www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205

ELECTROMAGNETIC BRAKING SYSTEM

Shreyansh Meshram[1], Dr. Sanjay Katarey[2], Prof. Neeraj Sen[3]

[1]Student, B. Tech, Department of Mechanical Engineering, Samrat Ashok Technological Institute Vidisha (M.P)

[2]Professor, Department of Mechanical Engineering, Samrat Ashok Technological Institute Vidisha (M.P)

[3]Guide, Department of Mechanical Engineering, Samrat Ashok Technological Institute Vidisha (M.P)

ABSTRACT

The principle of braking in road vehicles involves the conversion of kinetic energy into heat. This high energy conversion therefore demands an appropriate rate of heat dissipation if a reasonable temperature and performance stability are to be maintained. While the design, construction, and location features severely limit the heat dissipation function of the friction brake, electromagnetic brakes work in a relatively cool condition and avoid problems that friction brakes face by using a totally different working principle and installation location. By using the electromagnetic brake as supplementary retardation equipment, the friction brakes can be used less frequently and therefore practically never reach high temperatures. The brake linings thus have a longer life span, and the potential "brake fade" problem can be avoided. It is apparent that the electromagnetic brake is an essential complement to the safe braking of heavy vehicles.

In this thesis, a new mathematical model for electromagnetic brakes is proposed to describe their static characteristics (angular speed versus brake torque). The performance of the new mathematical model is better than the other three models available in the literature in a least- square sense. Compared with old models that treat reluctance as a constant, our model treats reluctance as a function of speed. In this way, the model represents more precisely the aggregate effect of all side effects such as degree of saturation of the iron in the magnet, demagnetizing effects, and air gap. The software program written in Mat lab can be used to code different brake characteristics (both static and dynamic) and evaluate their performance in different road scenarios.

It can be proven from this study that the electromagnetic brake is effective supplementary retardation equipment. The application and control of electromagnetic brakes might be integrated with the design of vehicles and their friction braking systems.

1. INTRODUCTION

In this project we are trying to make a braking system. Which can be applicable in two wheeler at high speed and low maintenan ce cost. Here we are using an electromagnetic coil and a plunger. There is an electromagnetic effect which moves the plunger in the braking direction.

When electricity is applied to the field, it creates an internal magnetic flux. That flux is then transferred into a hysteresis disk passing through the field. The hysteresis disk is attached to the brake shaft. A magnetic drag on the hysteresis disk allows for a constant drag, or eventual stoppage of the output shaft.

- This projects intends to the design and implementation of new system of retardation (braking) for automobiles.
- The design of the new brakes is based upon the phenomenon of electromagnetic induction and eddy currents.
- The design basically consists of very strong magnet and rotating metallic wheel.
- The wheel develops eddy currents due to the change in magnetic flux associated to the wheel due to its rotation.
- The eddy current development obeys Maxwell's law of electromagnetic induction and Lenz's law of direction of induced current.
- The current in turn dissipates the rotational energy of the wheel as heat bringing the wheel to a stop.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205

2. 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 equipment's compared with other retarders. By using by using the electromagnetic brakes are 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 197 Furthermore the electromagnetic brakes prevents the danger that can arise fr 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. Ina study with a vehicle with 5 axles and weighting 40 tones powered by a 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 to the order of 450 hp. The brakes, therefore, would have to absorb 300 hp, meaning that each brake in the 5 axels must absorb 30 hp that a friction brake can normally absorb with self destruction. The magnetic brake is wall 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 tot safety. The installation of an electromagnetic brake is not very difficult if there enough space between the gearbox and the rear axle. If did not need a subsidiairycooling system. It relay 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.

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.

3. EXECUTIVE SUMMARY

- Objective: Design an electromagnetic conventional braking system -Less cost with greater performance -No need for maintenance and/or replacement.
- Research: Other types of electromagnetic braking system with brake pads-Eddy-current braking system braking system - Electromagnetic Braking system.

4. PRODUCTS REQUIREMENTS

Overall Power supply to power the system -Hub and spindle assembly to simulate the actual spinning of the rotor -Custom made rotor with metal arranged for the most effective result -Brake pedal to simulate the real environment -TWO electromagnets to generate braking force .

5. GENERAL PRINCIPLES

Installation location :

Electromagnetic brakes work in a relatively cool condition and satisfy all tne ener8y requirements of bre LiLmpletely without the use of friction. Due to its specific in imission line of rigid vehicles).

There are in existence several types of electromagnetic retarder. Ih particular, there are electromagnetic retarders of the axial type and electromagnetic retarders of the Focal type. An electromagnetic retarder of the axial type is designed to be placed on a transmission shaft between a rear axle anda gearbox of the vehicle. In that case, the transmission shaft is in two parts, for mounting between those of the retarder. An electromagnetic retarder of the Focal type is designed to be placed directly on a transmission shaft on the output side of the gearbox or on the axle of the vehicde. The axle of a vehicle drives at least one road wheel, which road wheel drives at least one wheel of the same vehicle.

6. WORKING

The working principle of the electric retarder is based on the creation of Eddy currents within a metal disc rotating between two electromagnets, which sets up a force opposing the rotation of the disc. If the electromagnet is not energized, the rotation of the disc is free and accelerates uniformly under the action of the weight to which its shaft is connected. When the electromagnet is energized, the rotation of the disc is retarded and the energy absorbed appears as heating of the disc.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205

In this type of electromagnetic braking system, electromagnet is fixed in the back plate in this way the unequal braking effect at one shoe are balanced, even if the lining on one shoe is worn more than other the plunger will move to one side so that shoe still share equal acting force.

In this braking system, any one shoe out of two will remove & instead of it we will use the electromagnetic coil. As the current passes through this electromagnetic coil, it will produce the magnetic flux, this flux will attract the shoe with much force, and brake will apply.

A typical retarder consists of stator and rotor. The stator holds 16 Induction coils, energized separately in groups of four. The coils are made up of varnished aluminum wire mounded in epoxy resin. The stator assembly is Supported resiliently through anti-vibration mountings on the chassis frame of the vehicle. The rotor is made up of two discs, which provide the braking force when subject to the electromagnetic influence when the coils are excited. Careful design of the fins, which are integral to the disc, permit independent cooling of the arrangement.

7. DESIGN AND DEVICES

- Design Alternatives

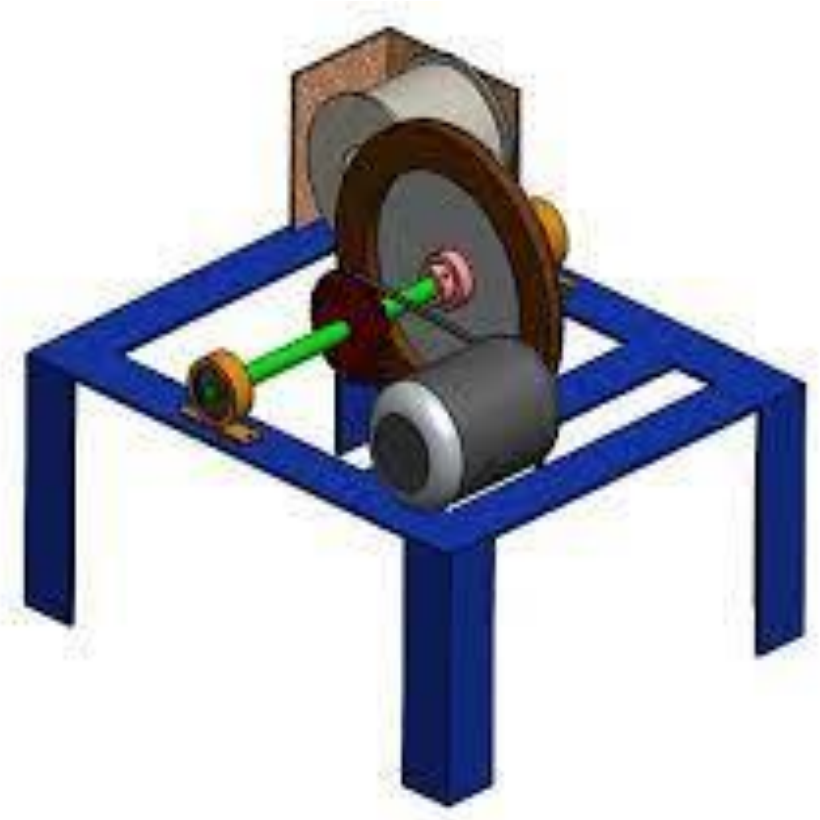
- Permanent magnets mounted on the wheel -Cleaning issue Magnet arrangement issue -Electromagnetic field around other mechanical components issue.
- Metallic material region all around the wheel-Electromagnetic field dispersion issue -Not enough braking force.

- Design Specifications (cont'd)

  General view- Pedal-8015 Microcontroller-Circuit board- Electromagnets- DC power supply Pedal 8051 Uc

  EM DC power supply

  Circuit board 2 [V output, Input Square Wave 14 [V] power

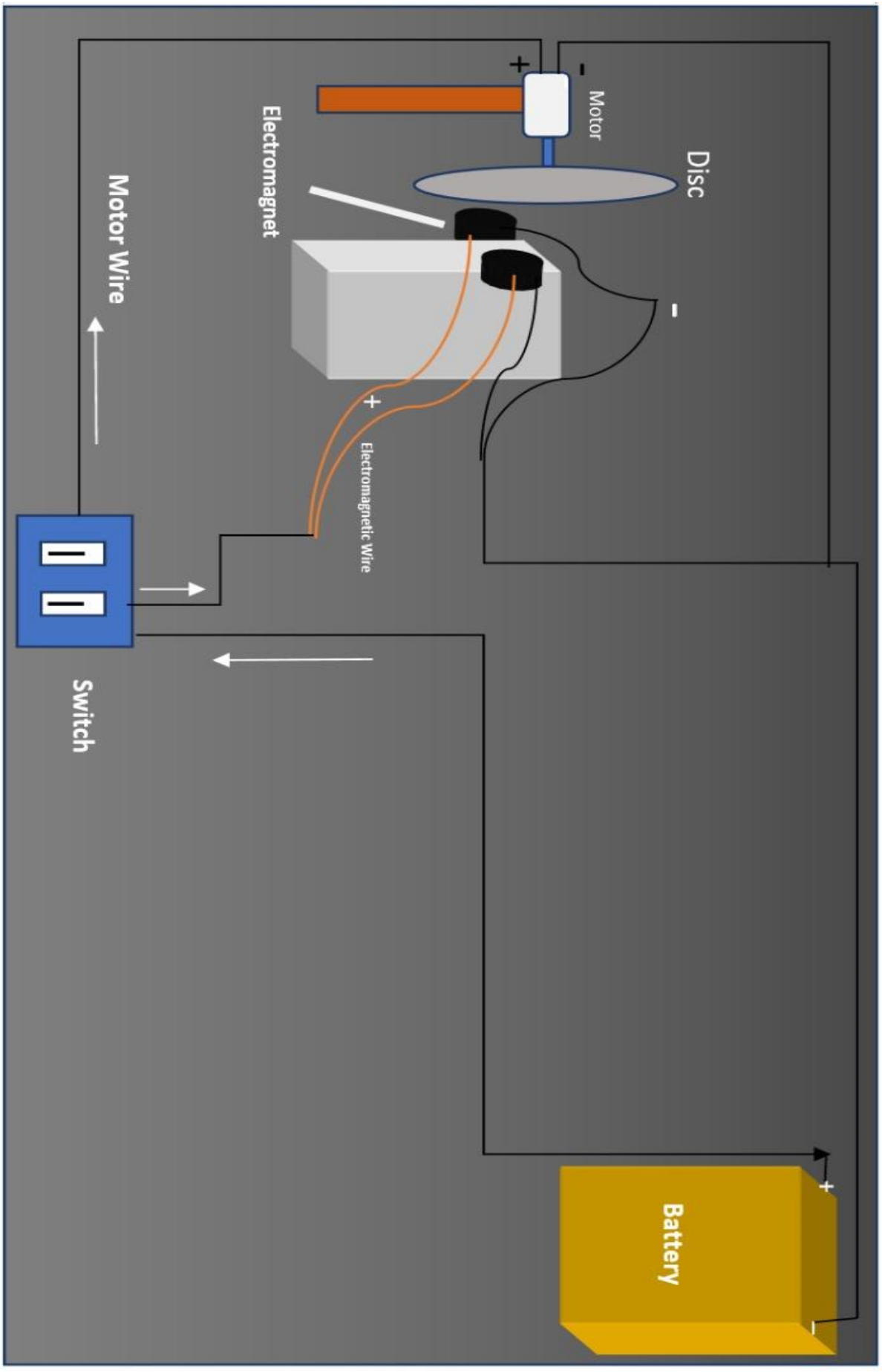


www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205



www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205

8. OUR FOCUS

The main objective of our project is to find out best material used for making disk.

The proper selection of rotor disc materialis very important in the design of eddy current brakes. Eddy current brakes rely on various material properties hence a material with good mechanical properties, a high electrical conductivity and good power dissipation capabilities.

9. USED DEVICES

DC Motor

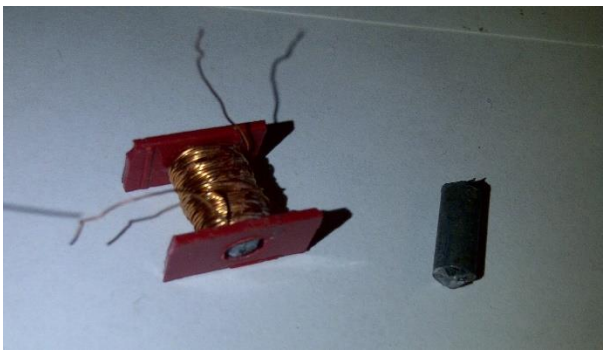
DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; A linear motor directly produces force and motion in a straight line.

Battery

An automotive battery or car battery is a rechargeable battery that is used to start a motor vehicle. Its main purpose is to provide an electric current to the electric-powered starting motor, which in turn starts the chemically-powered internal combustion engine that actually propels the vehicle. Once the engine is running, power for the car's electrical systems is still supplied by the battery, with the alternator charging the battery as demands increase or decrease.

Electromagnet

Electromagnets are commonly used for eddy current brakes, rather than permanent magnets, because the power of the magnetic field can be changed, and thus the braking effect as well. One major issue with eddy current brakes is that they cannot offer a “holding” torque.



www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205

Switches

A switch is used in a wired network to connect to other devices using Ethernet cables. The switch allows each connected device to talk to the others. Wireless-only networks do not use switches because devices such as wireless routers and adapters communicate directly with one another.

Wires

A wire is a flexible metallic conductor, especially one made of copper, usually insulated, and used to carry electric current in a circuit.

10. WORKING PRINCIPLE OF ELECTROMAGNETIC BRAKES

- When the electromagnet is not energized, the rotation of disk is free under the action of weight to which its shaft Is connected. when the electromagnet is energized ,the rotation of disk is retarded and the energy absorbed appears as heating of disk.
- As the metal disk cuts through the magnetic field a current which moves in a Circular manner in the disk is created thus the eddy currents, according to Lenz law the induced current will create its own magnetic field that opposes the magnetic field that Created it there by providing the necessary drag force required to retarding the motion of the disk.

11. MATERIALS ANALYSIS

Ferromagnetic materials display poor performance characteristics in the use as eddy currents disc materials. There are three strong candidates of material which are zinc, copper and aluminum.

Preferred Materials :

From their experimental evaluation aluminum proved to be the best material. A further investigation was carried out to analyze two different alloys of aluminum which are Al6061 and A17075, from the study was concluded that Al6061 has greater performance than Al7075 as the brake disc material. The ability of aluminum to perform better than the other material is due to the absence of magnetic susceptibility as shown in table. Although the disc material is not the only parameter to be considered to achieve the optimal results it can be concluded that the disc material plays a pivotal role in obtaining the optimal solution.

12. APPLICATIONS

- Already in use under some railway system.
- .Can be used for any road vehicles
- Equally applicable to heavy and light vehicles
- Can be used as additional retarder for aircrafts
- May also find application in virtually any rotating system which have metallic parts.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205

- This brake system can be use in two wheeler.
- Electromagnetic braking system can be used as a modern technology of braking in automobile.
- Electromagnetic braking system will be used in all types of light motor vehicle like car and heavy motor vehicle.

- Trams and trains use electromagnetic track brakes where the braking element is pressed by magnetic force to the rail . They are distinguished from mechanical track brakes, where the braking element is mechanically pressed on the rail.
- Electric motors in industrial and robotic applications also employ electromagnetic brakes.
- Recent design innovations have led to the application of electromagnetic brakes to aircraft applications.

13. LIMITATIONS

- Failure to act as a holding device.
- Usage of electric power for braking.
- Less effective under very low velocities.
- The installation of an electromagnetic brake is very difficult if there is Not enough space between the gearbox and the rear axle.
- Need a separate compressor.
- Maintenance of the equipment components such as hoses, valves has to done periodically.
- It cannot use grease or oil. Dependence on battery power to energize the brake system drains down the battery much faster.
- Due to residual magnetism present in electromagnets, the brake shoe takes time to come back to its original position.
- The installation of an electromagnetic brake is very difficult if there is not enough space between the gearbox and the rear axle.

www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062
Impact Factor : 2.205

14. ADVANTAGES

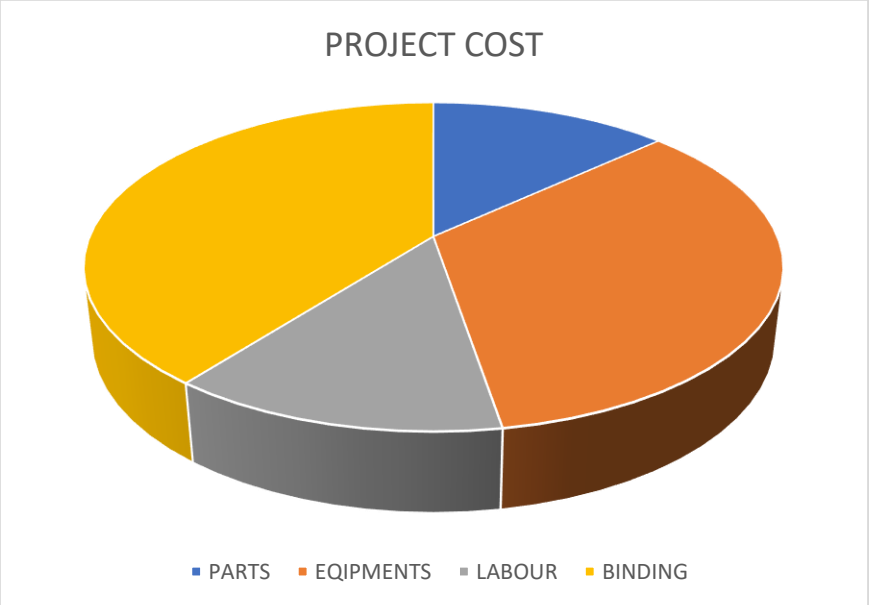
- Problems of drum distortion at widely varying temperatures. Which is common for friction-brake drums to exceed 500 °C surface temperatures when subject to heavy braking demands, and at temperatures of this order, a reduction in the coefficient of friction (‚brake fade") suddenly occurs.
- This is reduced significantly in electromagnetic disk brake systems.
- Potential hazard of tire deterioration and bursts due to friction is eliminated.
- There is no need to change brake oils regularly. There is no oil leakage .
- The practical location of the retarder within the vehicle prevents the direct impingement of air on the retarder Caused by the motion of the vehicle.
- .The retarders help to extend the life span of the regular brakes and keep the regular brakes cool for emergency situation.
- The electromagnetic brakes have excellent heat dissipation efficiency owing to the high temperature of the surface of the disc which is being cooled.
- Due to its special mounting location and heat dissipation mechanism, electromagnetic brakes have better thermal dynamic performance than regular friction brakes.
- Burnishing is the wearing or mating of opposing surfaces .This is reduced significantly here.
- Electromagnetic brake systems will reduce maintenance cost. The problem of brake fluid vaporization and freezing is eliminated.
- Electric actuation, no fluid. Easier integration with anti-lock, traction, and dynamic stability controls.
- Easy individual wheel braking control.

15. DISADVANTAGES

- Less effective under very low velocities.

16. PROJECT COST

CATEGORY	COSTS
Parts	500rs
Labour	500rs
Equipments	1300rs
Binding	2200rs
TOTAL	4500RS



www.ijprems.com
editor@ijprems.com

INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
Vol. 02, Issue 05, May-2022, pp : 53-61

e-ISSN : 2583-1062

Impact Factor : 2.205

17. FUTURE ASPECTS

- The proposed winding model should be verified and its validity with respect to frequency and model parameter settings investigated.
- In the core model the static hysteresis model should be improved, especially regarding the modelling of minor loops. E.g., the distribution function of the pseudo particles and the relation between reversible and irreversible processes should be studied more in detail.
- In the dynamic magnetization model the optimization of the Cauer circuit sections and the frequency and amplitude dependency of the parameter VO could be studied.
- If it is possible to find that dependency for a class of material, this would make this modela very useful tool. Then the only necessary adapting step would be to fit the static curve to the measured static curve.
- .The composite transformer model should also be validated in other operation modes like transient overvoltage.
- A more detailed reluctance network model of the transformer including three dimensional flux paths in the tank and construction details should be developed and verified.
- A static magnetization model that takes B as input and returns H should be developed.

18. CONCLUSION

Electromagnetic brakes are important supplementary retardation equipment in addition to the regular friction brakes. They have been used in heavy vehicles such as coaches, buses, or trucks under conditions such as reducing speed on motorways and trunk roads, and braking for prolonged periods during downslope operations. New types of electromagnetic brakes have been under development for lighter vehicles as wel. Regular friction brakes have an outstanding and vital load absorbing capability if kept cool. Electromagnetic akes help friction brakes to retain this capability under all conditions by absorbing energy at a separate location based on a totally different working principle. In this study, we proposed a modified static mathematical model for the electromagnetic brakes.

A sliding mode controller is designed and simulated for a nominal vehicle model under different road surface conditions. Microcontroller implementation of electromagnetic anti-lock braking system is evaluated. The performance of the modified mathematical model for electromagnetic brake is better than the other three models available in the literature in a least- square sense. There is only one "global" model which can be used at both low speed and high speed regions. Unfortunately, this model does not agree with the experimental results in the high speed region. Based 80 on the phenomena summarized from observation in the high speed region, we modified the old "global model by taking the "reluctance effect" into account. After this modification, we can model the speed- torque relationship more accurately.

A sliding mode controller is designed to implement the wheel slip control system. A nominal vehicle system model is used in a Mat lab /s-function simulation for testing the controller performance in different road surface scenarios. According to the simulation results, the controller performance is satisfactory. The wheel slip is kept in the appropriate range and brake torque is controlled to adapt to the new road surface quickly whenever the road surface changes.

19. REFERNCES

[1]. K.D. Hahn, E.M. Johnson, A. Brokken, & S. Baldwin (1998) "Eddy current.
[2]. damping of a magnet moving through a pipe", American Journal of Physics 66:1066-66.
[3]. M.A. Heald (1988) "Magnetic braking: Improved theory", American Journal of Physics 56: 521-2.
[4]. Y. Levin, S.L. Da Silveira &F.B. Rizzato (2006) "Electromagnetic braking: A simple quantitative model", American Joumal of Physics 74:815-17.
[5]. Sears, Francis Weston; Zemansky, Mark W. (1955). University Physics (2nd Ed.). Reading, MA: Addison-Wesley.
[6]. Siskind, Charles S. (1963). Electrical Control Systems in Industry. New York: McGraw-Hil, Inc. ISBN 0-07-057746-3.