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Research Article

Investigation on Life Rescue Technologies on Road-airbags and Anti-lock Braking System (ABS)

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Abstract: This study is mainly inclined towards understanding why there is a necessity for Airbags and ABS in vehicles and to analyse its pros and cons. A survey is been presented in this study on whether the use of airbags and ABS is beneficial to help curb road accidents. Accidents are prevailing world-wide due to the increased number of vehicles. These unexpected happenings lead to terrific consequences like causing damage to the vehicle and the people travelling in it. Damage to the vehicle can be passed over but if a human is being killed because of an accident, then it is pathetic. Hence AIRBAGS and ABS can be implemented, so that even if a massive accident happens, the victim is left with considerable injuries rather than having his life at stake. We mainly forward through this paper, an analysis of how a human life a can be saved by implementing these technologies. The working of airbags and ABS; also how they can be more efficient is also projected in this study.

Keywords: ABS, accident, accident avoidance, air bags, safety, seatbelt

INTRODUCTION

Why air bags: Air bags that will be folded and kept inside the vehicle at all possible places to reduce the life risk of travellers during accidents. When a massive disturbance happens around the air bags, it automatically opens up and air gets filled in it and becomes like a pillow. It is designed in a fashion that, once when it is opened, air surrounding it will enter the bag and enlarge its size. Hence this fills in the gap between the person on the seat to the hard surface on which is he is about to hit. Provided the traveller has passed on his seat belt, then it is anticipated that he will go and fall on the air bag, which will not harm him.

Assume, if there is a massive accident on the road, where two cars, having no air bags, hit each other head-on-head, then it is guaranteed that, the lives of people travelling in both the cars are under high danger. Due to this sudden jolt, the cars will try force stop because of the terrible hit. And as we know from the Newton's second law, the inertia of motion, people travelling in the car, will naturally stride front with the force with which the two cars collided. That is, people sitting inside the car will go and forcefully hit on the object that is in front of them, getting hurt badly.

If there are air bags in both the cars placed at appropriate places, then, if this head-on-head collision occurs, as per inertia of motion people travelling in it will go and hit the air bags, which will get opened due to the heavy force applied around it. Once the bag is opened it will be filled by air and due to this the folded air bag will become like a pillow. All these will happen within fraction of a second so that people sitting inside, instead of going and hitting on a solid surface, will go and rest on a air pillow which will avoid them from getting hurt badly. This paper has been written with having motto of understanding airbag and ABS. Also we aim at discussing the pros and cons of both.

MATERIALS AND METHODS

How airbags work: There is a crash sensor that connects the auto-mobile and the air bag. This is the most indispensible part of an air bag system, which senses or anticipates sudden crash or forced stopping or bragging of the vehicle, after a tremendous hit over an object. The most widely deployed sensor is, electro-magnetic sensors, which contains a tube or filament like feature and to its one is a circuit and on the rear side there will be a spherical ball like object attached with a small magnet. When a massive disturbance occurs to around this sensor, the magnet frees the ball, which travels through the tube and hits the other end, where the circuit switching happens. This signal from the circuit inflates the air bag. Usually the inflator will have a chemical set up that produces explosion of nitrogen gas which will get filled in up the air bag. This ensteering wheel scene happens with in fraction of a fraction of a second which can be approximated to 25 or 25 msec. This air bags demands reasonable force to y

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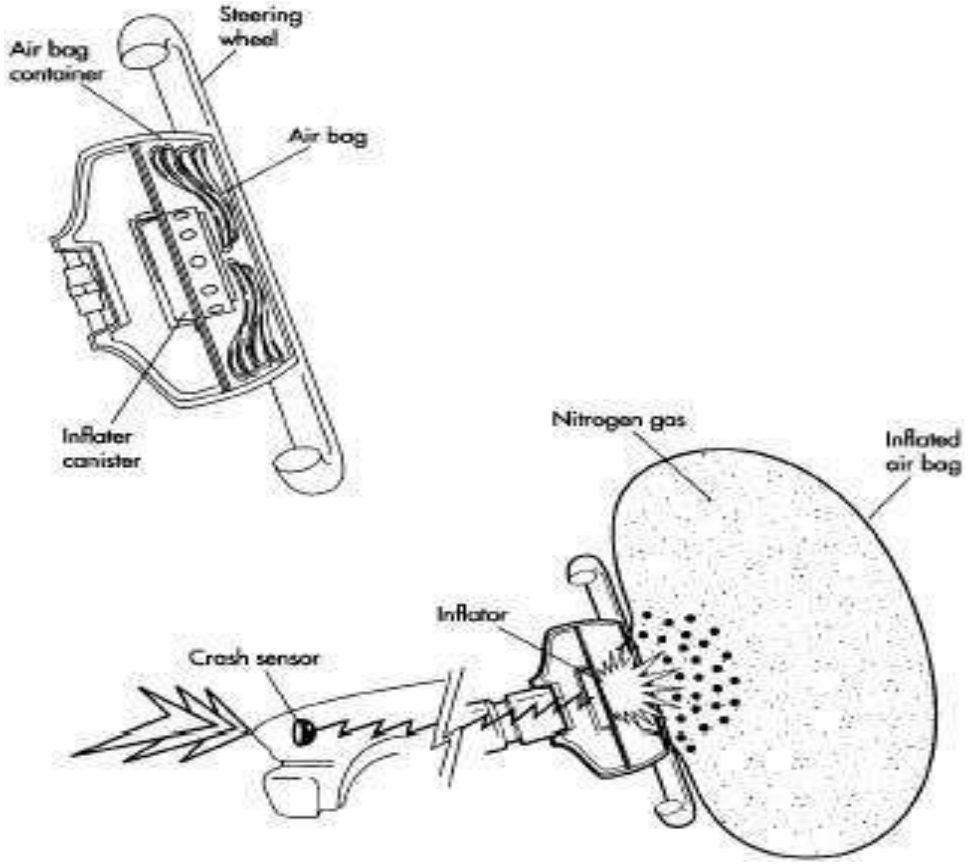

Fig. 1: Contents and working of airbags (image courtesy: wikipedia)

be applied upon it to get it opened. Also, air bags once opened are difficult to be refolded and replaced. Onl professionals can do it properly (Brain, 2000). A driver side air bag costs between $400-800.passenger side air bags costs around $1000. Curtain side air bags are comparatively cheaper to the previously discussed two. An informative picture showing its components is shown in Fig. 1.

Is it a life saver or a killer: Air bags are targeted and designed to reduce the life risk of people travelling in an auto mobile. But if the traveller did not pass on his seat belts, then it is not sure that he will land on the air bag and get less hurt. If seat belts are not laid, then the traveller is expected to fall along the direction in which the car strikes the opposite object (Kent, 2003). In this case, the air bag will further push the passenger towards some other direction.

Also air bags hold very well for adults, provided that air bags are complimented with seat belts. But what if a child travels in it or a physically challenged person travels in it. One cannot fix the air bags according to their heights, because one cannot guarantee that no adult will travel in it. Also when the airbags get open at the time, when it is actually not needed, it may even kill the person sitting before because the force in which it opens will be inordinate.

Can it be placed more efficiently: Air bags now serve only for a targeted purpose to save adults who have their seat belts on. To make it more efficient, one can try for a bigger size air bag which will rescue adult, children and pregnant women.

Air bag can be placed more efficiently by anticipating a place which can predict the height of the traveller, be it a child or an adult and then accordingly open in that height so that it can actually rescue the passenger.

Some people like a relaxed driving or may not be that comfortable in using a seat belt. In those cases, air bags can do an additional work that is when it opens it must surround the passenger by falling off in the rear sides.

Considering a case where the vehicle somersaults and goes top down. It is obvious that in this case the travellers will go and hardly get hit on the roof of the car due to the gravity. If an airbag is placed at the top off the car, then the risk of injury can be reduced to a reasonable extent. Also the inflated roof air bag must not exceed a certain height that it can hide the mirror that helps the driver see the surrounding.

Most of the accidents are caused because of the improper maintenance of the vehicle. Small intricate

Table 1: National centre for statistics and analysis NHTSA, survey of 2000 shows that

Belt used	Air bag in vehicle	Effectiveness of restrained use (%)	Fatalities	Lives saved by belts and air bags
Yes	Yes	53.72	3.565	4.138
No	Yes	14	3.364	548
Yes	Yes	48	0	0
No	Yes	0	1	0
Yes	No	48	2.008	1854
No	No	0	2.893	0
Yes	No	48	0	0
Total lives saved 6.540				

details like brake oil level, brake shoes condition, wheel pressure and battery condition are not frequently checked by the user regularly. So these can be consistently monitored at regular intervals by keeping these records maintained in the cloud which may help in avoiding accidents.

Detriments of air bags: Air Bags attempt to save the life of people travelling in a four-wheeler. But it does not care or address to two-wheeler riders, since it is impossible to find a proper place to keep air bag in a two-wheeler. This is because the designer cannot guarantee saying that, in case of an accident the rider will fall only on the front, or on any particular side. Also, it must care for the person who sits in the pillion. So implementing air bag in a two-wheeler is still a night mare.

Air bags once opened cannot be easily folded. It demands professional skills to fold it and replace it. Usually air bags are folded by automated machines where the folding will be so accurate and perfect so that it can open very easily in case of emergency. Air bags are expected to get into action within milliseconds when accidents happen. But it the folding is not done properly, it is of no use.

The air bag will open only when the air bag is hit around its peripherals. If the vehicle is hit hard at the back, then the airbag will not open for rescue, where having it is of no use:

- Some companies like Nissan, Renault, Skoda does not mandate seat belt which may not ensure the proper working of the air bag. As airbags work well only when seat belts are on.
- Since airbags cost high, people don't prefer using it.
- **Adjustable steering:** Now-a-days steering is adjustable in most of the vehicles, it can't cover drivers face.

In India, airbags are seen more as a luxury than as a necessity and a safety feature. But outside India, it is not so. Airbags are considered the mandatory feature that any car manufacturer is concerned about. Even for the smallest cars to the heavy vehicles, airbags are a must. Let's look at a survey.

According to latest government data, the accidents in India climbed up to 138.258 in 2012 from 84.674; about a decade back. The executives of Nissan and Suzuki say that not many Indians were willing to pay extra for the airbags, even if it was at most necessary in a country like India. Safety standards in India are around 10 years outdated from the western countries and, since most of the accidents happen by vehicles colliding with each other, airbags can save many lives. Table 1 shows a survey of accidents that happened and the number of lives saved due to the use of Airbags and seatbelts.

Fig. 2: Symbol of ABS

Anti lock Braking System (ABS): Whatever the vehicle may be, be it a two wheeler or a four wheeler; stopping it safely is one of the most important functions of a motor vehicle. If it fails, then the consequences may be damage to vehicle, personal injury or death even (Nice, 2000). Hence to improve the working of the brake systems, ABS was proposed and being implemented in leading automobile companies. This prevents a vehicle's brake from locking up and skidding during hard stops on wet icy roads.

What is ABS: An Antilock Brake System (ABS) is a secure and an effective braking system. ABS allows the driver to maintain directional stability, control over steering capability and in some situations, to reduce stopping distances during emergency braking situation, mainly on wet and slippery road surface (Sadegh, 2005). ABS has become as important as a seatbelt or an airbag these days and if the driver usually likes to takes risks by performing dangerous driving stunts or rather, is unaware of the braking system which is purely more than just stomping on the brake pedal, then ABS is worth every penny spent on. Figure 2 shows the symbol of ABS.

Following, let's see a survey in Table 2, based on Indian road traffic which shows the count of accidents that have occurred without the use of ABS.

Table 2: A survey on number of accidents in the absence of ABS

Population dense cities	Accidents caused by not using ABS
Lucknow	600 last year
Delhi	2110 last year
Kolkata	7290 (2013-2014 till date)
Chennai	9663 last year
Mumbai	25000 (2012 Jan-2014 Jan)
Amritsar	6513 last year
Trivandrum	5657 last year
Cherapunjee	400-600 last year

ABS-more technical approach: As you have already had an introduction to what an ABS system is, let's closer look at it; technically.

Types: Anti-lock braking systems use different ways depending on the type of brakes. They can be differentiated by the number of channels and that are individually controlled and the number of speed sensors:

- Four-channel, four-sensor ABS
- Three-channel, four-sensor ABS
- Three-channel, three-sensor ABS
- Two-channel, four sensor ABS
- One-channel, one-sensor ABS
- Components ABS

Speed sensor: A speed sensor's role is to determine the acceleration or deceleration of the wheel. These sensors use a magnet and a coil of wire to generate a signal. The rotation of the wheel induces a magnetic field around the sensor. The fluctuations of this magnetic field generate a voltage in the sensor. Since the voltage induced in the sensor is a result of the rotating wheel, this sensor can become incorrect at slower speeds. The slower rotations of the wheel causes incorrect fluctuations in the magnetic field and thus present with incorrect readings to the controller.

Valves: There is a valve in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions:

- In position one, the valve is open; pressure from the master cylinder is passed right through in to the brake.
- In position two, the valve blocks the line, isolating that brake from the master cylinder. This prevents the pressure from rising further; should the driver push the brake pedal harder.
- In position three, the valve releases some of the pressure from the brakes.

The majority of problems with the valve system occur; when they get clogged. When a valve is clogged, it is unable to open, close, or change position. An inoperable valve will prevent the system from modulating the valves and controlling pressure supplied to the brakes.

Pump: The pump in the ABS is used to restore the pressure to the hydraulic brakes after the valves have released it. A signal from the controller will discharge the valve at the detection of a wheel slip. After a valve release the pressure supplied from the user, the pump is used to restore a desired amount of pressure to the braking system. The controller will adjust the pumps status in order to provide the preferred quantity of strain and trim down slipping.

Controller: The controller is an ECU (Engine Control Unit) type unit in the car which receives information from each individual wheel speed sensor, in turn if a wheel loses traction the signal is sent to the controller, the controller will then limit the Brake force (EBD) and activate the ABS modulator which actuates the braking valves on and off.

Working of ABS: Without using an ABS what happens is that when you are travelling at say 80 km/h, you will keep moving in that pace, unless you interrupt and brake. So when you try to brake quickly, you are putting so much pressure on the brakes, which forces your steering wheel to decelerate from 80 to 0 km/h. This has to happen instantaneously and so it is very hard to make the steering wheels stop at such a fast rate. Naturally due to the pressure applied on the brakes and the less friction on the road it is travelling, the steering wheel gets locked. It becomes difficult for the steering wheel to take control of its motion and changing its trajectory. When such a situation arises steering control gets lost and cars can only be stopped after driving for longer distances.

While using an ABS in the vehicle, the speed sensors on the steering wheels realize that we are decelerating from 80 to 0 km/h. Braking at this limit is called "threshold braking" and is the fastest and safest way to stop a car. When it senses that action, it will try to reduce the pressure on the brake pad so that once again the steering wheels can accelerate to a moderate level and stay in motion. This pressure is released by the Hydraulic Control Unit. If the steering wheels are on the verge of getting locked, the process repeats and the pressure is adjusted. This pressure maintenance is often experienced like pulsing or jerking of the vehicle; where we feel we are losing grip on the steering wheels, but nothing actually happens as such. ABS takes control and allows the steering wheels to constantly rotate. This makes it comfortable for the driver to stop at a safe distance, maneuver the track or miss an obstacle coming on the way.

Below from Fig. 3 you can relate on how ABS is used in the car.

Internal description-detailed working of the system: Now coming to the more detailed description on how ABS works internally in the car. The major components are brake pedal, master cylinder, wheel speed sensors, Electronic Control Unit (ECU) and Hydraulic control

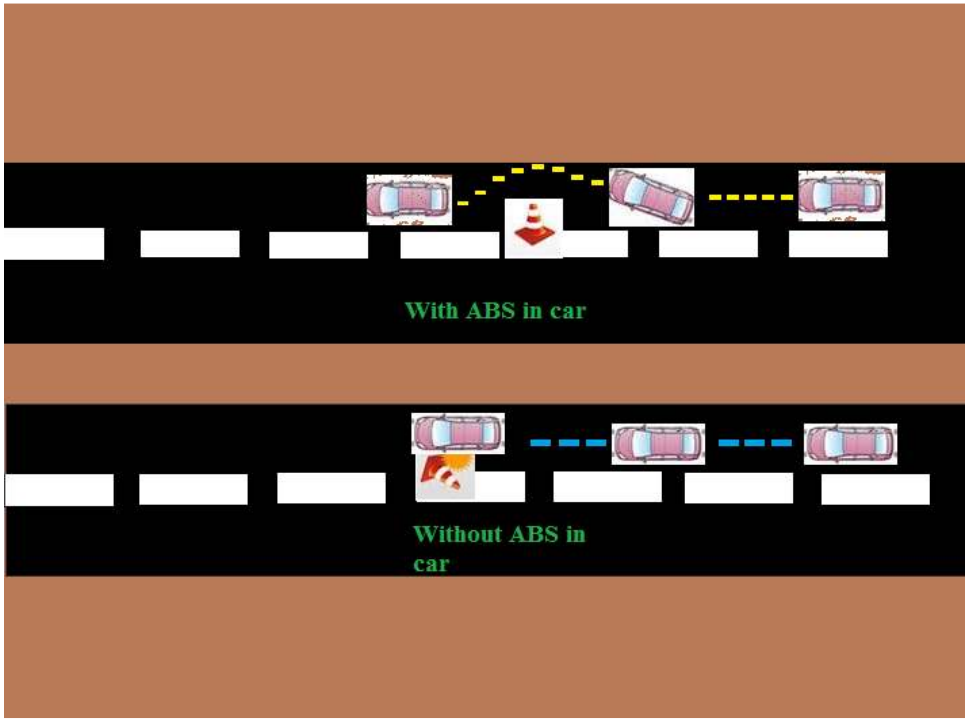

Fig. 3: Situation clearly describing motion of car with and without ABS

unit (Aly, 2012). The wheel speed sensor consists of a rotor that rotates when the wheel turns. As the wheel turns, the rotation induces a voltage to the sensor which is picked up and sent to the ECU.

As and when the driver wishes to apply brakes, the rotation of the wheel is no longer in its normal pattern and it changes. This change is notified to the ECU again. The important part is that, in case the ECU feels the wheels might lock while applying brakes, it sends a quick message to the hydraulic control unit (Fletcher, 2011).

In a three-tier channel system, the hydraulic unit controls the braking system using three solenoid valves. The valves are in sync with brake master cylinder, hence preventing. Each of them operates on each front wheels and one of them operates for the rear wheels. During the start of the journey, the ABS assures itself in working mode. When the journey starts it will be working, else a signal is given to the driver.

For now, if we see the braking systems in foreign cars like Toyota, Mitsubishi, Nissan etc., the braking system along with ABS, comprises of EBD (Electronic Brake force Distribution), Emergency Brake Assist and Electronic Stability Control. The major usage of this system being that, it can help curb a whole lot of accidents by increasing the rear braking force either with full or low load and provide vehicle balance torque.

If we take a look at its implementation in India, without specifying "Bosch" we cannot advance this survey. Bosch is a German multinational engineering and Electronics Company, which is the world's leading supplier of automotive technology. It is the first company to manufacture antilock braking systems in Indian vehicles. It has established a new manufacturing facility for its ABS antilock braking system at the Chakan plant in Pune, Maharashtra, India. Bosch is the only automotive supplier to manufacture ABS in India for passenger cars and light commercial vehicles.

Why the need for an ABS system: Consider a situation, suppose in the highway, there might be an instance when people suddenly tempt to cross the road without prior notice to the incoming vehicles. That time when the driver tries to brake, he uses so much force on the wheels and the wheels will get locked up. This results in either skidding of the vehicle or inability for the driver to take control of the vehicle's course. Here is where ABS helps. The braking system provides the correct force needed to control the vehicle by preventing the wheel to lock itself.

ABS is a new age braking system for better road safety. So by using such a system, a lot many accidents can be avoided. All we have to do is, when a situation arrives to quickly brake, just keep on pressing on the brakes firmly without releasing and steer away from the obstacle. Also remember to maintain a moderate distance from the car in the front, as braking is an involuntary action.

A point to be noted is that, in a survey of 594 car owners in Delhi, Mumbai, Bangalore, Chennai, Hyderabad and Kolkata considered ABS more

important than the airbag and second only to the seatbelt. While the awareness of Indian motorists is high, today's availability of ABS in the market is limited.

Current situation: India currently has one of the worst road accident rates worldwide. Government statistics show that 1.35 lakh people died in 2010 in road accidents across India, which increased to 1.42 lakh in 2011. Around 31% of the incidents involve commercial vehicles like trucks, buses and tractors. To install this ABS package, cost is expected to vary between 20,000 and 50,000 depending on the size and class of commercial vehicle.

Once mandated by the roads ministry, it would be an effective mechanism to improve passenger safety. We can assure this by the fact that; majority of heavy buses sold in India would be now installed with this system. Nearly 45,000 passenger buses and 1.6 lakh trucks would be covered by the new provision in the Indian market, where around three lakh units.

RESULTS AND DISCUSSION

Advantages of ABS: The main benefits of an Anti-lock Brake System (ABS) are:

- **Stops on ice flooring:** ABS prevents lock-ups and skidding, even in slippery conditions. Anti-lock brakes have been proven to save lives in some situation.
- **Insurance cost is low:** Since it is carefully tested safety device with a track record of success, insurers give clients specific discounts for having an ABS system on their vehicle.
- **Resale value is higher:** As a feature on a car or truck, an ABS can raise the market value of the vehicle. Where ever ABS technology has become usual on many vehicles, it could result in a lower price for resale.
- **Grip control:** ABS shares some of the infrastructure of a grip control systems, new technology helps to ensure that each wheel has grip on the road. That makes it easy for manufacturers to install both of these features at the factory.
- ABS works well with alloy wheel.

Disadvantages of ABS: Anti-lock brakes have are proven to be a reliable safety feature in most situations and insurers consider them to substantially considerably lower risk for a vehicle. However, not all drivers are sold on this option for a car or truck. Here are some of the downward that driver find in this kind of brake system:

- **Unpredictable stop times:** Anti-lock brakes are made to provide for fine or good braking in slippery conditions. Some drivers report that they find stopping distances for regular conditions are lengthened by their ABS, because there may be errors in the system, or because of noise of the ABS may contribute to the driver not braking at the same rate.
- **Maintenance cost:** An ABS can be expensive to maintain. Expensive sensors on each wheel can cost hundreds of dollars. To fix if they get out of collaboration or accident or it can develop other problems. This is a big reason to reject an ABS in a vehicle.
- **Delicate systems:** It's easy to cause a problem in an ABS by messing around with the brakes. Problems include confusion of the ABS, where a compensating brake sensor causes the vehicle to shudder, make loud noise or generally brake worse.

Advantages of airbags: The benefit of airbags are various. Under here are some of it:

- Air bags are created for injury reduction for body, particularly the torso (Allain, 2012).
- Designed with convenience for the passenger, a feel that it is invisible but is rightfully present to protect the passenger.
- Insurance is lower for cars with airbags.

Disadvantages of airbags:

- Air bags may be helpful and protective; but in some situations it could be injurious also.
- It could deploy very strongly and may hit small passengers like children. It can hurt their chest.
- Adults can sit atleast 10 to 12 inches away from airbags; by using seatbelts it can curb the potential damage that can occur due to air bags.

CONCLUSION

ABS ensures that the minimum stopping distance is achieved and it is still important to drive at a safe speed for the conditions and leave a gap of at least 2 sec between yourself and the vehicle in front in order to reduce the chances of needing to make use of the ABS. Wherein, air bags comes to the rescue after an accident occurs. It saves the lives of the passengers by providing an air pillow like object between the hard surface and the traveler. Both these techniques provide low risk on road.

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