ANTI-LOCK BRAKE SYSTEM

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An anti-lock braking system (ABS) is a safety system on motor vehicles which prevents the wheels from locking while braking.

The Anti-lock Braking System is designed to maintain vehicle control, directional stability and optimum deceleration under severe braking conditions on most road surfaces.

It does so by monitoring the rotational speed of each wheel and controlling the brake line pressure to each wheel during braking. This prevents the wheels from locking up.

A rotating road wheel allows the driver to maintain steering control under heavy braking.
HISTORY

- **1929** Anti-lock braking systems were first developed for aircraft, by Gabriel Voisin,

- **1950** Dunlop's Maxaret introduced a system and still in use on some aircraft models

- **1960** A fully mechanical system used in the Ferguson P99 racing car, the Jensen FF and the Ford Zodiac, but saw no further use; the system proved expensive and, in automobile use, somewhat unreliable

- **1964** Limited form of ABS in Austin 1800, utilizing a valve which could adjust front to rear brake force distribution when a wheel locked

- **1971** Chrysler, and Bendix Corporation, introduced 1971 Imperial. Called "Sure Brake",

- **1971** ABS Systems based Mercedes design were later introduced on other cars. GM introduced the "Trackmaster" ABS on their Cadillac models
1975 Ford also introduced ABS on the Lincoln Continental Mark III and the Ford LTD station wagon, called "Sure Trak"

1978 Bosch and Mercedes-Benz introduced the first completely electronic 4-wheel multi-channel ABS system in trucks and the Mercedes-Benz S-Class

1988 BMW became the world's first motorcycle manufacturer to introduce an electronic/hydraulic ABS system, this on their BMW K100

1992 Honda launched its first ABS system, this on the ST1100 Pan European

1997 Suzuki launched its GSF1200SA (Bandit) with ABS

Today ABS has become a standard equipment even for small cars
IMPORTANCE

25 years of ABS 1978 – 2003
ABS installation rate in new vehicles worldwide

ABS
THEORY

• When the car brakes (normally) wheels exert a forward force on the street which less than maximum static sliding friction.

• If the driver brakes very hard it can occur that the maximum static friction is surpassed and the wheels lose their grip and begin sliding.

• The amount of traction which can be obtained for an auto tire is determined by the coefficient of static friction between the tire and the road. If the wheel is locked and sliding, the force of friction is determined by the coefficient of kinetic friction.

• A tire that is just on the verge of slipping produces more friction with respect to the road than one which is locked and skidding. So locked wheels are less effective in stopping on a road.
Physics 101: Static Friction is Greater than Moving Friction

ABS IS Computer Controlled Brake Pedal “Pumping”

ABS Allows the Driver To Maintain Control During Hard Braking
With out ABS

With ABS
Figure 1. The Forces Acting on a Braking Vehicle
But in gravel, sand and deep snow, locked wheels dig in and stop the vehicle more quickly. A locked tire allows a small wedge of snow to build up ahead of it which allows it to stop in a somewhat shorter distance than a rolling tire.

When a tire does not slip, it will roll only in the direction it turns. But once it skids, regardless of the angle of the front wheels, the vehicle continues to skid in whatever direction its momentum sends it until either the driver releases the brakes.
The Anti-lock Braking System is designed to maintain vehicle control, directional stability and optimum deceleration under severe braking conditions on most road surfaces.

It does so by monitoring the rotational speed of each wheel and controlling the brake line pressure to each wheel during braking. This prevents the wheels from locking up.

The sensors - one at each wheel send a variable voltage signal to the control unit, which monitors these signals, compares them to its program information, and determines whether a wheel is about to lock up.

When a wheel is about to lock up, the control unit signals the hydraulic unit to reduce hydraulic pressure (or not increase it further) at that wheel’s brake caliper. Pressure modulation is handled by electrically-operated solenoid valves.
COMPONENTS

• Wheel Speed Sensors
• ABS Control Module
• Hydraulic Modulator
• Pump Motor and Accumulator
Wheel Speed Sensor

- The wheel speed sensor pickup has a magnetic core surrounded by coil and a toothed sensor ring.
The number of voltage pulses per second that are induced in the pickup changes in direct proportion to wheel speed. So as speed increases, the frequency and amplitude of the wheel speed sensor goes up.

The WSS signal is sent to the antilock brake control module, where the AC signal is converted into a digital signal and then processed.

The control module then counts pulses to monitor changes in wheel speed.
ABS Module

The ABS control module is a microprocessor and uses input from its sensors to regulate hydraulic pressure during braking to prevent wheel lockup.

The key inputs are wheel speed sensors and a brake pedal switch. The switch signals the control module when the brakes are being applied, which causes it to go from a standby" mode to an active mode.

When ABS braking is needed, the control module kicks into action and orders the hydraulic unit to modulate brake pressure as needed.
Hydraulic Motor

- The hydraulic modulator or actuator unit contains the ABS solenoid valves for each brake circuit.

- The exact number of valves per circuit depends on the ABS system and application.

- Some have a pair of on-off solenoid valves for each brake circuit while others use a single valve that can operate in more than one position.
Pump Motor and Accumulator

A high pressure electric pump is used in some ABS systems to generate power assist for normal braking as well as the reapplication of brake pressure during ABS braking.

The fluid pressure that is generated by the pump is stored in the "accumulator."

The accumulator on ABS systems where the hydraulic modulator is part of the master cylinder assembly consists of a pressure storage chamber filled with nitrogen gas.
Types of ABS Systems

By the number of channels-

- **Four-channel, four-sensor ABS** - Speed sensor on all four wheels and a separate valve for all four wheels. So individual wheel monitoring and optimum braking forces.

- **Three-channel, three-sensor ABS** - Speed sensor and a valve for each of the front wheels, with one valve and one sensor for both rear wheels.

- **One channel one sensor ABS** - One valve, which controls both rear wheels, and one speed sensor, located in the rear axle.
• **Open and closed systems:**

  - **Open anti-lock system:** The brake fluid released from the brakes during ABS stop is not returned to the brake; instead, the fluid is stored in an accumulator during the ABS stop, then returned to the master cylinder reservoir afterwards.

    This type is used in simple-rear wheel-only ABS designs.

  - **Closed system:** Closed system has some means, generally an electrically powered pump, to restore hydraulic pressure that's bled off during an ABS stop.

    The pump supplies fluid to an accumulator, where it's stored under pressure until is needed to increase brake
Additional Developments

- **Modern Electronic Stability Control (ESC or ESP) systems**
  - An evolution of the ABS concept. Here, a minimum of two additional sensors are added to help the system work: these are a steering wheel angle sensor, and a gyroscopic sensor.
  - The theory of operation is simple: when the gyroscopic sensor detects that the direction taken by the car does not coincide with what the steering wheel sensor reports, the ESC software will brake the necessary individual wheel(s) (up to three with the most sophisticated systems), so that the vehicle goes the way the driver intends.
  - The steering wheel sensor also helps in the operation of Cornering Brake Control (CBC), since this will tell the ABS that wheels on the inside of the curve should brake more than wheels on the outside, and by how much.
Disadvantages

- Increased braking distances under some limited circumstances (snow, gravel, "soft" surfaces),

- Creation of a "false sense of security" among drivers who do not understand the operation, and limitations of ABS.

- The anti-lock brakes are more sensitive on the damper condition. the influence of the worn components on the performance of the vehicle with anti-lock brakes is more significant than without anti-lock brakes, the stopping distance with defective shocks is by meters longer for the presented simulation scenario.
Anti-lock Brake System (ABS)
Queries ?

THANK U!