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Investigation of characteristics of Magnetic Braking System

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ABSTRACT:

Magnetic braking system is the most emerging technology in the automobile sectors. Braking system is the one which is mainly considered while describing the safety in driving of any automobiles. Magnetic braking system is the emerging concept which is to be incorporated with the conventional braking system in the automobiles to increase the efficiency of the braking system. The working of the braking system is explained with prototypic model. The ferromagnetic material is attached to the axle of the rear wheel and is surrounded by a casing containing magnetic coils. On the application of brake with the help of the electricity, the magnetic coils generate the repulsive force against the rotating element on the rear axle. Which helps to slow down the vehicle in an efficient manner.

KEYWORDS: Magnetic braking, magnetic coils, ferromagnetic materials and resistive force.

INTRODUCTION:

A brake is a mechanical device which helps to regulate or forbid the motion of the vehicles. Various types of braking mechanisms like drum brake, hydraulic brake, pneumatic brake and air brake are used to slow down the vehicles. Those systems are mainly work by creating frictional force between wheel drum and the brush. The only difference is of using different mechanisms. Many industries especially automobile industries come up with new innovations on automobiles. Magnetic braking system is one of the new emerging concepts to control the movements of the vehicle.

Braking systems vary with vehicles according to the requirements or purpose of the vehicles. For example, most passenger vehicles are come up with hydraulic braking system while in heavy load vehicles and bikes air brakes and mechanical brakes are used respectively. By the way magnetic braking system is one of the new concepts, which works based on the principle of repulsion and is to be incorporated with conventional braking system to increase the efficiency of braking.

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2. OBJECTIVES:

- To increasing the braking efficiency by incorporating with conventional braking system.
- To measure the braking time while using mild steel disc.
- To enhance the level of braking efficiency in all heavy motor vehicle and light motor vehicle.
- To reduce the friction that occurs in the brake shoe in frictional braking system while applying the brake.
- To produce high performance braking system with low cost.

3. METHODOLOGY:

Material Purchase

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Fabrication

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Experiment

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Problem Identification

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Literature Survey

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Result

4. MATERIAL SELECTION:

- There are a plenty of material that has good magnetic conductivity and one among that is mild steel.
- Mild steel has good magnetic conductivity due to the large amount of ferrite and iron takes a place in it, so we have considered the mild steel material to fabricate the disc and frame as well.
- Mild steel is not a light weight material, so it helps to generate enough inertia force to rotate a fly wheel after the motor power goes off.
- Moreover, mild steel is less expensive than copper and brass or any other material that has good magnetic conductivity and it is effortless to weld.

5. COMPONENTS USED:

Magnetic braking system comprises of a shaft, 12V DC motor, 12V battery, disc, driver, neodymium magnet, electromagnet, on/off switch. The motor is connected to the shaft with the help of a driver. Then a disc is also attached on the shaft. An electromagnet is attached on the frame which is placed near the disc at an airgap of 3mm. The neodymium magnet can be used to slow down the disc by the usage of a lever.

6. BLOCK DIAGRAM:

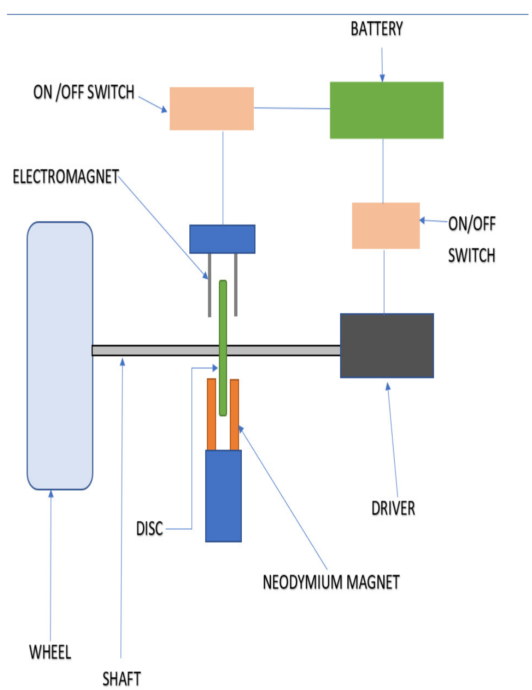

Fig. 1

7. WORKING PRINCIPLE:

7.1 WORKING:

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According to the principle of Faraday's law of induction, the movement of the metallic disc made up of mild steel across the magnetic field produced by the magnetic coils, induces an eddy current in the disc.

The direction of the induced current is given by the Lenz's law. According to which, the current induced in the conductor flows in a direction such that the magnetic

field produced by the induced current is opposite to the direction of the magnetic

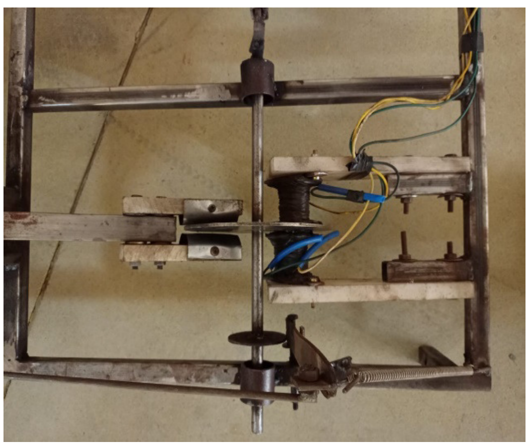

Fig.2

field which induces the emf. This opposing magnetic field flows in direction opposite to the rotation of the disc and thus produces a resistive force. This resistive force or braking force bring the rotating disc to rest. This is the working principle made used in magnetic braking system.

Initially the dc motor is turned on and the disc is allowed to rotate freely based on the following timings such as 15s, 30s, 45s, 60s, etc. Then it is allowed to slow down without any external forces and the time taken to stop the disc is noted. Based on the above readings the time taken by the disc to retard naturally can be known. The disc is then rotated for some time with the help of a dc motor and the electromagnetic brake is applied with the help of a switch. The time taken to slow down the disc with the application of electromagnets is noted. After the applying the brake powered by an electromagnet a comparison of time taken is made between the free rotation of disc and the application of electromagnetic brakes.

The final experimentation work is done by applying neodymium magnetic brake and electromagnetic brakes at the same time when the disc is in rotary motion. Then finally by comparing the values of time taken by the application of electromagnetic brake alone and applying both electromagnetic brake as well as neodymium magnet brake. From this, we can infer that the braking time is less when applying electromagnet brake and neodymium magnetic brake.

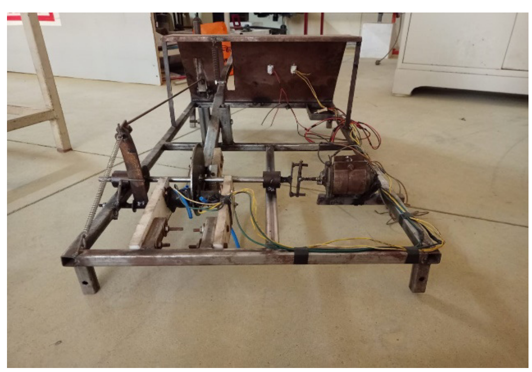

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Fig.3

8. OBSERVATIONS:

- Diameter of the mild steel disc = 160mm.
- Thickness of the mild steel disc = 3mm.
- Air gap between the disc and the coil =3mm.
- Speed of the 12v DC motor = 120rpm
- Braking time (using electromagnetic coil) = 3.56sec
- Braking time (using both electromagnetic coil and the neodymium magnet) = 2.42 sec

9. CALCULATION:

CALCULATION OF BRAKING TORQUE:

Braking torque (T_b) = $\sigma R^2 S d\theta i^2 (\mu_o n / I_g)$

Where,

σ = Electrical conductivity of the disc in Siemens/m

R = Distance between the centre of the pole and the centre of the disc in meter

d = Thickness of the disc in meter

μ_o = Permeability of air in H/m

n = Number of turns in the electromagnetic coil

I_g = Air gap between the disc and the coil in meter

I = Applied current to the coil in ampere

σ	10.E6
R	0.05
μ_o	1.257.E-6
n	250
I_g	0.003
i	7
d	0.003

Table 1

S = Area of the pole in meter square

$= \pi r^2$

$= 3.14 * (0.003)^2$

θ = Angular velocity of the disc in rad/second

= linear velocity / r

= $(2\pi/60) * r * RPM / r$

Where,

r = radius of the disc in meter

RPM = Revolution per minute

9.1 MODEL CALCULATION:

Braking torque when the disc is rotated at 100 rpm,

$T_{b\,(100)} = 10^7 * 0.05^{2\,*} 3.14 * (0.003)^2 * 0.003 *(((2\pi/60) * 0.08 * 100) / 0.08) * 7^2 * (1.257 * 10^{-6} * 250 / 0.003)$

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$T_{b\,(100)} = 0.0119$ Nm

Sl.no	Speed of the disc (rpm)	Braking torque (Nm)
1.	0	0
2.	50	0.00596
3.	75	0.00895
4.	100	0.01196
5.	120	0.01432

Table 2

10. Experimentation

The experimentation of this project done with the aid of stopwatch and the power supply of the battery to the Electromagnetic coil. The testing process consists of four various methods of test with a three different type of brakes. Applying a different brake in different times help to find out the efficiency of each brakes and time consuming by each a brake to stop the rotating disc or shaft. Aforementioned it has four types of testing methods such free rotation, applying a mechanical brake, makes the neodymium magnet indirect with rotating disc, supplying a power to the Electromagnetic coil to generate more repulsive force and hold the disc with no moments, and integrating the both neodymium magnetic effects and Electromagnetic effects brings a high intensity of stopping force or repelling force.

TRIAL - 1(FREE RUN): In first trail the rotating disc with the shaft run in a potential speed of the motor for 5 seconds and the power supply from the battery to the motor is cut off manually operated with the help of a on /off switch and then the time will be calculated by using the stopwatch to know how long it takes a time to stop.

TRIAL - 2 (NEODYMIUM EFFECTS):

Bringing the neodymium magnets very close to mild steel disc after the power supply goes off. Calculate the time consumption to stop the rotating disc.

TRIAL - 3 (ELECTROMAGNETIC EFFECTS):

Supplying the power to the Electromagnets after the motor power goes off and calculate the amount of time consumed to stop the disc.

TRIAL - 4(COMBINATION OF BOTH NEODIYUM AND ELECTROMAGNET):

Applying the both brakes at the same time after the 5 seconds of the motor run. This trial procedure helps us to know better about each brake's efficiency.

11. ADVANTAGES:

- This type of brakes is not influenced by atmospheric conditions.
- It satisfies all the energy requirements.
- It uses electromagnetic forces rather than frictional force.
- There is no wear or tear, because of no contacting surface.

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- Potential of braking is higher than the conventional braking system.
- More efficient under high velocities.
- The response time of braking also less.
- Brake force can be adjusted.

12. DISADVANTAGES:

- Less effective under low velocities.
- Needs conventional machine to hold a vehicle stationary.
- Special spring mechanism is needed for the quick return of the brake shoe.

13. APPLICATION:

- In trains and trams the braking element are pressed by magnetic force to the rail.
- Magnetic braking systems are also used in electric motors in industries and in robotic applications.
- It can also be used in light motor vehicles and heavy motor vehicles.

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14. RESULT AND DISCUSSION:

The graphs are plotted to show the efficiency level of magnetic braking system by measuring braking time for five different speeds of the mild steel disc, when using only electromagnetic coil and both electromagnetic coil and neodymium magnet.

Sl.no	Speed of the disc (rpm)	Braking time using coil (sec)	Braking time using coil and magnet (sec)
1.	0	0	0
2.	50	1.25	0.96
3.	75	2.07	1.17
4.	100	2.76	1.84
5.	120	3.56	2.42

Table 3

14.1 Speed of Disc vs Braking time - using electromagnetic coil:

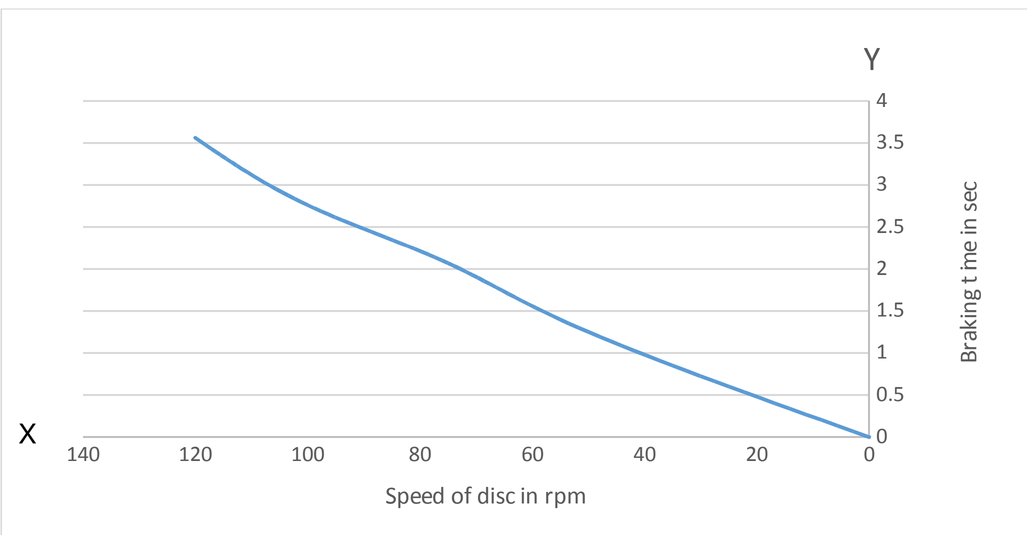

Fig.4

Fig.4 shows the variation of braking time with respect to the speed of the disc in rpm for five different speed. Here the braking force is obtained only by using the electromagnetic coil and not the neodymium magnetic arrangement. From the graph, It has been observed that the mild steel disc bring down to rest from highest speed within 3 seconds.

14.2 Speed of Disc vs Braking time - using electromagnetic_coil and neodymium magnet:

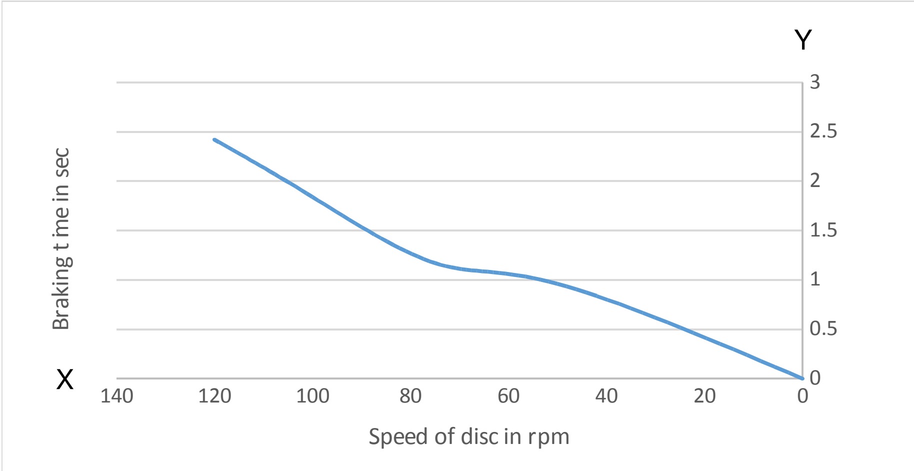

Fig 5

Fig.5 shows the variation of braking time with respect to the speed of disc in rpm for five different speed. Here the mid steel disc bring down to rest by applying braking force through both the electromagnetic coil and the neodymium magnet.

14.3 Speed of Disc vs Braking time – comparing fig.4 and fig.5:

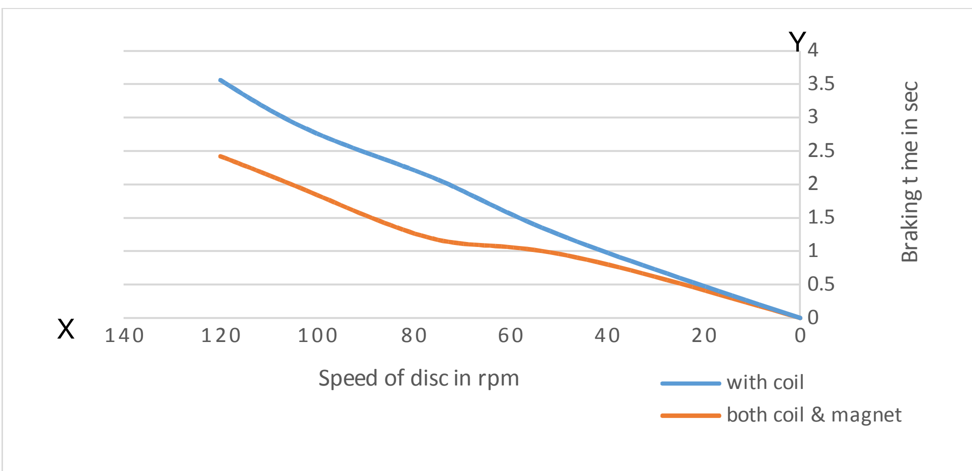

Fig.6

This graph is the comparison of the braking time of system by using electromagnetic coil and both electromagnetic coil and neodymium magnet. It shows the deviation of above two systems. From this graph, it has been observed that the braking time of the disc when using both the electromagnetic coil and the neodymium magnet is comparatively less than the braking time obtained when using electromagnetic coil. Result shows that the efficiency level of braking can be increased when using both the electromagnetic coil and the neodymium magnet.

15. CONCLUSION:

The purpose of this paper is to show the difference in braking time while using electromagnetic coil and using both neodymium magnet and the electromagnetic coil. The braking time for both the type is observed. Result shows that the braking time of the disc while using both neodymium magnet and the electromagnetic coil is less than the braking time while using electromagnetic coil.

With all the points on magnetic braking system, that they are more reliable than the conventional braking system. Choosing of materials for braking also needed for efficient braking. The air gap between the disc and the electromagnetic coil also affects the efficiency of braking. Thus, all the studies reveals that magnetic braking system is more efficient at higher velocities and less efficient on low velocities.

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