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FRICTIONLESS BRAKING SYSTEM

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ABSTRACT: *MOST OF BRAKING SYSTEM RUN ON THE PRINCIPLE THAT RELEASE OF KINETIC ENERGY TO THE HEAT ENERGY. THIS IS THE METHOD WHICH HAS ITS OWN DISADVANTAGES AND MUST BE REPLACED WITH MORE EFFICIENT BRAKING SYSTEM THAT I RESPOND QUICKLY, DOESN'T HEAT AND ALSO MAINTENANCE FREE. IN THIS PROJECT, A FRICTIONLESS BRAKING SYSTEM IS PROPOSED USING EDDY CURRENT PHENOMENON. THIS PHENOMENON IS ADMINISTRATED BY FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION AND LENZ' LAW. EDDY CURRENT IS GENERATED BY THE RELATIVE MOTION BETWEEN A METAL, ALLOY CONDUCTOR AND A MAGNET. THE CURRENT INDUCES MAGNETIC FIELDS IN THE CONDUCTOR WHICH OPPOSES THE ACTUAL MAGNETIC FIELD OF THE MAGNET AND RESULTS IN THE DECELERATION OF MOTION (LENZ LAW). THE CONSTANT MAGNETIC FIELD IS THE EASIEST DESIGN TO IMPLEMENT. THE MECHANISM WHICH IMPLEMENTS THIS PHENOMENON IN EVOLVING BRAKING SYSTEM. THIS BRAKING SYSTEM IS FRICTIONLESS, HENCE IT'S ADVANTAGEOUS OVER CONVENTIONAL FRICTION BRAKES IN TERMS OF PERFORMANCE AND MAINTENANCE. THE PROPOSED SYSTEM IS IMPLEMENTED IN REAR WHEEL OF VEHICLES.*

Key Words: Conventional Braking System, Eddy Current, copper Disc, Electromagnet, Eddy Current Braking System, Eddy Current Embedded Conventional Braking system, Ansys

INTRODUCTION

Magnetic brakes (also called eddy current brakes or EC brakes) slow or stop motion using magnetic force to apply mechanical resistance (friction). The original name was "eddy-current brakes" but as the years passed by, the name changed to "magnetic brakes", referring to their method of actuation. Having becoming famous in the middle of the 20th century especially in trains and trams, the variety of applications and brake designs has increased significantly, but the basic operation remained the same. Magnetic brakes are the brakes working on magnetic power. They work on the principle of magnetism. These brakes are a great replacement on the regular brakes due to their many merits. The reason for using this brake in vehicles is to reduce damage in brakes as it frictionless. Magnetic brakes are of possible use today's vehicles. The working principle of this system is that when the magnetic field passes through and at right angles to the rotating disc an eddy current is produced opposite to the rotating disc direction. This eddy current tries to stop the rotating disc. This results in the rotating disc comes to a halt.

History

It is found that magnetic brakes can develop a minus power which represents almost double the highest power output of a regular engine, and a minimum of thrice the braking power of an exhaust brake. (Reverdin, 1994). These activities of magnetic brakes make them much more useful contender for supplementary deceleration equipment compared with other decelerators. By using by using the magnetic brakes as a supplementary deceleration equipment, the friction brakes can be used less often, and so really never reach big temperatures. The brake linings would last more longer longer before requiring repair and the dangerous "brake fade" problem could be dodged. In a research conducted by a truck producing company, it was shown that the magnetic brake assumed 80% of the load which would else have been demanded of the regular service brake (Reverdin, 1974). Furthermore, the magnetic brakes prevent the danger that can arise from the continuos use of brake beyond their capacity to spread away heat.

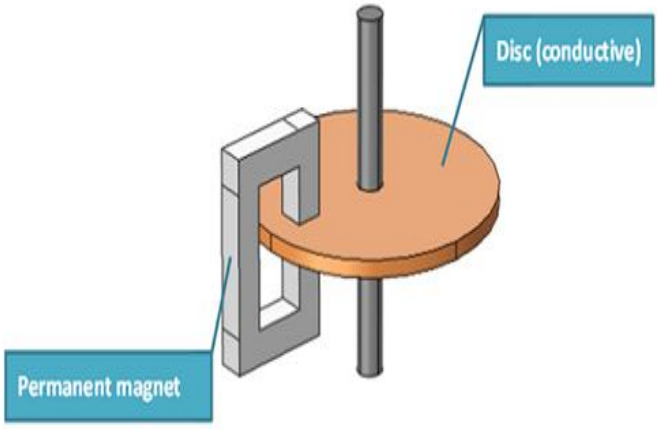

FIGURE 1: A SCHEMATIC DIAGRAM OF THE MAGNETIC BRAKING PHENOMENON

This is possible to happen mostly when an automobile is descending a long slope at a large velocity. In a study with an automobile with 5 axles and weighing 40 tonnes powered by a powered by an engine of 310 b.h.p going down a slope of 6% at a stable speed between 35 and 40 mph, it can be found that the braking power required to uphold this velocity in the form of around 450 h.p. hence would have to take in 300 h.p., implying that indivisual brakes in the 5 axels must absorb 30 h.p., that a regular brake can usually absorb with itself getting worn away. The magnetic brake is nicely accustomed to such

situations since it will automatically absorb more than 300 h.p. It hence can surpass the requirements of continuous non- stop braking, leaving the regular brakes cool and prepared for emergency braking in full safety. The setting up of a magnetic brake is not too difficult if there is sufficient gap between the gearbox and the rear axle. If needed a secondary cooling system. It relies on the effectiveness of engine parts for its use, so do hydrokinetic and exhaust brakes. The exhaust brake is an on/off device and hydrokinetic brakes have a very unusual control system. The magnetic brake control system is an electrical switching unit which gives it better controllability.

1.2Types of Braking Systems

Electromagnetic Brake System

A growing style of brakes, electro magnetic brakes use a motor that is comprised in the automobile which assist the automobile come to rest. These types of the brakes are used in maximum hybrid vehicles and use a motor to charge the battery and regenerative brake. instance, some buses will use it as a subordinate retarder brake.

Frictional Brake System

A frictional brake is found in numerous vehicles. They are provisional brakes, and naturally found in two types; pads and shoes. As the name suggests, these brakes use friction to brake the vehicle from moving. They typically comprise a rotating disc with a stationary pad and a rotating surface. On most band brakes the shoe will compress and rub against the external of the rotating drum, otherwise on a drum brake, a rotating drum with shoes will enlarge and rub against the interior of the drum.

Hydraulic Brake System

A hydraulic brake system is containing a master cylinder that is supplied by a reservoir tank of hydraulic braking fluid. This is linked by a collection of rubber fittings and metal pipes which are connected to cylinders of the wheel. The wheel contains two opposite piston which are located on the band, drum brake which are pressured to push the pistons distinctly forcing the brake pads in the cylinders, thus triggering the wheel to retard motion.

1.3 Scope and the Significance

The following are the significances:

Magnetic brakes fulfil all the energy needs of braking without the using friction. They have greater heat spreading capacity to avoid drawbacks that regular brakes face at times.

They can also be used as a supplementary deceleration equipment in addition to the regular brakes on heavy automobiles.

These brakes' part cost is less so these brakes are more economical.

They can be used as a new method for the future problems of crude oils.

1.4 Limitations

The following are the limitations:
The set up of an magnetic brake is very tough if there is not sufficient gap between the gearbox and rear axle.
It cannot use greases or oils.
Magnetic brakes are good at slowing objects down, but not completely stopping them

MATERIALS AND METHODS

When a conductor in the form of a rotating disc at a big velocity, is kept in a magnetic flux it intersects the magnetic field lines, hence an electromotive force (emf) will be produced in the disc by law of electromagnetic induction proposed by Faraday. Due to the emf , eddy currents are formed in the disc. These eddy currents are produced in the form of loops (fig-2). These Eddy current produces a magnetic field independently due to self-induction which is in opposite direction to the source magnetic field. Due to this a force of drag is produced which converts kinetic energy of rotation to heat energy. This heat energy is then lost out by convection. Braking force is proportional to change in magnetic field. So, braking force produced in proportional to strength of magnetic flux and rate of variation at which the disc is cutting the magnetic flux that is speed of disc.

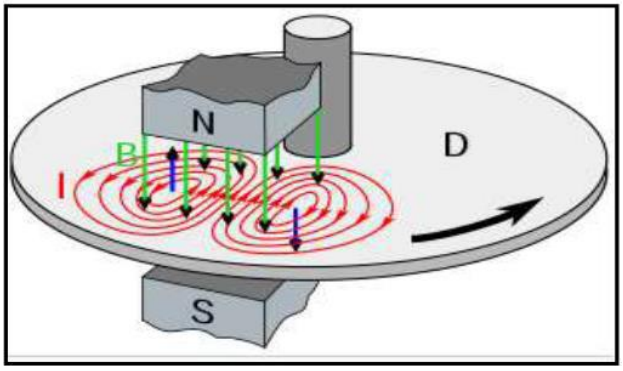

FIGURE 2: THE EDDY CURRENT PRINCIPLE

2.1 Conceptual & Theoretical Framework

Our system is divided majorly in two different components:

1) Driving Component

a. **Electric Motor**: An Electric motor is an electric machine that converts energy of electricity into mechanical energy. In regular mode, many electric motors function by the relation between an electric motor's magnetic field and the currents in windings to produce a force inside the motor. Electric motors are classified by type of electrical power source used, internal make, usage, type of resultant motion ,etc.

b. **Disc**: Disc gets in movement with the use of the motor. Both motor and disc is attached with the help of a connecting chain drive.

c. **Power Control**: This unit consists of power supply to whole model and to convert AC 220 V Supply to a DC 12V Supply.

2) Braking Component

a. **Magnet**: A magnet is a type Of rock which produces a field of its own to pull or push other ferrous materials or magnets. Magnet creates a magnetic field which is concentrated in at the edge of the disc.

b. **Handle**: It is part on which the main magnet will be attached. It will be leveraged to the frame.

3) Other Parts

Bearing: The use of a deep Groove Ball Bearing is to reduce rotational resistance and support radial and axial forces. In this project SKF 6200 ball Bearing type of bearing is used.

Chain: The use of chain is to transmit motion from electric motor to the driving shaft of disc

2.2 Working Mechanism

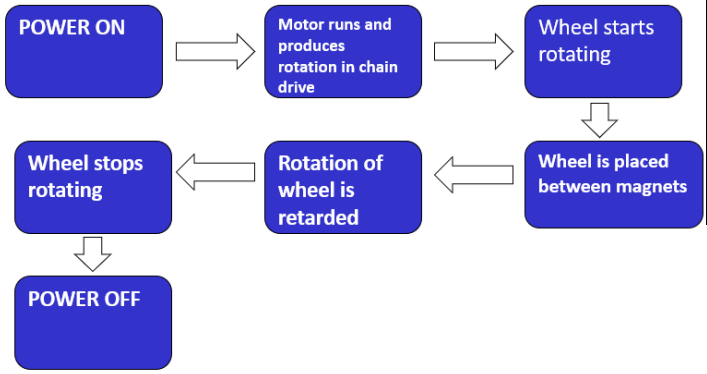

FIGURE 3: FLOW CHART OF THE WORKING MECHANISM

2.3 Complete Fabrication of the System

Methodology to Fabrication of magnetic braking system :
Study the problems in the making of magnetic braking system

Designing the needed components.
Selecting of needed materials.
Buying the materials.
Fabrication of the magnet's handle.

2.4 Experimental Setup

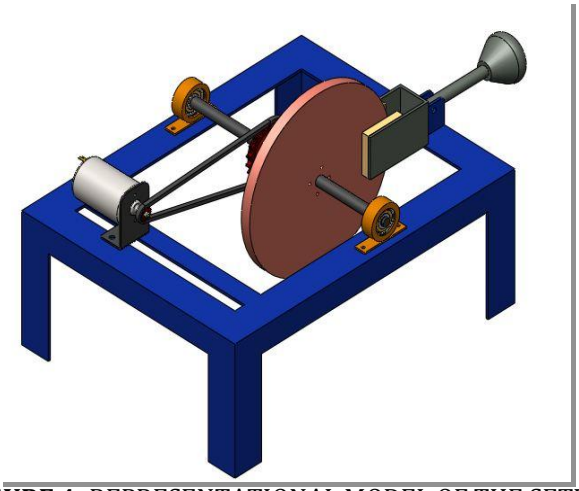

FIGURE 4: REPRESENTATIONAL MODEL OF THE SETUP

The given Figure 4 is a 3D model that has been created on Solid Works 2016 as per the required dimensions drawn to scale.

Sr. No.	PART	QUANTITY
1.	Mild steel frame cut pieces	9
2.	Copper Disc	1
3.	Mild Steel Shaft	1
4.	Deep Groove Ball Bearings	2
5.	DC Motor RS775	1
6.	Power Supply Unit	1
7.	Chain Drive	1
8.	Wires	4-6
9.	Permanent Magnet	2
10.	Magnet holder	1
11.	Nuts, bolts & clamps	As per requirements

TABLE 1: BILL OF MATERIALS

The Table 1 represents the list of materials for fabrication of the setup shown in Figure 5.

FIGURE 5: THE ACTUAL FABRICATED MODEL

2.5 Analysis

Analysis is done using ANSYS R16.2. The 3D model of the disc was created in DS Solid Works 2016. The eddy current brakes changes kinetic energy of rotation into heat energy which is lost to the surrounding. The heat energy is also lost by convection. As disc is rotating in air , heat transfer occurs by forced convection also.

Temperature Distribution

Temperature distribution of copper disc is analysed. Electromagnet rating is 12-volt 14 ampere. So highest amount of heat input to disc is 12x14=168 watts. The heat is lost to surroundings by forced convection when disc is moving. The atmospheric temperature is assumed to be 30^0C. The peak temperature attained is 30.097^0C. Because of the incoherence in the copper disc because of the bolts, temperature produced is greater between the bolts.

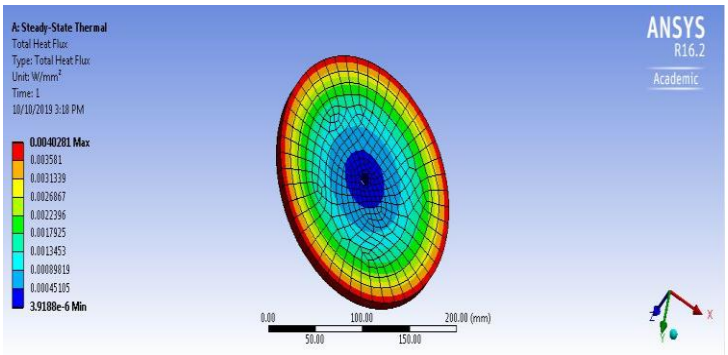

FIGURE 6: STEADY STATE THERMAL HEAT FLUX OF THE DISC IS FOUND TO BE MAXIMUM AT THE EDGES HAVING A MAGNITUDE OF 0.0040 W/MM^2

Total deformation of shaft

Considering the weight of the disc the deformation of shaft was analysed using ANSYS

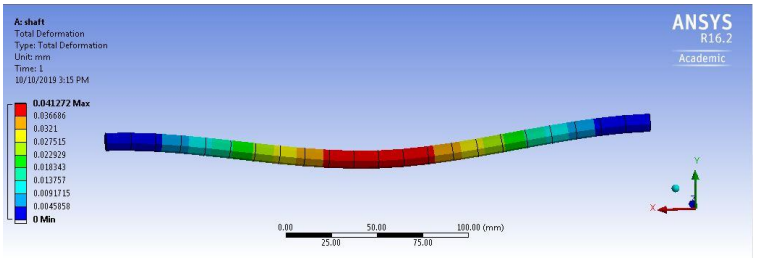

FIGURE 7: THE MAXIMUM DEFLECTION OF THE SHAFT IS FOUND TO BE 0.041 MM AT THE CENTRAL PORTION

CALCULATIONS

The design calculations were done using the PSG Design Data Book. The method in which the parts were designed is as follows:

Permanent magnet was selected as per the amount of magnetic force required.

Chain drive was selected as per maximum motor speed.

Shaft was designed as per maximum shear stress principle. Bearings were selected from SKF Catalogue.

Frame cross section was decided as per total weight of the setup.

Hence, the following data was tabulated:

PARAMETERS	RESULTS
Calculate braking force	6.37 N
Design of disc	Diameter=200mm Thickness=10mm
Design of shaft	Diameter=10mm Length=300mm
Design of chain drive	N_1=12,N_2=20, PCD_1=25mm, PCD_2 =40mm
Selection of motor	2000 to 6000 RPM
Design & selection of bearing	ID=10mm OD=30mm

TABLE 2: THE DESIGN PARAMETERS OF THE SYSTEM

RESULTS AND DISCUSSION

The speed is measured by a tachometer and time is measured by a stop watch. The speed of the wheel reduced from 70 kmph to 0 kmph within 0.65 seconds.

4.1 Graphical Results

The disc does not get stopped immediately but it slows down the speed and bring it to rest after a certain time lag. Hence disc locking is eliminated and antilock braking system is not

needed and because there is no locking of wheel, skidding is eliminated.

The figure 8 shows that the maximum braking torque occurs at a critical speed of 800 rpm. After passing over the critical speed the braking torque value reduces due to the impact of eddy current depths.

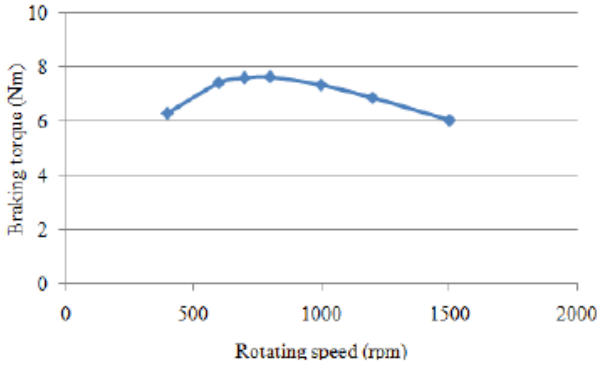

FIGURE 8: THE GRAPH SHOWS THE VARIATION IN BRAKING TORQUE WITH CHANGE IN ROTATING SPEED

The figure 9 shows the relationship between the braking torque & the magnetic position of disc. As the distance between the magnet from the center of the disc increases, the braking torque continuously increases. This was due to the arm's braking distance that became longer with farther permanent magnet position, so that the braking torque became even greater.

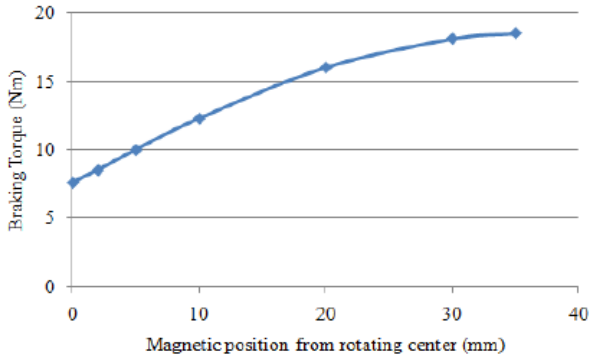

FIGURE 9: A PLOT BETWEEN BRAKING TORQUE & MAGNETIC POSITION

The given Figure 10 shows the plot between braking torque & air gap. As the air gap increases the braking torque decreases due to the fact that the increased air gap reduces the magnetic flux passing through the disc, hence reducing the braking features including braking torque.

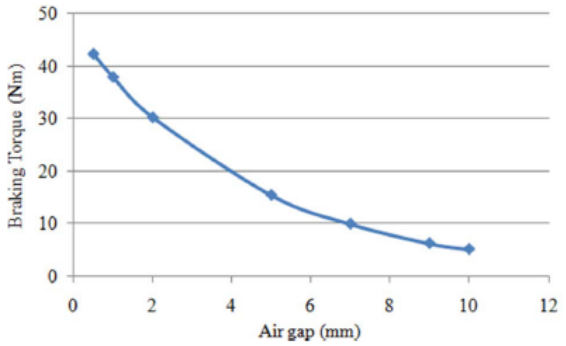

FIGURE 10: GRAPH BETWEEN BRAKING TORQUE & AIR GAP

4.2 Cost Evaluation

The cost estimation is as follows:

PART	COST(In INR)
Permanent magnets	100
M.S Fabricated stand	600
DC Power supply 12V	249
DC Motor RS 775	279
Brake unit with wheel	1600
Wires, screws , nuts, bolts	60
TOTAL	2888

TABLE 3: COST REQUIREMENTS

As seen in Table 3, the cost requires to setup the given system is just INR. 2888 , which is much lesser as compared to a regular friction brake, which requires INR.3600 on an average along with extra periodic replacement/ maintenance costs. Hence, the proposed setup is definitely more economical for use.

CONCLUSION

Frictionless braking produces effective braking with small wear and tear. The maintenance cost of this braking is small. This braking is a non-contact braking system and therefore there is no friction and minimum wear and tear. Thus, wreckage formed in braking is small and hence is eco-friendly. This braking is more clean way of braking. Wheel skidding is eliminated as the wheel does not get locked. It is very suitable for high speed. It works on the electricity and takes up very little amount of power for a small time period. It only Consumes small space hence installation is easy. It can be used effectively to replace typical braking systems.

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BIOGRAPHIES

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