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Braking System Approaching towards the Betterment and It's Consequences

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Abstract

In order to meet safety standards, several systems have been studied and developed. The brake systems are one of the most critical systems in the vehicle, other than having an air bag, good suspension systems, good handling and stable cornering. Passengers may be placed in a dangerous position without a braking mechanism in a car. It is therefore important that all vehicles have a proper braking system. Braking is a mechanism that transforms the vehicle's kinetic energy into mechanical energy. The disc brake is a system which is used to de-accelerate or stop wheel rotation. The wheel is attached to a brake disc or rotor, typically made of cast iron or a ceramic composite. By acting mechanically, hydraulically, pneumatically or electromagnetically on both sides of the disc, the friction material of the brake pad mounted on a system called a brake calliper is forced to stop the wheels. For the investigation of how disc brake functions more effectively, it is important to understand action force and friction force on the disc brake with new material, which can help minimise heat generation and provide better tribological performance.

Keywords: Disc Brake, Emergency brake, Handbrake, Parking Brake

1. Introduction

Brakes are the most essential protection features in a car. The main function of the braking system is to decelerate the vehicle, maintain the speed of the vehicle during the downhill operation, and eventually, under either flat or sloping road conditions, park the vehicle stationary.

The first two functions are related to the service brakes, while the secondary or parking brakes are related to the last function. Providing the clamping force produced between the disc or pad and the drum or lining is the fundamental principle of the brake system. The vehicle can fail to decelerate or stop as intended due to insufficient clamping force. The disc brake is a device that slows the friction created by pressing the brake pads against a brake disc with a collection of callipers to rotate the wheel. Typically, the brake disc or rotor is made of cast iron and, in some cases, composites such as reinforced carbon-carbon or composites of ceramic matrix. It's connected to the wheel. Friction material in the form of brake pads, placed on a system called a brake calliper, is operated or driven mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc for the stopping of a particular device or wheel. The friction phenomenon causes the disc or wheel to slow or stop. Brakes convert heat to rotational motion, and if the brakes get too hot, this process is known as brake fade as it becomes less efficient. The invention and use of disc-type brakes started in the 1890s in England. Frederick William Lanchester invented the first disc brake with the calliper style car in his Birmingham, UK factory in 1902 and used it successfully on

Lanchester cars. Disc brakes provide better stopping performance compared to drum brakes, as the disc is more easily 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 a certain stationary part of the vehicle, such as the axle casing or the stub axle, as each part containing a piston is cast into two parts. The friction pad is held in place between each piston & disc by holding pins, springs, plates, etc. & passages are drilled in the calliper to allow fluid movement in the housing and the passages are connected for bleeding to another one between the cylinder and the piston, every cylinder has a rubber sealing ring. In order to stop the motion of the member, a brake is a mechanism by which frictional resistance is applied to the rotating member. The brake absorbs either the kinetic energy of the rotating member in the course of performing this purpose or the potential energy given up by objects being lowered by hoists, elevators, etc. In the form of heat, energy absorbed by the braking portion is dissipated. In order to stop the engine, the heat is dissipated into the surrounding atmosphere, so the braking system should have the following requirements: [1-5]

A. In an emergency, the brakes must be strong enough to stop the vehicle at a minimum distance.

B. During braking, the driver must have proper control over the vehicle and the vehicle must not skid.

C. The brakes must have better anti-fade functionality, i.e. their efficiency should not decrease with continuous prolonged use.

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

Brakes are usually defined as follows: hydraulic brakes, electric brakes, mechanical brakes. Mechanical brakes can be subdivided into the following two classes, according to the direction of the acting force:

1) Radial brakes: A force operates in the radial direction on the brake drum. External brakes and internal brakes are subdivided into radial brakes.

2) Axial brakes: The force on the brake drum works only in the axial direction.

E.g. Cone brakes with disc brakes.

The disc brake consists of a cast iron disc that is bolted to the wheel hub and a calliper called a stationary housing. The calliper, like the axle casing or the stub axle, is attached to some stationary part of the vehicle and is cast into two parts, each containing a piston. The friction pad is held in place between each piston & disc by holding pins, springs, plates, etc. & passages are drilled in the calliper to allow fluid movement in the housing and that passages are connected to another one for bleeding Between the cylinder and the piston, every cylinder has a rubber sealing ring. The disc brake is a brake that slows the wheel's rotation because of the friction created by pressing the brake pads with a calliper set against a brake disc. The brake disc is traditionally made of cast iron, and is now made of composites such as reinforced fibre carbon or composites of ceramic matrix for a few days. It's connected to the wheel. The friction material, which is mounted on a system called a brake calliper, in the form of brake pads, is mechanically, hydraulically, pneumatically or electromagnetically pushed against both sides of the disc to stop the wheel. The disc and attached wheel are caused to slow or stop by friction. Brakes convert motion to heat, and they become less efficient if the brakes get too hot, a process is known as brake fade. The invention and use of disc-type brakes started in the 1890s in England. Frederick William Lanchester invented the first disc brake with the calliper style car in his Birmingham, UK factory in 1902 and used it successfully on Lanchester cars. Disc brakes have improved stopping efficiency compared to drum brakes, as the disc is more easily cooled.[6-10].

2. Construction of Brakes

2.1 Types of Brakes

2.1.1 Disc Brake

Disc brakes allow use of friction created to slow or stop an automobile between the disc attached to a wheel and the wheel itself. Disc brakes consist of brake pads that act as a material for friction and are connected to a device called a brake calliper. When the brake pedal is driven by a driver the brake pads are mechanically, hydraulically, pneumatically or electromagnetically pulled against both sides of the disc mounted on the wheels, thus controlling the speed

2.1.2 Drum Brake

For inventing the modern drum brakes in 1902, Louis Renault is credited. By creating friction between the wheels and a collection of shoes or pads that press against the inside surface of a

spinning drum, drum brakes control speed. Attached to the spinning wheels is the drum. Usually, either leading/trailing or twin leading drum brakes are listed. Out of the two types, the twin leading drum brakes are more effective.

2.1.3 Hand Brake

Hand brakes are latching brakes and are normally used, if not driven, to keep a car stationary. The brakes are often configured on the floor and between the front passenger and the driver, also known as the e-brake, emergency brake, parking brake, parking brake, or slide stick. They can, however, also be configured at the bottom of the dashboard as a lever, or as a foot-operated pedal. The brake consists of a cable at one end connecting the braking system and a lever on the other. To actuate or release the brake, the driver operates the hand-lever (or a pedal).

2.1.4 Power Brakes

To assist the driver in braking, a braking system using power braking uses the power of the engine and/or the power of batteries. While traditional brakes produce enough force to control an automobile's speed, by supplementing it from other sources (i.e. engine/batteries), power brakes further enhance this power, thereby causing highly efficient braking. Air suspended brakes, vacuum suspended brakes, hydraulic boosters and electro-hydraulic booster brakes are some common power brake types.

2.1.5 Hydraulic Brakes

In order to apply the braking force from the control unit (i.e. the brake pedal) to the actual brake system, hydraulic brakes consist of a braking mechanism using brake fluid. Hydraulic brakes are based on a multiple piston system in which each of the output pistons creates an equal force on the brake pedal when pushed, thereby multiplying the force and causing effective braking.

3. Design of Brakes

In England, the invention of calliper disc type brakes started in the 1890s. In 1902, although the disc was thin and a cable driven brake pad, Lanchester Motor Company developed the brakes that seemed to be the same as and worked in a similar way to a modern disc brake system.

For another 60 years, other prototypes were not practical or commonly available in cars. Effective application started in aeroplanes before World War II, and even the German Tiger tanks were fitted with discs in 1942. Real technical advancement started to arrive in the 1950s after the war, which led to a crucial demonstration of dominance at the 1953 24 Hours of Le Mans race, requiring high-speed braking several times per lap. Using disc brake equipped vehicles, the Jaguar racing car team that time won, with much of the credit being given to the brakes for superior performance over rivals equipped with drum brakes. Then mass production began with the Citroën DS in 1955. Disc brakes provide greater stopping resistance compared to drum brakes because the disc is cooled more easily. As a result, discs are less vulnerable to brake fade caused by overheating of brake components. Disc brakes also recover more easily from immersion where as wet brakes are less efficient than dry ones. Most designs of drum brakes have at least one significant leading shoe, which gives a servo effect. A disc brake, on the other hand, does not have a self-servo effect and its braking force is always proportional to the pressure placed by the braking mechanism on the brake pad through any brake servo, braking pedal or lever. This appears to make the driver feel better and helps prevent an inevitable lock-up. Drums are often susceptible to mouthing bells and trapping worn lining material inside the frame, both causing different problems with braking. Typically, the brake disc or rotor is made of cast iron and, in some cases, composites such as reinforced carbon-carbon or composites of ceramic matrix.

It's connected to the wheel. Friction material in the form of brake pads, placed on a system called a brake calliper, is operated or pushed mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc for the stopping of a specific vehicle or wheel. The friction phenomenon causes the disc or wheel to slow or stop.

4. Disc Brake Components

The hydraulically operated foot brakes on the rear wheel are seen on almost all two wheelers. In Figure 1.1, the configuration of the proposed braking system is shown.

The machine components are described below:

- Brake lever or pedal. (pushes the master cylinder piston)
- Master cylinder. (produces pressure in the structure of the brakes)

- Hydraulic lines. (transfer from master cylinder to wheel hydraulic pressure)
- Disk or rotor.
- Unit of Caliper.
- Mechanical relation.(Move the unit of the calliper in the radial direction)

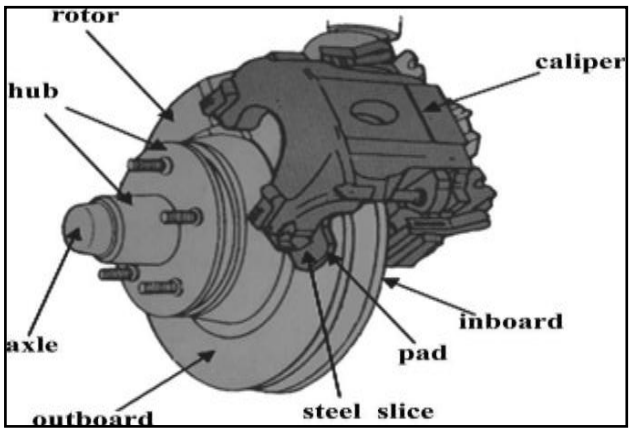

Fig.1.Parts of the Disc Brake

4.1 The Brake Disc

The revolving portion of the disc brake assembly to which the brake pads are applied is the brake disc or rotor. Usually, the content is made of grey iron. The configuration of the discs differs greatly in relation to the dissipation of heat. Some are simply flat, while others are hollowed out with fins or drilled vanes that connect the two contact surfaces of the disc together. Due to friction, the ventilated disc design helps to dissipate the produced heat and is generally used on the front discs that are more heavily mounted. Discs also have holes or cut slots in the disc for bikes, bicycles, and many vehicles. This is done for better dissipation of heat, to help better dispersal of surface water, to reduce noise produced, to reduce mass. In order to help extract dust and gas, slotted discs have shallow channels machined into discs. Both drilled holes and slotted cuts are part of some discs. In general, slotted discs are not used on regular vehicles because they wear rapidly. In racing cars, this removal of material is advantageous because it keeps the pads soft and prevents vitrification of their surfaces. On the other hand, in wetted condition, drilled or slotted disc always has a beneficial impact because the holes or slots prevent a water film from building up between the disc and the brake pads. As a means of reducing thermal tension, cracking and warping, a floating disc is splined, rather than rigidly bound, to the hub. This enables the disc to expand symmetrically and with less unnecessary heat transfer to the hub housing in a controlled manner.

4.2Calliper Unit

A single form of piston floating calliper is used in the disc brake system here. With the calliper assembly, the cylinder is shaped like a mono block. It has one piston, a pad, and one stationary pad that can be shifted. Fluid pressure forms in the cylinder as the brake is applied which allows the pad to rub against the disc on the side of the piston. The floating body of the calliper is also pushed to the right by the fluid pressure that pushes the pad against the disc and stops the wheel's rotation. The clearance between the disc and the pads is automatically maintained between the piston and the cylinder by means of the piton seal ring.

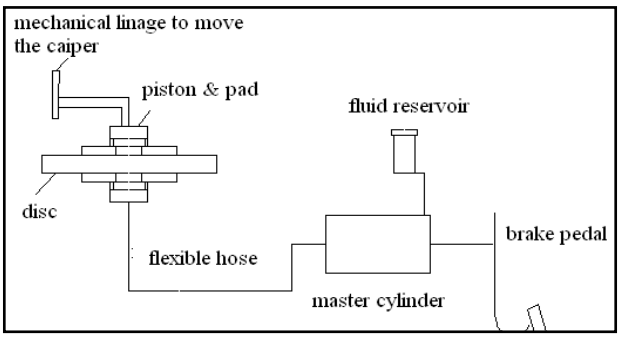

Fig. 2 Components of the disc brake unit

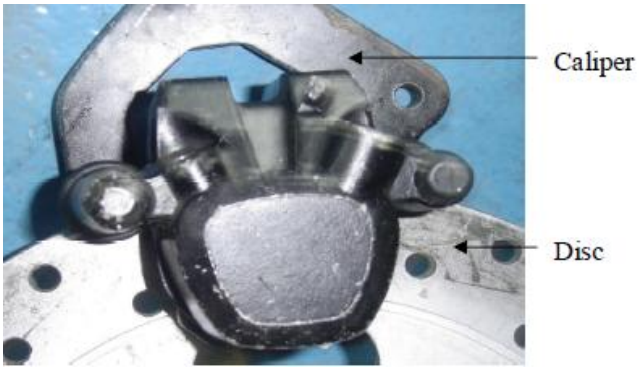

Fig. 3 Single Piston Floating Type Caliper

4.3 Master Cylinder Unit

A significant unit of the entire disc brake system is

the master cylinder. There are two primary chambers in the standard master cylinder. Reservoir of fluid and chamber of pressure. The fluid reservoir stores the brake fluid and compensates for any change in fluid volume in the pipe lines. Inside the pressure chamber, a piston works. As shown in Figure 1.3, in the basic master cylinder design, the fluid reservoir is an integral part of the master cylinder unit. Basically, these types of master cylinders are used for the front disc brakes. The motion of the brake fluid when the brake is released is shown in figure 1.4.

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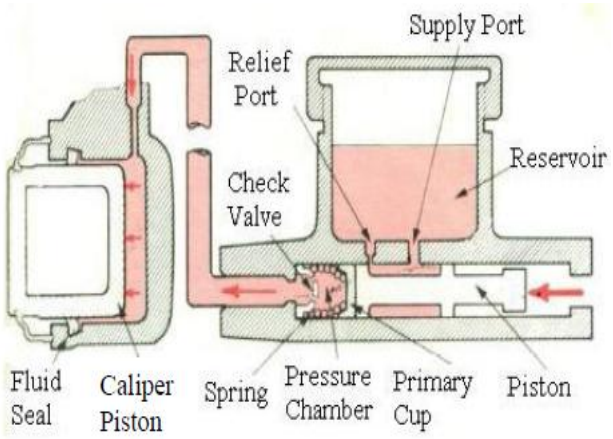

Fig. 4 Basic master cylinder when brake is applied

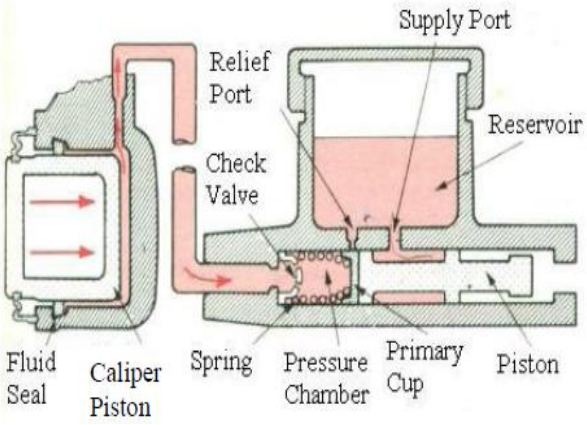

Fig.5 Basic master cylinders when brake is released

4.4 Disc Brake Pads

The current area of contact of the pad is increased for retaining enough area of contact with the disc, as the calliper moves in the radial direction for loaded conditions. The calliper is pushed outward from the middle of the disc with respect to the pivot when the pillion load is increased.

In that situation, since the disc size, i.e. the outer diameter, is small when compared to the centre of the brake pad, the brake pads do not have sufficient area to have contact with the disc. The centre of the calliper piston is greater than the outer radius of the brake disc. That's why the brake pad size has been increased.

Fig. 6 Brake Pads

5. Problems Occurred In Disc Brake

The main compositional component of the disc material is grey cast iron, so the damaging reasons for the disc may be scarring, cracking, warping or excessive rusting. In such instances of failure, it becomes necessary to change the entire disc. This is achieved especially where the cost of a new disc could potentially be cheaper than the cost of resurfacing the original disc for employees. If the thickness of the disc can vary in the expectation of the manufacturer and become unsafe for use in the case of ventilating discs, it becomes unnecessary. As a solution to lateral run-out, vibration problems and brake noise problems, most leading vehicle manufacturers suggest brake disc skimming. In a brake lathe, the machining process removes a very thin coating from the disc surface to clean away nominal damage and restore uniform thickness. It is important to make the device lighter by using disc brakes instead of drum brakes to increase mileage. To bring the vehicle to a stop, braking systems depend on friction. Hydraulic pressure forces the brake pads against the cast iron disc. When a car is decelerated, load is shifted to the front wheels – this ensures that the front brakes do much of the work in stopping the vehicle. Scarring can occur if, as they reach the end of their service life, brake pads are not frequently changed and are assumed to be worn out. Cracking is often limited to drilled discs, and can create tiny cracks around the edges of drilled disc holes. In general, the discs are made of cast iron and a certain amount of what is called "surface rust" is natural. When brakes are

introduced, noisy noise or high pitched squeal occurs. Most brake squeal is produced by vibration, which is known as force-coupled excitation, due to resonance instability of the brake components, especially the pads and discs. This sort of squeal does not affect the efficiency of stopping brakes.

6. Advantages and Disadvantages Of Disc Brakes

Benefits of Disc Brake:

1) They have better strength.
2) An environmental condition like wetness affects the property.
3) Mud and snow don't clog them.
4) They are not affected by, or out-of-true, rim damage.
5) They don't risk brake shoes' scratching the tyre or diving under the rim and locking the wheel.
6) They do not enforce special lubrication criteria, such as a coaster brake, or risk contamination by lubricants such as an integral drum brake, being external to the hub or overheating the hub on long, steep downhill runs.
7) When used as a downhill drag brake on a tandem or cargo bike, they often dissipate heat without overheating the tyre of particular interest.
8) They do not wear rims—in particular in sand and mud, or with composite carbon-fiber rims. When removing or repairing a wheel, they don't leave black dust (wear particles) on aluminum-alloy rims to get all over your face.

Disadvantages of Disc Brake:

1) A front disc brake quite strongly stresses one blade of the front fork, requiring a stronger, heavier fork, resulting in a bumpier ride with a non-suspension fork, and creating 'brake steer' if a fork is not quite rigid enough.
2) Behind the fork blade, a front disc brake calliper produces a powerful force that tends to loosen a fast release and pull the wheel out of the fork. To address this issue, special hub and fork designs are needed.
3) In general, disc brakes are stronger than rim brakes. In contrast to drum brakes or rim brakes, disc brakes are costly, complex and difficult to maintain.
4) There are some grabby disc brakes. If dirt gets stuck between the callipers, this issue is probable.
5) The disc is delicate and easily bent. This vulnerability does not occur in other hub brakes.

7. Summary

In order to stop the motion of a machine, a brake is a mechanism by which frictional resistance is applied to the moving machine member.

It is important to understand how disc brake functions more effectively, the action force and friction force on the newly designed disc brake, which will help minimise the accident that could occur in today's life. Brakes are the most critical protection devices in a car.

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