonged period of time is the quickest way to damage them. Discharging causes a chemical change in the positive plates of the battery, converting them from lead oxide to lead sulphate. If the battery remains in a discharged state for a few days, a portion of the plate may not return to lead oxide upon recharging. If the battery remains discharged for a longer period, a greater amount of the positive plate will remain lead sulphate. The parts of the plates that become "sulphated" can no longer store energy. If such batteries are repeatedly partially charged after deep discharge, they can fail in less than a year. It is important to ensure that lead-acid batteries are not left in a deeply discharged state for an extended period of time to prevent damage.

It is important to regularly check the charging status of your batteries. One way to do this is by using a hydrometer to check the specific gravity of your lead acid batteries. However, if batteries are deeply discharged and then quickly recharged, the specific gravity reading may be inaccurate because the electrolyte at the top of the battery may not have mixed with the fully charged electrolyte. It is important to take this into account when interpreting the specific gravity readings.

It is important to regularly check the electrolyte level in wet-cell batteries at least four times a year and add distilled water to each cell as needed. However, it is important to avoid adding water to discharged batteries as electrolyte can be absorbed during discharge. If water is added to a discharged battery and then recharged, the electrolyte can overflow and cause a mess.

It is important to keep the top of your batteries clean and regularly check that the cables are tightly connected. However, it is crucial to avoid tightening or removing cables while the battery is charging or discharging as any spark generated during this

process can cause a hydrogen explosion inside the battery. This explosion can ruin one or more cells and can also cause serious harm to you.

During charging, the flow of current is reversed through the electrolyte, leading to a reversal of the chemical reactions that occurred during discharge. As a result, the lead ions from the lead sulphate on the right side of the equation combine to form the lead and lead peroxide electrodes again. Additionally, the sulphate ions combine with hydrogen ions from the water on the left side of the equation to produce more sulfuric acid.

CURRENT RATINGS

Lead-acid batteries are commonly measured in terms of their ability to supply discharge currents for a specific duration of time, while keeping the output voltage above a certain minimum level, usually between 1.5 to 1.8V per cell. This rating is often expressed in ampere-hours (A.h.), based on a specific discharge time of typically 8 hours. Automobile batteries usually have a rating of 100 to 300 A.h.

To provide more context, cold cranking power (CCP) is the maximum current that a lead-acid battery can deliver at 0-degree F for a short period of time, usually 30 seconds, while maintaining a voltage of at least 7.2V. This rating is important for starting engines in cold weather, as cold temperatures can reduce the battery's ability to deliver power. A CCP rating of 450A means that the battery can supply a current of 450A for 30 seconds at 0-degree F without the voltage dropping below 7.2V.

Note that the ampere-hour unit specifies the amount of charge, measured in coulombs, that a battery can supply. For instance, a 200 A.h. battery can supply 200 amps of current for one hour, which is equivalent to 720,000 coulombs of charge. One coulomb of charge is equal to one ampere-second. Therefore, the charge supplied by a 200 A.h. battery can also be expressed as 7.2×10^5 ampere-seconds, or coulombs.

In order to recharge the battery completely with a charging current of 10A, it would take 20 hours to provide the identical amount of charge that the battery can provide during an 8-hour discharge at 25A.

Lead-acid batteries are rated based on a temperature range of 77 to 80°F. While higher temperatures can increase the chemical reaction, temperatures above 110°F can shorten the battery's lifespan.

At low temperatures, the current capacity and voltage output of lead-acid batteries decrease. The ampere-hour capacity decreases by approximately 0.75% for each 1°F decrease below the normal temperature rating. At 0°F, the available output is only 60% of the battery's ampere-hour rating.

In cold weather, it is crucial to have an automobile battery fully charged. Additionally, when the electrolyte is diluted by water in a discharged state, it freezes more easily.

SPECIFIC GRAVITY

Measuring the specific gravity of the electrolyte is a common method to check the state of discharge for a lead-acid cell. Specific gravity is a ratio that compares the weight of a substance with the weight of an equal volume of water. For example, concentrated sulfuric acid is 1.835 times as heavy as water for the same volume, so its specific gravity is 1.835. Water has a specific gravity of 1 since it is used as the reference.

At a temperature range of 70 to 80°F, a fully charged automotive cell will have a specific gravity of 1.280 due to the mixture of sulfuric acid and water. As the cell discharges, the specific gravity decreases due to the formation of more water. When the specific gravity reaches approximately 1.150, the cell is considered completely discharged.

A battery hydrometer, shown in Figure (5.4), is used to take specific-gravity readings. It has a calibrated float with specific gravity marks that will rest higher in an electrolyte with a higher specific gravity.

A hydrometer is used to measure specific-gravity readings, as shown in figure (7). Note that the calibrated float with specific-gravity marks will rest higher in an electrolyte of higher specific gravity. The decimal point is often omitted for convenience, and for example, the value of 1.220 in figure (5.4) is simply read as "twelve twenty". A hydrometer reading of 1260 to 1280 indicates full charge, approximately 1250 is half charge, and 1150 to 1200 indicates complete discharge.

The significance of specific gravity is highlighted by the fact that the open-circuit voltage of a lead-acid cell is nearly equivalent to

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

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

CHARGING THE LEAD-ACID BATTERY

The diagram in the figure illustrates the requirements for charging a lead-acid cell. To produce current in one direction, an external DC voltage source is needed. Moreover, the charging voltage must be greater than the battery's electromotive force (EMF). Typically, 2.5 volts per cell is sufficient to exceed the cell's EMF, allowing the charging voltage to produce current in the opposite direction of the discharge current.

When charging a lead-acid battery, the current can be reversed by connecting an external DC voltage source to the battery with opposite polarities (+ to - and - to +). This allows the charging current to flow in the opposite direction of the discharge current. In this configuration, the charging voltage must be higher than the battery's electromotive force (EMF) by approximately 2.5V per cell. By doing this, the battery becomes a load resistance for the charging source, allowing the charging current to flow. The net voltage available for charging in this example is 3V, as calculated by subtracting the battery voltage (12V) from the charging voltage (15V).

An automotive battery charger, used for charging batteries, is a D.C. power supply that converts AC power from the line into DC output through rectification.

Float charging is a technique where the battery and charger are continuously connected, providing current to both the load and the battery to keep it fully charged. Figure (insert figure number) demonstrates this method, with the charger supplying power to the load as well as the current required to maintain the battery at full charge. In this scenario, the battery functions as an auxiliary D.C. power source.

An interesting fact is that automotive batteries are connected to a float charging circuit. This circuit includes an alternator or AC generator with rectifier diodes driven by an engine belt. When the car is started, the battery provides power for the cranking. Once the engine is running, the alternator charges the battery. The vehicle does not have to be in motion for this to occur. A voltage regulator is utilized in this system to keep the output at around 13 to 15 V.

To store the energy from the solar panel, a 24V battery is required. This is achieved by connecting two 12V batteries in series, with the constant voltage of 24V controlled by the charge controller.

Performing an equalizing charge is recommended when there is a difference of 0.05 specific gravity among cells in a battery. This involves a prolonged overcharge, which causes the battery to gas or bubble. However, it is important to note that sealed or gel type batteries should not be equalized.

The lifespan of lead-acid batteries can be significantly extended with appropriate maintenance and usage. Conversely, if the batteries are not properly maintained, their life can be significantly reduced.

Wire

Wires in figure 4.5 are metal components used to conduct electricity. They are often designed to be flexible, which makes them more versatile in their applications. Wires play a crucial role in electrical devices such as computers, transformers, and power transmission systems that distribute electricity over long distances. Without wires, electricity would not be readily available, making them an essential element of modern life. Wires come in different sizes and compositions depending on their intended use.



Figure.4.5. Wires

Square Rod

Mild steel in figure 4.6 is a metal that contains iron and carbon and is commonly used in general engineering applications due to its cost-effectiveness. It has a low carbon content and is ferromagnetic, which means it has strong magnetic properties due to its high iron content..



Figure .4.6 Square Rod

Bolts and Nuts

A screw and bolt in figure 4.7 are types of fasteners made of metal with a helical ridge called a male thread. They are used to fasten materials by engaging with a matching female thread in a matching part. Some screws are self-threading, where the thread cuts into the material as the screw is turned to create an internal thread that pulls the fastened materials together and prevents pull-out. Screws are commonly used to fasten wood, sheet metal, and plastic. Bolts, on the other hand, require a preformed female thread such as a nut. Bolts are closely related to screws.



Figure .4.7. Bolts and Nuts

Press Switch 12v 7A

A push button switch in figure 4.8 is a device that can be used to turn something on or off by using a simple electric or air switch mechanism. These switches may be designed to function as either momentary or latching action switches, depending on the model. The button of the switch is typically made from a sturdy, long-lasting material like plastic or metal.



Figure 4.8. Press Switch

A push button switch is a compact device that enables the completion of an electric circuit through pressing it. When activated, a small metal spring enclosed within the switch connects two wires, allowing the current to flow.

Conversely, when deactivated, the spring retreats, the connection is broken, and the current ceases to flow .

BICYCLE

A bike, short for bicycle in figure 4.9 , is a machine used for transportation. Typically, bikes consist of a frame with two wheels, handlebars for steering, a seat, and two pedals. Bicycles are popular around the world and are used for various reasons such as exercise, sport, and commuting. To ride a bike, the rider sits on the seat and puts their feet on the pedals, which are connected by a chain to the back wheel. When the rider pushes on the pedals, the back wheel rotates, propelling the bike forward. The rider can steer by turning the handlebars or leaning in the desired direction.



Figure 4.9 Bicycle.

Bikes can have either coaster brakes or hand brakes. Coaster brakes work by pedaling backward to stop, while hand brakes are controlled by levers on the handlebars. When the rider squeezes the levers, pads are pressed against the wheels, causing the bike to come to a stop.

Many bicycles are equipped with gears that allow riders to maintain a consistent pedaling speed while navigating different types of terrain. Shifting gears involves adjusting the bicycle's chain to different sprockets, which alters the mechanical advantage of pedaling. Higher gears offer less mechanical advantage and require more effort to pedal but enable the bicycle to travel at faster speeds. Riders may shift to higher gears when riding on flat, even surfaces. Lower gears offer greater mechanical advantage, making pedaling easier but limiting speed. Riders may shift to lower gears when ascending hills or facing other challenging terrain.

There are six primary types of bicycles: utility, mountain, hybrid, touring, racing, and bicycle motocross (BMX). Utility bicycles are equipped with heavy frames and typically have only one speed. Mountain bikes feature wide tires, flat handlebars, and multiple speeds, making them ideal for riding on rough trails. Hybrid bicycles are similar to Figure 4.9. Press Switch Figure 4.10 Bicycle. 33 mountain bikes, but they have narrower tires and are suitable for both road and offroad use. Touring and racing bicycles feature narrow tires, lightweight frames, curved handlebars, and multiple speeds, and are commonly referred to as road bikes because they perform best on

paved roads. BMX bikes, on the other hand, are designed for racing on dirt tracks and have a small frame, low seat, high handlebars, and one speed.

MANUFACTURING PROCESSES

The manufacturing processes in figure 4.10 involved in creating a final product can vary widely depending on the industry and product being produced. Some common manufacturing processes include shaping shafts, frames, rotavators, hoppers, and ploughs. These processes begin with the creation of the raw materials from which the design is made. The materials are then modified through various manufacturing processes such as treating, machining, or reshaping to create the required parts. Quality assurance tests and checks may be performed during or after the manufacturing process to ensure that the final product meets the required specifications. Planning the production process prior to manufacturing is also an important aspect of the overall manufacturing process.

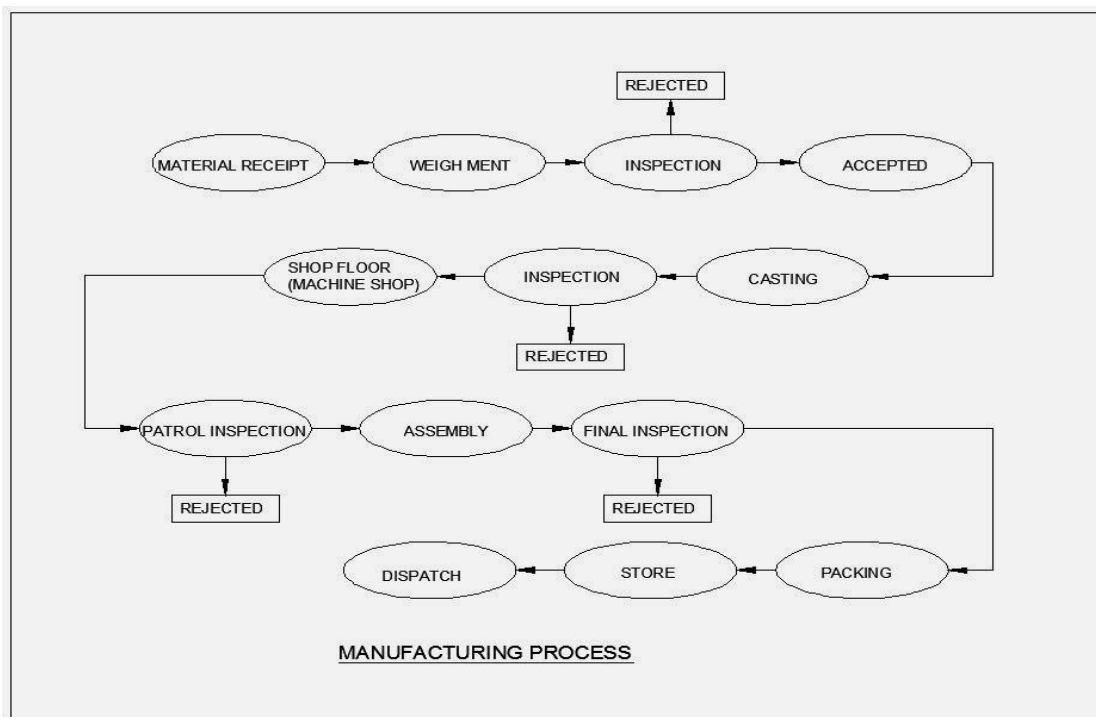


Figure 4.10 Manufacturing process

OPERATIONS

METAL CUTTING

Metal cutting in figure 4.11 or machining is the process of by removing unwanted material from a block of metal in the form of chips.

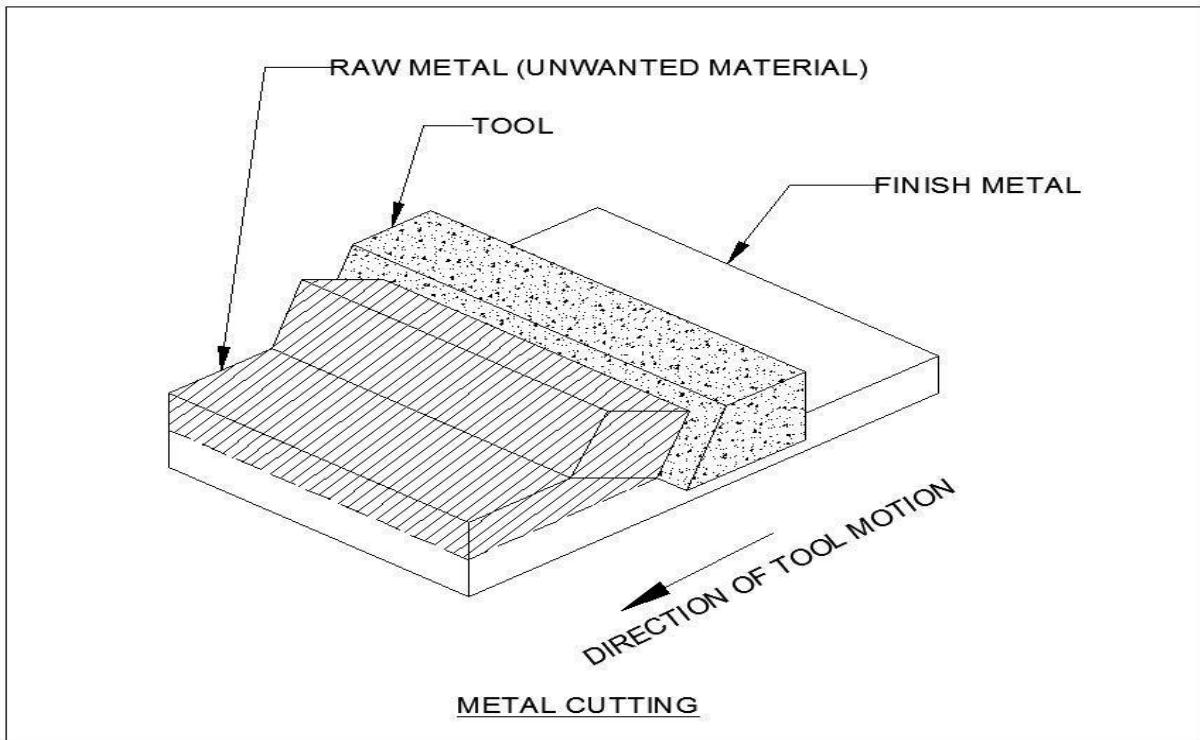


Figure 4.11 Metal cutting

Cutting involves fracturing materials to produce chips. Different cutting methods are used, including sawing, shaping, broaching, drilling, grinding, turning, and milling.

Despite the variations in machines and tools for each method, the fundamental mechanism for causing the fracture can be understood using the orthogonal cutting model.

Machining by figure 4.12 involves the removal of excess material from a workpiece to achieve the final desired shape. This process is typically done in several stages, with each stage requiring the workpiece to be held in a fixture that provides access to the portion of the workpiece to be machined. Common fixtures include vises, clamps, and chucks.

Each setup involves holding the workpiece in a different position, and one or more cutting operations may be performed using one or more cutting tools. To switch from one setup to the next, the workpiece must be released from the previous

fixture, the new fixture must be installed on the machine, the workpiece must be clamped in the new position, and the machine tool coordinates must be set to the new location of the workpiece. Finally, the machining operations for the new setup can begin.

Process planning involves determining the optimal sequence of individual cutting operations and grouping them into a minimum number of setups to minimize the time and cost associated with setup changes. The choice of fixture for each setup is also an important consideration. By carefully planning the cutting process, the 37 number of setups can be reduced, which can help to improve efficiency and reduce costs.

These notes will be organized in three sections:

- (i) Introduction to the processes,
- (ii) The orthogonal cutting model and tool life optimization and
- (iii) Process planning and machining planning for milling.

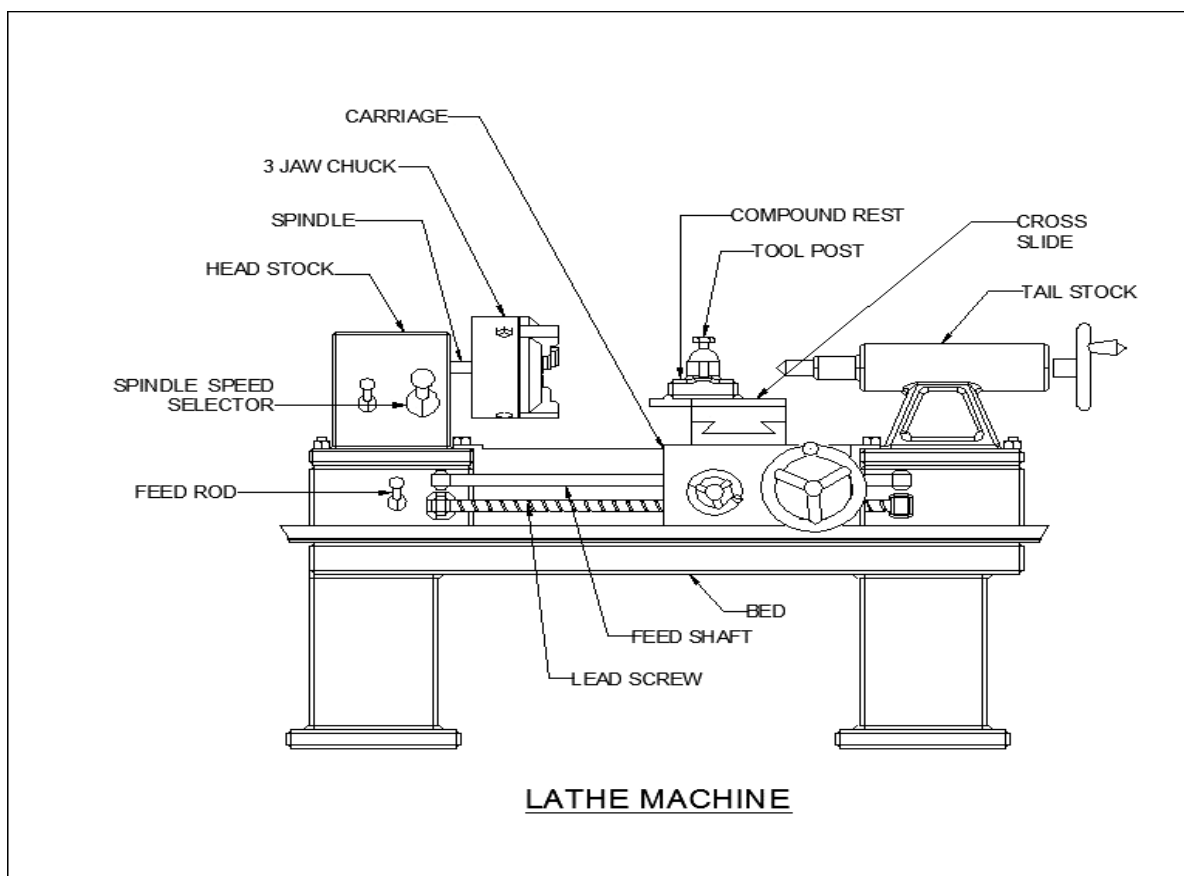


Figure 4.12 Lathe Machine

SAWING

Cold saws are stationary saw machines that use circular saw blades to cut through various types of metal, including sheet metal. The name of the saw is derived from the fact that it employs a cutting process that keeps both the metal and the blade from overheating. Cold saws are powered by electricity and are typically not portable. They are commonly used in the manufacture of metal products such as automobile parts, aircraft frames, machine components, and pipes.

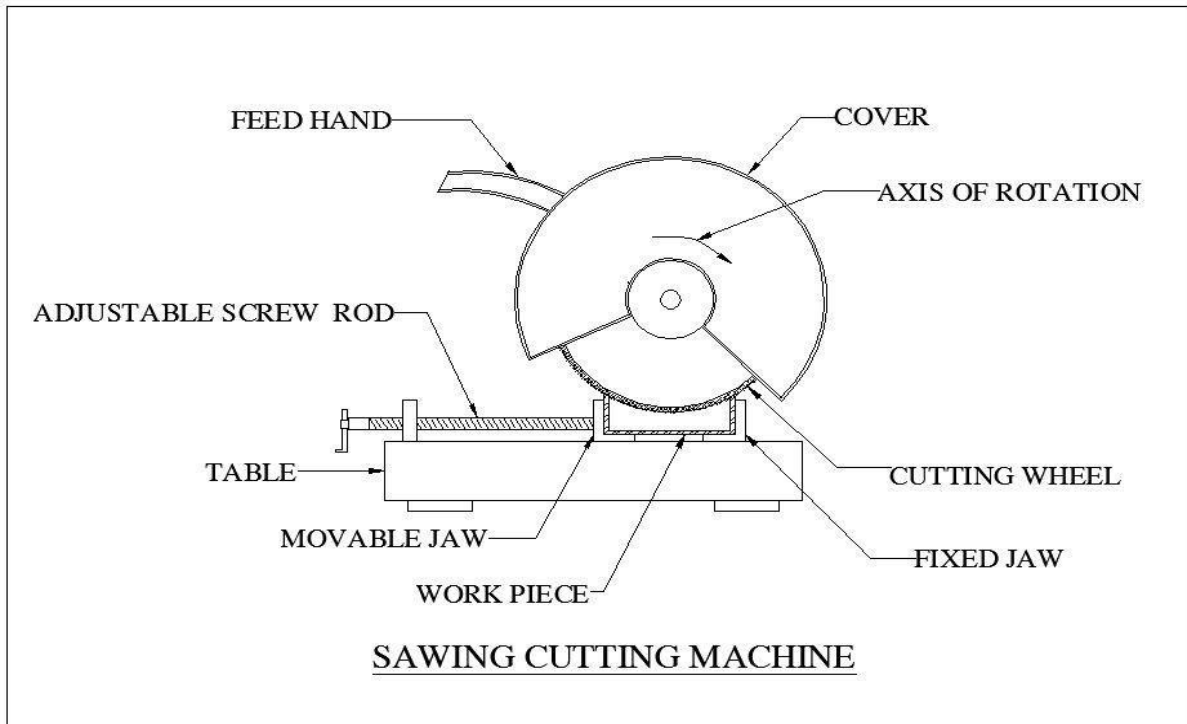


Figure 4.13 Sawing cutting machine

In addition to high-speed steel blades, cold saws can also be fitted with tungsten carbide-tipped blades that resist wear and tear. One key advantage of tungsten-tipped blades is that they can be sharpened, which prolongs their lifespan. This type of blade is especially effective for cutting thin sheet metal and other relatively slender metallic components.

Circular saw blades in figure 5413 that are used with cold saws are typically made of highspeed steel, which is highly resistant to wear and can withstand frequent use. This means that several cutting projects can be completed before needing to replace the blade. High-speed steel blades are particularly useful when cutting through thicker metal sections.

Along with the high-speed steel blades, a cold saw may also be equipped with a blade that is tipped with tungsten carbide. This type of blade construction also helps to resist wear and tear. One major difference is that tungsten tipped blades can be resharpened from time to time, extending the life of the blade. This type of blade is a good fit for use with sheet metal and other metallic components that are relatively thin in design.

WELDING

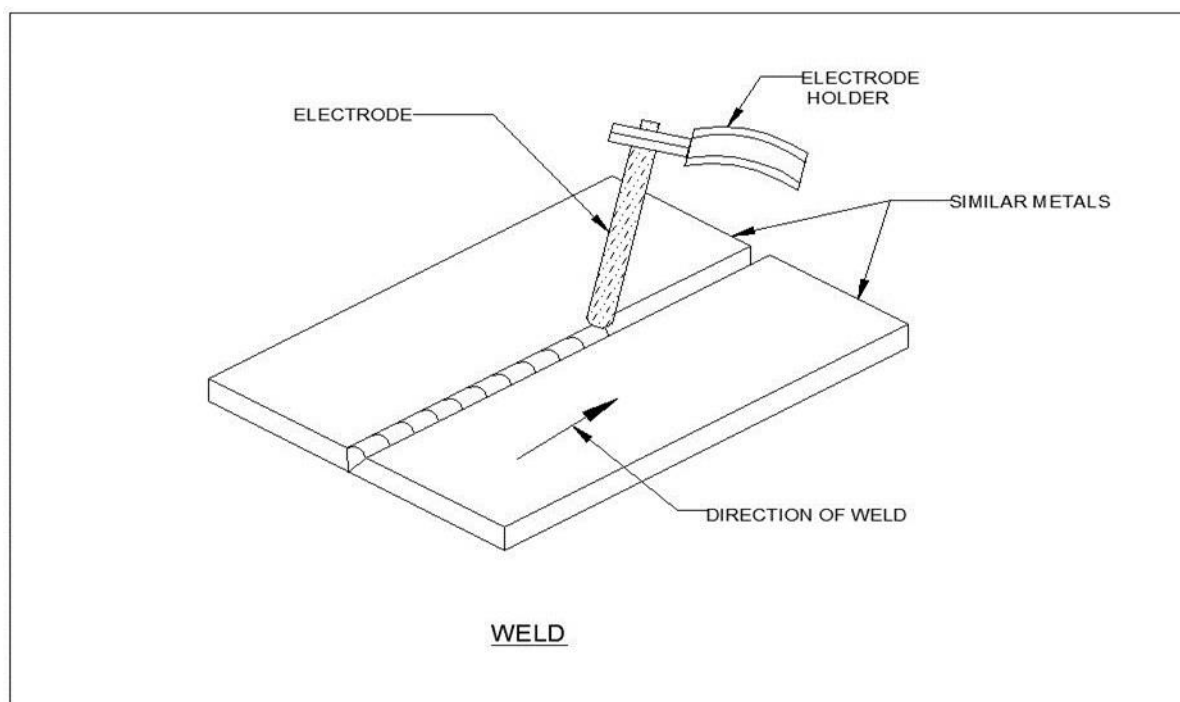


Figure 4.14 Welding

Welding in figure 4.14 can produce strong, permanent joints between metals by melting and fusing the base metals and filler material. The strength of the weld joint depends on several factors, including the type of welding process used, the skill of the welder, the properties of the base metals and filler material, and the design of the joint. In some cases, the weld joint can be even stronger than the base metals being joined, but this is not always the case and depends on the specific application and materials involved.

Welding is a process utilized to create long-lasting connections between two or more materials. This method finds extensive use in a variety of applications including

the production of automobile bodies, aircraft frames, railway wagons, machine frames, 39 structural works, tanks, furniture, boilers, general repair work, and shipbuilding.

WELDING OPERATION

Several welding processes like in figure 4.15 are based on heating with an electric arc, only a few are considered here, starting with the oldest, simple arc welding, also known as Shielded metal arc welding (SMAW) or stick welding. In this process an electrical machine (which may be DC or AC, but nowadays is usually AC) supplies current to an electrode holder which carries an electrode which is normally coated with a mixture of chemicals or flux. An earth cable connects the work piece to the welding machine to provide a return path for the current. The weld is initiated by tapping ('striking') the tip of the electrode against the work piece which initiates an electric arc. The high temperature generated (about 6000oC) almost instantly produces a molten pool and the end of the electrode continuously melts into this pool and forms the joint.

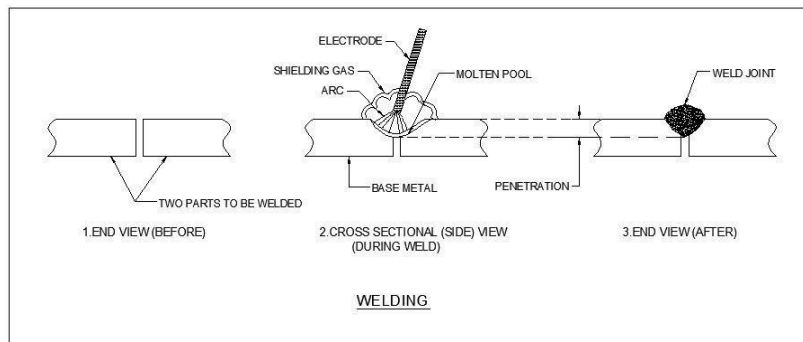


Figure 4.15 Welding

The operator needs to maintain a consistent gap between the electrode and the workpiece while moving the electrode along the joint to ensure that the arc remains stable and the weld is of good quality

The flux coating on the stick electrode used in SMAW provides multiple functions during the welding process. It not only creates a protective gas shield to prevent the molten metal from reacting with the surrounding air and forming unwanted oxides and nitrides, but also helps to create a slag that protects the molten metal and facilitates the welding process. The slag serves as a thermal barrier, keeping the heat in the weld and preventing rapid cooling, which can cause cracks and other defects. Once the weld has cooled, the slag can be removed by chipping or brushing to reveal the finished weld.

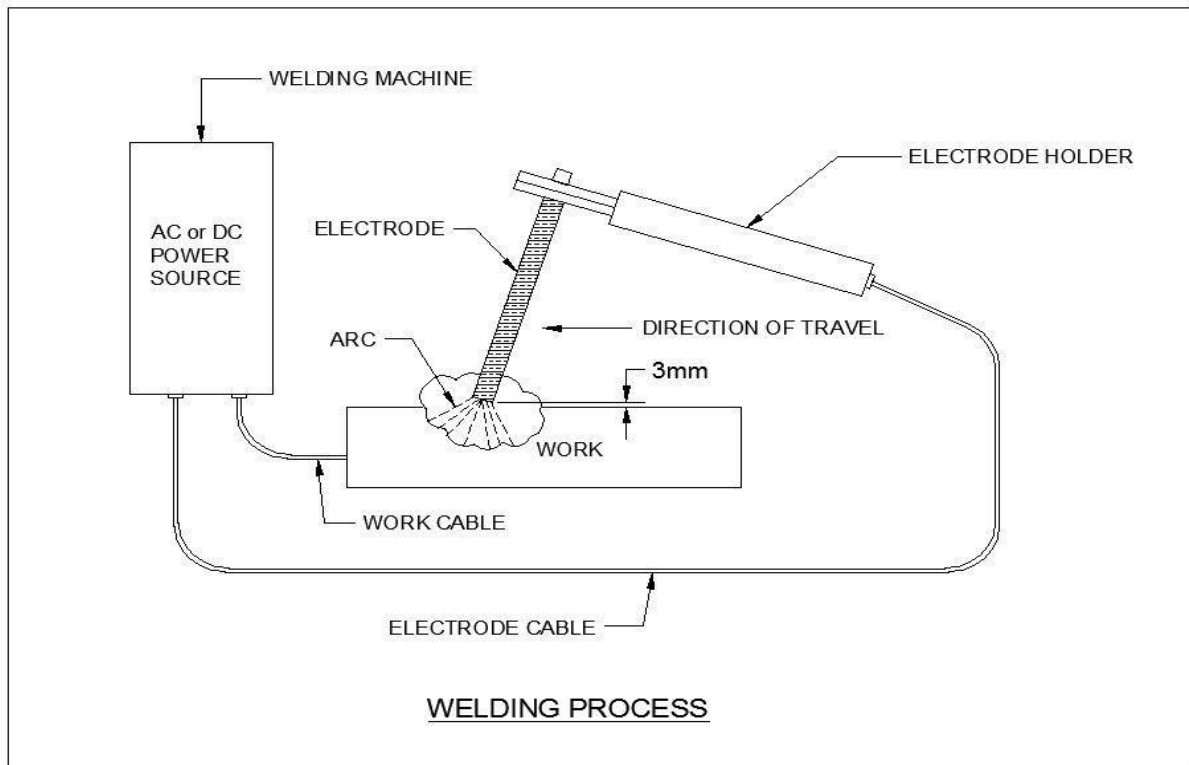


Figure 4.16. Arc welding

The Shielded Metal Arc Welding (SMAW) (in figure 4.16) process is typically not recommended for welding steel that is thinner than approximately 3mm. Additionally, since the process is discontinuous and requires manual operation, it may not be suitable for certain applications. However, SMAW remains a popular choice for jobbing shops and on-site steel construction work. One advantage of the process is the availability of a wide range of electrode materials and coatings, which allows for its use on a variety of steels, heat-resistant alloys, and certain types of cast iron.

DRILLING

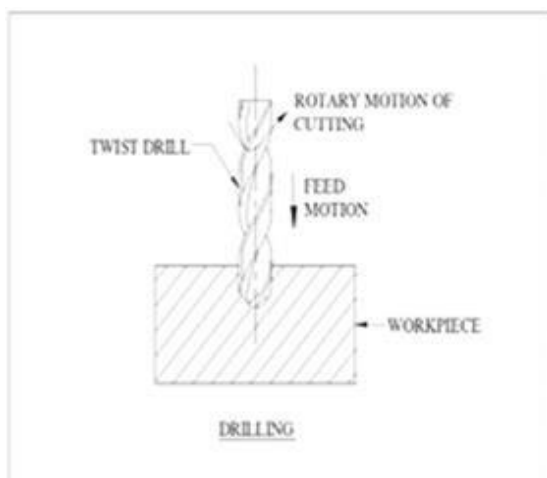


Figure 4.17 Drilling

Additionally, the drill bit in figure 4.17 is usually made of a high-speed steel or other hard material that can cut through the material being drilled. The size and shape of the hole are determined by the size and shape of the drill bit, and the speed and feed rate of the drill are important parameters that affect the efficiency and quality of the drilling process. Drilling can be performed manually or with the use of automated machinery, depending on the complexity and size of the workpiece.

OPERATION

The twist drill tool, or drill bit in figure 4.18, has straight cut teeth at the bottom for most of the metal cutting, and curved cutting teeth along its cylindrical surface. The helical flutes created by the curved teeth are important in pushing the chips out from the hole as it is being machined. Because the tip of the drill has zero velocity, it cannot do much cutting, so a small hole in the material called a centre-hole is commonly machined before using the drill. Centre-holes are made by special drills called centre-drills, which also provide a way for the drill bit to get aligned with the location of the centre of the hole. There are many different types of drill shapes and sizes available.

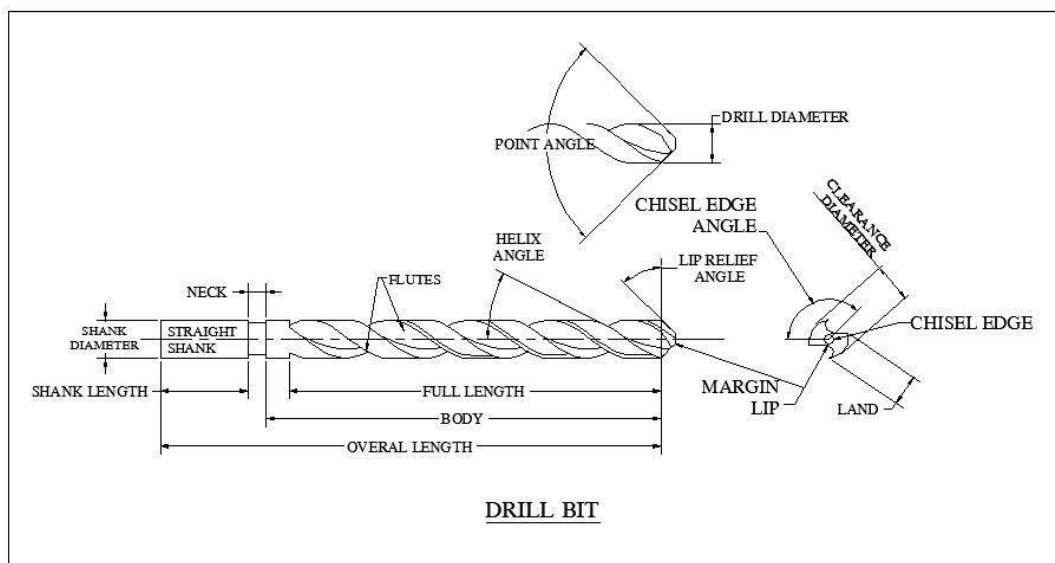


Figure 4.18 Drill bit

Drill bits are typically made of hardened steel, which may be coated with materials like high-speed steel or titanium nitride to increase their durability. For cutting harder materials, drills with carbide or CBN inserts are often used. The size and angle of the drill bit's point depend on the material being cut, with smaller angles used for softer materials and larger angles for harder, more brittle materials. When drilling deep or long holes with a high Length/Diameter (L/D) ratio, a special guiding support is needed for the drill bit to prevent it from bending or breaking. This process, known as gun-drilling, is commonly used for making gun barrels with diameters of a few millimeters or more and L/D ratios up to 300. 43 Figure 5.10 Drilling Machine When drilling very small diameter holes (less than 0.5 mm), the tool may break or get stuck in the work piece, making drilling not useful. Additionally, the size of the hole made by the drill is typically slightly larger than the measured diameter of the drill due to various factors such as vibration of the tool spindle and misalignment of the drill with the

spindle axis. To achieve tight dimension control on hole diameter, a smaller hole is first drilled, typically 0.25 mm smaller than the required size, and then a reamer is used. Reaming involves low material removal rate and low depth of cut, but provides good dimension accuracy by the drilling lathe in figure 4.19.

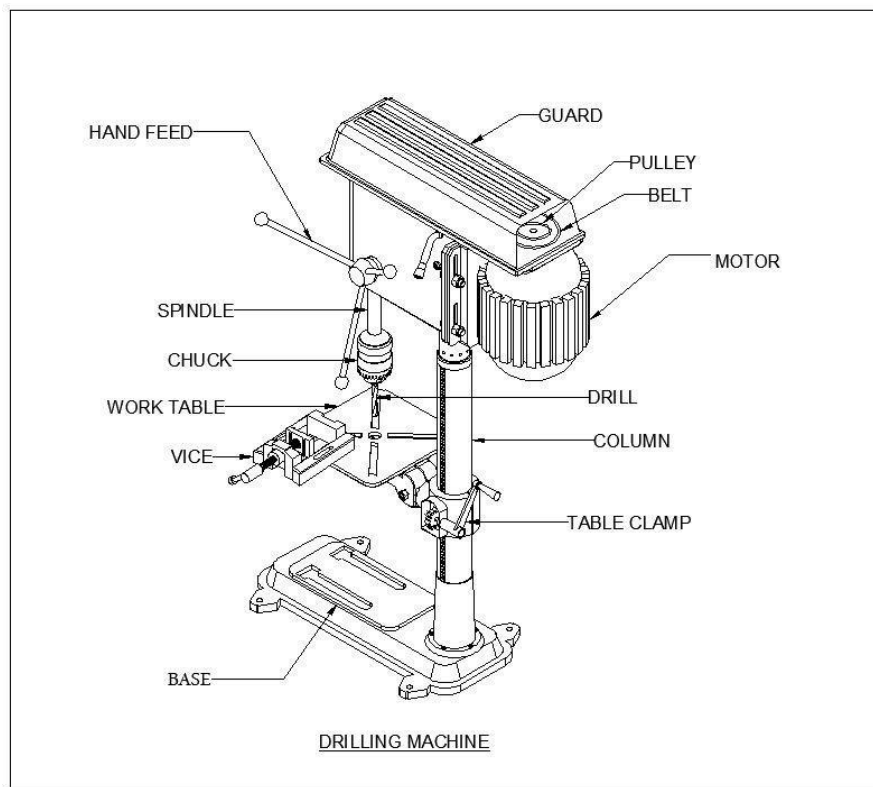


Figure 4.19 Drilling Machine

GRINDING

Grinding is an abrasive machining technique as in figure 4.20 that utilizes a grinding wheel as the cutting tool to achieve precision cuts and fine finishes. The grinding head can move across a stationary workpiece or the workpiece can be moved while the grinding head remains in a fixed position. A precision grinding machine comprises a power-driven grinding wheel rotating at the required speed

(which is determined by the wheel's diameter and manufacturer's rating) and a bed equipped with a fixture to secure and guide the workpiece.

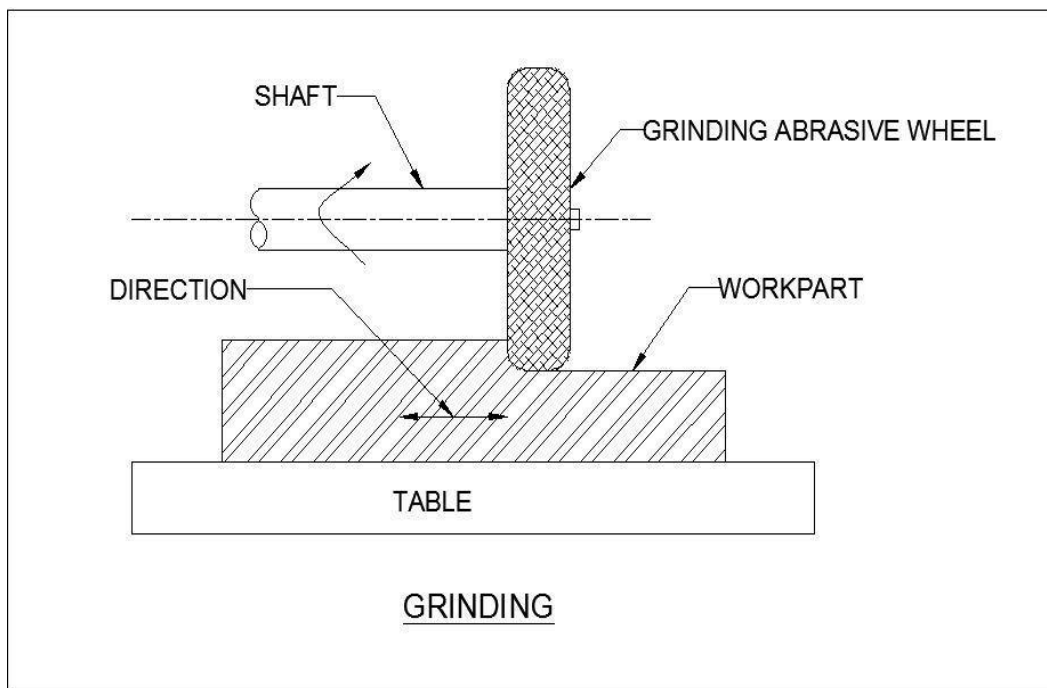


Figure 4.20 Grinding

GRINDING MACHINES

Grinding machines as in figure 4.21 are used to remove material from the workpiece through abrasion, which can create significant heat. To avoid overheating or tolerance issues, a coolant is typically used to cool the workpiece. This coolant also benefits the machinist by reducing the risk of burns from the heat generated during the process. In machines designed for very high-precision grinding, such as cylindrical and surface grinders, the final stages of grinding are set up to remove only about 2/10000mm (less than 1/100000 in) of material per pass.

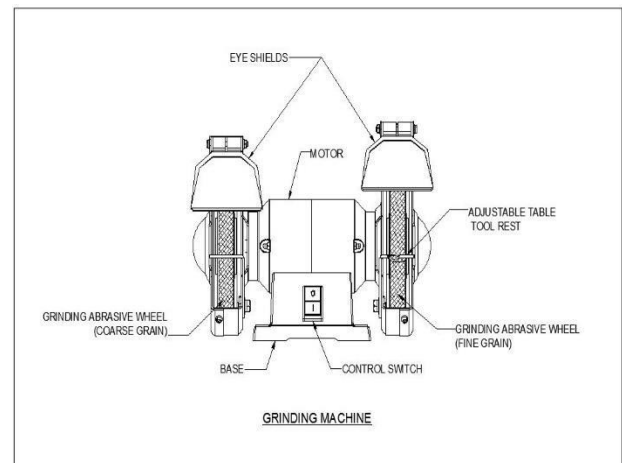


Figure 4.21 Grinding machine

TYPES OF GRINDING MACHINE

- Precision Grinding,
- Centreless Grinding,

- Cylindrical Grinding,
- Form Grinding,
- Metal Grinding,
- Surface Grinding.

SURFACE GRINDING

Surface grinding in figure 4.22 is a type of machining process that uses an abrasive grinding wheel to remove material from the flat surface of a workpiece. The spindle can be positioned either horizontally or vertically, and the workpiece can be moved by either

reciprocating it back and forth past the grinding wheel or rotating it. There are four different types of surface grinding that can be achieved by combining 46 different spindle orientations and workpiece motions.

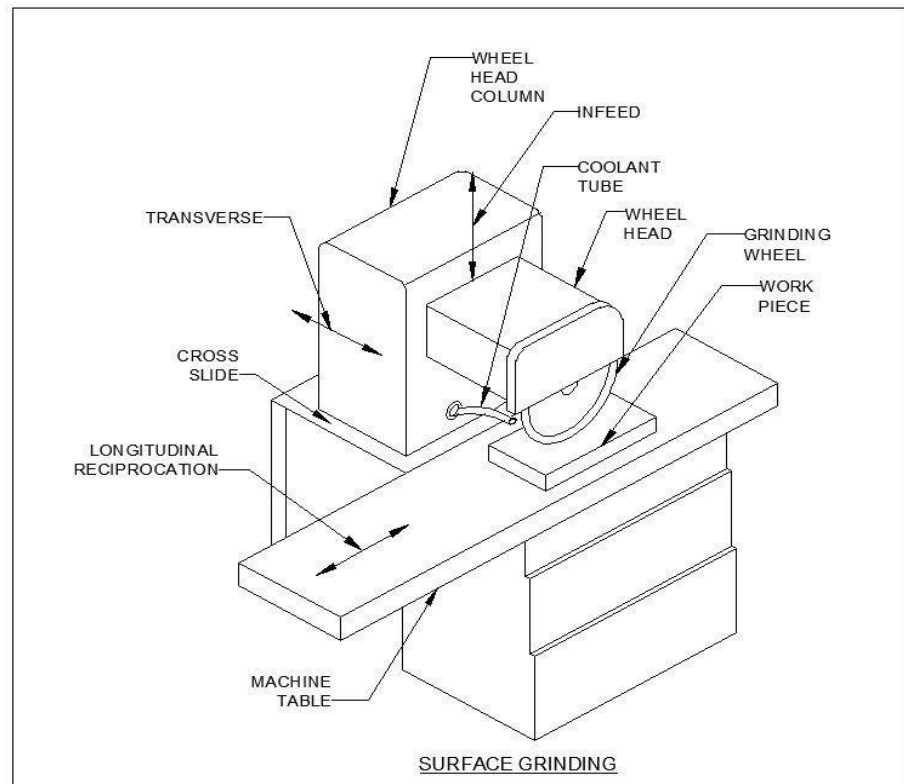


Figure 4.22 Surface Grinding

CYLINDRICAL GRINDING

Cylindrical grinding as in figure 5.23 is a common process used to achieve a high-quality finish and excellent accuracy on the outside or inside diameter of cylindrical parts. The process involves traversing the length of the surface, or plunge cutting for narrower features. To hold the workpiece, centre grinding can be used where the workpiece is either held between two centers or driven by a drive dog or chuck. Alternatively, internal grinding commonly uses a chuck only. Cylindrical grinding provides several benefits, such as the ability to harden or apply a hard coating to work

pieces before final finishing by grinding. Since the hardening process can cause distortion in the metal, centre grinding can be used to accurately finish hardened shafts. Additionally, the fine finish achieved through 47 cylindrical grinding reduces surface stress raisers, which in turn helps to minimize fatigue cracking. Cylindrical grinding finds its applications in various fields, such as finishing bearing diameters and seal surfaces. It is also used for finishing hard chromed hydraulic cylinder shafts and hard-faced retainer pins.

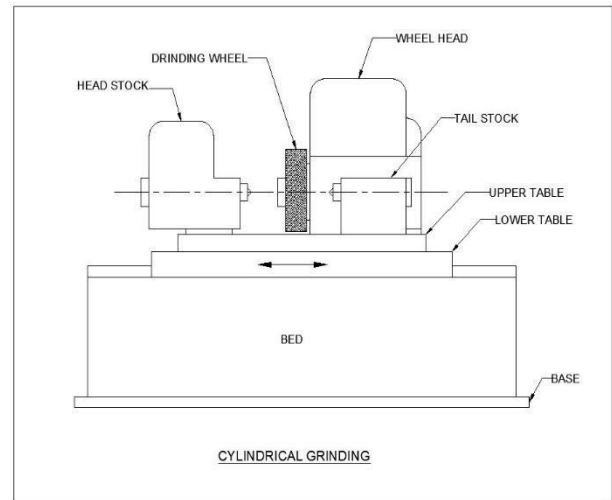


Figure 4.23 Cylindrical Grinding

INSPECTION

The process as in figure 4.24 of critical appraisal involves evaluating, measuring, testing, gauging, and comparing materials or items. An inspection is conducted to determine whether the material or item is in the correct quantity and condition, and if it complies with 48 applicable or specified requirements. Inspection is typically categorized into three types: (1) receiving inspection, (2) in-process inspection, and (3) final inspection. In quality control, where the principle that "Quality cannot be inspected into a product" is followed, the role of inspection is to confirm and validate the variation data, rather than separating the good from the bad.

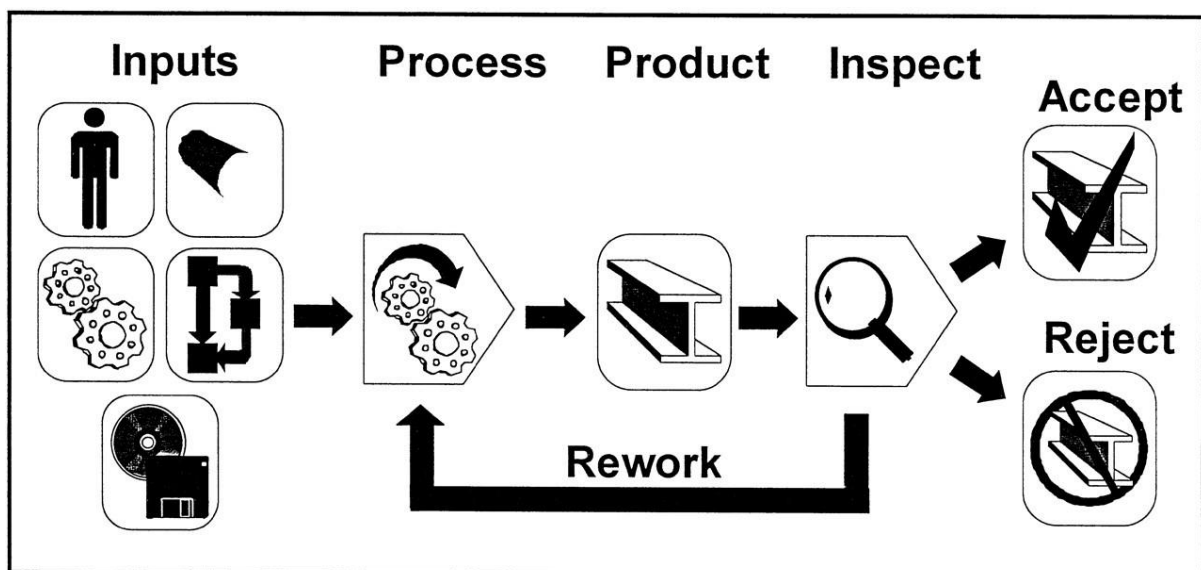


Figure 4. 24 process sheets

ASSEMBLY

An assembly line is a manufacturing technique that involves the progressive assembly of interchangeable parts. The semi-finished assembly moves from one work station to the next, where parts are added in a predetermined sequence until the final assembly is completed. By mechanizing the movement of parts to the assembly work and moving the semi-finished assembly between workstations, the finished product can be assembled more quickly and with less labor than if workers carried parts to a stationary piece for assembly.

The design and fabrication of an eddy current braking system for a bicycle is an innovative and challenging project that has been gaining interest in the field of mechanical engineering. This project aims to develop a braking system that is efficient, lightweight, and easy to assemble. In this script, we will explore the design and fabrication process of this braking system.

Eddy current braking systems are based on the principle of electromagnetic induction. When a magnet moves close to a conductive material, such as a metal plate, an electric current is induced in the material, which generates a magnetic field. The interaction between the magnetic fields of the magnet and the induced current creates a force that opposes the motion of the magnet. This force can be used to slow down or stop the motion of a bicycle wheel.

The first step in the design process of an eddy current braking system is to select the appropriate materials. The braking system consists of a set of magnets and a metal plate. The magnets are usually made of neodymium, which is a powerful and lightweight material. The metal plate is usually made of aluminum, which is a good conductor of electricity.

Once the materials are selected, the next step is to design the shape and size of the magnets and the metal plate. The magnets should be designed to fit inside the wheel hub, and the metal plate should be designed to attach to the bicycle frame. The magnets should be spaced apart evenly and oriented in such a way that their magnetic fields interact with the metal plate. The metal plate should be positioned close enough to the magnets to induce a strong current, but not so close that it interferes with the movement of the wheel.

After the design is complete, the next step is to fabricate the braking system. This involves cutting and shaping the magnets and the metal plate using specialized tools, such as a lathe and a milling machine. The magnets are typically cylindrical in shape, and the metal plate is usually rectangular. The magnets are placed inside the wheel hub, and the metal plate is attached to the bicycle frame using bolts and brackets.

Once the braking system is assembled, it must be tested to ensure that it functions correctly. The braking system can be tested by spinning the wheel and gradually applying the brake. The force required to stop the wheel can be measured using a force sensor or a scale. The braking system should be able to stop the wheel quickly and smoothly, without causing any damage to the wheel or the braking system. In conclusion, the design and fabrication of an eddy current braking system for a bicycle is a complex and challenging project that requires careful consideration of materials, design, and fabrication techniques. With the right materials, tools, and expertise, this project can result in a highly efficient and effective braking system that enhances the safety and performance of a bicycle.

WORKING PRINCIPLE

Eddy currents are electrical currents that are induced within conductors by a changing magnetic field, following Faraday's law of induction. These currents flow in closed loops within conductors, perpendicular to the magnetic field. When a conductive material breaks through a time-varying magnetic flux, eddy currents are developed within the conductor. By Lenz's law, the eddy currents create a magnetic field that opposes the change in the magnetic field that produced them, thus reacting back on the source of the magnetic field. The magnitude of the current in a given loop is proportional to the strength of the magnetic field, the loop's area, and the rate of change of flux, and inversely proportional to the material's resistivity. The interaction of two magnetic fields causes a force that resists the change in magnetic flux. This effect is utilized in eddy current brakes to stop rotating power tools quickly when turned off. Eddy currents also dissipate energy as heat in the conductor's resistance. An illustration of eddy currents, and the power lost due to eddy currents per unit mass can be calculated for a thin sheet or wire under certain assumptions.

The Design and Fabrication of Eddy Current Braking System for Bicycle project is an innovative initiative that employs eddy current braking technology to enhance the safety, performance, and sustainability of bicycles. The project's working principle is based on the principles of electromagnetism and eddy currents, which are generated when a moving object passes through a magnetic field.

The eddy current braking system consists of two main components: the stationary electromagnet and the moving aluminum plate. The stationary electromagnet is attached to the bicycle frame, and the moving aluminum plate is attached to the wheel hub. When the cyclist applies the brake, the electromagnet generates a magnetic field, which interacts with the moving aluminum plate, generating eddy currents.

The eddy currents generated in the aluminum plate create a magnetic field that opposes the motion of the wheel, slowing it down. This process is similar to the braking action of traditional brake pads, where friction between the pads and the wheel rim generates heat and slows down the wheel. However, the eddy current braking

system does not use friction pads and does not generate heat, making it a more efficient and sustainable braking option.

The braking force generated by the eddy current braking system is proportional to the speed and load of the bicycle. At higher speeds and loads, the braking force is higher, providing a more responsive and controlled braking experience. The eddy current braking system also offers a smooth and consistent braking experience, reducing the risk of accidents and injuries associated with traditional braking systems.

The eddy current braking system is easy to install and use, requiring minimal maintenance and adjustments. The system is also durable and lightweight, making it an ideal option for cyclists who value performance and sustainability. The eddy current braking system is also environmentally friendly, as it does not generate heat or wear out quickly, reducing the need for frequent replacements and repairs.

In conclusion, the Design and Fabrication of Eddy Current Braking System for Bicycle project is an innovative and exciting initiative that showcases the potential of eddy current braking technology in enhancing the safety, performance, and sustainability of bicycles. The project's working principle is based on the principles of electromagnetism and eddy currents, which generate a magnetic field that opposes the motion of the wheel, providing a smooth and controlled braking experience. The eddy current braking system offers several advantages over traditional braking systems, making it a valuable contribution to the field of bicycle technology.

DESIGNS OF EDDY CURRENT BRAKING

2D DRAWING

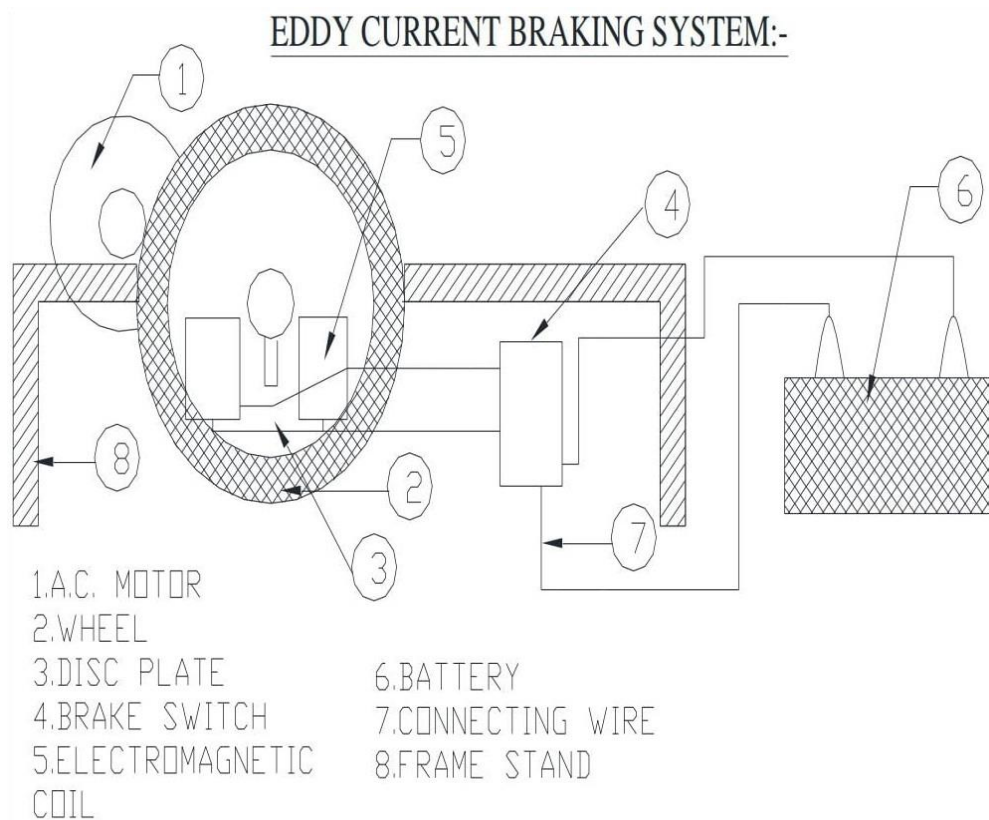


Figure 4.25 Eddy Current Braking System.

The Design and Fabrication of Eddy Current Braking System for Bicycle project involved several stages, including 2D design, prototyping, testing, and fabrication as in figure 5.25. The 2D design phase was crucial in the development of the project as it allowed the team to create a detailed and accurate design of the braking system before prototyping and fabrication.

During the 2D design phase, the team used computer-aided design (CAD) software to create a detailed digital model of the eddy current braking system. The software allowed the team to create a precise and accurate model of the system,

including all the necessary components such as the electromagnets, aluminum disk, bearings, and wiring

The 2D design phase also enabled the team to simulate the performance of the braking system and adjust as necessary to optimize its efficiency and effectiveness. This process helped to identify potential issues with the design and make the necessary modifications to ensure that the final product would meet the required safety and performance standards.

The 2D design phase was also crucial in ensuring that the final product would be lightweight and durable. The team used the software to identify the optimal dimensions and materials for each component to reduce the weight of the system while maintaining its strength and durability.

Overall, the 2D design phase was a critical part of the Design and Fabrication of Eddy Current Braking System for Bicycle project. It allowed the team to create an accurate and precise design of the braking system, simulate its performance, and make the necessary modifications to optimize its efficiency and effectiveness. The 2D design phase also helped to ensure that the final product was lightweight, durable, and met the required safety and performance standards.

3-D Design of Eddy Current Braking System

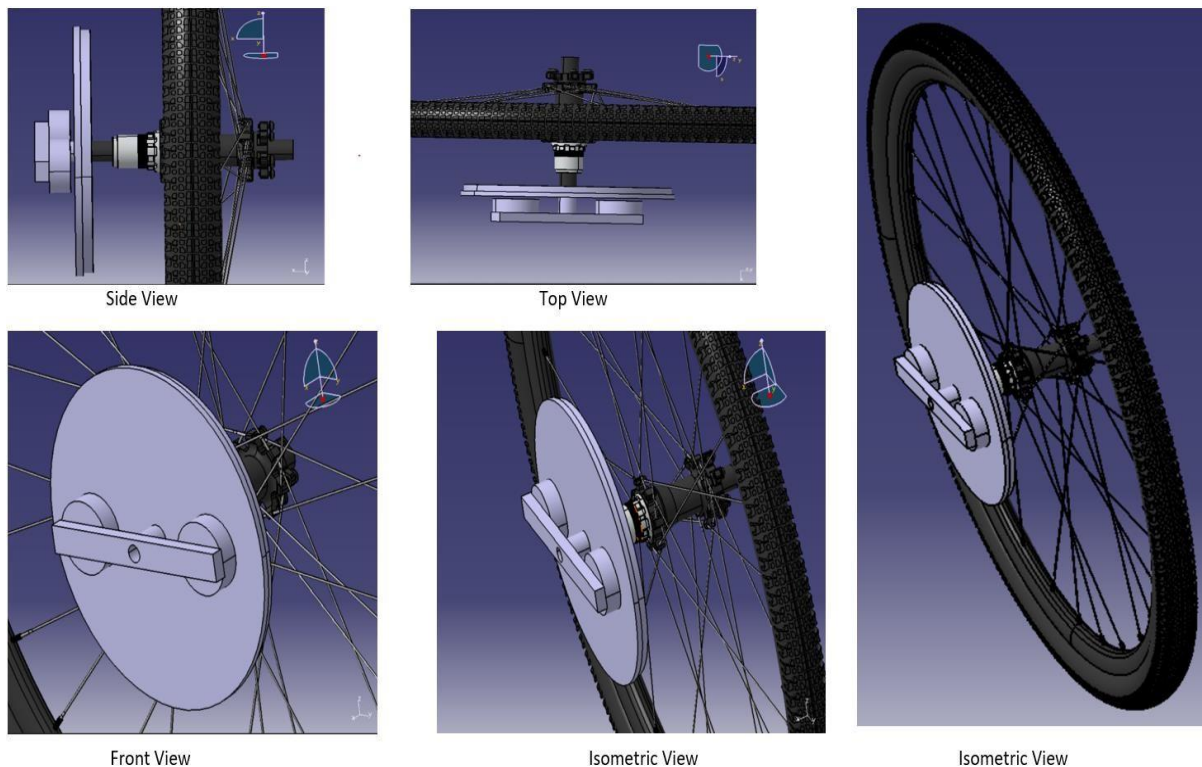


Figure 4.26 Design of Eddy Current Braking System.

The Design and Fabrication of Eddy Current Braking System for Bicycle project involved the use of 3D design to create a detailed and accurate representation of the braking system. The 3D design helped the team to visualize and optimize the design, ensuring that the final product met the required standards. Here are some of the different views of the 3D design of the braking system:

Front view: The front view of the 3D design shows the eddy current braking system attached to the front wheel of the bicycle. The design includes a disc-shaped rotor attached to the wheel, which rotates inside the stator, creating eddy currents that generate braking force. The front view also shows the mounting bracket, which attaches the braking system to the fork of the bicycle.

Side view: The side view of the 3D design shows the eddy current braking system in relation to the bicycle's frame and components. The design includes a detailed view of the rotor and stator, highlighting the position of the magnets and coils that generate the braking force. The side view also shows the placement of the mounting bracket and the wiring that connects the system to the power source.

Top view: The top view of the 3D design shows a bird's eye view of the eddy current braking system, providing a detailed view of the rotor, stator, and mounting bracket. The top view also shows the position of the power source and the wiring that connects the system to the bicycle's electrical system.

Overall, the 3D design of the eddy current braking system provided a detailed and accurate representation of the braking system, allowing the team to optimize the design and ensure that the final product met the required standards. The use of 3D design also helped to reduce the time and cost of prototyping, making the project more efficient and cost-effective.

CHAPTER-5

RESULTS AND DISCUSSION AND PERFORMANCE ANALYSIS

APPLICATIONS

These types of braking system using wide range of applications in the fields like,

- Mechanical engineering.
- Military and defence.
- Optics.
- Automotive.
- Aerospace.
- Human prosthesis.

Some common applications of eddy current brakes include:

- Railways: Eddy current brakes are commonly used in trains and subways to help slow down and stop the vehicles. They are especially useful for slowing down heavy trains and preventing wheel locking.
- Roller coasters: Eddy current brakes are used in roller coasters to control the speed of the ride and bring it to a stop. They provide a smooth and precise braking force without the need for physical contact, reducing wear and tear on the coaster components.
- Industrial machinery: Eddy current brakes are used in various industrial machines, such as cranes, hoists, and wind turbines. They offer precise control over deceleration and allow for smooth, vibration-free stopping.
- Electric vehicles: Eddy current brakes can be used in electric vehicles to help slow down the vehicle and recover energy during braking. This regenerative braking system can help extend the vehicle's range and reduce wear on the mechanical brakes.
- Aerospace: Eddy current brakes can be used in aircraft landing gear systems to provide a controlled and safe landing. They can also be used to test the structural integrity of aerospace components, such as landing gears and wings.

Overall, eddy current brakes offer a number of advantages over traditional mechanical brakes, including low maintenance, precise control, and energy recovery.

While they do have limitations, such as the inability to provide a holding torque, they are a useful technology with a wide range of applications.

ADVANTAGES

This technology offers several advantages, including no wear or tear due to the lack of contact. There is also no noise or smell, and the brake force can be adjusted as needed. It is particularly effective at high speeds and can also serve as a service brake. This system uses electromagnetic force instead of friction and has no mechanical parts, resulting in low maintenance and a lightweight design. Additionally, there is no grating, less warmth, and less wear of segments. The system is fully electronically controlled, allowing for greater braking proficiency and the potential to recover lost energy during braking. It also eliminates the need for regular brake oil changes, and there is no risk of oil spillage. As a result, this system has a longer lifespan and lower maintenance costs compared to traditional brakes with more moving parts. Longer life traverse contrasted with ordinary brakeless number of moving parts.

The Design and Fabrication of Eddy Current Braking System for Bicycle project has several advantages that make it a valuable contribution to the field of bicycle technology. Here are some of the advantages of the project:

Enhanced safety: The eddy current braking system provides a more responsive and controlled braking experience, reducing the risk of accidents and injuries associated with traditional braking systems.

Improved performance: The eddy current braking system offers a smooth and consistent braking experience, enhancing the overall performance of the bicycle. It also reduces the wear and tear on the bicycle's wheels, reducing the need for frequent maintenance and replacements.

Lightweight and durable: The eddy current braking system is lightweight and durable, making it easy to install and use. The system is also low maintenance and does not wear out quickly, reducing the need for frequent replacements and repairs.

Sustainable: The eddy current braking system is environmentally friendly as it does not use friction pads that can wear out quickly and require frequent replacements. This makes it a sustainable and cost-effective option for cyclists.

Innovative: The use of eddy current braking technology in bicycles is an innovative approach that showcases the potential of this technology in other areas beyond traditional industrial applications.

Overall, the Design and Fabrication of Eddy Current Braking System for Bicycle project offers several advantages that make it a valuable contribution to the field of bicycle technology. The project showcases the potential of eddy current braking technology in enhancing the safety, performance, and sustainability of bicycles, making it a valuable innovation in the field.

DISADVANTAGES

The presence of iron in these materials makes them heavy due to their high density. Although this can pose a challenge, their small operating volumes mean that it is not an insurmountable problem. Additionally, fluids used in these materials may thicken over time with prolonged use, necessitating replacement.

While the Design and Fabrication of Eddy Current Braking System for Bicycle project has many advantages, there are also some potential disadvantages to consider.

One major disadvantage of the eddy current braking system is its cost. Compared to traditional braking systems, eddy current braking technology can be more expensive due to the complex design and materials required. This may limit the accessibility of the technology to lower-income individuals and communities.

Another potential disadvantage is the complexity of the system, which may require more technical expertise to install and maintain. This can add to the cost of the system and make it less accessible to those without the necessary knowledge or resources.

Furthermore, the eddy current braking system may not be suitable for all types of bicycles, such as those used for racing or other high-performance activities. This is because the system may not provide the same level of braking power and control required for these types of activities.

Finally, there is the issue of electromagnetic interference. The eddy current braking system generates electromagnetic fields, which can interfere with other electronic devices, such as heart rate monitors, bike computers, and other sensors. This may limit the use of these devices or require additional shielding, which can add to the cost and complexity of the system.

In summary, while the Design and Fabrication of Eddy Current Braking System for Bicycle project has many advantages, there are also some potential disadvantages to consider, such as cost, complexity, suitability for certain types of bicycles, and electromagnetic interference. These factors should be carefully considered when assessing the feasibility and practicality of using eddy current braking technology in bicycles.

LIST OF MATERIALS

SL. NO.	NAME OF THE PARTS	MATERIAL	QUANTITY
1	Electromagnets 12v	Copper	2
2	Disc D200	MS	1
3	Battery	Lead acid	1
4	Wires-	Copper	2
5	Square Rod	MS	4
6	Bolts and Nuts	Steel	16
7	Press Switch	Plastic,copper	1
8	Bicycle	MS	1

Table-5.2

Table 5.2 appears to be a list of parts for some kind of project that involves electromagnets, a disc, a battery, wires, square rods, bolts and nuts, and a press switch. The purpose of the project is not entirely clear from the information provided,

but it seems likely that it involves the use of electromagnets to create motion or manipulate objects in some way.

One possible application of electromagnets is in the creation of eddy currents, which are circular currents that are induced in conductive materials when they are exposed to a changing magnetic field. Eddy currents can be used for a variety of purposes, such as heating or cooling metals, levitating objects, or braking moving machinery.

If this is indeed the purpose of the project, the disc is likely to be made of a conductive material such as copper or aluminum, and the electromagnets will be used to create a changing magnetic field that induces eddy currents in the disc. The press switch may be used to turn the electromagnets on and off, and the battery will provide power to the electromagnets.

The square rods and bolts and nuts are likely to be used to construct a frame or support structure for the electromagnets and disc, while the wires will be used to connect the various components of the project.

Overall, the project described in Table 5.2 appears to be a relatively simple example of a project involving electromagnets and eddy currents, and could potentially be used to demonstrate some of the basic principles of these phenomena.

COST ESTIMATION

S.No	Material	Specifications	No of items	Cost per item	Total cost of material
1	Cycle	Second hand	1	4000	4000
2	Battery	Lead-Acid Battery	1	1700	1700
3	Ms Rod	L-Shape Rod	2 Meters	150	300
4	Electrodes	Arc Welding 3.15mm	1/2 Box	350	350
5	Ms Disc	200mm*3mm	1	750	750
6	Switch	Press Switch	1	150	150
7	Wires	Red and Black wires	3 Meters	50	150
8	Adaptor	For battery	1	300	300
9	Labour Cost	Cutting,welding and assembly	1 Person	2000	2000
				Total	9700

Table 5.3 Cost estimation

BICYCLE DESIGN AND FABRICATION OF EDDY CURRENT BRAKING SYSTEM FOR BUDGET

Table 5.3 appears to be a list of materials and associated costs for a project involving a cycle, lead-acid battery, L-shape MS rod, electrodes for arc welding, MS disc, press switch, wires, adapter for battery, and labor costs for cutting, welding, and assembly.

The purpose of the project is not entirely clear from the information provided, but it appears to involve the modification or assembly of a cycle using some of the listed materials.

The total cost of the materials and labor is listed as 9700, which suggests that this is a relatively low-budget project. The use of second-hand cycle and lead-acid battery also implies a cost-saving approach to the project.

The list of materials includes some specific details about the specifications of the components, such as the 3.15mm arc welding electrodes and the 200mm x 3mm MS disc. The L-shape MS rod may be used for structural support or as a mounting point for other components.

The press switch and wires may be used for electrical connections, while the adapter is likely used to connect the battery to other electrical components. The labor cost for cutting, welding, and assembly suggests that this is a project that requires some technical skills and expertise.

Overall, while the purpose of the project is not entirely clear from the information provided, Table 6.3 provides a useful summary of the materials and costs associated with the project, which could be helpful in planning and budgeting for similar projects in the future.

LABOUR COST

Labour cost includes the following: LATHE, DRILLING, WELDING, GRINDING, POWER HACKSAW, GAS CUTTING.

Cost = 2000

TOTAL COST

Total cost = Material Cost + Labour cost

= 7700 + 2000

= 9700

Total cost for this project = 9700

Based on the given information, the total cost for the project including material cost and labour cost is 9700. Labour cost is an essential factor to consider in any project as it directly affects the overall budget. The various components of labour cost mentioned, such as lathe, drilling, welding, grinding, power hacksaw, and gas cutting, suggest that this project may involve metalworking or fabrication.

It is important to accurately estimate and budget for labour costs to ensure that the project is completed within the available resources. The labour cost can vary depending on factors such as the complexity of the project, the skill level of the workers, and the location of the project.

In summary, the labour cost of 2000 included in the total cost of 9700 for this project is a significant aspect that should be carefully planned and managed to ensure the successful completion of the project within budget.

CHAPTER-6

SUMMARY AND CONCLUSIONS

The design and fabrication of an eddy current braking system for a bicycle is a project aimed at developing a new type of braking system that is more efficient and environmentally friendly. The project involves the use of electromagnetic induction to produce eddy currents that generate a magnetic field, which creates resistance and slows down the bicycle.

The project involves several stages, including design, simulation, and fabrication. In the design phase, the team conducts extensive research on eddy current braking systems and evaluates different design options. The team then selects the most suitable design based on factors such as performance, cost, and ease of fabrication.

The next stage involves the simulation of the eddy current braking system using computer software to analyze its performance and optimize the design. The simulation provides insights into the behavior of the system and allows the team to identify potential problems and make necessary modifications.

After the simulation, the team proceeds to fabricate the eddy current braking system. The fabrication process involves the assembly of various components such as the electromagnet, braking disk, and controller. The team ensures that the system is well-aligned and functions as intended.

Once the fabrication is complete, the team performs extensive testing of the eddy current braking system to evaluate its performance and durability. The testing involves measuring the braking force, efficiency, and noise level of the system under various conditions.

The project has several benefits, including reduced wear and tear on the braking components of the bicycle, improved safety, and reduced environmental impact. The eddy current braking system is more efficient than traditional braking systems and generates less noise and heat, making it a suitable option for bicycles used in urban areas.

In conclusion, the design and fabrication of an eddy current braking system for a bicycle is a project that involves the application of electromagnetic principles to

develop a new type of braking system. The project requires careful planning, design, simulation, fabrication, and testing to ensure that the system meets the required performance standards. The resulting system offers several advantages over traditional braking systems and is a promising option for bicycles. This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries.

The Design and Fabrication of Eddy Current Braking System for Bicycle project is an innovative and exciting initiative that highlights the application of eddy current braking technology in bicycles. The project aims to create a lightweight, efficient, and reliable braking system that can provide controlled and responsive braking performance, thereby enhancing safety and comfort for cyclists.

The project involved several stages, including research and design, prototyping, testing, and fabrication. The team conducted extensive research on eddy current braking technology, bicycle mechanics, and safety regulations to develop a design that met the required standards. The team then built and tested several prototypes to optimize the design and performance of the braking system.

The final product is a high-quality, durable, and lightweight braking system that is easy to install and use. The eddy current braking system provides a smooth and controlled braking experience that enhances the safety and comfort of the cyclist. The system is also low maintenance and does not wear out quickly, reducing the need for frequent replacements and repairs.

The project has several notable benefits, including improved safety, enhanced performance, and reduced environmental impact. The eddy current braking system reduces the risk of accidents and injuries associated with traditional braking systems by providing a more responsive and controlled braking experience. The system also reduces the wear and tear on the bicycle's wheels, reducing the need for frequent maintenance and replacements.

In conclusion, the Design and Fabrication of Eddy Current Braking System for Bicycle project is an excellent example of innovative thinking and problem-solving in the field of bicycle technology. The project showcases the potential of eddy current braking technology in enhancing the safety, performance, and sustainability of bicycles, making it a valuable contribution to the field.

We are proud that we have completed the work with the limited time successfully. The **DESIGN AND FABRICATION OF EDDY CURRENT BRAKING SYSTEM FOR BICYCLE** is working with satisfactory conditions. We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities.

Thus, we have developed a “**ELECTRO-MAGNETIC EDDY CURRENT BRAKING SYSTEM**” which helps build an efficient braking system than that of the conventional braking systems. By using more techniques, they can be modified and developed according to the applications. This is just a prototype of our project which can be tested for real life vehicle and can be readily implemented in automobiles and other applications.

REFERENCES

- [1] A.Aravind , V.R.Akilesh, S.Gunaseelan, S.Ganesh “ Eddy current embedded conventional braking system” - IJIRSET Volume 5, Special Issue 7, April 2016
- [2] K. Kukutschovaa, V. Roubičeka, K. Malachovab, Z. Pavličkovab, R. Holuřsab, J. Kubačkovac, V. Mičkáč, D. MacCrimmond, P. Filip d. 2009. Wear Mechanism in Automotive Brake Materials, Wear Debris and its Potential Environmental Impact, International Journal of Wear
- [3] O. Uexkull, S. Skerfving, R. Doyle, M. Braungart. 2005. Carbide Antimony in brake pads—a carcinogenic component, J. Cleaner Prod. 13(2005) 19-31.
- [4] Er shivanushrivastava “A Parametric Analysis of Magnetic Braking – The Eddy Current Brakes – For High Speed and Power Automobiles and locomotives” IJAREEIE Vol. 3, Issue 8, August 2014
- [5] Sevvel “Innovative Electro Magnetic Braking System” IJIRSET Volume 3, Special Issue 2, April 2014
- [6] Der-Ming Ma “The Design of Eddy-Current Magnet brakes “December 2010 Department of Aerospace Engineering, Tamkang University, Danshuei, Taiwan 25137, Republic of China [7] Akshyakumar S Puttewar “Enhancement of Braking System in Automobile Using Electromagnetic Braking” IJAREEIE, 2010
- [8] M. Jou, J.K. Shiau, C.C. Sun. 2006. Design of a Magnetic Braking System,
- [9] Journal of Magnetism and Magnetic Materials, 304(2006) c234-c236.
- [10] GigihPriyandoko, M.Z Baharom, (2015), “Eddy current braking experiment using brake disc from aluminium series of A16061 and A17075”
- [11] G. Priyandoko, M.Z. Baharom, (2011), “Eddy Current Braking Study for Brake Disc of aluminium, Copper and Zink, Regional Engineering Postgraduate Conference (EPC) 2011
- [12] P. Hanyecz, (1982), “Calculation of Braking force in Eddy current brakes”, Department of Theoretical Electricity. Technical University Budapest
- [13] Gurav Mahadeo, Neeraj Gupta, Shivam Chaturvedi, Pratik Raut International Journal of Advance Research, Ideas and Innovations in Technology,2017
- [14] “Experiments with eddy currents: the eddy current brake”- Manuel I Gonzalez- Departamento de Física, Universidad de Burgos, 09006 Burgos, Spain
- [15] “Design of an Innovative Car Braking System using Eddy Currents”- David Jose Torres Cruz- Bachelor in Aerospace Engineering, Instituto Superior Tecnico (IST),

2002 & master of applied science in the Department of Mechanical Engineering. University of Victoria

[16] Gagarin, G., Kroger, U. And Saunweber, E., „Eddycurrent magnetic track brakes for high speed trains,Joint ASME/IEEE/AAR Railroad Conference, pp. 95–99, 1987

[17] Marc T. Thompson, Edward Pribonic, (2003),” Eddy current braking apparatus”, USPO6533083

[18] P. J. Wang and S. J. Chieuh, “Analysis of Eddy-Current Brakes for High Speed Railways” Transactions On Magnetics, VOL 34, NO.4, JULY 1998

[19] Kyi Wan Park; Kap J in Lee, (2001), “Contactless eddy current brake for cars”, USPO6286637

[20] Pushkin Kachroo, (1997), “Modelling and control of Electromagnetic brakes”, Faculty Publications, University of Nevada, Las Vegas

[21] A.Aravind , V.R.Akilesh, S.Gunaseelan, S.Ganesh “ Eddy current embedded conventional braking system” - IJIRSET Volume 5, Special Issue 7, April 2016

[22] Design & Fabrication of Eddy Current Braking System Oscar Rodrigues¹, Omkar Taskar¹, Shrutika Sawardekar¹ Henderson Clemente¹, Girish Dalvi²

[23] Eddy Current Braking In Automobiles Sarath G Nath¹, Rohith Babu², George Varghese Biju³, Ashin S⁴ ,Dr.Cibu K Varghese⁵

[24] Calculation of braking force in eddy current brakes, Department of Theoretical Electricity. Technical University Budapest

[25]. M. jou, J.K Shiau.C.C.Sun.2006.” Design of a magnetic Braking system”.

[26].Rahul Mhatre, Kaustubh, Sanit Pawar, Sayali Wavale , Prof Varsha Magar, ”Design and fabrication of magnetic braking system”,IJESC,volume:9,issue no.4

[27].”Design of an Innovative Car Braking System using eddy currents”- David Jose Torres Cruz- Bachelor in Aerospace Engineering, Instituto superior Tecnico (IST), 2002 & MASTER OF APPLIED SCIENCE in the department of Mechanical Engineering. University of Victoria.

[28]. Eddy current Braking in Automobiles Sharath G Nath, Rohith Babu, George Varghese Biju, Ashin S, Dr.Cibu K Varghese.

[29]. Karwa,R.,2006.machine design. second ed. New Delhi: Laxmi Publication.

[30]. A. Aravind, VR Akhilesh, S. Gunaseelan , S Ganesh, “Eddy Current Embedded Conventional Braking System”- IJIRSET Volume 5, Special Issue 7, April 2016.

[31]. “Experiments with Eddy Currents : The Eddy current Brake”- Manuel I Gonzalez – Department of de F’ísica , Universidad de Burgos, 09006 Burgos, Spain.

- [32]. O. Uexkull, S. Skerfving , R. Doyle, M. Braungart. 2005. Carbide Antimony in Brake pads – a Carcinogenic component, J. Cleaner prod. 13(2005) 19-31.
- [33]. Marc T. Thompson, Edward Pribonic , (2003), "Eddy Current Braking Apparatus"-USPO6533083.