

Braking system used in motorcycles -performance and safety

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Abstract: Motorcycles brakes work by converting kinetic energy into thermal energy hence reducing the speed of the motorcycle. This paper discusses different braking systems used in motorcycles with different braking performance and safety. The four most commonly used types of braking systems in a motorcycle are antilock braking system, disc brake, drum brake, and combined braking system. Usually, the choice of brake used in the bike depends and the cost of the motorcycle. Different types of brakes require a different level of skill to operate, for example antilock braking system requires less skill than simple disc brakes.

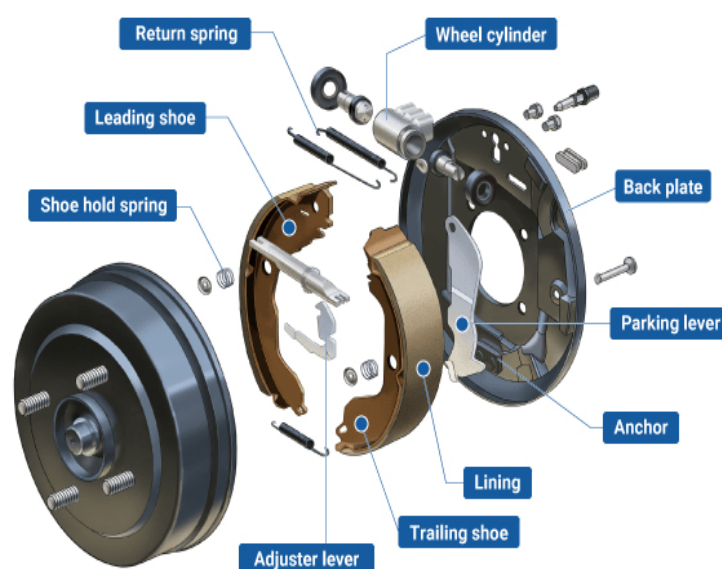
Keywords: Motorcycle, motorcycle braking system, drum braking system, disc braking system, antilock braking system (abs), combined braking system (CBS), brakes, drum brake, disc brake, brake performance, rider safety.

Introduction: In the 1800s, the first mechanisms to slow the momentum of a vehicle and prevent motion were tested. Now, over a century later, the braking system has evolved into a complex device designed to adapt to different road conditions. From the early drum brakes to modern-day discs, brake system evolution has improved safety and reduced the risk of car crashes across the globe. The main goal of the inventors was to enable humans to handle a motorcycle with ease. Brake system evolution has improved safety and reduced the risk of motorcycle crashes across the globe.

Drum braking system:

The drum braking system was invented by Louis Renault a French manufacturer in 1902. The system is also known as a mechanical drum braking system.

The following image shows how a drum braking system looks on the inside



The brake drum acts as the braking surface on the side of the wheel. The wheel hub is where the brake drum and wheel is attached. The backplate holds all the braking components together. The brake shoes are the part that is pushed towards the drum. When the shoe is pushed out the brake lining comes in contact with the brake drum hence creating friction which slows down the wheel. The shoe holds spring holds the shoe to the backplate. The returning spring helps the trailing shoe to return to its original place.

When the brake is pressed the brake oil travels to the wheel cylinder. The wheel cylinder is the hydraulic part that pushes the brake shoes. In the wheel cylinder, there is an inlet port for oil to enter and a bleeder port for the excess air to bleed out. In the modern drum braking system, the shoe system is auto-adjusted which means that when the lining wears out the shoe automatically adjusts itself for optimum braking. The adjuster lever does the job of adjusting the breaks to the current conditions of the lining.

Drum brakes require very less input force and are very cheap to manufacture. They are also more long-lasting than disc brake and provide more braking force than similar size disc brakes. The frequency of maintenance is also low.

Although drum braking has many pros (hence it is used till date in low-cost motorcycles) it has many cons too as stated.

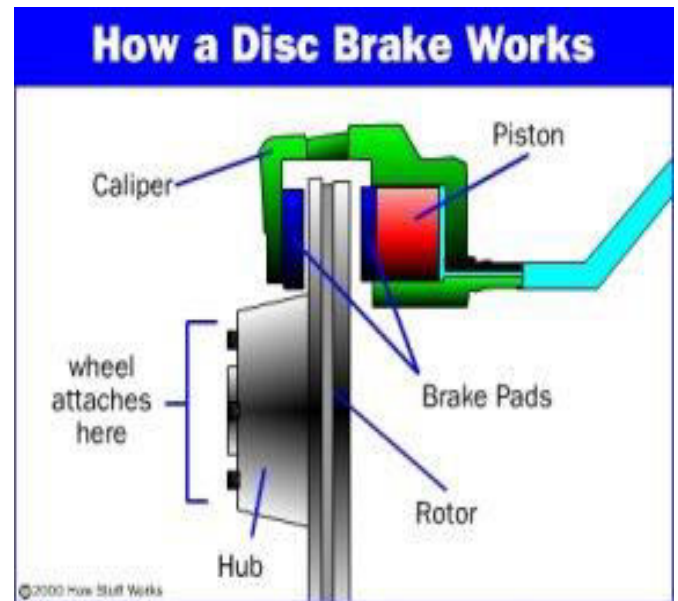
Under heavy braking, the brakes can produce a lot of heat and which leads to the drums to distort and cause vibrations. The heat from the brakes can lead the drum to expand due to thermal expansion hence more input will be required. Excessive drum heat can cause the brake fluid to vaporize. Brakes can overheat to the point where they become glazed. Maintenance of drum brake is more time consuming than disc brake because drum brakes are more complex.

From the above statements, we can conclude that drum brakes are usually used in cheaper motorcycles and motorcycles with less power which travel at lower speeds so that there are no overheating issues.

Disc braking system:

The development of disc brakes began in the 1890s. The first caliper-type disc brake for an automobile was patented by Frederick William Lanchester in 1902 and used successfully on

Lanchester cars. The first mass-produced road motorcycle with disc brakes is the 1969 Honda cb750.



the brake caliper assembly hovers above the disc. The brake caliper assembly contains the brake pads which are pushed towards the disc by pistons when the input is provided by the rider. When the rider squeezes the brake lever oil is pushed from the reservoir towards the assembly. Depending on the braking force required by the vehicle the pistons can be made from aluminum, plastic, or chrome-plated steel. When the calipers are cast out of a single piece of metal is called a monobloc. Monobloc calipers are expensive but they are stronger than the rest. 2 piece brake calipers are made in 2 separate halves which are bolted on together. 2 piece brake calipers are used for mass production since they are inexpensive and easier to mass-produce. When the piston is pushed the brake pads come in contact with the rotor and the rotor slows down. Since the wheel is connected to the rotor via the hub they also slow down hence reducing the speed. The kinetic energy of the vehicle is converted into thermal energy and the temperature of the brake pads and rotor increases substantially. This is why proper cooling is required. For a different type of cooling, there are vented rotors and solid rotors. The

vented rotors can remove heat easily hence keeping the temperature lower than solid rotors

one of the biggest performance advantages for disc brakes is rapid cooling since most of the rotor surface area is exposed to the air and heat from the rotor can be transferred fast (unlike the drum brakes where most of the very hot components are enclosed and don't have ventilation). Because of the rapid cooling, it is used in racing motorcycles (for example moto GP). Also, because of their shape, rotors tend to scrape off the water more effectively. After being driven through water, disc brakes operate at peak performance almost immediately.

The most apparent disadvantage in such kinds of brakes is noise. The assembly tends to create squeals and squeaks. Another issue is that the rotors warp easier than in drum brake systems. Since the brake pads are pressing on each side of the rotor, thickness variations of as small as 0.0003" (0.0076 mm) can cause brake pedal pulsations, requiring resurfacing or replacement. The last disadvantage is that since disc brakes are not self-energizing, they need higher clamping forces, which requires a power booster. This also makes it harder to use them as effective parking brakes.

These types of brakes require some amounts of skill to operate since they are very powerful and can cause accidents if not used properly. The first use of these kinds of breaks was in racing hence we can conclude that they are generally used for high-performance vehicles.

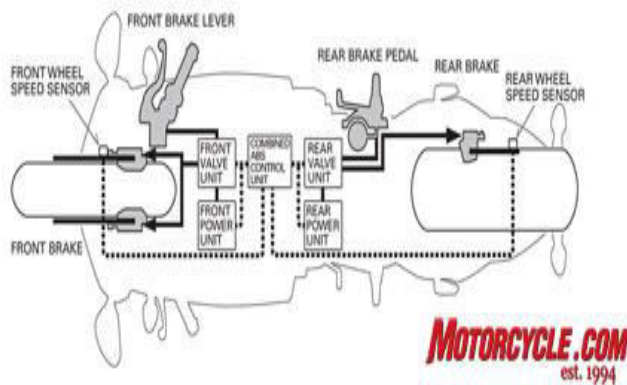
Antilock braking system:

As the name suggests antilock braking prevents the wheels from locking up. During normal braking conditions, the driver can brake without the wheels locking up. During heavy braking or in slippery conditions the wheels then lock up. Abs controls the brake pressure independent of the

input force and enables the brakes to brake optimally with minimum slip.

The electronic control unit (ECU) is the brains of the operation (modulator), the wheel spin sensor is the sensor that detects when the wheel is about to lock up and the hydraulic modulator is the part that manages the hydraulic part i.e. it enables the ECU to release the brakes irrespective of our input (when the wheels are slipping). The following controls a regular disc brake. All these components together including the disc brake are called an ABS

different amount traction in the front and back wheels on applying the brakes the difference in frictional forces on the wheels will produce a torque which will create spin. What abs does is prevent the wheels from completely locking up. The abs systems include speed sensors attached to the wheels when a sensor detects that a wheel is about to lock up a modulator unit partially releases the brake pad on that wheel. This way the wheels will be able to spin intermittently during braking. You can immediately see the effect of this small wheel rotation on steering and control. Here, the wheels will have a rotational velocity component. This allows the steering to function and the driver will be able to steer the vehicle even during braking hence keeping the vehicle in control.



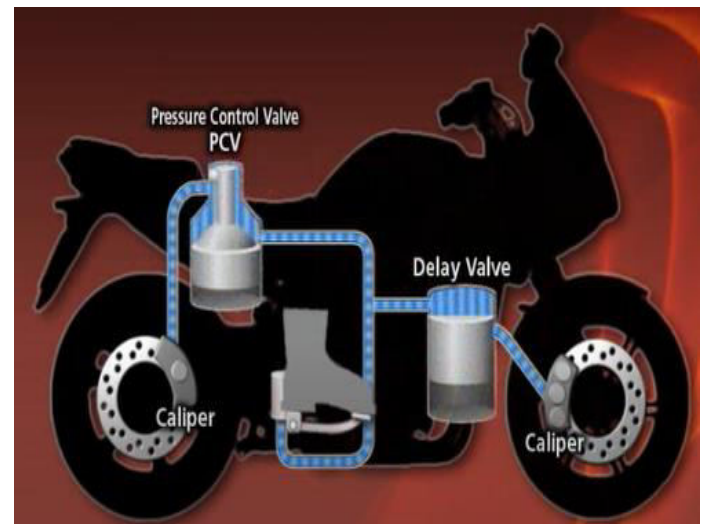
It's the best braking system for slippery conditions (rain and ice) and no skill is required to operate it. Instead of feathering the brake in simple disc brakes you can just press and hold the brake and will get the same or better results. The insurance cost for motorcycles with abs is less since its less accident-prone and very safe. The resale value of automobiles with abs is usually higher than normal. The performance could be less or more than the simple disc brake depending on the road conditions.

The biggest disadvantage of abs is that it is expensive. Abs can also be unreliable and can malfunction. In bad abs systems, people have found that the braking distance is higher than a simple disc in abs. It's also easy to cause a problem in abs by messing around with brakes. It is relatively delicate than a simple drum and simple disc braking system.

Combined braking system:

A combined braking system (CBS) is also known as a linked braking system (lbs). In this system when the rider presses one pedal or lever both

brakes are activated. Although both brakes are active, they both aren't applied with the same force. Honda was the first company to manufacture a street-legal bike with a combined braking system in 1983. At the time it was called the unified braking system. This system was derived from a 1970 RCB1000 world endurance race bike.



A pressure control valve (PCV) has been integrated into the rear hydraulic system of the rear brake and a delay valve has been added to the front brake system. By depressing the rear brake pedal hydraulic pressure is applied to the pressure control valve and delay valve. The hydraulic pressure applied to the PCV transfers to the piston in the rear brakes and activates the rear brakes. To enable good maneuverability the delay valve is closed at this stage hence the front brake is not applied. By depressing the rear brake harder the pressure in the delay valve increases and it opens. This puts pressure on the front brake piston and the front brake is applied. The PCV then starts to loosen up lessening the hydraulic pressure on the rear brake which makes it difficult for the rear brake to lockup.

Although the system was derived from older racing motorcycles it is not ideal for high-performance motorcycles. Maintenance and brake activity ratio customization is not so easy and it can cause uncomfortable situations on braking. On

sudden braking or heavy braking, the wheels will lock up and the rider may lose control unlike in ABS. Unlike abs, CBS is a mechanical feature and can't be switched off.

It is better than any other braking system at a lower price point and works well for low capacity motorcycles and mopeds. Compared to drum braking it is safer. This type of braking system does not require much skill like the antilock braking system, so it is good for new riders and learning riders.

Conclusion: All the above mentioned braking systems are very different and they all have very different applications. From a performance point of view, abs and disc brake perform better than CBS and drum brakes. In extreme motorcycle racing where a high level of skill is involved, a disc brake should be enough since the rider doesn't require inputs from the ECU and can control the bike by himself. for a regular road bike with a high-performance antilock braking system should be the most favourable braking system. From a safety point of view, abs should be the safest option since it prevents the wheels from locking up and losing control but for lower displacement mopeds and motorcycles (which don't reach those high speeds like higher displacement bikes) CBS should work almost as good as abs and locking up of the rear wheel should be difficult since the speed is less. We can conclude that the antilock braking system should be the best since it has the best performance and is the safest.

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