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DESIGN AND FABRICATION OF EDDY CURRENT BRAKING SYSTEM FOR BICYCLE

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Abstract - *In Automotive Industry many traditional brakings which are used now a days by the concept of mechanical blocking. It results in skidding and wear and tear on the vehicle. And if the vehicle's speed is very high, the brake can't deliver that high braking force and it will cause problems. These disadvantages of ordinary brakes can be overcome by a simple and effective braking mechanism called 'Eddy Current Brake'. It is a method without abrasion for braking vehicles, including trains. It makes use of the opposite tendency of eddy current. Eddy current is the swirling current produced within a conductor, which is subject to a change of magnetic field. Due to the tendency of eddy currents to be oppositional, eddy currents lose energy. Eddy current brake consists of a conductive non-ferromagnetic metal disc (rotor) attached to the rear axle of the bicycle wheel, with an electromagnet located with its poles on the disk without contact, so the magnetic field by electromagnets passes through the disk. The electro-magnet makes it possible to vary the braking force.*

Key Words: Eddy Current Braking System, Eddy Current, Magnetic Field, Brakes, Frictionless Brake Disc, Wheel.

Nomenclature:

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

Bp is the peak magnetic field (T),

d is the thickness of the sheet or diameter of the wire (m),

f is the frequency (Hz),

k is a constant equal to 1 for a thin sheet and 2 for a thin wire,

ρ is the resistivity of the material (Ω m), and

D is the density of the material (kg/m3).

1.INTRODUCTION

Transitioning to a new braking system is necessary for light of the green technology trend, which emphasizes the significance of protecting the environment. Compared to the present braking system, which employs brake pads, the new technology creates far less air pollution when braking. Environmental damage might be caused by brake dust. Reference: (Kukutschova et al., 2009) [2]. A number of toxic chemicals in the debris have been shown to induce cancer via interactions with DNA in live beings (Uexkull et al., 2005) [3]. When compared to traditional braking systems, eddy current braking offers various benefits. It's eco-friendly, and it helps keep brake pads from wearing out prematurely and vibrating excessively. According to its proponents, eddy current brakes are good for the planet because they cut down on brake shoe wear, a major source of air pollution. This experiment was designed to investigate the workings of an eddy current braking system using electromagnets and aluminium for the brake discs in light of the need for novel braking systems that are both environmentally friendly and capable of alleviating the aforementioned typical difficulties. I was. Eddy currents are a crucial phenomenon in electromagnetic induction that may be used in a wide variety of fields. When a conductive substance travels through a stationary magnetic field, it generates a drag force called eddy current braking (Jou et al., 2006, p. Energy is lost and friction is created when flux changes cause eddy currents in conductors (Jou et al., 2006) [8]. As a result, the electromagnetic braking system has no contact parts to lessen lining wear. Worn-out debris is reduced, which is a positive for the environment.

2. WORKING PRINCIPLES OF EDDY CURRENT:

Faraday's law of induction states that a changing magnetic field inside a conductor would cause current loops, or "eddy currents," as seen in Figure 1. When a magnetic field is applied to a conductor, eddy currents will form closed loops inside the conductor and flow in a direction perpendicular to the field. Changes in the magnetic flux associated with a metallic conductor result in a closed-loop induced current in the conductor (Figure 1). Eddy currents are the common name for several types of currents. When a conductor is interrupted by the time-varying magnetic flux, eddy currents are produced. In a conductor, eddy currents move in a plane transverse to the magnetic field, following closed loops. Lenz's law states that eddy currents react to the source of the magnetic field by producing a magnetic field that is perpendicular to the change in the magnetic field that caused it. These eddy currents, which circulate within the conductor, cause a magnetic field of the opposite polarity to that of the externally applied field. Current in a closed loop is

proportional to the magnetic field intensity, the loop area, and the magnetic flux rate of change, and inversely proportional to the resistivity of the material. Two magnetic fields interacting generates a force that opposes magnetic flux changes. When a moving magnetic field induces eddy currents in a nearby conductive surface, that surface acts as a drag force against the moving magnet. Eddy current braking is a technique that makes advantage of this phenomenon. By way of illustration, a moving magnetic field induces eddy currents in a nearby conductive surface, which creates drag and therefore resistance to the magnet's forward motion. Eddy current braking makes advantage of this phenomenon. When the power is turned off, the motor of the power tool is immediately stopped by the eddy current brakes. When electricity flows through a conductor's resistance, heat is generated.

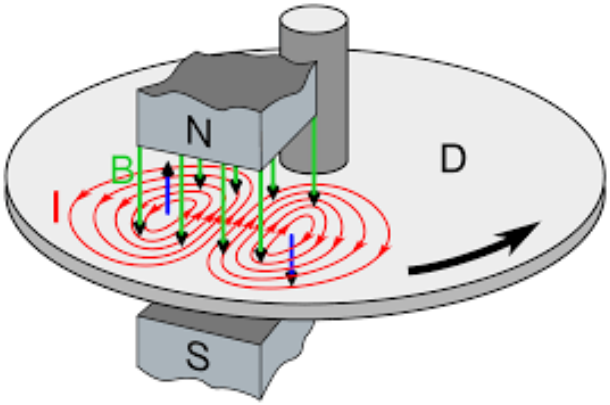


Figure 1 : Eddy Current Braking

3. METHODOLOGYOF EDDY CURRENT BRAKING BICYCLE:

Rather of using friction and kinetic energy to slow down an object's movement, as is the case with traditional mechanical brakes, eddy current brakes use electromagnetic. By producing an opposing force that spins inside the conductor as it moves through a magnetic field, eddy currents are generated. Lenz's Law states that eddy currents are the inverse reaction to a magnetic field, since they generate a magnetic field that is in opposition to the source magnetic field. Clean deceleration is possible because to this electromagnetic force response. Eddy current braking is cutting edge technology that has several benefits over traditional mechanical stopping. Eddy current brakes are great for many equipment since they need no moving parts and require almost little maintenance. Eddy current braking is often used by manufacturers because of its physical and financial benefits. A non-ferromagnetic, electrically conducting disc spins vertically in a toroidal magnetic field to provide an eddy current brake. Eddy currents are induced in the conductor when the disc spins. A braking torque is then generated by spreading the force over the disc. Since the intensity of the magnetic field (and therefore the braking effect) can be adjusted with electromagnets, they are often employed in place of permanent magnets for eddy current braking. Eddy current brakes suffer mostly from a lack of retaining torque, which is a critical safety feature. Since this is the case, they are often utilized in addition to regular mechanical brakes.

The following equation [25] may be used to determine the power lost per unit mass for a thin sheet or wire due to eddy currents under particular conditions (uniform material, uniform magnetic field, no skin effect, etc.).

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

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

4. BRAKING EFFICIENCY:

The effectiveness of a brake may be measured by its capacity to slow a vehicle to a halt, to keep it moving at a constant rate while going downhill, or to keep it moving downhill. [12]

STEP 1

The only place to get an accurate estimate of your car's overall braking effort is at a repair shop. To stop your automobile with the floor brake engaged, the overall braking force is equivalent to what you would normally exert. Tires are tested on a special machine that spins them around and then stops them cold. It's designed to make you feel like you're driving a real automobile, complete with stops and starts. Get your automobile checked out on the tyre machine so the technician can calculate how much force is needed to stop the vehicle.

STEP 2

Find out how much your car weighs. In the owner's handbook, you may find the vehicle's curb weight.

STEP 3

To get the braking efficiency %, multiply this quantity by 100 and then divide the result by the vehicle's weight.

5. SUGGESTED MATERIALS REQUIRED FOR THIS PROJECT:

1	Electromagnets12v	5	Square Rod
2	MS disc	6	Bolts and Nuts
3	Battery12v 7A	7	PressSwitch12v7A
4	Wires	8	Bicycle

Table 1 : Materials for Eddy current Braking System

5.1 COMPONENTS OF EDDY CURRENT BRAKING (As per Table 1) :

5.1.1 ELECTROMAGNETS:

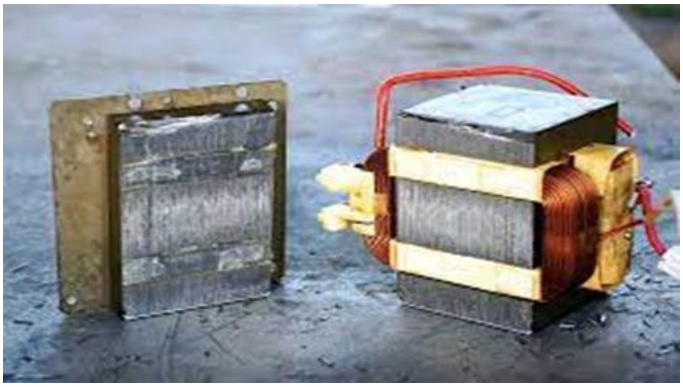


Figure 2 : Electromagnets

Electromagnets are often made by winding a wire into a coil, as seen in Figure 2. When the current flows through the wire, a magnetic field is produced, with its centre of attraction located at the coil's central hole. When the power is cut, the magnetic field dissipates at the disc. Wire is often wrapped around a core of a ferromagnetic or ferrimagnetic material, such as iron, to generate a magnetic field. A stronger magnet may be produced by concentrating the magnetic flux in a core.

The main benefit of electromagnets over permanent magnets is that the intensity of the magnetic field may be quickly adjusted by varying the current through the windings. Electromagnets, in contrast to permanent magnets, do require a source of energy in order to maintain their magnetic field steady.

A battery might power this DC electromagnet. Instead of employing permanent magnets, electromagnets are employed. This is because electrical actuation is not only faster than mechanical actuation, but also results in less energy being wasted. Furthermore, magnetic fields cannot be stored like permanent magnets, thus they must be generated as needed. Increasing the current through the coil or the number of turns may both increase the magnetic field's strength. Permanent magnets, which are necessary for large magnetic fields, are bulky and difficult to set up. Electromagnets are lightweight, portable, and don't interact with other metals. An electromagnet is a kind of magnet that is driven by electricity to generate a magnetic field. Cutting off the current to the disc causes the magnetic field there to disappear. An electromagnet's magnetic field is typically produced by a large number of closely spaced twists of wire. Wire is often wrapped around a core of a ferromagnetic or ferrimagnetic material, such as iron, to generate a magnetic field. A stronger magnet may be produced by concentrating the magnetic flux in a core. Electromagnets may be found in a wide variety of devices, including motors, generators, relays, speakers, hard drives, MRI machines, scientific equipment, and magnetic separation devices. Electromagnets are used for lifting and moving heavy ferrous materials in the industrial sector, such as scrap metal and steel.

5.1.2 BATTERY

It is suggested that electromagnets' Eddy Current Braking may benefit from a lead acid battery. Here, the energy from the battery will be temporarily converted into a magnetic field around the disc.

5.1.3 MS DISC: Mild steel plates, which are formed of flat steel, have many uses in the building, manufacturing, and industrial industries due to their strength and versatility (not aesthetically). Standard practice calls for inches to be used for describing the thickness of mild steel.

5.1.4 Ms Rod: Structural steel, often known as a ferrous metal, is composed of iron and carbon. It's an inexpensive material that can be put to use in many common engineering applications. Mild steel's high magnetic properties belie its low carbon content. Therefore, it is referred to as a "ferromagnetic" material.

6.FEATURES OF EDDY CURRENT BRAKING:

1. There is no friction, hence there is no wear and tear.

2. Not a peep, not a stink. Force of the brakes is variable.

3. Strong stopping power at high velocities.

4. Functions as a service brake as well.

5. Magnetic force is replaced by electromagnetic force. Non-mechanical (no moving components, no friction) (no moving parts, no friction).

6. Allows for electrical signal activation at will

7. Easily maintained

8. Inconspicuous in weight

9. Avoids any grating

10. Reduced comfort

11. decreased section wear.

12. Total electronic control.

13. Superb capability to recoup energy lost when braking.

14. Possible recovery of energy lost while braking.

15. No regular brake oil changes are required.

16. Avoids oil leakage.

17. Fewer expenses for maintenance.

18. Higher durability as compared to standard brakes.

Figure 3 : Suggested design at rear wheel.

Figure 4 : Suggested Design of Eddy Current Braking for Bicycle .

7. FABRICATION OF EDDY CURRENT BRAKING BICYCLE:

Fabrication Process as shown in Chart 1 as per Fig 3 and 4 :

1. Flatten down discs of Ms Steel plate.

2. Welding the disc to the shaft of a bicycle requires removing the hub.

3. Use nuts and bolts to secure the wheel hub.

4. Construct a frame for the electromagnets using the rods at the end and weld it together.

5. Install the electromagnets in the welded frame.

Note: Provide the smallest possible space between the electromagnets and the Ms disc.

6. Install the battery in the frame of the bike. Attach a button to the grip of the handlebars.

7. Connect the battery to the electromagnets and the switch.

8. The flux is produced at the discs attached to the wheel while the bicycle is in motion.

9. If we flip the switch, we get the opposite flux.

The discs and electromagnets generate an eddy current, which causes the system to decelerate and eventually halt.

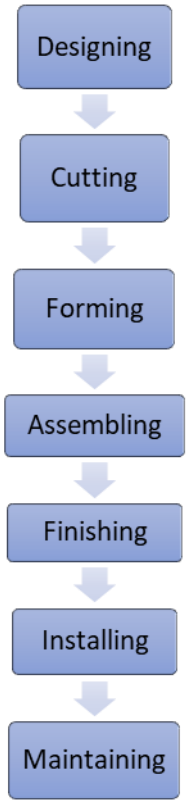
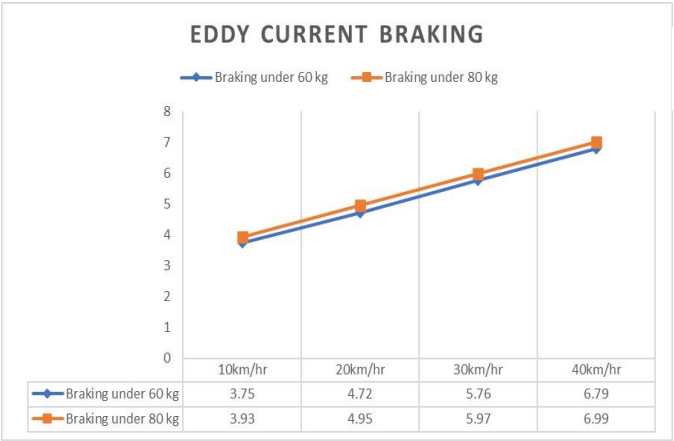


Chart 1 : Materials for Eddy current Braking System

8.RESULTS:

To stop a moving vehicle or to prevent it from moving while stopped, braking is used. Brakes work by generating friction between a stationary component and a disc or drum that spins in tandem with the wheels. Friction generates the stopping force by transforming the kinetic energy of the moving vehicle into heat, which is then dissipated into the surrounding air. Frictional forces are affected by the kind of contacting surfaces, the forces acting on those surfaces, and the speed at which the surfaces are moving past one another. The amount of effort required to slow down is directly

related to the frictional force between the lining and the drum and the amount of pressure applied by the band or shoe. In contrast, if the force exerted exceeds a particular threshold. More force is wasted when the brakes lock up and the wheels slide over the pavement. So, the adhesion between the tyre and the road determines the greatest braking effect that can be achieved, which in turn is determined by the load on the wheel upon which the brake operates and the coefficient of friction between the tyre and the road. To what extent the vehicle slows down depends on how quickly its kinetic energy is transformed into thermal energy. The electromagnet's spinning of the Ms Disc is halted by eddy currents when the push switch is pushed. Eddy currents are used to slow the bike to a halt. Estimated results of eddy current bicycle are shown below in chart 2



	10km/hr	20km/hr	30km/hr	40km/hr
Braking under 60 kg	3.75	4.72	5.76	6.79
Braking under 80 kg	3.93	4.95	5.97	6.99

Chart 2 : Approx Stop Time/ Bicycle Speed Results

9.Conclusion:

It was a terrific chance to put our little expertise to use on this project. Working on this project taught us a great deal about preparation, economy, construction, and processing. Taking on a project together is a great way to bring academia and business together, in our opinion. Bicycles equipped with electromagnetic eddy current braking systems that are both well-designed and manufactured perform well. We fully appreciate the challenges of maintaining quality and tolerances. We made excellent use of the resources afforded to us by using our knowledge and expertise. This is why we came up with the "Eddy Current Electromagnetic Brake System," which aids in the construction of a more effective braking system than is possible with traditional braking systems. Various additional technologies may be included into its evolution and refinement as needed for specific uses. The project is merely at the prototype stage, but it can be readily used in automobiles and other uses.

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