International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 05 | May 2021 www.irjet.net p-ISSN: 2395-0072

DESIGN AND WORKING OF BRAKE PAD WEAR INDICATING SYSTEM

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Abstract : *It one of the chipset break wear sensor as compare to others where its only based on resistance changes in wearing material as wearing material is carbon brush where its easily available in market and this changing resistance can be calculated with the help of microcontroller and when the carbon brush wear with break pad its indicate the resistance and this generated resistance can be used as an feedback to microcontroller and the microcontroller give visible indication to driver to indicate its condition to replace break pad as the study in Indian vehicle not used wear sensor where break pad is most safety issues and other hand metal sheet mounted on break pad its make squealing noise most of the time this noise cannot reaches to the driver ear when wear indication shown dash-board .*

Keywords:- Brake pad, sensor, microcontroller, light, wear, etc.

1. INTRODUCTION

In this paper, a review of previous research project that are related to this project will be discussed. These kind of surveys were held as one of the tools to have some ideas on how this project works. It is based on other achievement and also to formulate the advantage of proposed solution. This may help in problem solving skills and options required for design and develop of wear sensors.

1.2 Issues occurs due to break pad wear

One of the main issues is safety as breaks plays an very important role in our vehicle to immediately stop at every situations hence our breaking system should be as well as proper condition

When the break pad wear out as driver doesn't know the break pad status that can causes the break disc damage where the cost of the disc is more than 80% as about brake pads.

1.3 What should my brake inspection include?

All brake inspection should be include a test drive, so your car mechanic can test the effectiveness of your brakes firsthand. They should also conduct a visual inspection to measure your brake pad and shoe thickness to ensure they are wearing evenly and meet all required safety standards. A car mechanic will also check your rotors for hotspots, your calipers for wear, and your wheel cylinders, brake lines and master cylinder for leaks. They will also check the levels and quality of your brake fluids and ensure that your brake and anti-lock brake sensors are properly placed and routed.

Whether you are experience issues with your braking or you simply want to schedule an inspection. Break pad sensor is used to indicate the status of your break pad current condition. It is an essential element of the braking system. It is used for monitoring life of brake and brake pad. It is highly resistance to the high temperature.

The brake pad wear sensor accurately informs the driver about the current condition of the vehicle's brake pad. Sensor is mounted on the brake pad, one sensor for the front axle and one sensor for the rear can be installed to determine and indicate when the driver needs to perform a replaced.

Brakes are the most important safety system in our vehicles. Brakes give us the ability to slow down or stop the vehicle in an instant and can help us to avoid a serious accident. If the Brakes aren't well maintained or regularly inspected then it can let you down when you need them the most. This brake pad wear sensor has longer life and no need to visually inspect the brake pad.

1.1 What are the most common brake system issues?

The most common brake system problem include: a spongy brake pedal , a hardest brake pedal , squealing sound when braking, vibrations when braking and a persist brake warning light . A healthy brake system should not make noises or vibrate, and should be firm when pressed, rather than soft or hard. If you hear or feel something unusual when braking, it's important to contact your local car mechanic as soon as possible. To avoid expensive repair bills you should schedule regular services that include full brake and brake pad inspections.

2. LITERATURE REVIEW

The literature review is carried out to understand the important of brake pad and the present development in the brake pad monitoring system. Lots of researches work is carried out in order to understand the various characteristics of brake pads materials as well as the types of brake pads. Many authors try to focus their research on effect of various speed limits and normal contact pressure on brake pads. Some research also carried out to development of economical brake lining wear indicating system. The recent investigation by N.Chand S. A. R. Hashimi S. Lomash and A. Naik was toward development of asbestos free brake pads. This experiment focuses on physical of new material asbestos free with wearing properties. From their experiment, it is says that the asbestos-free friction lining material can be used for brake as well as other friction lining applications [1]. Mikael Erikson , Filip Bergman , Staffan Jacobson have investigated the surface characterization of brake pad after running under silent and squealing condition . This experiment focus on the previously almost unexplored area of the connection between brake pad surface topography and the occurrence of squeals. From the experimental result , they indicated that pads with small contact plateaus have a larger tendency to generate squeal than pads with a few large plateaus. More over in the silent pressure interval, the size of the contact plateaus increases rapidly with brake pressure [2]. Friction layer and friction film on PMC brake pad were investigated by W. Osterle, I. Urban , using Focused Ion Beam technique, where, it was used to characterize superficial layers at micro-contact areas of a commercial brake pad. The friction material was a polymer matrix composite (PMC) with approximately 50% metal content (semi metallic) and the counter part was a cast iron rotor. Experiment depending on the constituent of the pad , one , two or three layers were identified. The experiment is show that the FIB technique provides additional information which in combination with the more conventional technique (L M) , (S E M)and (T E M) increases the knowledge on the role of third body formation and superficial layers on brake pads. [3] Zmago Stadiler Kristoffer Krnel Tomaz Kosmac have researched friction behavior of sintered metallic brake pads on a C/CSiC composite brake disc. This experiment was aimed studying on the frictional and wear property of sintered metallic (MMC) brake lining in combination with a C/C–SiC brake disc. From the result, they conclude that the friction performance of MMC-type brake pads on a C/C–SiC brake disc is dependent on the base metallic matrix composition and formation of a friction layer on the brake pads surface [4]. The effect of metal fiber of the friction performance of automotive brake friction materials were investigated by H. Jang K . Ko S.J. Kim R.H. Basch and J.W. Fash [5]. This experiment investigate the effect of different metallic fiber upon friction and wear performance of various brake friction couple . The results show that, when gray cast iron was used as a counter disk at low temperatures, the friction materials containing copper or steel fibers showed high speed sensitivity M.Boniardi F. D'Errico C. Tagliabue G. Gotti and G. Perriconne [6] have investigated failure analysis of a motorcycle brake disc. The failure has studied on small cracks on the disc brake. These crack were mainly located near by the holes placed on flange to ventilate and refresh pad . From the result, it is stated that the lifespan of a motorcycle brake disc depend strictly on the geometry (position of holes, shape of spokes, etc.)the material properties at high temperatures and operating conditions Werner Osterle and Ingrid Urban [7] investigated about third body formation on brakeS and rotors. The experiment was focused on the surfaces of a brake pads and rotors after a run-in period during which a stable coefficient of friction had been developed. The Focused Ion Beam technique (FIB) is used to reveal tribologically induced surface films and for cross-sectional preparation of superficial layers. It was found that the definitely exists a third body at the surfaces of both counterparts and it comprises of a Nano crystalline microstructure which implies that investigations on the nanometer scale are essential for understanding the frictional behaviors of such contacts.

2.1 Brake pad wear using sensor:

Infra-Red (IR) based microcontroller sensors were used to detect the brake pad wear. The IR sensor is placed near the brake pad, connected to the microcontroller. The distance between brake pad & brake rotor decreases continuously while wearing out. The distance is the main parameter that is sent to the micro controller. When the distance falls below certain specified limit, the micro controller activates the warning system at the dash board. It constantly monitors the condition of the brake & gives continuous feedback [8].

They conducted an experiment on brake pads where the sensor is integrated with the brake pad by drilling a hole of required depth. The hole is drilled when the hardness is maximum. The place to drill the hole is selected based on result of hardness tests. The depth of hole is based on brake pad's initial thickness & the thickness where the driver should be warned. For the test purpose, micro switch was used. The difference in resistance is measured when the sensor wire wears out due to friction. After carrying out few test runs, the authors successfully did the sensing of brake pad with proper functioning of micro switch & the embedded sensor in the brake pad. (9)

It's an another experiment using sensor, the system that not only warns the driver of brake failure but also applies reverse braking torque through a secondary braking unit. The authors considered brake fluid leakage as the main cause of brake failure. The fluid leak is detected by aliquid level sensor which sends the warning signal once the level decreases below the specified limit. The reverse braking torque is applied through the Ratchet -Pawl mechanism. It is also said that the ignition of the engine is turned OFF when it is detected for leakage. A micro-controller governs all the processes. The authors concluded that usage of this secondary braking ensures the safety and also added that this can still be improved. (10)

2.2 Pad Life Calculation:
Stopping distance & initial brake pad thickness are the two parameters which are measured by the ECU (Electronic Control Unit). The ECU is preloaded with formulae & algorithms based on input data. The Electronic Control unit calculates the data & predicts the brake pad thickness. When the predicted brake pad thickness is nearer or equal to preloaded safe limit of the brake pad, a warning light glows indicating the brake pad's replacement time. Many parameters were taken as constants during the test runs. The authors added that in real life implementations, these parameters may not be constant. (11)

Simulated wear on geometrically designed brake pad & rotor in general purpose FEA software (ANSYS). The positioning & movement of brake rotor & pad is governed by Archard's wear law and the results from tests are integrated into one by explicit Euler's integration. The tests were conducted on ANSYS software under steady state condition. The results obtained from the tests conclude that the wear is maximum (red) at the edges & becomes even (blue) after some time. The thermoplastic properties of brake pad were also considered in this experiment. (12)

2.3 Study on Different Pad Materials:

- **Ceramic Brake Pads**

They are the most expensive types of brake pads are available but they are last longer than any other type. The ceramic compound brake pads are made of is great for absorbing the heat that results from any type of continuous and hard, violent braking. In fact even in endurance racing these ceramic brake pad can stand up to what you put them through, and they work efficiently whether your brakes or warm or cold. These are made with small amounts of copper and clay, which is molded into the compound to make for a strong and long-lasting brake pads.

- **Low metallic brake pad**

these brake pads are made, they tend to be quite noisy and lot of brake dust. However they have excellent heat-transfer capabilities and are made with up to 30% metal such as copper or steel. They are organic in nature and offered excellent braking capabilities. Low metallic brake pads are greatest when it comes to braking and heat transfer, and the materials that they are made of are completely organic

- **Non-Metallic Brake Pads**

Non-metallic brake pads are the softest type of pads, being made of various rubbers, resins, and glasses, along with a small number of metal fiber. The composite material will wear away quickly and should only be used for regular, daily road-driving. Because they are soft , non-metallic brake pad are not the top choice for people who drive a lot or put their vehicles through a lot each and every day , but for driver who do not put a lot of mileage on their vehicle every year, these pads are fine. If you do more driving, you should either purchase the metal-type brake pads or be prepared to change your non-metallic ones frequently. Regular organic pads cause a lot of dust to cover components located near the brakes, along with other materials that are thought to be toxic to human life, which is one of the many reasons that the non-metallic brake pads were developed. If your vehicle does not have large brake need these types of brake pads will suffice. If you choose alternatives the price may be a bit higher but they will last you much longer than regular non-metallic brake pads.

- **Non-Asbestos Organic (NAO) Brake Pads**

These types of brake pads are made of materials such as high-temperature resins, fibers, and fillers. They are softer than the semi-metallic type of brake pad and they create more dust in the long run. The brake pads also deteriorate rather quickly, so it behooves the car-owner to pay attention to their pros and cons before purchasing a set of these brake pads.

- **Semi metallic brake pad**

In the majority of vehicles semi-metallic brake pads are mostly used. Made with a combination of metal and synthetic components, they are a mostly metallic hybrid compound. An organic resin seal all of the materials together, and they are molded into various shapes and baked in a furnace to hardened them. Semi-metallic brake pads are very durable, as well as heat-resistance and resistance to wear. However because these pads have a

lower friction coefficient when it comes to lower temperature, they need a little more pedal power when the brake are cold. Semi-metallic brake pads are usually made sintered graphite, iron, or steel, and therefore they are great when you need the high-performance capability in yours vehicle. In fact, these types of brake pads are perfect for heavy vehicles and performance of vehicles because they are study, well-made, and diverse brake pads. They contain up to 65% metal, but they also are noisier to operate , wearing down your rotor a lot faster than other types of brake pads, and don't always perform well at low temperatures.

2.4 Study of different wearing indicators

The wearing indicator is a monitoring device used to inform the driver promptly when the brake pad has reached its minimum thickness / wearing limit. For disc-brake pad, this is usually two millimeters. The wear indicator may be electronic or acoustic depending on the brake system.

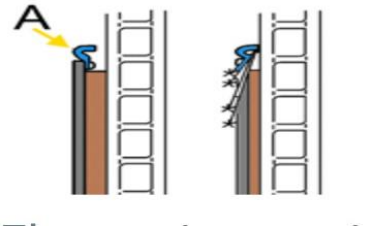

Fig 1. Acoustic wear indicator

- **Electronic wear indicator**

In its simplest form, an electronic wear indicator comprising a wear indicator in the brake pad, a circuit and warning display on the dash-board. When the wear limit on the brake pads is reached, contact is made with the warning contact (B) embedding in the brake pad. This are completes the circuit, causing the warning device to light up. Either 2 or 4 warning contacts may be installed depending on the design of the brake system.

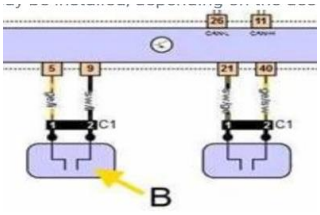

Fig.2 Electronics wear indicator

3. CONSTRUCTION & WORKING

3.1 Components

In this project, the components to be use are as given below:

- **Acoustic wear indicator**

The acoustic wear indicator is purely mechanical, and takes the form of a scratch plate (A) mounted on the base plate of the brake pad. When the wearing limits is reached the brake disc comes into contact with the scratch plate when the brake is operated. The combination of this contact and the rotation of the disc brake generates an unpleasant scratching sound.

- Arduino Nano-microcontroller
- Carbon Brush
- RGB LED
- Metal Strip or Rod
- Resistors
- Voltage Regulator

3.2 Construction & working

Electronic brake pad wearing sensor eliminate the tab by using a small sensor - a loop of wire with a low current passing through it. As the pad wears out, the loop is exposed and makes contacts with the rotor or disc, creating an open circuit.

3.2.1 What is a brake pad wear sensor?

Brake pads wear overtime. However, the amount of time it takes to do this can vary greatly. Road conditions, driving style , speed, load , and the type of pads and discs can all impact the speed at which this happened , making it's difficult for drivers, and technicians to determine when a new set may be needed. The introduction of the brake pad wear sensor removes this uncertainty by letting drivers know when the pad has worn and in some cars even predicting. As well as helping plan future brake jobs, it also ensures the brake pads are in good working order for a safe and controlled ride.

3.2.2 How does brake pad wear sensors work?

Today's brake pad sensors are an evolution of the traditional metal tabs found in many older braking systems. By rubbing against the discs, these make a loud screeching sound, providing an audio clue to the driver that the pads have reached their maximum wear limits. Electronic brake pad wear sensors eliminate the tab by using a small sensor - a loop of wire with a low current passing through it. As the pad wears out, the loop is exposed and makes contacts with the rotor or disc, creating an open circuit. This illuminates the dashboard warning light, indicating it's time to replace the brake pads. The latest sensors go one step further. As well as alerting the driver to a worn pad, they can also gauge how much mileage is left Known as 2 stage sensors they feature two resistor circuits that run parallel with each other at different heights in the sensor housing. When the first circuit is breached, resistance in the sensor increases and the system calculates how much life is left in the brake pad using inputs such as wheel speed, mileage, brake pressure, brake temperature and brake operating time. This information is display on the driver dashboard, either as a physical number on vehicle start up, or a warning light which changes color as the pad wears. Once the circuit is broken, the circuit becomes open. This triggers the warning light that advises it's time for a brake service. Whilst many brake pad wear systems feature a sensor on the inboard pad at each corner of the vehicle, the number can vary - between one and four depending on the design of the braking systems. The position of the senor can also vary. The most common type of electronic wear sensors are embedded directly in the brake pad material, and therefore are not removable others are mounted on the brake pad itself.

3.2.3 When do brake pad wear sensors need to be replaced?

As brake pad wear sensors are designed to break, they should be replaced as a matter of course every time new brake pads are Fitted. It's also advisable to regularly inspect the sensors, in between pad changes, and replace where necessary. Over time, heat from the brakes can damage both the wiring and clips. They are also prone to damage during other work on the vehicle such as installing new brake discs.

Where the wear sensor at open loop circuit that time no current will allow to flow in system as its break pad in new or in working condition.

when the break pad wear out as well as carbon brush also wear and inside the carbon brush the current conduction will completed and circuit will in closed loop.

This closed loop circuit gives feedback to microcontroller to calculate the generated resistance this generated resistance feedback used as break pad indication.

4. DESIGN

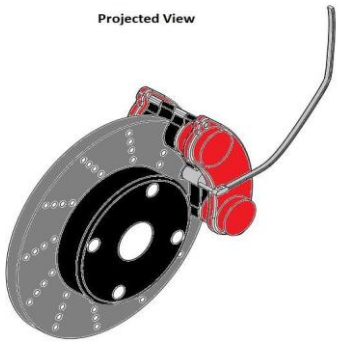

Fig . 3 Projected View of brake pad assembly with sensor

5. ADVANTAGES

- Its directly indicates break wear and the life of break pad on driver dashboard
- Due to the indication on dashboard driver alert to replace break pad as soon as possible time.
- As its time to time care taken to changing wearied break pad no accidental issues happened.
- Due to replacing break pad at the time no further causes happened as like disc scratches and due to disc scratches the changing disc its more than costly as compare to cost of break pad.
- Most important it's a safety issues and if it's made alerts on driver dashboard. It's alertness more than depending on listing noise of pinching metal of break pad.
- No maintenance required as its electronics programmable device directly connected to disc assembly.
- One of cheapest device as carbon brushes available

- It can be use any vehicles where disc break assembly used

6. DISADVANTAGES

- Its design may be varies as break pad and caliper assembly arrangements.
- Extra cost have to pay as replacement of carbon brushes with replacement of break pad
- If external arrangement happened then it's require separated microcontroller device.
- Device required external power from battery of vehicles because its low voltage device its required 3.3v power for conduction in carbon brushes.

7. APPLICATION

- Four wheeler application
- Two wheeler application
- Mechanical Crane
- Mechanical machines

8. CONCLUSION

The main function of the brake pad wear sensor is to warn the driver, when the pads get worn out. Thus, Wear sensors are the crucial purchase element for avoiding accidents. Strict standards have been set for this wear sensor. By availing this sensor in all vehicles, we can almost avoid 99% of accidents which are caused due to the brake pad failure. This project also reduces the cost involved in the concern. Project has been designed And analyze the entire requirement task which has also been provided.

9. ACKNOWLEDGEMENT

The authors would like to thank all authors of different research papers referred during the writing of this paper. The authors will also like to thanks the teachers or guides for giving us guidance time to time, which help us to overcome the problems during writing of this paper.

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