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KATHMANDU UNIVERSITY
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

PROJECT REPORT



STUDY AND FABRICATION OF ELECTROMAGNETIC BRAKING SYSTEM.

In Partial Fulfillment of the Requirements for the
Bachelor's Degree in Mechanical Engineering

Nitesh Kumar Yadav	020478-16
Sujan Shrestha	020474-16
Suman Thapa	020475-16
Samip Timilsina	020476-16

July 15, 2017.

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PROJECT EVALUATION

Study and Fabrication of Electromagnetic Braking System.

by

Nitesh Kumar Yadav.

Sujan Shrestha.

Suman Thapa.

Samip Timilsina.

This is to certify that I have examined the above Project and have found that it is complete and satisfactory in all respects, and that any and all revisions required by the thesis examination committee have been made. This page is centre aligned, not justified.

Er. Hari Dhakal

Hari Pd Neupane, HOD

July 2017

ACKNOWLEDGMENTS

I am highly indebted to the help of project supervisor and project coordinator of the department of Mechanical Engineering, Kathmandu University.

I express heartily thank to the project group of ME-1 2016, School of Engineering Kathmandu University providing with the help in the project.

Thanks to all the classmates and faculty staff of department of Mechanical Engineering who helped directly and indirectly to carry out this project.

Nitesh Kumar Yadav.
Sujan Shrestha.
Suman Thapa.
Samip Timilsina.

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ABSTRACT

This project aims to create a electromagnetic braking system model capable of applying brakes without any friction loss and without losing the energy supplied. It uses a two electromagnets which runs by the supply of power from the circuit. Also, there is a wheel which is attached to the motor so when the power the supplied, by the help of motor the wheel rotates. Then a fan is attached near electromagnets to cool the electromagnets from excessive heating. A metal bar is in the vicinity of the electromagnets and wheel so when the electromagnets produces eddy currents which stops the rotating wheel or rotor. This model helps in a way to be a used a retardation equipment in vehicles.

LIST OF ABBREVIATIONS

bhp	Brake horse power
cm	Centimeter
EMBS	Electromagnetic Braking System
mhp	Miles per hour
RPM	Revolution per minute

LIST OF SYMBOLS

A	Ampere	[A]
R	Radius	[L]
V	Voltage	[ML ² T ⁻³ A ⁻¹]

CHAPTER 1 INTRODUCTION

1.1 Background and Rational

Electromagnetic brakes (also called electro-mechanical brakes or EM brakes) slow or stop motion using electromagnetic force to apply mechanical resistance (friction). The original name was "electro-mechanical brakes" but over the years the name changed to "electromagnetic brakes", referring to their actuation method. Since becoming popular in the mid-20th century especially in trains and trams, the variety of applications and brake designs has increased dramatically, but the basic operation remains the same. Electromagnetic brakes are the brakes working on the electric power & magnetic power. They work on the principle of electromagnetism.

These brakes are an excellent replacement on the conventional brakes due to their many advantages. The reason for implementing this brake in automobiles is to reduce wear in brakes as it is frictionless. Electromagnetic brakes are of today's automobiles. 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. This eddy current tries to stop the rotating wheel or rotor. This results in the rotating wheel or rotor coming to rest/ neutral.

History

It is found that electromagnetic brakes can develop a negative power which represents nearly twice the maximum power output of a typical engine, and at least three times the braking power of an exhaust brake. (Reverdin 1994). These performance of electromagnetic brakes make them much more competitive candidate for alternative retardation equipments compared with other retarders. By using the electromagnetic brakes as supplementary retardation equipment, the friction brakes can be used less frequently, and therefore practically never reach high temperatures. The brake linings would last considerably longer before requiring maintenance and the potentially "brake fade" problem could be avoided. In research conducted by a truck manufacturer, it was proved that the electromagnetic brake assumed 80% of the duty which would otherwise have been demanded of the regular service brake (Reverdin 1974). Furthermore the electromagnetic brakes prevent the danger that can arise from the prolonged use of brake beyond their capability to dissipate heat. This is most likely to occur while a vehicle descending a long gradient at high speed. In a study with a vehicle with 5 axles and weighing 40 tonnes powered by an engine of 310 b.h.p travelling down a gradient of 6% at a steady speed between 35 and 40 m.h.p, it can be calculated that the braking power necessary to maintain this speed is of the order of 450 hp. The brakes, therefore, would have to absorb 300 hp, meaning that each brake in the 5 axles must absorb 30 hp, that a friction brake can normally absorb with self-destruction. The magnetic brake is well suited to such conditions since it will

independently absorb more than 300 hp (Reverdin 1974). It therefore can exceed the requirements of continuous uninterrupted braking, leaving the friction brakes cool and ready for emergency braking in total safety. The installation of an electromagnetic brake is not very difficult if there is enough space between the gearbox and the rear axle. It did not need a subsidiary cooling system. It relies on the efficiency of engine components for its use, so do exhaust and hydrokinetic brakes. The exhaust brake is an on/off device and hydrokinetic brakes have very complex control system. The electromagnetic brake control system is an electric switching system which gives it superior controllability.

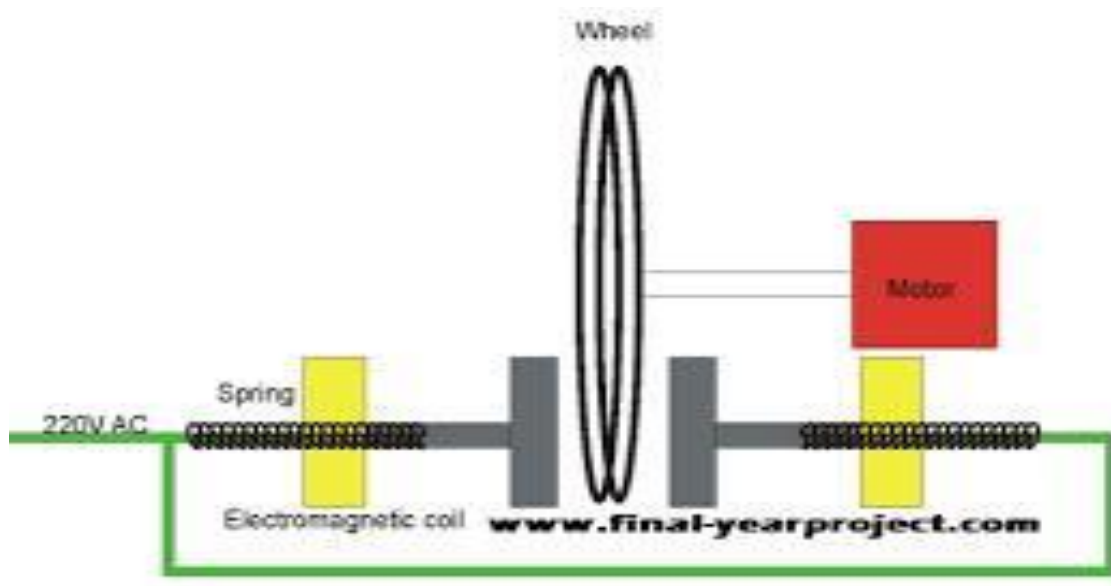


Fig 1.1 Schematic Diagram of Principle of Electromagnetic Braking System

1.3 Types of Braking System

- **Electromagnetic Brake System**

A rising style of brake system, electromagnetic brakes use an electric motor that is included in the automobile which help the vehicle come to a stop. These types of brakes are in most hybrid vehicles and use an electric motor to charge the batteries and regenerative brakes. On occasion, some buses will use it as a secondary retarder brake.

- **Frictional Brake System**

A frictional brake system is found in many automobiles. They are service brakes, and typically found in two forms; pads and shoes. As the name implies, these brakes use friction to stop the automobile from moving. They typically include a rotating device with a stationary pad and a rotating weather surface. On most band brakes the shoe will constrict and rub against the outside of the rotating drum, alternatively on a drum brake, a rotating drum with shoes will expand and rub against the inside of the drum.

- **Hydraulic Brake System**

A hydraulic brake system is composed of a master cylinder that is fed by a reservoir of hydraulic braking fluid. This is connected by an assortment of metal pipes and rubber fittings which are attached to the cylinders of the wheels. The wheels contain two opposite pistons which are located on the band or drum brakes which pressure to push the pistons apart forcing the brake pads into the cylinders, thus causing the wheel to stop moving.

1.2 Objectives

- **Primary Objective**

The main objective of our project is to design and fabricate an Electromagnetic Braking System model.

- **Secondary Objective**

Besides the main objective, following are our secondary objectives:

1. To understand project planning and execution
2. To understand the fabrication techniques in a mechanical workshop
3. To understand the usage of various mechanical machine tools and also measuring tools
4. To make day to day human life more easier by proper use of technology

1.4 Significances and Scope:

The following are the significances:

1. Electromagnetic brakes satisfy all the energy requirements of braking without the use of friction. They have better heat dissipation capability to avoid problems that friction brakes faces times.
2. They can also be used as a supplementary retardation equipment in addition to the regular friction brakes on heavy vehicles.
3. These brakes's component cost is less so these brakes are cheap.
4. They can be used as an alternative method for the future crisis of the crude oils.

1.5 Limitations:

The following are the limitations:

1. The installation of an electromagnetic brake is very difficult if there is not enough space between the gearbox and rear axle.
2. It cannot use grease or oil.
3. EM brakes are good at slowing things down, not completely stopping them.

CHAPTER 2 METHODOLOGY

Basically, this project was to study and analyze electromagnetic braking system as a secondary measure for the hydraulic braking system. First, the base for the electromagnets and the stand for fitting the wheel, is made. Then, a wheel is made and attached to the spook whereas the spook is attached to the stand by the help of bearings.

An electromagnet is made by winding the copper wire with the cylindrical body and attached to it's base. Furthermore, an U shaped metal rod is welded with a L shaped metal bar forming a brake shoe and then its end are rest inside the electromagnet. Also a fan is also attached to motor and the motor is attached to the base. So the electromagnet and the motors of wheel and fan are circuited to an external battery and by turning it on, they work respectively.

2.1 Theoretical/Conceptual Framework

Our model is divided mainly into two different units ;

1) Driving Unit.

2) Braking Unit.

1) Driving Unit

a) Electric Motor

An Electric motor is an electrical device that converts electrical energy into mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. Electric motors may be classified by electric power source type, internal construction, application, type of motion output, and so on.



Fig 2.1.1: Electric DC motor

b) Wheel

Wheel gets in motion with the help of running motor. Both motor and wheel is connected with the help of connecting chain and chain ring.

c) Power control

This division consists of power supply to whole system and a separate power control system to control the motion of motion.

2) Braking Unit

a) Electromagnet

An electromagnet is a type of magnet in which the magnetic field is produced by an electric current. The magnetic field disappears when the current is turned off. Electromagnets usually consist of insulated wire wound into a coil. A current through the wire creates a magnetic field which is concentrated in the hole in the center of the coil. The wire turns are often wound around a magnetic core.

b) Brake Shoe

It is part that will stop the main wheel when the electromagnet is turned on.

3) Other parts

Spring:

A coil spring, also known as a helical spring, is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. : Two compression springs are used to push back the brake shoe back in its position.



Fig 2.1.3: Spring

Bearing:

The purpose of Ball Bearing is to reduce rotational friction and support radial and axial loads. In this project 608 2RS type of bearing is used.



Fig 2.1.3(b): Bearing

2.2 Working Mechanism

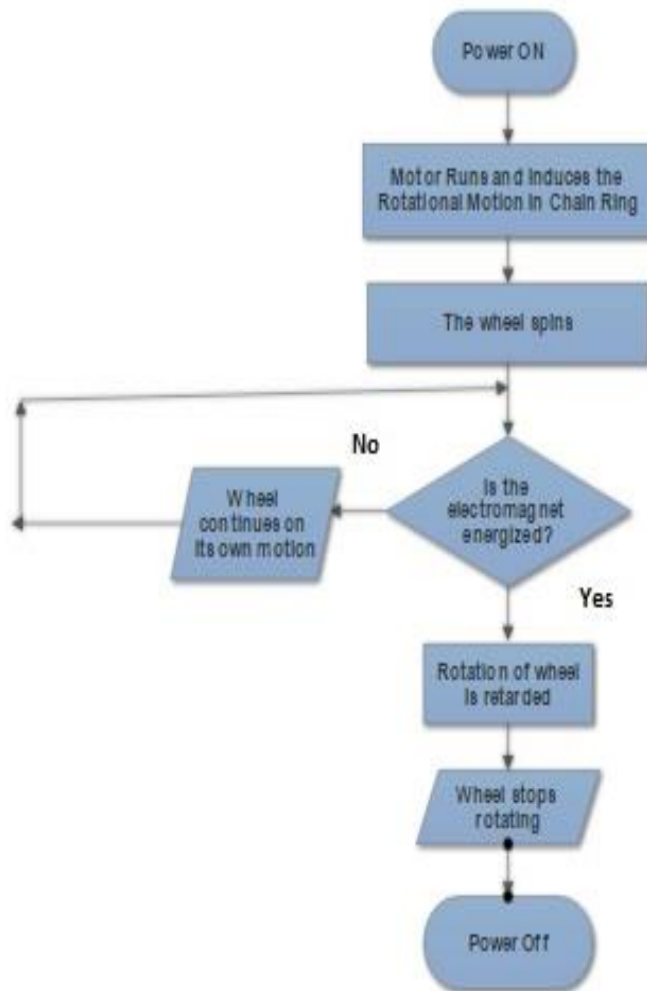


Fig 2.2: Flowchart of the working mechanism

Chapter 3 FABRICATION

a) Base plank

It consists of rectangular wooden plank which acts as a base for all the component of EMBS. It will have dimension of 80*50*1 cm.

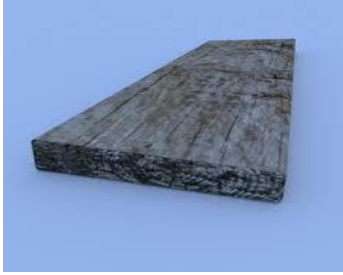


Fig 3.a: Base Plank

b) Electric motor

DC Wiper motors is used to move the wheel .



Fig 3.b: Electric Motor

c) Electromagnet:

In this project, we used electromagnet to stop the wheel. Basically, it made by winding the copper wire round the cylindrical body to required strength.

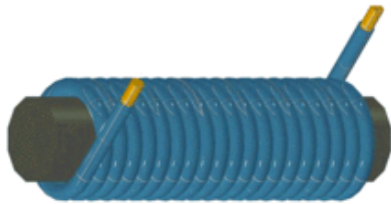


Fig 3.c: Electromagnet

3.3 Overall Fabrication of the System

Methodology to Fabrication of electromagnetic braking system model

1. Analyze the problems in the fabrication of electromagnetic braking system
2. Designing the required components.
3. Selection of required materials.
4. Purchasing the materials.
5. Fabrication of the electromagnet.
6. Preparation of report and submit.

Chapter 4 CALCULATIONS

1

Magnetic force produced (B)= μIN

$$=4\pi \times 10^{-7} \times 2 \times 550$$

$$=0.00138 \text{ T which is magnetic force produced by one}$$

electromagnet as we are using two electromagnets so our total force will be

Total Magnetic force(B)= $2 \times B$

$$=0.00276 \text{ T.}$$

2.

Total Force produced(F)=($B \times B \times A$)/($\mu G \times G$)

$$=0.00276 \times 226.194 / 50.265$$

$$=171.396 \text{ N}$$

3.

Resistance of wire(R)= $\rho L/A$

$$=1.7 \times 10^{-8} \times 13.8 / 0.503$$

$$=0.466 \Omega$$

4.

Heat produced(H)= $I^2 R \times T$

$$=2^2 \times 0.466 \times 60$$

$$=112 \text{ J}$$

Where I is current,

N is number of turns,

A is cross sectional area,

G is the gap between magnet and iron,

R is the resistance of copper wire,

L is the length of copper wire,

ρ is the resistivity of copper,

T is time in seconds.

Chapter 5 GANTT CHART

Table 5: Gantt Chart for Second Semester

Weeks	1	2	3	4	5	6	7	8	9	10	11
Literature review											
Consultation											
Proposal submission											
Material selection and purchase.											
Model design and Construction											
Midterm presentation											
Testing and Debugging											
Demonstration											
Report submission and final submission											

Work Completed	
Work Remaining	

CHAPTER 6 BUDGET ESTIMATION

Table 6: Table for Budget estimation

S/N	Particulars	Specification	Rate	Unit	Total (NRs)
1.	Ply Wood	0.5*0.3m	100per sq m	1	200
2.	Motor	1500RPM	300	1	300
3.	Electromagnet		200	2	400
6.	Battery	12v 7,8AH, 20HR	800	1	800
8.	Switch		20	3	60
9.	Bearing	608 2RS HF	100	2	200
10.	Battery	AA	10	4	40
11.	Small Cooling Motor	DC	30	1	30
12.	Others(Glue stick,soldering iron,pulley,wires,leds)				300
				Total	2330

CHAPTER 8 CONCLUSION

This report presents the performance of an electromagnetic braking system which includes various components with its cost effectiveness and efficient methodologies to utilize the supplied energy. With the application of the effective and strong electromagnet we can have greater efficient braking system.

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