

FAILURE ANALYSIS: THE AUTOMOTIVE BRAKING SYSTEM

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Once an automobile is set in motion, it possess momentum. Brakes are necessary to slow it down or bring it to an abrupt stop. Most of today's passenger vehicles use hydraulic braking systems. A hydraulic liquid in a sealed container is used to transmit pressure to the braking components, that come into contact with each other, resulting in friction, which slows the vehicle.



The braking system consists of a hydraulic system and a frictional system. The hydraulic system is made up of the master cylinder, calipers and/or wheel cylinders, connecting lines and brake fluid. Today's vehicle is equipped with two independent hydraulic circuits installed in different configurations for different designs. The frictional system consists of brake pads and/or shoes, linkages and the brake disks or drums.

When the brake pedal is depressed, a vacuum or hydraulic power booster transmits motion to the master cylinder, which develops the required pressure in the system to actuate the wheel calipers or cylinders. The calipers then squeeze the brake pads onto the brake disk and the wheel cylinders expand the brake shoes onto the brake drums. The friction between the pads/shoes and the disks/drums provides the necessary drag to decelerate the vehicle.

Even though brake systems are designed to perform safely for a wide range of situations and under a variety of extreme conditions, partial or full brake failures still occur. Failure of braking system components under ordinary driving conditions is likely to occur if:

1. Parts are defective due to design or manufacturing.
2. Parts become severely worn due to operator abuse or neglect.
3. Parts become unreliable due to improper maintenance or repair.

Partial brake failures involve the loss of one hydraulic circuit or the loss of power assist. If the brake effectiveness is decreased enough, an accident may occur.

The purpose of a brake failure analysis is to determine how the intended design effectiveness or deceleration capability of the brake system is altered if a partial failure should occur within the system.

Failures in the brake system could be internal; within the master cylinder, calipers or wheel cylinders, if a seal fails or if a valve does not operate.

The failure can also be external if a connection between any of the lines and the master cylinder or the caliper/wheel cylinders fails. The actual brake lines can rust or sustain damage from an impact and hence fail. If any of the above failures occur, the hydraulic circuit cannot be pressurized due to leaks; reducing brake force, changing brake force distribution or increasing pedal application time.

The power assist or booster failure results in decreased brake line pressure, and poor braking performance through all four wheels. These failures reduce the brake efficiency resulting in an increase in stopping distance.

Adequate use of brakes combined with regular system checks and proper maintenance can reduce the chances of brake failures.

When a braking system failure is suspected, an expert should be retained quickly to examine the evidence before it is handled, altered or changed in any way. This will allow for an accurate report, suitable for subrogation purposes against manufacturers, and maintenance personnel where appropriate.