STUDY & ANALYSIS OF ANTI-LOCK BREAKING SYSTEM (ABS)

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Abstract: One of the important reasons why sudden braking causes the vehicle imbalance and accidents is that the wheels lose their maneuverability by locking. ABS is developed to prevent the brakes from being locked. It has greatly reduced fatal accidents. So, it can be called a life-saving system for ABS. ABS is a vital system for the safety of the driver and passengers in motor vehicles. While the vehicle is driven, another vehicle or any person or object may come out in front of the vehicle and the driver may have to brake suddenly. That's where ABS comes into play. In this work, the research is done on how the system works exactly, what it does in vehicles, and how it works in different conditions (change in vehicle speed, road conditions, and environment conditions)

Keywords:* *Anti-lock Breaking System, Vehicle Imbalance, vehicle speed, road conditions, and environment conditions

I. INTRODUCTION

ABS (Anti-lock Braking system) assures complete control of the steering wheel by preventing the vehicle from wheel locking in sudden braking situations. ABS system is developed to prevent the locking of the wheels in the vehicles. In the type of ABS braking system, an electronic control unit is used to control the change in the number of revolutions of each wheel and is called as the brake Control Module (BCM or EBCM). While driving, it may need to urgently press the brake pedal because of the various obstacles that appear in front of the vehicle. In such cases, both the clutch and the brake or only brake pedal must be pressed at the same time very strongly in order to stop the vehicle. Otherwise, the vehicle hit the object, or it could lead to an accident that will cause a huge damage. When the brake pedal is suddenly pressed, the wheels of vehicles that do not have an ABS system lose their connection with steering wheel and are locked. Therefore, in this case the wheels cannot sense the commands from steering wheel. However, vehicles with an ABS system do not lock the wheels in sudden braking situations. The ABS aim is when a vehicle at high speed it cannot suddenly stops, it cannot stay where it is due to moment of inertia. It continues to slide forward suddenly. At this time, passengers inside the vehicle can even jump out of the windshield. However, ABS slows the wheels and stops the vehicle in controlled way.

❖ Design approach

Many factors contribute to a successful Anti-lock Braking system(ABS) design, since this system is the most well known system for the vehicle safety designed because safety is one of the most important concern of everyone . In the day-to-day life there is always a risk with a disastrous situation which need to be faced. To alleviate, different manufacturing industries are trying to implement this technology in the vehicles with electronic driver inorder to assure safety. The present research work deals with the study and scope of ABS System of how this system can potentially save everyone from this situation.

II. WORKING OF ABS

The Anti-lock Braking system(ABS) has four main parts which are: wheel speed sensors (one for each wheel), Pressure release valves, hydraulic unit and an electronic module which is connected to the Control unit of cars's Engine.
Suddenly when the wheel gets locked up , the rotational speed will be nil and the sensor observes that the speed is decreasing and send a signal to the controlling module. This module then processes the data. Finally when the wheel regains the rotational speed and stops skidding and slowly the sensors pick up the increase in speed and will send the signal to the control module. Ultimately the pressure decreases and the braking effort will increase. The greatest advantage of using this Anti-lock Braking system(ABS) is the above action will be performed for almost 15-17 times a second which is not possible for a human to perform.

Speed sensor: The speed of each wheel is monitored by the sensor which has the capability to determine the required acceleration and deceleration of the wheels. A controller unit in this system receives the information from the ABS speed sensor wheel individually. When an individual wheel loses the traction , a signal will be sent to the controller to limit the brake force and activate the ABS Module.

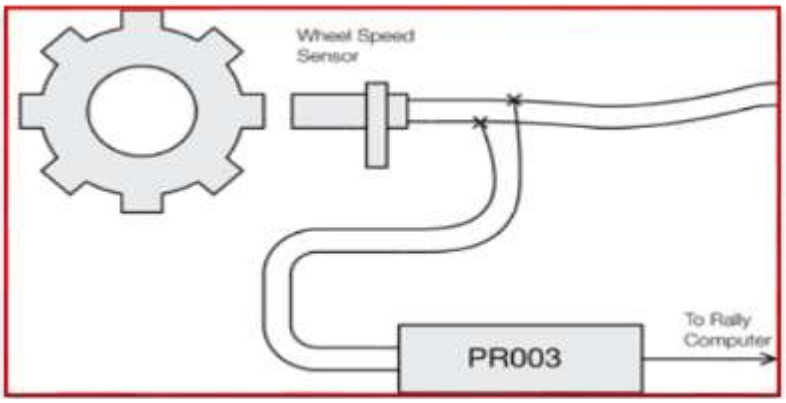


Fig 1 : Speed sensor

Valves: The valves play a vital role in this system (ABS) and regulate the air pressure to brake during the ABS action. It controls the pressure and limits it a certain proportion only as per the requirement .Whenever the brake pedal is pushed harder, then the valves limit the pressure on the brakes. In the open position, when the brake valve is opened, the pressure from the cylinder it allowed to transfer to the brakes. In the block position, when the brake valve is closed the pressure from the cylinder to the brakes is constrained. In the release position, the valve releases some of the pressure on the brakes. The last step is repeated until the vehicle comes to halt.

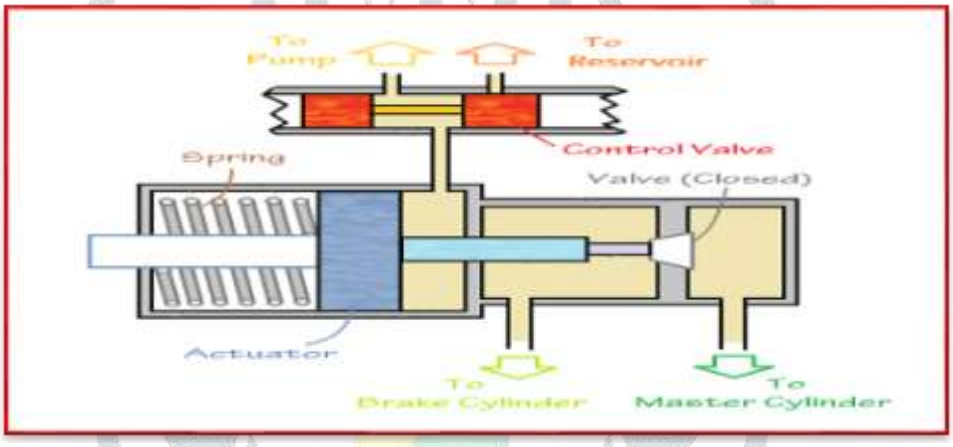


Fig 2: Valve

Electronic Control Unit (ECU):

It accepts the signals, and develops the signals accordingly and filters the signals for verifying the wheel rotational speed and acceleration. The ECU gets a signal from all the wheels or the sensors in the circuit and controls/ limits the brake pressure/force to each of the wheel, according to the data that is analyzed.

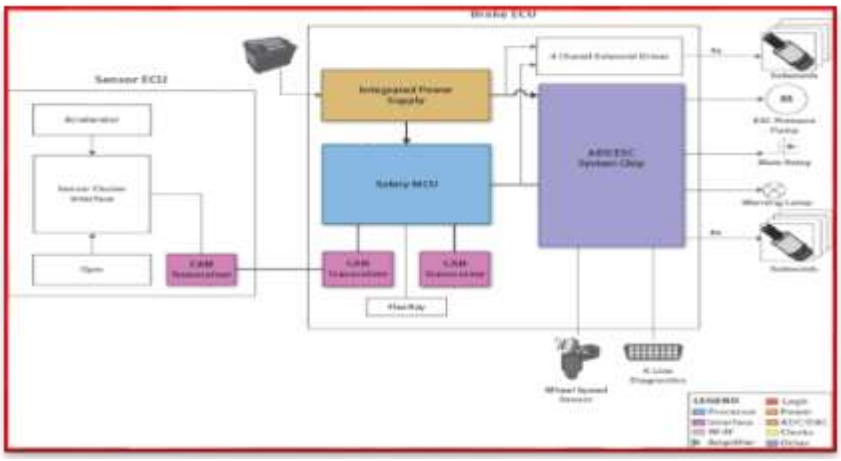


Fig 3: Block Diagram

Hydraulic control unit:

It is used to restore the pressure to the hydraulic brakes once the valves are released. It receives the signals from the ECU either to apply or release the brakes under the anti-lock conditions.

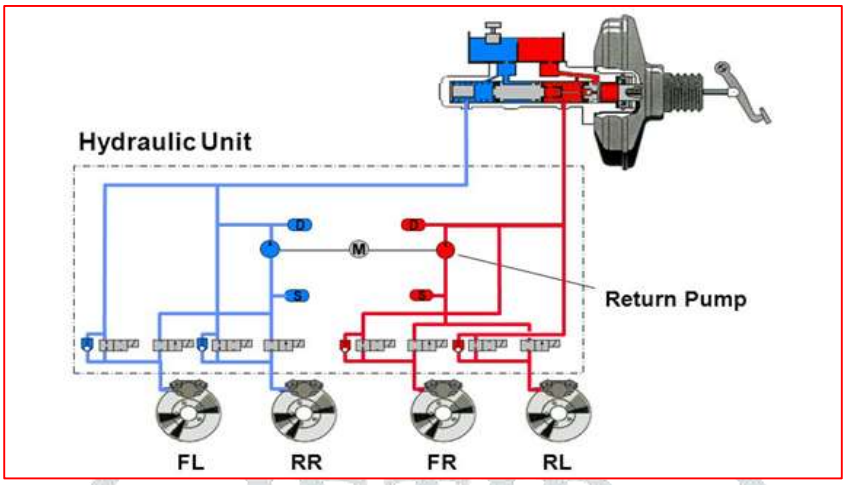
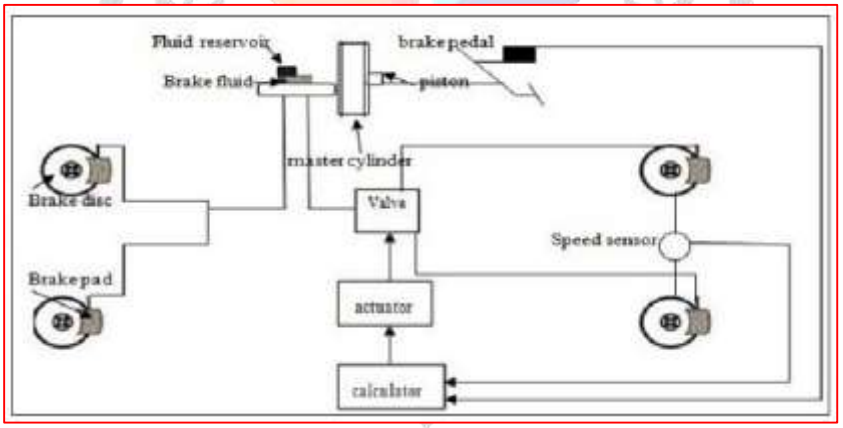


Fig 4: Hydraulic Unit

If a situation like wheel-locking is detected , then the wheel velocity to increases and the wheel slip will decrease. When the wheel velocity increases, the ECU reapplies the brake pressure and restricts the wheel slip to a certain degree. The hydraulic control unit controls the brake pressure in each wheel cylinder based on the inputs from the system sensor. As a result, this controls the wheel speed. The process is repeated until the next breaking operation



III. ANALYSIS ON ABS:

Now ABS system are used in high speed vehicles and designed based on thar road. But coefficient of friction is different from road to road, vehicle velocity changes, environmental condition's (snow, rain, etc) are not same in all times. At these conditions, when we apply brake the stopping distance and chance of skidding when braking during turns are different in above conditions.
Anti-lock braking systems (ABS) controls the wheel slip close to the optimal value.

Wheel slip:

The ABS system has to control the wheel slips s [-] around an optimal target.
The wheel slip is calculated as:
$S = 1—\omega w / \omega v$

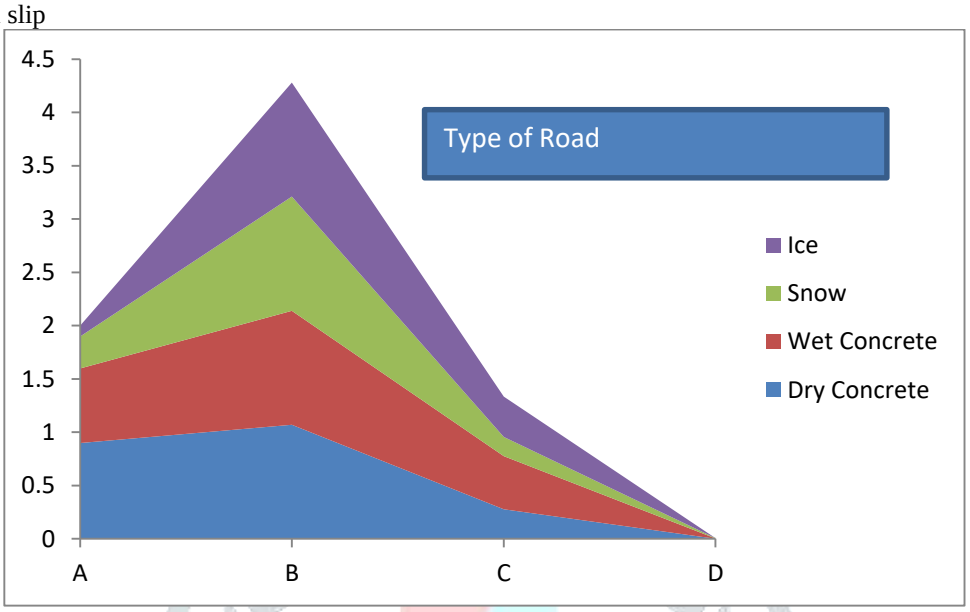
Where,
ωv [rad/s] is the equivalent angular speed of the vehicle, equal with:

ωv = vv / ϒw
where, vv [m/s] is the vehicle speed.

Friction coefficient:
The friction coefficient depends upon many factors, like:

- slippage of the wheel
- speed of the vehicle
- road surface
- Environmental conditions (humidity, temperature, etc.)

The friction coefficient can be expressed as an empirical function, where slip is a function argument:
$\mu(s) = A * (B * (1 - e^{-C*s}) - D * s$
S [-]—is the wheel slip



Due to change in friction coefficient the wheel slip also changes for different conditions the relation between slip of the wheel and friction coefficient is shown fig

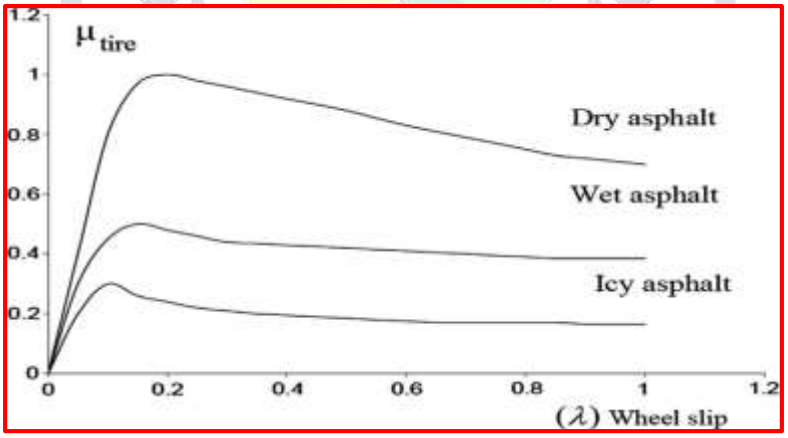
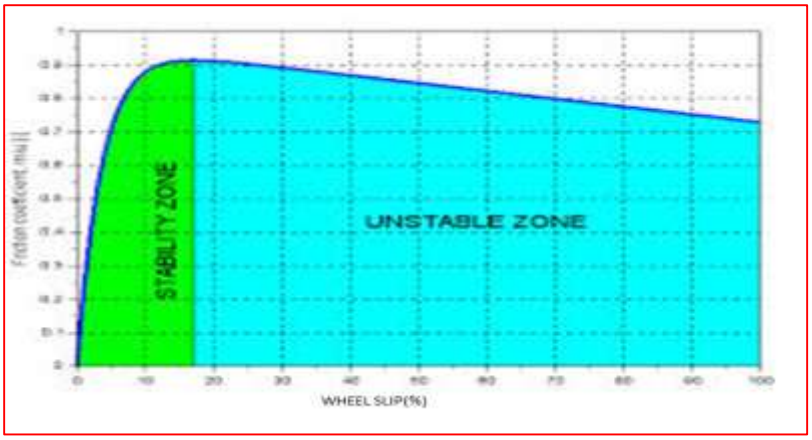
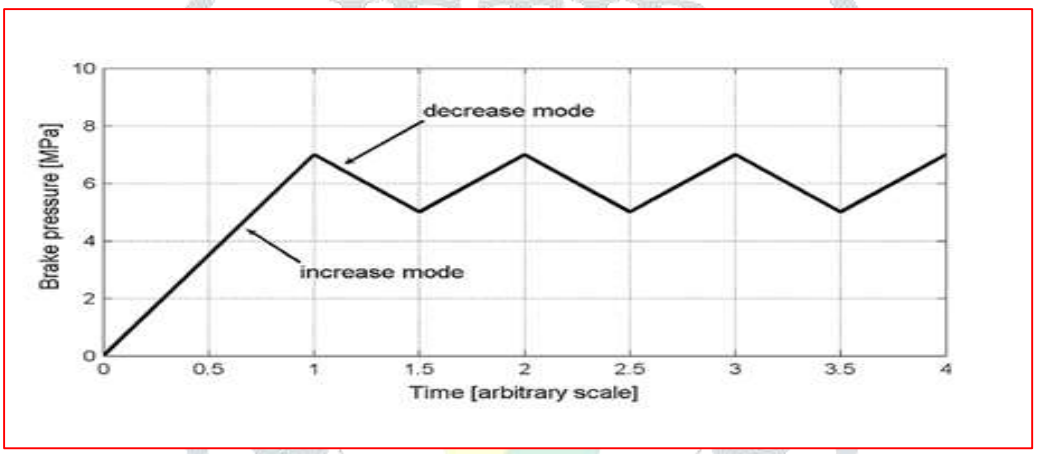


Fig: Relation between slip and friction coefficient



The friction coefficient curve is split into two areas:
Stability zone: It is observed that in many cases the friction coefficient increases while the wheel slip increases.
Unstable zone: Here, the friction coefficient decreases while the wheel slip increases.

For this particular example, the ABS system will have to keep the wheel slip around 20%, where friction coefficient has the highest values.



IV.CONCLUSIONS

In ABS system whenever the brake is applied, the brake pedal just act as switch. After applying brake the ECU plays a major role, it applies brake pressure continuously up to maximum wheel slip (in safety zone) and after attain maximum wheel slip (safety zone) brake pressure decreases. This process repeats until brake pedal release. In dry conditions the maximum wheel slip in safety zone is equal to 20%. Generally the ABS systems are designed based on dry conditions. For wet conditions the maximum wheel slip in safety zone is 15%. In this condition the wheel slip increases to 20% may lead skid , to reduces this skidding make sense to brake pedal.increasing brake pedal pressure the ECU increases wheel slip ratio. Therefore changes of skidding of vehicles in different conditions will reduce.

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