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FABRICATION AND PERFORMANCE EVALUATION OF ELECTROMAGNETIC BREAKING SYSTEM

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ABSTRACT

The electromagnetic braking mechanism was developed in this research. It is the responsibility of the braking system to keep the occupants, the driver, and other road users safe and comfortable. A powerful brake is required to bring the vehicle to a complete halt in an emergency situation within the lowest possible time. Power to weight ratio is poor due to the large convention braking system. Small and heavy vehicles, such as cars, jeeps, trucks, and buses, may benefit from an electromagnetic braking system. This article discusses how to minimise the risk of a car accident by reducing the likelihood of a brake failure. It also saves time and money on brake system maintenance. The brake's efficacy should not fluctuate over time. The anti-fade and efficient functioning of a brake may be achieved by sufficient cooling of the brake. Lubrication and maintenance must be performed correctly to provide safe, effective, and progressive braking with minimal driver fatigue. In emergency circumstances, this technique delivers a faster reaction time and prolongs the life of the friction brake.

Keywords: General Service Administration, Demand Capacity Ratio, Shear Wall.

I. INTRODUCTION

Mechanical resistance is provided by electromagnetic force, which is sometimes known as EM brakes or EM brakes (friction). Brakes with electronic controls are sometimes referred to as "electro-mechanical controls" but their actuation technique led to a term change to "electromagnetic brakes" over time. Since they became widespread in trains and trams in the middle of the twentieth century, the number of applications and brake designs has risen rapidly. However, the fundamental functioning has remained the same during this period. Brakes that use both electric and magnetic power are known as electromagnetic brakes. Electromagnetism is the basis of their operation.

This is a great substitute for convectional brakes because of its numerous benefits. Because this brake is frictionless, it reduces the amount of wear on the brakes in vehicles, which is why it has been used. Modern autos use electromagnetic brakes. Eddy currents run in the opposite direction of the revolving wheel/rotor It occurs It occurs when the magnetic flux lines up with the wheel's revolution. The wheel or rotor is stopped by this eddy current. serving as a pulley Rotor will eventually stop and enter neutral mode.

As a result of the evolution of its actuation method, electronic brakes were initially referred to as "electro-mechanical brakes." Brakes have evolved fast since they first appeared on trains and trams in the middle of the twentieth century. Despite this, the system's basic functions have remained unchanged. The term "electromagnetic brakes" refers to brakes that utilize both electric and magnetic power. Their functioning is predicated on the principles of electromagnetism. Because of its multiple advantages, this is an excellent option for convectional brakes. To lessen the amount of wear on a vehicle's brakes, this frictionless brake has been employed. Electromagnetic brakes are now standard equipment on most modern cars. A rotating wheel or rotor generates eddy currents in the opposite direction. When the wheel is rotating in the opposite direction as the magnetic flow, this phenomenon happens. The wheel or rotor is being magnetized by this eddy current. Consequently, the whirling rotor or wheel comes to a halt.

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1.1 Types of Braking System

1. System of Magnetism, Electricity, and Mechanical Action Modern vehicles are equipped with electromagnetic brakes, which use an electronic motor to help slow down the vehicle. A common feature of hybrid vehicles is regenerative braking, which uses an electric motor to charge the battery while also generating energy to operate the brakes. Some buses may sometimes utilise it as an extra retarder brake.

2. Frictional Braking Mechanism Friction braking systems are commonplace in vehicles. Most service brakes use pads or shoes. Vehicles with friction brakes use the force of friction to slow down or stop. The most typical setup is a weather spinner with a stationary pad and a revolving forecast screen. Shoes in a drum brake expand and rub on the inside surface of the spinning drum, as opposed to the outside surface as in band brakes.

3. In a hydraulic brake system, a reservoir of hydraulic braking fluid nourishes a master cylinder, which then applies brake pressure to wheels. The cylinders of the wheels are fitted with a variety of metal and rubber pipes and fittings. To stop the wheel from moving, brake pads are forced into cylinders by the pressure of two opposing pistons positioned on the band or drum brakes on each of the wheels.

1.2 Research objectives

1. The primary goal Our project's primary goal is to create a scale model of an Electromagnetic Braking System.
2. Secondary Purpose: In addition to our primary goal, we've set the following subsidiary goals:
3. In order to comprehend the procedure for organising and carrying out a project.
4. To be familiar with mechanical workshop construction methods
5. To get an understanding of the different mechanical machine tools as well as the various measurement instruments.
6. Making human existence more manageable via the intelligent use of modern technologies

II. LITERATURE SURVEY

Reading review articles on different brakes helps our staff better understand the work of others in the field. We can learn a lot from the papers on the following list.

Deyi Li, Hongbo Gao: The type, model, quantity, and location of sensors installed on the intelligent vehicle test platform are different, resulting in different sensor information processing modules. The driving map used in intelligent vehicle test platform has no uniform standard, which leads to different granularity of driving map information. The sensor information processing module is directly associated with the driving map information and decision-making module, which leads to the interface of intelligent driving system software module has no uniform standard. Based on the software and hardware architecture of intelligent vehicle, the sensor information and driving map information are processed by using the formal language of driving cognition to form a driving situation graph cluster and output to a decision-making module, and the output result of the decision-making module is shown as a cognitive arrow cluster, so that the whole process of intelligent driving from perception to decision-making is completed. The formalization of driving cognition reduces the influence of sensor type, model, quantity, and location on the whole software architecture, which makes the software architecture portable on different intelligent driving hardware platforms

Garrett J. Marshall, Colin P. Mahony, Matthew J. Rhodes, Steve R. Daniewicz , Nicholas Tsolas , Scott M. Thompson: Reducing heat accumulation within vehicles and ensuring appropriate vehicular temperature levels can lead to enhanced vehicle fuel economy, range, reliability, longevity, passenger comfort, and safety. Advancements in vehicle thermal management remain key as new technologies, consumer demand, societal concerns, and government regulations emerge and evolve. This study summarizes several recent advances in vehicle thermal management technology and modeling, with a focus on three key areas: the cabin, electronics, and exterior components of vehicles. Cabin-related topics covered include methods for reducing thermal loads and improving heating, ventilation, and air-conditioning (HVAC) systems; and advancements in window glazing/tinting and vehicle surface treatments. For the thermal management of electronics, including batteries and insulated-gate bipolar transistors (IGBTs), active and passive cooling methods that employ heat pipes, heat sinks, jet impingement, forced convection, and phase-change materials are discussed. Finally, efforts to model and enhance the heat transfer of exterior vehicular components are reviewed while considering drag/friction forces and environmental effects. Despite advances in the field of vehicle thermal management, challenges still exist; this article provides a broad summary of the major issues, with recommendations for further study.

Electromagnetic Braking: A Method to Improve Automobile Braking, Keeping the vehicle under control as it is travelling down a steep or declining slope, as well as stopping it in the shortest distance possible, are the two primary functions of the vehicle's braking system. Magnetic brakes are a novel idea. Compared to electromagnetic brakes, a conventional motor's maximum extreme power output is double that of the latter, while the braking energy of a fume brake is three times more than that of the former. Accidents are prevented, and the number of occurrences is drastically decreased, as a consequence of this improved braking mechanism. When used with a friction braking system, electromagnetic brakes may assist reduce brake failure and overheating. Anti-lock braking systems might be replaced with micro-controlled electromagnetic discs (ABS). When used in conjunction with traditional mechanical brakes, these devices may help brakes last longer and perform as if they were fully loaded. Electromagnetic brakes do not need anti-skid equipment, even in wet conditions. Drum brakes are inferior than disc brakes in terms of stopping power, making them less useful as an additional or emergency braking mechanism in vehicles.

Literature review on electromagnetic brake, Using an adjustment mechanism, a pole piece and the pair of permanent magnets adjacent to it may be aligned in a different way. This mechanism allows the magnet support and the pole piece support assembly to move relative to one another. An axis-based brake disc structure and an annular surface mechanism have been devised by inventors for a vehicle braking system. So, the magnet support assemblies may be shifted relative to one another to adjust the angular distance between each pole piece and the next pair of permanent magnets. There are a number of possible configurations for the pole pieces and magnets, depending on whether or not the vehicle is in the braking or non-braking phase. In an urgent situation, this might act as a brake. Since the braking force is directly related to the velocity of the vehicle, eddy braking technology may potentially be useful for fast cars.

Local of Bedford, Ohio Mr. Stephen Z. Oldakowski The magnetic brake, which may be used to stop or lock, is controlled by electromagnetic principles. This magnetic braking system consists of a rotating shaft and a brake disc. The non-rotating core housing of the shaft has a permanent magnet and bipolar solenoid. To stop the shaft from turning, the magnetic armature located next to the main housing assembly may be moved toward the main housing and into contact with a brake disc. When the brake disc hits the armature, the spring pushes it outward. A spinning shaft that is completely locked or completely unlocked is all that is required to keep the brakes in the set or released state, respectively. The armature may be maintained in position by the permanent magnet in the absence of a solenoid, despite the efforts of the spring.

Holzhausem's Karl Erny, sadly deceased Elevator brake levers are operated by compression springs and brake linings on a brake drum. Monitor the armature tappet of the brake magnet using this sensor. The brake magnet tappet is attached to the bracket on one end, while the sensor is housed in a distance piece on the other end. A restoring lug is attached to the mechanical indication. When a potential for harmful operation is detected, the sensor signals are assessed by a monitor, and a safety circuit is engaged if necessary. The technology allows for the state of the brake to be verified. Brake linings last longer when the armature is flush with the brake magnet housing. The brake linings are useless since the armature is touching the magnet housing.

III. SYSTEM METHODOLOGY

The proposed methodology is as shown in the below figure,

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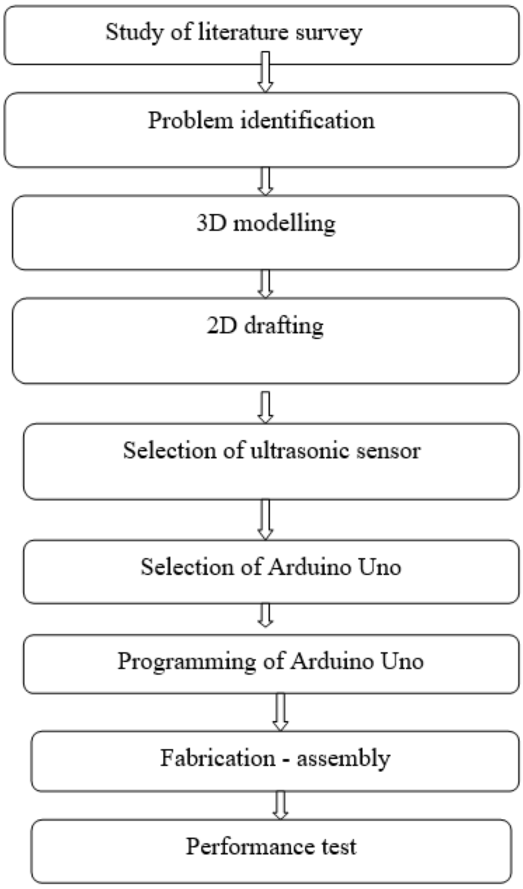

Figure 1: System methodology

As a proof of concept for our project, we implemented this braking system onto a single wheel. Then, the control unit manages the system as a whole. Once the battery is attached, the control unit may run on its own. One side of the braking system might be a conventional hydraulic system, while the other could use an eddy current braking system. Eddy current braking is activated in the event of a malfunction in the hydraulic braking system. Eddy current brakes use electromagnets with their poles on each side of a coil to create a magnetic field that flows through the coil and slows the car. The coil is linked to the axle of the wheel. It is when the magnetic coils are wound onto the clutch that the clutch engages. While in motion, the vehicle's coils absorb and store part of the magnetic pulse's energy, and even when it's interrupted, the coils' magnetic field continues to hold the vehicle in place. Braking force may be adjusted thanks to the electromagnet. There is no braking action when no current is flowing through the coil winding. By applying pressure to the brake pedal, the driver induces a magnetic field in the electromagnet coil windings. More current means more eddy currents, which means more forceful braking. Permanent magnets are used in power tool brakes, and when the power is shut off, a linkage moves the magnets to a position next to the disc. Like traditional friction disc brakes, the disc heats up when the kinetic energy of the moving vehicle is converted into thermal energy (Joule heating) by the eddy currents that flow through the resistance of the disc. Eddy current brakes are more likely to overheat than their linear counterparts because the metal of the disc passes through the magnetic field many times.

3.1 Components employed

Electric DC motor

This mechanical gadget uses an electric motor to transform electrical energy into mechanical energy. In normal operation, the magnetic field and winding currents of a standard electric motor are employed to create internal force. When classifying electric motors, it's important to think about their power source, internal construction, intended use, and output motion type, among other things. DC geared motors provide minimal inertia and smooth low-speed characteristics. Motors with closed feedback loops send geared motor position to a control circuit.. DC motor, potentiometer, gear reduction and control unit make up the geared motor In order for the motor to receive control signals that reflect the output of the motor shaft, these components must function together. Geared motors aren't as simple to turn in either direction as DC motors are to turn in either direction.

Figure 2: Electric DC motor

Wheel

Powered by a running motor, the wheel begins to turn. The engine and the wheel are linked by a chain and a chain ring, respectively. The wheel is seen in the illustration below.

Figure 3: Wheels

Electromagnet

An electric current produces a magnetic field in an electromagnet. When the power is turned off, any detectable magnetic field disappears. Electromagnets are created by winding insulated wire into a coil. When a current flows through a wire coil, the magnetic field is concentrated at the coil's centre. It is normal practise to wind the twisted wires around a magnetic core

Figure 4: Electro magnetic

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To power up the module the battery is essential and it is as shown in the below figure, the controlling of the module is as shown in the below figure.

Figure 5: Battery

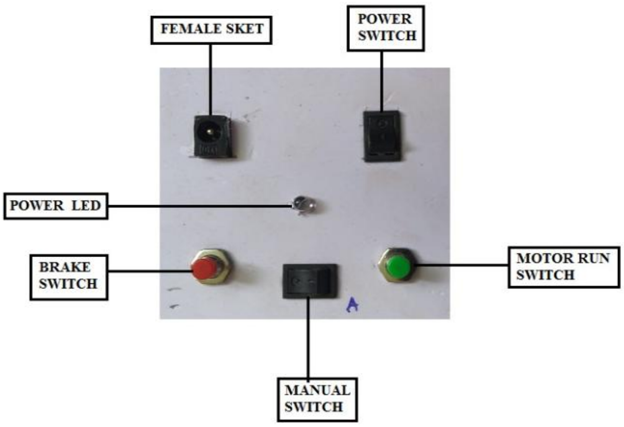

Figure 6: Control panel.

To find the distance between the object and the model the ultra sound sensor is employed and it is as shown below,

Figure 7: Ultrasound

The flow chart of the proposed model is as shown in the below figure,

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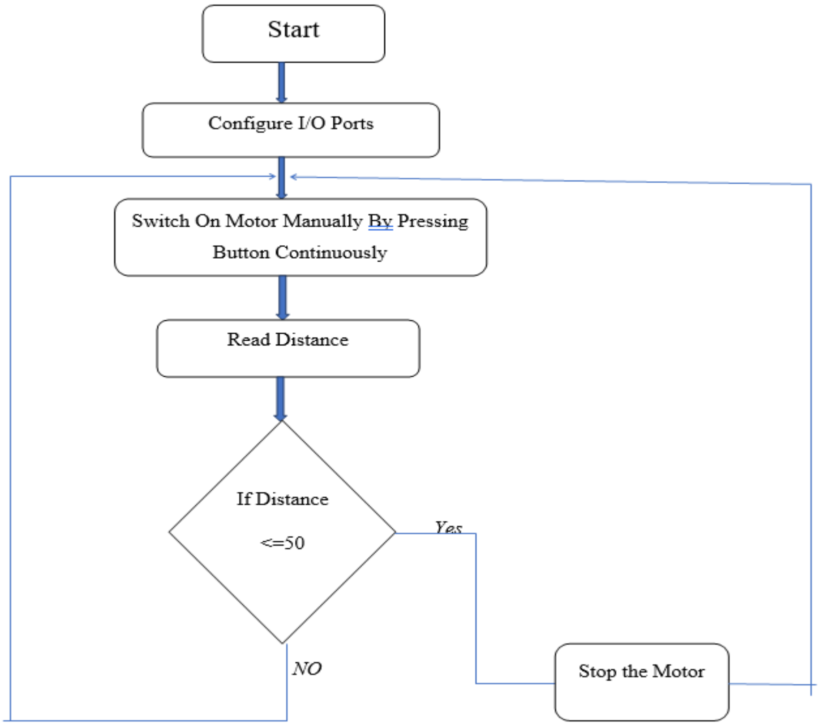

Figure 8: Proposed model.

The model is designed by using the software tool and the dimensions are shown in the below figure,

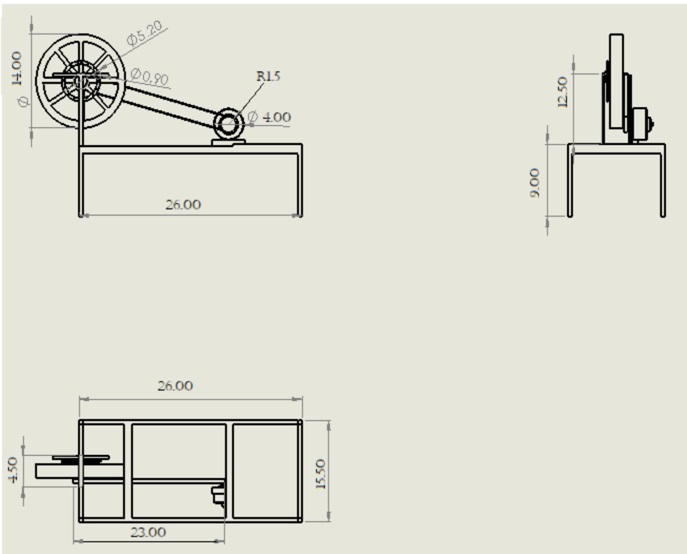

Figure 9: 2D drawing of the proposed model.

IV. IMPLEMENTATION

To design the body of the model the software employed is solidworks2015

What may be found in Solid works 2015 has come and gone. When it comes to 3D software for solid modelling, Solid works is a powerful parametric tool with synchronous technology. This Windows-based programme allows you to produce an orthographic depiction of a mechanical design.

Features of solid works

A draught file is used to project a 3D model onto one or more 2D views of a component or assembly file. Solid works interface with Windows Indexing, SharePoint, or Teamcenter provides product lifecycle management

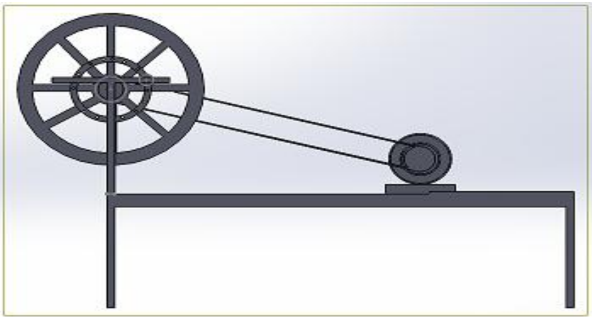

Figure 10: Front view of the proposed model.

By considering the different view angles the prototype for the model is captured is as shown in the below figure,

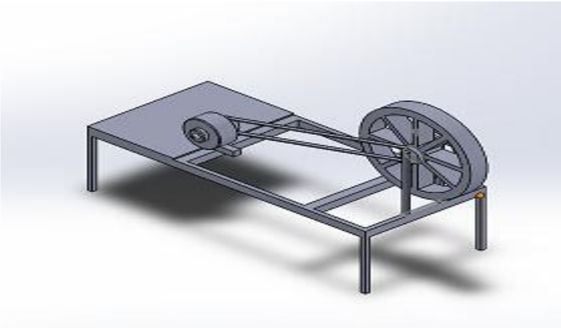

Figure 11: Angle view

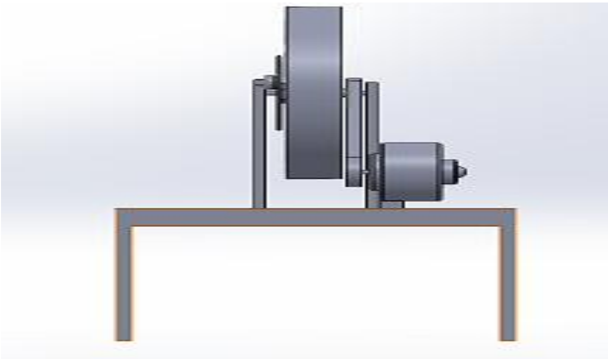

Figure 12: Side view

The calculations considered for the implementation is as shown below,

1. Area of the electromagnet A=pi*r2

A=pi*(0.0125)2

A= 4.908*10-4

2. Current and Voltage supplied (I/V) = 1.55amp/12v

AH=IT, I=AH/T, I=14/9,I=1.55amp

Let the plate and wheel assembly maximum weight to be consider approximately 1 Kg which is 9.81N so that will be

F= [B2 *A]/2μ

F is the force in N

B is magnetic field

A is area of pole face in m2

μ is the permeability of free space

9.81 = (B2*4.908*10-4)/ (2*4π*10-7)

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B2= (9.81*2*4π10-7)/(4.908*10-4)

B2 = 0.05023

B =0.2241 Wb/m2

1 Total magnetic flux in core

Φ = B*A

Φ= 0.2241*4.908*10-4

Φ = 1.099*10-4 Wb/m2

2 Electromagnetic intensity

H =B/μ

H = 0.2241/(4π*10-7)

H = 178333.11 AT/m

3 To find the power of electromagnet which is manually constructed

N is number of turns in electromagnetic coil = 200

g is air gap between electromagnet and plate = 5*10-5 m

F = (N*I)2μa/(2*g)

F = (200* 1.55)2*4π10-7*(2(5x10-5))

F =1.2076*10-5 N

4 Performances testing

For constant speed 2000 rpm

R= radius of wheel = 0.1778 m

V = rω

V= 0.1778*(2*π*2000/60)

V = 37.0707m/s

According to Newton's law of motion

V= u + at

a = (v-u)/t

Initial velocity of wheel u =37.0707m/s

Final velocity of wheel v = 0 m/s

a = (0 – 37.0707)/1

a = -37.0707 m/s2

a = (0- 37.0707)/3

a = -12.356m/s2

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

V. RESULT AND DISCUSSION

The steps of the model design is as follows,

- **Initiation**

Conceptualization of the electromagnetic braking system followed by the laws governing it.

- **Analysis**

Collection of relevant data and working parameters and components (such as magnets, Break disc, motor, ultrasonic sensor,.) an essential part of the electromagnetic brakes' research and design

- **Design**

To analyse the collected data and calculate the required parameters like electromagnetic field strength , magnetic flux in core, electromagnetic intensity, performances testing ,stopping distance and braking response.

- **Construction**

To analyze physical parameters and design the prototype part by part. The designed parts are shown below

- **Testing**

To acquire the required materials and manufacture the prototype as per the design developed.

This process work consists of Arduino microcontroller with ultrasonic sensor and Microcontroller unit receive the distance of the object by using ultrasonic sensor. Once the distance get closed or object is reaches to the ultrasonic the motor moving is going to be stopped or else it is keep moving..

Ultrasonic as get echo once trigger pins which we used to calculate distance once the ultra ray triggers or sends from the ultrasonic sensor are its back from the object echo will receive the signal and microcontroller unit checks the timings of sense and receive time and shows the distance of the object and if it is reaches 50cm its stops the moving of the wheel.

- **Deployment**

After the completion of construction of the prototype, it is implemented in a two wheeler replica working system and tested for various parameters such as electromagnetic field strength , magnetic flux in core, electromagnetic intensity, performances testing ,stopping distance and braking response,

- **Maintenance**

Post the test results, it is decided whether the prototype should be put in for mass production or altered/refined.

The model is as shown in the below figure by considering the different view angles.

Figure 13: Proposed real time model

The top view of the model is as shown in the below figure,

Figure 14: Top view of the model.

VI. CONCLUSION

Magnetic brakes are more dependable than conventional brakes. Disc brakes are subject to substantial thermal loads during normal and severe braking. In the absence of thermal stress, a few high-g braking cycles produce macroscopic fissures in the rotor thickness and disc brake radius. The investigation suggests that rotor failure is due to low-cycle thermomechanical fatigue. Effective braking requires choosing the right materials. Air gap between disc and electromagnetic coil impacts braking. All investigations showed that magnetic braking is more effective at high speeds and less effective at low speeds.

VII. FUTURE SCOPE

Magnetic brakes are preferable than frictional ones. This brake's swirl and attractiveness make it successful. This brake may aid vehicle stopping. A regulated electromagnetic structure may replace abs. It may be used to slow a fast-approaching train. These brakes work like stacked brakes when mixed. These brakes may be used in the rain, thus no anti-slip device is needed. Electrical management reduces accidents. This brake is less powerful than plate brakes. It may be used as an emergency or supplemental car brake.

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