Anti-Lock Brakes - What they can and cannot do.

On February 2, 1996, the National Highway Traffic Safety Administration announced it had dropped the federal motor vehicle safety standard (FMVSS) requirement for anti-lock brake systems on all new cars. This decision was prompted by studies that indicated a 0% decrease in the overall number of accidents when comparing ABS equipped cars with those not so equipped and a 40% increase in the incidence of single vehicle run-off-the-road accidents. A report was also released on February 3, 1996, by Failure Analysis Associates, a research and testing firm, that contradicted the results of the NHTSA study.

by James O. Harris

Antilock brakes are impressive performers on the test track and in television advertising. They prevent vehicle wheels from locking, decrease the distance required to stop and improve a driver's control during emergency braking on wet and slippery roads.

What has surprised a lot of people is that antilocks are not reducing the frequency or cost of accidents. This is the case despite the obvious benefits of antilock brakes in test situations.

When Highway Loss Data Institute (HLDI) researchers compared insurance losses for cars with standard brakes and losses for the same cars without antilock brakes, the results were clear. "We found no reduction in claim frequencies or average amount of insurance payments under either collision or property damage liability coverages," says HLDI Senior Vice President Kim L. Hazelbaker.

Because of their design, antilock brakes should make a difference on roads where wheel lockup is most likely to occur, on roads that are wet and slippery. So, HLDI researchers studied claims in 29 northern states during the winter months where inclement weather was the norm. They found no difference in the frequency of claims for vehicles with or without antilock brakes.

Why aren't antilocks making the expected and much projected difference? "We don't know for sure." says HLDI President Brian O'Neill, "but it's probable that the circumstances are quite rare in which antilocks can reduce crashes. We don't know how many crashes are preceded by skidding or loss of control that antilocks could have prevented, but the new HLDI findings suggest the number cannot be very high."

The HLDI findings do not apply to all vehicles. Antilocks provide a clear safety advantage for big trucks. Tractor trailers have poor braking capabilities compared with cars. On dry surfaces, they take much farther than cars to stop. On wet and slippery surfaces, the disparity is even worse. Because tractor trailers are articulated, they can jackknife during heavy braking. These characteristics magnify the importance of antilock brakes which are required on new trucks in Europe and Japan. British fleet managers report they have virtually eliminated jackknifing crashes since fitting their fleets with antilocks.

Until the HLDI findings were published, the only other study on the effect of antilocks was conducted on a small fleet of taxicabs in Germany between 1981 and 1983. Like the HLDI research, the German study found no difference in crash rates with or without antilocks.

Antilock brakes have become very popular with the public. Forty-three percent of the 1993 model cars came equipped with them and the ratio for 1994 models is eighty percent. This brings the total number of cars on the road today with antilocks to about 18,000,000.

Much of the increase is because of the growing safety reputation antilock brakes forged on the test track. This reputation has been inflated by car commercials that imply antilocks can prevent crashes because of better stopping power under all conditions. Consumers very often haven't been shown cars with antilocks performing on surfaces that are wet and slippery. This is the very surface on which antilocks should make their main contribution.

Many car owners don't know how to use antilock brakes effectively and the manuals that come with their automobiles offer little help. Some of the manuals don't spell out how using antilock brakes is different from using regular brakes. Some manufacturers provide no instructions at all. One manufacturer says its "system functions with normal brake application."

This is false. Traditionally, drivers are trained to brake gently on slippery roads or to pump their brakes to avoid a skid. But it is firm, continuous brake pressure that is required to activate antilocks, which should never be pumped. This is exactly what the antilock feature does for the driver automatically, it pumps the brakes many times a second. With the driver pumping antilock brakes during a skid, braking effectiveness may be reduced to the point of no brakes at all.

A survey by the Insurance Institute for Highway Safety found that 9 out of 10 owners of recent model cars want their next car to have antilocks. Further questioning revealed drivers have very little knowledge of how this technology works. Forty five percent of the owners of vehicles with antilock brakes incorrectly indicated how to use them, they said pumping is the way to stop with antilocks on a slippery surface.

When asked specifically about their use of antilock brakes, 53 percent said they'd never used them. Among those who reported using the antilock feature, 62 percent said they thought it had kept them from being involved in a crash, a notion that's directly contradicted by the HLDI research findings.

"It's obvious many people are guessing unrealistically about crashes that have been prevented by these brakes," O'Neill says. Otherwise, their crash experience before they started driving a car with antilocks must have been horrible. The reality is that most situations involving emergency braking don't result in crashes with or without antilock brakes. And for most drivers, skidding out of control is a very rare event."

Because of these misconceptions about the circumstances in which antilock brakes can help, it's useful to review what they can and cannot do.

In normal braking, a vehicle slows as its wheels are gradually brought to a stop. Without antilock brakes, hard or emergency braking will cause the wheels to lock before the vehicle comes to a halt. In this case, some or all of the tires skid along the road. How the vehicle skids depends on the coefficient of friction, or drag factor, between the tires and the road surface. A vehicle may skid forward in a straight line or it may skid forward and drift to the right or left if the surface of the road is not level. Then again, a car may spin out. In any of these cases, the driver has effectively lost all control over the direction the car will travel.

Antilock brakes can help with these problems but how much depends on the road surface. Antilocks don't make much difference in stopping distances on dry roads but they can help a driver maintain control when the wheels would otherwise lock during emergency stops. The most pronounced improvement occurs on slippery surfaces where the drag factor is low. Here, antilocks can significantly reduce stopping distance and prevent loss of control.

The actual reduction in stopping distance when a vehicle is equipped with ABS is not that significant under most circumstances. A reduction of 10% of the total stopping distance is typical. This means a vehicle that would skid 60 feet on a given surface at 40 miles per hour without ABS would still skid 54 feet if equipped with ABS. ABS will not make a car stop on inherently slick surfaces (snow, ice, rain, etc.) as if the same road were dry. As indicated above, there are also instances where ABS will increase stopping distance.

There are several types of antilock brake systems but they all operate similarly. Sensors near each wheel monitor rotational speed and, as the brakes are applied and the wheel slows, an electronic control unit determines when any wheel is about to lock. The control unit then signals for reduced brake pressure, just enough to allow the wheel to start rotating again, thus preventing lockup.

Understanding antilocks better requires knowing about the concept of wheel slip, or the speed of a vehicle's wheels in relation to the speed of the vehicle itself. When a car is rolling freely, without any braking, there is no wheel slip. That is, there is no difference between the speed of the vehicle and speed of its wheels. But when the wheels are fully locked, as in a skid, slip is at a maximum.

Wheel slip increases along with brake pressure. Without antilocks, braking force rises to a peak and then falls as the wheels lock. What antilocks do is control the speed of the wheel to keep them away from lockup and maximize braking force. They do this by allowing brake pressure to increase until close to or just beyond the peak, then release the brakes until wheel slip is reduced and then apply them again. This pressure/release/pressure cycle happens many times per second so the amount of braking force is as great as possible. It continues until traction is restored or the driver releases the brake pedal.

Why don't antilocks help with stopping distances as much on dry pavement as on a wet surface? Because maximum braking is easy to achieve on dry roads with or without antilocks. Even if the wheels lock, the coefficient of friction between the tires and road surface is still fairly high so a vehicle stops relatively quickly.

It's possible, on some surfaces, to stop sooner without antilock brakes than with them, although such instances are rare. This occurs when loosely packed snow or gravel creates a "dam" effect in front of a locked wheel and thus shortens the stopping distance compared with what antilocks could achieve.

When all of a vehicle's wheels lock, the vehicle skids forward and perhaps somewhat left or right, depending on the coefficient of friction between each tire and the road. When only the front wheels lock, and there is little or no braking on the rears, the tendency is for the vehicle's back end to move faster than the front. This results in a rotation as the rear end tries to pass the front end and the vehicle can spin out of control. When front wheels lock, there is no steering control.

The National Highway Traffic Safety Administration has conducted a series of tests to evaluate the performance of antilock brakes under conditions that have been encountered in actual accidents. These tests focused on split friction surfaces. In these instances, the two right wheels of a car would be on one surface, as when the tires have gone off the edge of the road and are now on wet grass. The left tires are still on the paved road surface, such as wet asphalt. There is a considerable difference in the effective drag factors between the two surfaces.

With normal brakes, the right side wheels would be expected to lock up first, causing the vehicle to spin counter-clockwise. With antilocks engaged, all four wheels should continue to rotate allowing the driver to bring the car to a safe stop in a relatively straight line.

The test vehicles all came to a halt in a straight line with the antilocks engaged. When they were turned off and a panic stop was attempted, they all rotated 45 degrees before coming to a stop. During one series of tests, using dry asphalt on one set of wheels and loose gravel on the other, the total stopping distances increased, some dramatically. In one instance, the test vehicle required 62 percent more distance to stop and in another 74 percent. These results were expected as antilock brakes are less effective on loose gravel than standard brakes.

Tests conducted by the International Association of Accident Reconstruction Specialists and the Michigan State Police Traffic Crash Reconstruction Unit had results that were not expected.

In these tests, antilock brake equipped vehicles were placed in hard cornering maneuvers while braking. This is a situation motorists could find themselves in if they were turning sharply to avoid a collision while braking hard. The test vehicles stopping distances were between 19 and 70 percent greater than those of vehicles with standard brakes.

This type of situation could lead to claims of brake failure by consumers. A car equipped with antilock brakes in a high speed evasive maneuver will not slow down as quickly, or behave as a driver might expect, as a car with conventional brakes. What has occurred is that much of the available tire/roadway friction is allocated to cornering, leaving little for the antilock sensors to detect and slow the vehicle. In essence, there may be very little rotation of the tire during hard cornering so the sensors do not allow high braking pressure.

Antilocks help motorists by preventing wheel lockup. A vehicle with such brakes remains stable during most hard braking situations and the driver can maintain steering control. This benefit is apparent on both dry and wet roads. But because wheel lockup is more likely on slippery roads in straight line skid situations, this is where antilocks provide the greatest benefit. The presence of antilock brakes, in certain situations and with an uninformed driver, may actually contribute to an accident.