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1) Review on Design & Investigation of Automobile Disc Brake System

2) Braking System Approaching towards the Betterment and it's Consequences.

3) Historical Approach of Braking System Towards the Betterment

***Abstract*— Multiple system has been studied and developed in order to meet safety requirements. Instead of having air bag, good suspension systems, good handling and safe cornering, there is one most critical system in the vehicle which is brake systems. Without braking system in a vehicle will put passengers in unsafe position. Therefore, it's must for all vehicles to have proper braking system. Braking is a process which converts the kinetic energy of vehicle into mechanical energy. The disc brake is a device used to de-accelerate or stop the rotation of wheel. A brake disc or rotor usually made of cast iron or ceramic composite, is connected to the wheel. Friction material of brake pad mounted on a device called a brake calliper is forced by the action of mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc to stop the wheels. It's important to understand action force and friction force on the disc brake with new material for the investigation how disc brake works more efficiently, which can help to reduce heat generation and provide better tribological results.**

***Keywords*—Disc Brake, Emergency brake, Handbrake, Parking Brake.**

I. INTRODUCTION

The most important safety systems in a vehicle are brakes. The main function of braking system is to decelerate the vehicle, to maintain the vehicle's speed during downhill operation and finally to park the vehicle stationary either on a flat or slope road conditions. The first two functions are related to the service brakes, while last function is referred to the secondary or parking brakes. The basic principle of the brakes system is to provide clamping force that generated between the disc or pad and drum or lining. Insufficient clamping force may cause the vehicle fail to decelerate or stop as intended.

The disc brake is mechanism which slows rotation of the wheel by the friction caused by pushing brake pads against a brake disc with a set of callipers.

The brake disc or rotor is usually made of cast iron, in some cases be made of composites such as reinforced carbon-carbon or ceramic matrix composites. This is connected to the wheel. For stopping particular vehicle or wheel, friction material in the form of brake pads, mounted on a device called a brake calliper, is operated or forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. The phenomenon of friction causes the disc or wheel to slow or stop. Brakes convert rotational motion to heat, and if the brakes get too hot, it becomes less effective, this phenomenon is known as brake fade. Disc type brakes development and use began in England in the 1890s. First disc brake with calliper type automobile was patented by Frederick William Lanchester in his Birmingham, UK factory in 1902 and used successfully on Lanchester cars. In comparison with drum brakes, disc brakes offer better stopping performance, because disc is more readily cooled. A disc brake consists of a cast iron which is bolted to the wheel hub and a stationary housing called calliper. The calliper is connected to some stationary part of the vehicle like the axle casing or the stub axle as is cast in two parts each part containing a piston. Friction pad is held in between each piston & disc in position by retaining pins, springs, plates etc. & passages are drilled in the calliper to permit the flow of fluid in housing and that passages are connected to another one for bleeding. Every cylinder is having rubber sealing ring between the cylinder and piston.

A brake is a device by means of which frictional resistance is applied to rotating member, in order to stop the motion of the member. In the process of performing this function, the brake absorbs either kinetic energy of the rotating member or the potential energy given up by objects being lowered by hoists, elevators etc. Energy absorbed by braking member is dissipated in the form of heat.

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This heat is dissipated in to the surrounding atmosphere to stop the vehicle, so the brake system should have the following requirements:

A. The brakes must be strong enough to stop the vehicle with in a minimum Distance in an emergency.

B. The driver must have proper control over the vehicle during braking and the vehicle must not skid.

C. The brakes must have better anti fade characteristics i.e. their effectiveness should not decrease with constant prolonged utilization.

D. The brakes should have good anti wear properties based on mode of operations.

Generally Brakes are classified as follows: Hydraulic brakes; Electric brakes; Mechanical brakes.

The mechanical brakes according to the direction of acting force may be sub divided into the following two groups:

1) Radial brakes: Force is acting on the brake drum which is in radial direction. The radial brakes are subdivided into external brakes and internal brakes.

2) Axial brakes: Force is acting on the brake drum which is in axial direction only. E.g. Disc brakes Cone brakes.

Disc brake consists of a cast iron disc which is bolted to the wheel hub and a stationary housing called caliper. The caliper is connected to some stationary part of the vehicle, like the axle casing or the stub axle and is cast in two parts, each part containing a piston. Friction pad is held in between each piston & disc in position by retaining pins, springs, plates etc. & passages are drilled in the calliper to permit the flow of fluid in housing and that passages are connected to another one for bleeding. Every cylinder is having rubber sealing ring between the cylinder and piston.

The disc brake is brake which slows rotation of the wheel by the friction caused by pushing brake pads against a brake disc with a set of caliper. The brake disc is usually made of cast iron, now a days it is made of composites such as reinforced carbon carbon or ceramic matrix composites. This is connected to the wheel. For stoping the wheel, friction material which is in the form of brake pads, mounted on a device called a brake caliper, is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of disc. Friction causes the disc and attached wheel to slows or stop. Brakes convert motion to heat, and if the brakes get too hot, they become less effective, a phenomenon is known as brake fade.

Disc type brakes development and use began in England in the 1890s. First disc brake with calliper type automobile was patented by Frederick William Lanchester in his Birmingham, UK factory in 1902 and used successfully on Lanchester cars. In comparison with drum brakes, disc brakes offer better stopping performance, because disc is more readily cooled.

II. Construction Of Brakes

2.1 Types of Brakes

2.1.1 Disc Brake

Disc brakes make use of friction generated between the disc attached to a wheel and the wheel itself, to slow or stop an automobile. Disc brakes consists of brake pads that serve as friction material and is fixed onto a device called a brake caliper. When the brake pedal is pushed by a driver the brake pads are mechanically, hydraulically, pneumatically or electromagnetically forced against both sides of the disc mounted on the wheels, thus regulating the speed.

2.1.2 Drum Brake

Louis Renault has invented the modern drum brakes in 1902. Drum brakes regulate speed by causing friction between the wheels and a set of shoes or pads that push against the inside surface of a rotating drum. Drum is attached to rotating wheels. Generally, drum brakes are classified as either leading-trailing or twin leading. Out of that two types, the twin leading drum brakes are more effective.

2.1.3 Hand Brake

Hand brakes are latching brakes and are normally used to keep an automobile stationary, when not being driven. Also known as e-brake, emergency brake, park brake, parking brake or slide stick, the brakes are often configured on the floor and between front passenger and the driver. However, they can even be configured as a lever at the bottom of the dashboard, or as a foot-operated pedal. The brake comprises a cable that connects the braking system at one end and a lever on the other. The driver operates the hand-lever (or a pedal) to actuate or release the brake.

2.1.4 Power Brakes

A braking system employing power braking uses the engine's power and/or the power of batteries to assist the driver in braking.

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Although conventional brakes generate enough force to regulate the speed of an automobile, power brakes further enhance this power by supplementing it from other sources (i.e. engine/batteries), thus causing highly efficient braking. Some common types of power brakes are: air suspended brakes, vacuum suspended brakes, hydraulic booster and electro-hydraulic booster brakes.

2.1.5 Hydraulic Brakes

Hydraulic brakes consists of a braking mechanism that uses brake fluid, to apply the braking force from the controlling unit (viz. brake pedal) to the actual brake mechanism. Hydraulic brakes are based on a multiple piston system, wherein the brake pedal when pushed, produces an equivalent force on each of the output pistons, thus multiplying the force and cause efficient braking.

III. Design Of Brakes

Development of calliper disc type brakes began in England in the 1890s. In 1902, Lanchester Motor Company designed the brakes that seems to be same as and operated in a similar way to a modern disc brake system even though the disc was thin and a cable actuated brake pad. Other designs were not practical or widely available in automobiles for another 60 years. Successful application began in airplanes before World War II, and even the German Tiger tanks were fitted with discs in 1942. After the war, the real technological progress began to arrive in the 1950's, which was leading to a critical demonstration of superiority at the 1953, 24 Hours of Le Mans race, that required braking from high speeds several times per lap. The Jaguar racing car team that time won, using disc brake equipped cars, with much of the credit being given to the brakes superior performance over rivals equipped with drum brakes. Then mass production began with the year 1955 Citroën DS. Compared to drum brakes, disc brakes offer better stopping resistance because the disc gets more readily cooled. As a result discs are less prone to the brake fade caused when brake components overheat. Disc brakes also recover more quickly from immersion where as wet brakes are less effective than dry ones. Most drum brake designs have at least one important leading shoe, which gives a servo effect. In contrast, a disc brake has no self-servo effect and its braking force is always proportional to the pressure placed on the brake pad by the braking system via any brake servo, braking pedal, or lever. This tends to give driver better feel and helps to avoid impending lockup.

Drums are also prone to bell mouthing and trap worn lining material within the assembly, both causes of various braking problems. The brake disc or rotor is usually made of cast iron, in some cases be made of composites such as reinforced carbon-carbon or ceramic matrix composites. This is connected to the wheel. For stopping particular vehicle or wheel, friction material in the form of brake pads, mounted on a device called a brake calliper, is operated or forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. The phenomenon of friction causes the disc or wheel to slow or stop.

IV. Disc Brake Components

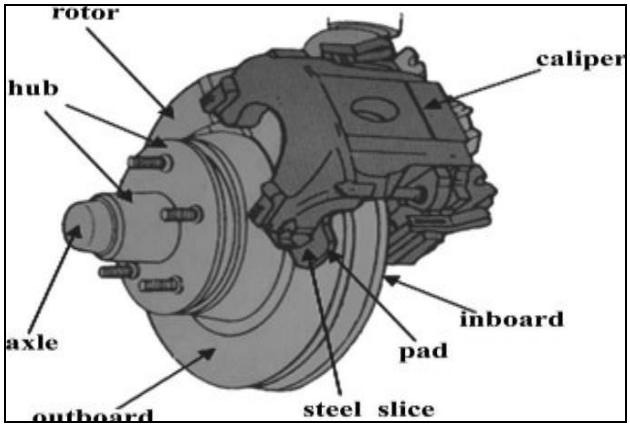

Figure 1.1 Parts of the Disc Brake

Almost all two wheelers uses the hydraulically operated foot brakes on the rear wheel. A layout of the proposed braking system is shown in Figure 1.1. The components of the system are listed below:

- Brake lever or pedal. (pushes the master cylinder piston)
- Master cylinder. (produces pressure in the brake system)
- Hydraulic lines. (transfer hydraulic pressure from master cylinder to wheel)
- Disc or rotor.
- Caliper unit.
- Mechanical linkage. (To move the caliper unit in radial direction)

4.1 The Brake Disc

The brake disc or rotor is rotating part of disc brake assembly, against which the brake pads are applied. The material is typically of gray iron.

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The design of the discs varies somewhat in concern with the heat dissipation. Some are simply solid, but others are hollowed out with fins or drilled vanes joining together the disc's two contact surfaces. The ventilated disc design helps to dissipate the generated heat due to friction and is commonly used on the more heavily loaded front discs.

Discs for motorcycles, bicycles, and many cars often have holes or cut slots through the disc. This is done for better heat dissipation, to aid better surface water dispersal, to reduce noise produced, to reduce mass. Slotted discs have shallow channels machined into disc to aid in removing dust and gas. Some discs are of both drilled holes and slotted cuts. Slotted discs are generally not used on standard vehicles because they quickly wears. This removal of material is beneficial in racing vehicles since it keeps the pads soft and avoids vitrification of their surfaces. On other side, drilled or slotted disc still have a positive effect in wetted condition because the holes or slots prevents a film of water building up between disc and brake pads.

A floating disc is splined, rather than rigidly fixed, to the hub as a way of avoiding thermal stress, cracking and warping. This allows the disc to expand in a controlled symmetrical way and with less unwanted heat transfer to the hub housing.

4.2 Calliper Unit

The disc brake mechanism here employs a single piston floating caliper type. The cylinder is formed as a mono block with the calliper assembly. It has one movable piston, pad, and one stationary pad.

When the brake is applied, fluid pressure developed in the cylinder which causes the pad to press against the disc on the piston side. The floating caliper body is also moved to the right by the fluid pressure which pulls the pad against the disc and stops the rotation of the wheel. The clearance between the disc and the pads is maintained automatically by means of piton seal ring between the piston and the cylinder.

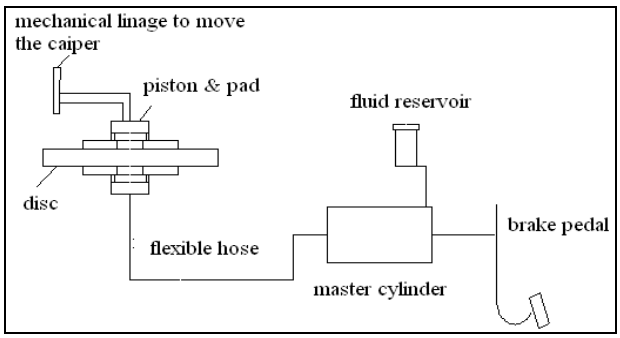

Figure 1.2 Components of the disc brake unit

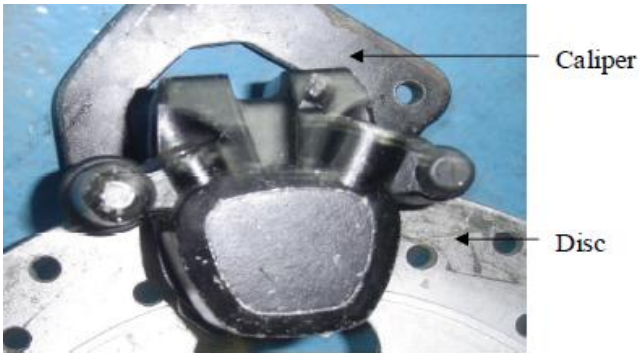

Figure 1.3 Single Piston Floating Type Caliper

4.3 Master Cylinder Unit

The master cylinder is an important unit of the whole disc brake system. The typical master cylinder has two main chambers viz. fluid reservoir and pressure chamber. The fluid reservoir stores the brake fluid and compensates for any change in fluid volume in the pipe lines. A piston operates inside the pressure chamber.

In the basic master cylinder design as shown in Figure 1.3, the fluid reservoir is an integral part of the master cylinder unit. These types of master cylinders are basically used in the front disc brakes. Figure 1.4 shows the brake fluid motion when the brake is released.

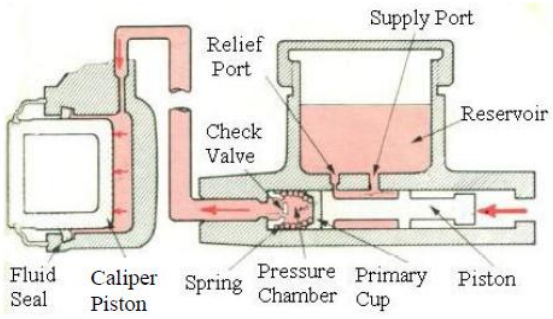

Figure 1.4 Basic master cylinder when brake is applied

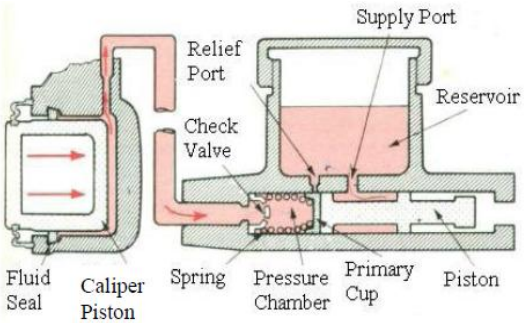

Figure 1.5 Basic master cylinder when brake is released

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4.4 Disc Brake Pads

The existing area of contact of the pad is increased for maintaining enough area of contact with the disc, when the caliper moves in the radial direction for loaded conditions. When the pillion load is increased, the caliper is moved outwards from the disc center with respect to pivot. In that condition, brake pads do not have enough area to have contact with the disc since the disc size i.e. outer diameter is small when it is compared with centre of brake pad. The calliper piston centre is larger than the brake disc outer radius. That's why the size of the brake pad is increased.

Figure 1.6 Brake Pads

V. Problems Occurred In Disc Brake

Gray cast iron is the main compositional component of the disc material, so scarring, cracking, warping or excessive rusting may be the damaging reasons of the disc. It become necessary to change the entire disc for such failure cases. This is done mainly where cost of a new disc may actually be lower than cost of workers to resurface the original disc. It becomes unnecessary if the thickness of disc may differ in manufacturer's expectation and become unsafe for use in case on ventilates discs. Most leading vehicle manufacturers recommend brake disc skimming as a solution for lateral run-out, vibration issues and brake noises issue. The machining process performed in a brake lathe that removes a very thin layer off the disc surface to clean off nominal damages and restore uniform thickness. For improvement in mileage its necessary to make system lighter by the use of disc brakes instead oif drum brakes. Braking systems depends on friction to bring the vehicle to a halt – hydraulic pressure pushes brake pads against cast iron disc. When a vehicle is decelerated, load is transferred to the front wheels – this means that the front brakes do most of the work in stopping the vehicle.

Scarring can occur if brake pads are not changed regularly when they reach the end of their service life and are considered to be worn out. Cracking is limited mostly in drilled discs, which may develop small cracks around edges of drilled holes on the disc. The discs are generally made from cast iron and a certain amount of what is known as "surface rust" is normal. Loud noise or high pitched squeal occurs when brakes are applied. Most brake squeal is produced by vibration which is due to resonance instability of the brake components, especially the pads and discs is known as force-coupled excitation. This type of squeal should not affect brake stopping performance.

VI. Advantages And Disadvantages Of Disc Brakes

Advantages of Disc Brakes:

1) They are strong.
2) They are little affected by wet conditions.
3) They don't get clogged with mud and snow.
4) They aren't affected by rim damage or out-of-true.
5) They don't risk brake shoes' damaging the tire or diving under the rim and locking the wheel.
6) Being external to the hub, they don't impose special lubrication requirements like a coaster brake, or risk contamination by lubricants like an integral drum brake, or overheat the hub on long, steep downhill runs.
7) They also dissipate heat without overheating the tire -- of special importance when used as a downhill drag brake on a tandem or cargo bike.
8) They don't wear rims -- especially an issue in sand and mud, or with carbon-fiber composite rims. They don't leave black dust (wear particles) on aluminum-alloy rims, to get all over your hands when you remove or replace a wheel.

Disadvantages of Disc Brake:

1) A front disc brake stresses one blade of the front fork very heavily, requiring a stronger, heavier fork, resulting in a bumpier ride with a non-suspension fork, and if a fork isn't quite rigid enough, producing 'brake steer".
2) A front disc brake caliper behind the fork blade generates a powerful force tending to loosen a quick release and pull the wheel out of the fork. Special hub and fork designs are needed to surmount this problem.
3) Disc brakes are generally heavier than rim brakes. Disc brakes are expensive, complicated and difficult to maintain than drum brakes or rim brakes.
4) Some disc brakes are grabby. This problem is likely if dirt gets trapped between the calipers.

5) The disc is vulnerable and easily bent. Other hub brakes do not have this weakness.

VII. SUMMARY

A brake is a device by means of which frictional resistance is applied to moving machine member, in order to stop the motion of a machine. It's important to understand the action force and friction force on the newly developed disc brake, how disc brake works more efficiently, which can help to reduce the accident that may happen in day today life. The most important safety systems in a vehicle are the brakes.

REFERENCES

[1] C. Raghunath Reddy, Dr. Naga Prasad Naidu, et al. "Design and analysis of master cylinder of hydraulic braking system", International Journal of Engineering and Research A Peer reviewed International Journal, ISSN-2321-7758, vol-04, Issue 2, Mar-Apl-2016.

[2] V. M. Thilak , R. Krishnara Deepan & R.Palani ,"Transient Thermal and Structural Analysis of the Rotor Disc of Disc Brake ", International Journal of Scientific & Engineering Research Volume 2, Issue 8, August-2011 Issn 2229-551.

[3] Kotalwar S. P., Dr. S.H. Sarje, et al. "Emergency Brake System", International journal on innovations in mechanical and Automotive Research, vol-1 Issue 2, April-2015.

[4] S. Mahajan, Jessy Joy, et al. "A reaview on brake Assist system", International Journal of Engineering science and innovative Technology (IJESIT) ISSN:2319-5967, Vol.4, Issue 3, May-2015.

[5] Ali. Belhocine, Abu. Rahim Abu Bakar, "Structural and contact analysis of disc brake assembly during single stop braking event", American Journal of mechanics and application, vol-2, August 2014, pgs.21-28.

[6] Prof. Wakchaure P.B. "Parking brake lateral play in 4 wheelers, International Journal of scientific and Research publication", volume 3, April 2013.

[7] Faculty of Mechanical Engineering PSG Collage of Technology, "Materials", in PSG-Design-Data-Book, Coimbatore, India, 2011, pp 1.11.

[8] Faculty of Mechanical Engineering Visvesvaraya National institute of Technology, "Design data for Machine element", Denett& Company, Nagpur, India, ISBN-978-81-89904-63-0, June 2011.

[9] R. S. Khurmi, J. K. Gupta, "A Text book of Machine Design", S. Chand publication.

[10] Dr.Kripal Singh, "A Text Book of Automobile Engineering", Standard Publication Distributers, Vol-1