

Stopping Power

Forensic Brake Failure Investigations Explained



By Ryan L. Devine and Gregory J. Quan

Many drivers can recall a near miss saved by the quick application of brakes, while a smaller number remembers pounding the brake pedal too late and crashing. What does this subset have in common? Significant numbers of them will blame their accidents on brake failure. Most of them are wrong.

The reality is drivers judge distances poorly, especially traveling at freeway speeds. Typically, they have no idea how their brakes behave in critical situations and consequently believe crashes result from mechanical malfunction, when in truth their brakes performed as designed, but their following distances were too short for their speeds. The standardization of electronically controlled antilock braking systems (ABS), which prevent wheel lockup and skidding during heavy braking, has compounded the problem because ABS can make strange grinding noises when it activates, leading untutored drivers to suspect braking issues. When coupled with a human tendency to avoid blame, brake failure becomes the commonplace excuse for many crashes.

As a result, a significant percentage of the workload of forensic automotive investigators is brake-failure examinations. Despite the frequency of the claims, actual malfunctions in these complex systems are rare, although they can happen. Investigation requires the input of a trained automotive specialist who knows where to look for problems in braking components to find the telltale evidence of failure. Often it is issues of neglectful maintenance by owners that impedes brake function, especially when tiptop performance is required.

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*Stopping Power was a feature story in the July 2011 issue of **Claims** magazine. To read the online version, visit www.propertycasualty360.com.*

Brake Physiology

In a typical automotive disc-brake system, when the driver depresses the brake pedal, that pressure is transferred to a system of fluid-filled brake lines. The fluid then transmits the pressure to the calipers, clamping the brake pads against the brake rotors, which are attached to the wheels. The friction generated between the pads and the rotor provides the force that stops the vehicle. Loud squeaking from the brakes when applied usually signals brake pads that are reaching the end of expected use and should be replaced.

Brake Failures 101: Wear and Tear

Pad or shoe wear from normal usage is the most common brake-maintenance issue and examining those parts of the braking system is typically the first step for a forensic investigator. He will look for unusual wear in the pads or shoes. That effort entails removing the vehicle's wheels to access the brake pads and may require taking out the pads for more precise measurement.

When an investigator removes the brake pads, he can also inspect the pad surface. A smooth, reflective quality may indicate "glazing" caused by overheating, which decreases stopping power. Overheating may also result in brake rotor discoloration, and is usually caused by excessive brake "riding" by the driver.

Less commonly, brake failures may be caused by excessive rotor or drum wear. With the wheels removed for the pad inspection, the brake rotors or drums can then be checked for thickness, diameter, and warping to ensure that they are within manufacturer specifications. Rotors and drums need replacement less frequently than pads and shoes, but excessive wear can contribute to brake failure, especially if the pads or shoes are similarly worn.



Close-up: Brake Pad Surface

These brake pads show wear but are still functional with no evidence of overheating or glazing.



Close-up: Brake Pad Thickness

When viewed from the side, you can see that the brake pads are still within manufacturer thickness specifications.



Close-up: Brake Fluid Evaluation

Determining the boiling point of brake fluid reveals a limited usage life.

Brake Failure 101: Fluid Issues

In a typical hydraulic brake system, a brake fluid leak can result in complete brake failure if the fluid level drops too low. Such leaks can develop from excessive wear due to vibration or age, or from collision or roadway hazard damage. For example, an investigation of a suspected brake failure in a medium-duty truck that sustained significant crash damage in a freeway accident revealed that the truck had a brake-line design that allowed the primary fluid lines to rub against one another. The constant friction of the rubbing lines culminated in a sudden fluid leak and a complete loss of braking power.

Inspection for fluid leaks is simple and should be done by mechanics as part of routine maintenance. A forensic investigator examining a crashed vehicle will have little trouble spotting a leak, but determining its cause may be more complex, sometimes requiring laboratory examination with advanced equipment.

Another fluid-related cause of brake failure is the introduction of small air bubbles into the brake lines. Air bubbles occur when overheating brake fluid reaches the boiling point (brake fluid ages and has a limited usage life) or a slow leak allows air into the system. (A boiling point or other chemical test can determine if the vehicle's brake fluid has exceeded its useful life.) The resulting bubbles interfere with the brake system's ability to transmit braking force to the wheels, causing the brake pedal to feel softer than normal and making it very difficult to apply maximum braking effort. Such a condition can contribute to an accident if a driver does not have sufficient stopping distance when facing a hazard. Once again, the way to avoid failures due to tainted or deficient fluid brake failures is proper preventative maintenance practices by the vehicle owner including changing the brake fluid in accordance with manufacturer recommendations and regular brake bleeding to eliminate any air introduced into the system.

Brake Failure 101: Mechanical Problems

The most-unexpected cause of brake failure that investigators may encounter is a mechanical failure in the brake pedal assembly. In rare cases it is possible for the master cylinder (the component that distributes the brake pedal force to the wheels) to become detached from the pedal linkage. This condition is immediately obvious to an inspecting investigator, so the real item of interest will be determining the cause of the linkage failure, whether it is rust, tampering, or metal fatigue.

Brake Failure 101: Tapping Accident Data

Increasingly, crash data retrieved from a damaged vehicle's event data recorder is providing useful insight to accident investigators. If the module is accessible in a brake failure examination, and has collected the crash event data, then the forensic investigator can gain insight into driver actions in the seconds that preceded and followed impact. A brake failure allegation could wither away if that data reveals that the driver never engaged the brakes prior to a collision. More likely, the data will deliver the context that will guide the further investigation of a brake failure allegation. Perhaps the record will show that the driver was not speeding and applied the brakes suitably, but did not stop quickly enough to avert disaster. That could open the possibility of a brake problem that should be identified in the claims resolution process. A brake failure from a maintenance issue could implicate a repair shop, thus identifying a subrogation opportunity, whereas an original equipment failure could result in a product liability action.

Managing Brake Failure Claims

While brake failure is probably the most common excuse for a crash, cumulative experience shows that driver error probably trumps actual brake malfunctions as the primary cause of accidents due to braking issues. Sure it is easy to be swayed by a dramatic recitation of the crash story, but if there is any doubt about the logic or sense of the event sequence, consult an automotive expert.

Close-up: Brake Rotor

Although worn and rusty, this brake rotor is still functional.

