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DESIGN AND FABRICATION OF ELECTROMAGNEIC BRAKING SYSTEM

N.Suneel Kumar[1],G.Gayatri[2],N.Madhu[3],P.Venkata Sai Ram[4],P.Harshit Patrudu[5]

Assistant Professor[1], B.Tech Students[2345],NSRIT,Sontyam,Visakhapatnam,AP

ABSTRACT: An electromagnetic brake is a new and revolutionary concept. These are totally friction less Electromagnetic brakes are the brakes working on the electric power & magnetic power. An Electromagnetic Braking system uses Magnetic force to engage the brake, but the power required for braking is transmitted manually. Electromagnetic braking system is a modern technology braking system used in light motor & heavy motor vehicles. This system is a combination of electro-mechanical concepts. The frequency of accidents is now-a-days increasing due to inefficient braking system. The concept helps in reducing or eliminating sources of heat generation, friction, noise, and wear of materials. There is no involvement of fluids as used in hydraulic braking systems. Electromagnetic brakes work on the principle of repulsion and attraction between two electromagnet field coils. The repulsion between the field coils opposes the motion of the wheel. This repulsion is initiated within the field coils by a switch or a lever that allows current to be supplied to the coils. Each coil is separately spaced evenly on both the outer and inner array of field coils. The disc is connected to a shaft and the electromagnet is mounted on the frame. When electricity is applied to the coil a magnetic field is developed across the armature because of the current flowing across the coil and causes armature to get attracted towards the coil. As a result, it develops a torque and eventually the vehicle comes to rest.

Introduction:

A brake is a device, where it restricts motion. It is commonly known that the brakes use friction to convert kinetic energy into heat. But the Electromagnetic brakes have been used as supplementary retardation equipment in addition to the regular friction brakes on heavy vehicles. They work on the principle of electromagnetism. The working principle of this system is that when the magnetic flux passes through and perpendicular to the rotating wheel the eddy current flows opposite to the rotating wheel/rotor direction.

By using the electromagnetic brake as supplementary retardation equipment, the friction brakes can be used less frequently and therefore practically never reach high temperatures.

Electromagnetic brakes operate electrically, but transmit torque mechanically. This is why they used to be referred to as electro-mechanical brakes. Over the years, EM breaks became known as electromagnetic, referring to their actuation method. Since the brakes started becoming popular over sixty years ago, the variety of applications and brake designs has increased dramatically, but the basic operation remains the same. The electromagnetic brakes make up exactly 80% of all of the power applied brake applications. Electromagnetic brakes have been used as retardation equipment in addition to the regular friction brakes on heavy vehicles and in some cars.

Literature survey:

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

2. Hung-Chi Wu, 958-2, Ghung Shan Rd., Tao-Yuan, Taiwan “Invention to an adjustable magnetic brake.” In particular to one including an aluminum fan, a magnetic conducting ring enclosing the aluminum fan, a permanent magnet disposed within the aluminum fan, a fixing seat for keeping the permanent magnet in position, a sliding seat mounted in the fixing seat and provided with a bearing, a housing, bolts provided on one side of the fixing seat and extending out of the housing, a mounting plate connected with the bolts and a wire connected with the mounting plate such that when the wire is pulled outwards, the permanent magnet will be moved outwards.

3. Jae-Woong Lee, Seoul, Rep. of Korea “A magnetic brake system for a vehicle”. A plurality of brake disk solenoids for generating the magnetic force; a plurality of brake pad solenoids for generating the magnetic force; a braking sensor for detecting whether a brake pedal is applied; a wheel speed sensor for detecting wheel speed; a magnetic polarity sensor for detecting magnetic polarity of the brake disk solenoids; and a control unit for controlling the brake pad solenoids using signals from the braking sensor. The wheel speed sensor and the magnetic polarity sensor.

4. Albert E. Miller, Dayton, Ohio. “Invention on fishing reel and an improved type of reel having a compensated magnetic brake.” For preventing backlash or overrunning of the spool. An object of this invention is to provide a reel which is inexpensive to manufacture and which is durable and trouble-free in operation.

Still another object of this invention is to provide an improved form of magnetic brake having spring means for modifying the brake action. A further object of this invention is to provide a fishing reel which is smooth in operation and which is readily adjustable to desired degrees of drag or braking effect. Combination of parts and in the mode of operation as will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of the present invention monitored. The more the brake linings wear off due to abrasion, the smaller the distance between the armature and the brake magnet housing is clearly shown.

5. Karl Erny, Holzhausem. “Elevator drive brake device with compression springs and brake linings on a brake drum creating a braking force.” A sensor is provided to detect the movement of a brake magnet armature tappet. A bracket is attached to the brake magnet tappet on one end and a distance piece carrying the sensor housing is arranged on the other end. A restoring lug is attached to the existing mechanical indicator. A monitor evaluates the sensor signal and turns off the elevator drive in the event of dangerous operational states via a safety circuit. The system allows the state of the brake device to be monitored. The more the brake linings wear off due to abrasion, the smaller the distance between the armature and the brake magnet housing.

.6. M. Qian and P. Kachroo. “Modeling and control of electromagnetic brakes for enhanced braking capabilities or automated highway systems”. A modified mathematical model is developed for electromagnetic brakes, is proposed to describe their static characteristics i.e. angular speed versus brake torque. This paper describes electromagnetic brakes as a supplementary system for regular friction brakes. This system provides better response time for emergency situations, and in general keeps the friction brake working longer and safer. To control the brakes, a robust sliding mode controller is designed to maintain the wheel slip at a given value. Simulations show that the controller designed is capable of controlling the vehicle with parameter deviations and disturbances.

7. Sevvel P, Nirmal Kannan V, Mars Mukesh S. “Innovative Electro Magnetic Braking System”. In this paper, the conventional braking systems have been analyzed i.e., different friction brakes, hydraulic brakes along with their effects and difficulties which include Brake fading effect, Brake fluid leakage, brake fluid vaporization and brake fluid freezing. Next is the description of the working principle of electromagnetism using the known Oersted experiment, magnetic effect of the flow of current in a conductor and the factors affecting the strength of electromagnet are discussed.

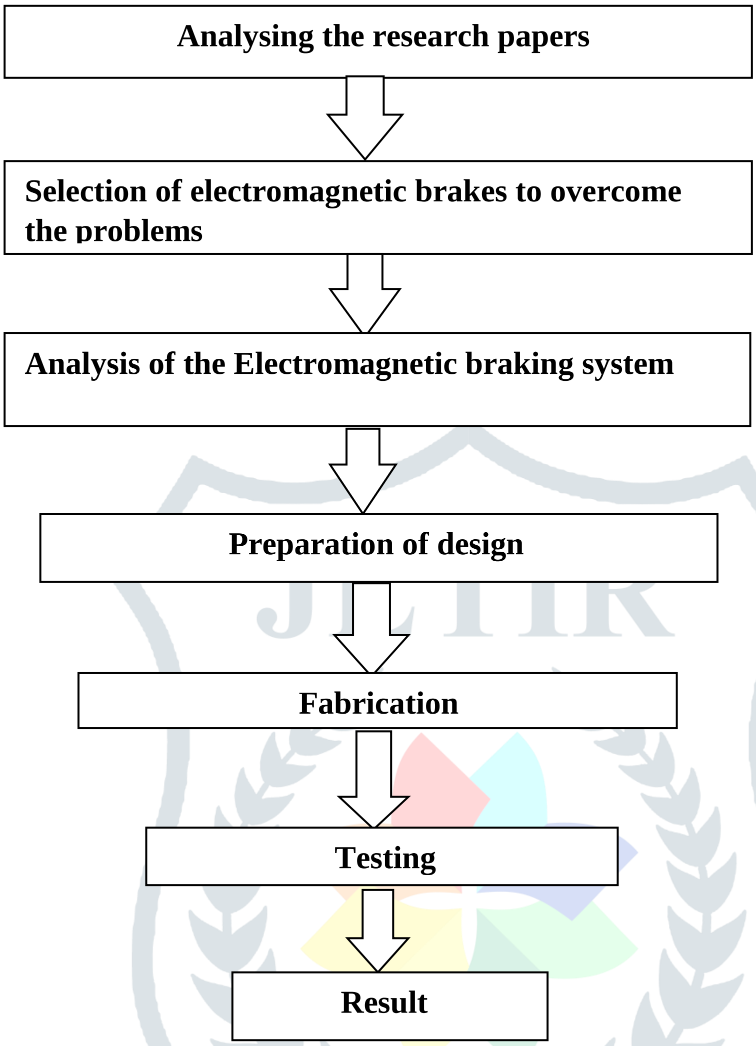
8. Min Joua, Jaw-Kuen Shiaub, Chi-Chian Suna. “Design of a magnetic braking System”. In current experiment, an upright magnetic braking system was designed using permanent magnet which can be used in elevators as one of the safety features, particularly, for skyscrapers. The guiding track is designed as the conducting plate which is easy to construct with building or join with existed elevators. Two pairs of permanent magnets (NdFeB-35) are mounted with the loading table in both front and rear side. The approaches to design the magnetic braking system are based on the principle of design for manufacturing and design for assemble. Therefore, the considerations and their corresponding assumptions are as followings: (1) Rectangular magnets are used in this study. This will reduce the model from 3D to 2D. (2) The magnets are mounted in symmetry in order to reduce the vibrations due to unbalance of forces. Thus, the analysis can be treated as 2D and symmetric pr0blem. The distance between front magnet and rear magnet is equal to two times of the air gap plus the thickness of track. The model analyzes and computes the magnetic flux density at an early level of braking system design. This project demonstrated that the air gap has a significant effect on the magnetic flux density.

1.1 Objectives

2. 1. The main objective of our project is to control the speed of the vehicle as well as to stop it when and where quickly and efficiently.
3. 2. By using electromagnetic braking, we can reduce the reaction time of braking
4. 3. By automating the system we can implement it on the automobiles for the safety measures on daily basis.
5. 4. We can minimize the time of the braking and bring to 3 seconds
6. 5. These systems can be used as an additional braking system in aircrafts which provides extra safety measures.

7. Methodology

8. To fabricate the model, it all begins with a systematic plan where the fabrication is of seven steps of solving process. The steps are as follows:



Analysing the research papers:

Collect all the relevant data about the problems and the research programs which are happening around and the outcomes of them and evaluate them by comparing with the other research programs where to sort out the demerits of the conventional types of braking systems in a more effective.

Analysis of the Electromagnetic braking system:

To study and analyze about the system where by focusing on to the working principle and the fabrication materials and design required for the model to be done and even a study towards the functioning of the braking system according to the design planned

Preparation of design:

In this step it is more concentrated on to the design part where looking on to several alternatives of designs according to the installation specifications as planned in the previous steps.

Fabrication:

In this step the process consists of working on to the chosen design and approach into the reality. The model is then fabricated as per the specifications given and check fall the mechanisms work perfectly.

Testing:

The model is tested to check if it meets all the objectives and the model is again made to test whether there has to be done any improvement or any modifications to it. After the test is done completely the model is then made to implement.

Result:

The output of the model is taken down and tabulated and the result is presented by calculating and submitted.

. Result and Discussion

1. Area of the Electromagnet = 12.4 m

2. Current & Voltage supplied (I/V) = 7amp/230volts.

3. Length of electromagnet (L) =90 mm.

Let the plate & wheel assembly maximum weight is to be considered approx. 2kg. Which is 19.62N so that will be

$F = B^2.A / 2\mu$

F is the force in Newton.

B is the magnetic field in teslas.

A is the area of the pole faces in square meters.

μ is the permeability of free space.

In the case of free space (air) $\mu = 4\Pi.10^{-7}$ H.m^-1

$19.62 = B^2(12.4)/2x4\pi x10^{-7}$

B=0.00199wb/m^2

4.1. Total magnetic flux in core:

Ø = B ×A

Ø = 0.00199×12.4

Ø = 0.0246 wb.

4.2. The magnetizing force:

H = B/μ = 0.00199/4π×10^-7

= 1583.59 AT/m.

For air gap of 0.5 mm magnetic force is given by between magnet & plate.

AT = H×L = 1583.59×90×10^-3= 142.52 AT

To find the power of electromagnet which is manually constructed

Assuming N = number of turns in the electromagnetic = 800

F= (NxI)^2μa / (2xg)

g = air gap between electromagnet & plate

F= (8x1)^24πx10-7x0.00199 / (2x0.5)2

F= 16.045N for each electromagnet

If the model is driven by the motor, then the calculation will be as follows

Assuming,

Single phase AC motor.

Power = 12v/5A=60 watt.

Speed= 0-8600 rpm (variable).

Motor Torque

P = 2 Π N T/ 60

T = 60 x 60/ 2 Π x 8600

T = 0.066 N-m

4.3. Performance testing:

For constant speed at taking 2000 rpm

r= radius of wheel

$V= r\dot{\omega}= 0.9\times 2\pi n/60$

$V =0.9\times 2\pi\times 2000/60$

V= 188.4 m/s

According to Newton's law of motion

V= u+at

a= (v-u)/t

where the initial velocity of the wheel u=188.4 m/s and final velocity v=0

therefore a= (0-188.4)/1 = -188.4 m/s^2

a=(0-188.4)/3 = -62.8 m/s^2

Result:

Hence the deceleration of the electromagnetic braking system takes place according to the braking time.

4.4. Performance testing of the model when powered by a manual method:

For constant speed at taking 200 rpm

r= radius of wheel

$V= r\dot{\omega}$

$= 0.9\times 2\pi n/60$

$=0.9\times 2\pi\times 200/60$

V= 18.8 m/s

According to Newton's law of motion

V= u+at

a= (v-u)/t

where the initial velocity of the wheel u=188.4 m/s and final velocity v=0

therefore a= (0-18.8)/1 = -18.8 m/s^2

a=(0-18.8)/3 = -6.2 m/s^2

Result:

Hence the deceleration of the electromagnetic braking system by using manual method takes place according to the braking time.

Conclusion:

The Electromagnetic braking system is found to be more reliable as compared to other braking systems. In addition, it is found that electromagnetic brakes make up approximately 80% of all of the power applied brake applications. Electromagnetic brakes have been used as supplementary retardation equipment in addition to the regular friction of the brakes. This enhanced braking system not only helps in effective braking but also helps in avoiding the accidents and reducing the frequency of accidents to a minimum. Furthermore, the electromagnetic brakes prevent the danger that can arise from the prolonged use of brake beyond their capability to dissipate heat. ABS usage can be neglected by simply using a micro controlled electromagnetic disk brake system. For the brake distribution of the electromagnetic braking system, the abrasion, noise, harmful friction dust, and the risk of thermal failure in braking system were reduced obviously. These electromagnetic brakes can be used in wet conditions which eliminate the anti-skidding equipment, and cost of these brake are cheaper than the other types. The concept designed by us is just a prototype and needs to be developed more. It can not only be used in the field of automotives but also in the field of aeronautics. Hence the electromagnetic braking system can be a better technological revolution in the future applications.

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