Mahatma Gandhi Mission's
College of Engineering and Technology
Noida, U.P., India

Seminar Report

On

"Advancement in safety & security in Automobiles"

As

Part of B. Tech Curriculum

Submitted by:

Amit Kumar Tiwari
VIII Semester
1309540008

Under the Guidance of:

Mr. Ram Prakash
Associate Professor
MGM COET, Noida

(Seminar Coordinator)
Mr. Ram Prakash

Submitted to:
HOD
Mechanical Engineering Department,
MGM COET, Noida

Mahatma Gandhi Mission's
College of Engineering and Technology
Noida, U.P., India

Department of Mechanical Engineering

CERTIFICATE

This is to certify that Mr. **Amit Kumar Tiwari** B. Tech. Mechanical Engineering, Class **BT-ME** and Roll No. **1309540008** has delivered seminar on the topic **"Advancement in safety & security in Automobiles"**. His seminar presentation and report during the academic year 2016-2017 as the part of B. Tech Mechanical Engineering curriculum was good.

(Guide) **(Seminar coordinator)** **(Head of the Department)**

Acknowledgement

I would like to express my deep sense of gratitude to my supervisor Mr. Ram Prakash sir, Professor, Mechanical Engineering Department, M.G.M. College of Engineering and Technology, Noida, India, for his guidance, support and encouragement throughout this project work. Moreover, I would like to acknowledge the Mechanical Engineering Department, M.G.M. College of Engineering and Technology, Noida, for providing me all possible help during this project work. Moreover, I would like to sincerely thank everyone who directly and indirectly helped me in completing this work.

(Amit Kumar Tiwari)

Abstract

This report is based on the concept of Safety conscious design and security that has always been remain a vital aspect in car development .The increasing luxury and power of the cars pays major role for the instability and poor safety of the automobile .Here is the safety precautions which prevents the major porn parts of human life .This safety system consist of the Electronic stability control (EST) , properly positioned air bags call and an highly improved XDS tech glasses, Anti-lock Braking system (ABS), Night Vision ,Emergency Brake assist etc. ,which are assisted by sensor to give the maximum safety for pleasure riding. The position of air bags helps to protect the vital human from injury in case of accidents .The emergency act of the seat belt tension make the victim to be back rest and relative lower body movement. We think that this safety avoids the major loss of life in case of an accident. In the event of an accident, the onboard e-call device transmits an emergency call to the most appropriate public service answering point along with certain vehicle related data. Actually, it works either with the human intervention or even without it; there will also always be a voice connection between the vehicle and the rescue center in addition to the data link.

CONTENTS

List of Figures

CHAPTER 1

INTRODUCTION TO SAFETY OF AUTOMOBILE

The automobile is a revolutionary technology. Increased personal mobility created new economic, social, and recreational opportunities and changed the American landscape. But the benefits of mobility were accompanied by dramatic new risks. Automobiles placed speed and power in the hands of individuals. In the early twentieth century, a soaring rate of traffic deaths and injuries prompted expressions of concern. A dialogue among physicians, safety advocates, engineers, journalists, and others revealed differing opinions about the causes of accidents, injuries, and fatalities. Driver behavior, automobile design, highway engineering, and traffic hazards all were blamed. Efforts to retain the benefits of personal mobility while minimizing its sometimes-tragic consequences focused on specific problems from controlling driver behavior to redesigning automobiles to improving the driving environment. It took decades to understand, prioritize, and minimize these risk factors. In the 1910s, speeding, reckless driving, collisions, and pedestrian fatalities were new problems requiring new solutions. The first remedies comprised a social response focused on controlling and improving driver behavior. By the early 1920s, the National Safety Council compiled accident statistics, held conferences, and sponsored Safety Week campaigns in cities in the hope that increased public.

The modern passenger cars have become not only faster but more comfortable and considerably safer. And even though the traffic volume our roads has increased several fold the risk of accident remain relatively high. Due to the modern safety system adopted. Seat belts and airbags are perhaps two of the most well-known and still most effective system. The protective capabilities of these systems can only be fully realized if seat belts are used on every trip buckle up and then drive. Wearing seat belt can alone prevent many injuries or lessen the severity of injuries. Whereas an air bag alone cannot provide the same degree of protection since they are designed only to supplement the protective effect of the seat belt.

Automobile safety is the study and practice of design, construction, equipment and regulation to minimize the occurrence and consequences of automobile accidents. Road traffic safety more broadly includes roadway design. One of the first formal academic studies into improving vehicle safety was by Cornell Aeronautical Laboratory of Buffalo, New York. The main conclusion of their extensive report is the crucial importance of seat belts and padded dashboards. However, the primary vector of traffic-related deaths and injuries is the disproportionate mass and velocity of an automobile compared to that of the predominant victim, the pedestrian.

In India, a pedestrian is injured by an automobile every 8 minutes, and are 1.5 times more likely than a vehicle's occupants to be killed in an automobile crash per outing. Improvements in roadway and automobile designs have steadily reduced injury and death rates in all first world countries. Nevertheless, auto collisions are the leading cause of injury-related deaths, an estimated total of 1.2 million in 2016, or 25% of the total from all causes. Of those killed by autos, nearly two-thirds are pedestrians. compensation theory has been used in arguments against safety devices, regulations and modifications of vehicles despite

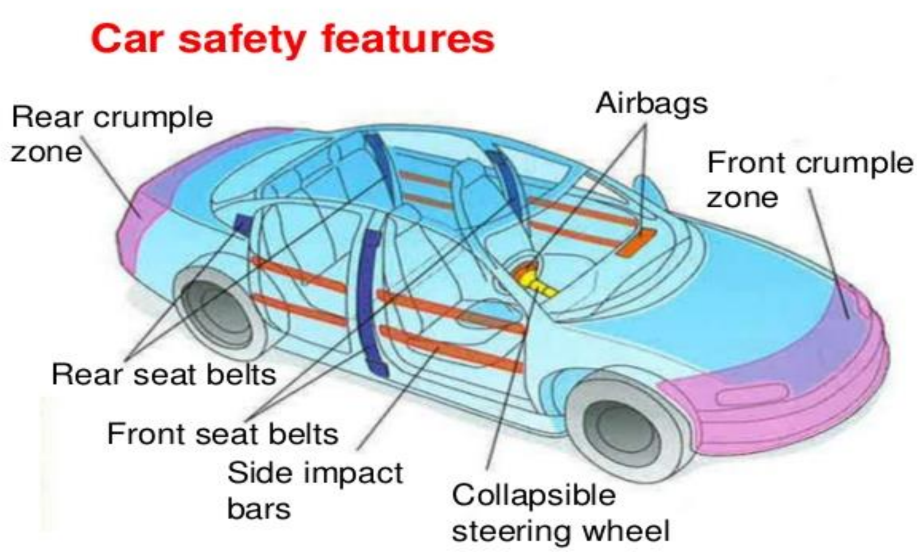


Fig.1 Car safety features

1.1 HISTORY

Automobile safety may have become an issue almost from the beginning of mechanized road vehicle development. The second steam-powered "Fardier" (artillery tractor), created by Nicolas-Joseph Cugnot in 1771, is reported by some to have crashed into a wall during its demonstration run. However according to Georges Ageon the earliest mention of this occurrence dates from 1801 and it does not feature in contemporary accounts.

One of the earliest recorded automobile fatalities was Mary Ward, on August 31, 1869 in Parsons town, Ireland.

In 1922, the Duesenberg Model A became the first car to have four-wheel hydraulic brakes.

In 1930, safety glass became standard on all Ford cars.

In the 1930s, plastic surgeon Claire L. Straith and physician C. J. Strickland advocated the use of seat belts and padded dashboards. Strickland founded the Automobile Safety League of America.

In 1934, GM performed the first barrier crash test.

In 1936, the Hudson Terraplane came with the first back-up brake system. Should the hydraulic brakes fail, the brake pedal would activate a set of mechanical brakes for the back wheels.

In 1937, Chrysler, Plymouth, DeSoto, and Dodge added such items as a flat, smooth dash with recessed controls, rounded door handles, a windshield wiper control made of rubber, and the back of the front seat heavily padded to provide protection for rear passengers.

In 1942, Hugh DE Haven published the classic mechanical analysis of survival in falls from *Mechanical analysis of survival in falls from heights of fifty to one hundred and fifty feet*.

In 1947 the American Tucker was built with the world's first padded dashboard. It also came with middle headlight that turned with the steering wheel, a front steel bulkhead, and a front safety chamber.

In 1949 SAAB, incorporated aircraft safety thinking into automobiles making the Saab 92 the first production SAAB car with a safety cage.

Also in 1949, the Chrysler Crown Imperial was the first car to come with standard disc brakes.

In 1955 a USAF surgeon who advised the US Surgeon General wrote an article on how to make cars safer for those riding in it. Aside from the usual safety features, such as seat belts and padded dashboards, bumper shocks were introduced.

In 1956, Ford tried unsuccessfully to interest Americans in purchasing safer cars with their Lifeguard safety package. (Its attempt nevertheless earns Ford *Motor Trend*'s "Car of the Year" award for 1956.)

In 1958, the United Nations established the World Forum for Harmonization of Vehicle Regulations, an international standards body advancing auto safety. Many of the most lifesaving safety innovations, like seat belts and roll cage construction were brought to market under its auspices. That same year, Volvo engineer Nils Bohlin invented and patented the three-point lap and shoulder seat belt, which became standard equipment on all Volvo cars in 1959. Over the next several decades, three-point safety belts were gradually mandated in all vehicles by regulators throughout the industrialized world.

In 1958, Saab were first to introduced seat belts as standard.

In 1959, American Motors Corporation offered the first optional head rests for the front seat.

Effective on new passenger cars sold in the United States after January 1, 1964. front outboard lap belts were required.

Effective in 1966, US-market passenger cars were required to be equipped with padded instrument panels, front and rear outboard lap belts, and white reverse (backup) lamps.

In 1966, the U.S. established the United States Department of Transportation (DOT) with automobile safety one of its purposes. The National Transportation Safety Board(NTSB) was created as an independent organization on April 1, 1967, but was reliant on the DOT for administration and funding. However, in 1975 the organization was made completely independent by the Independent Safety Board Act (in P.L. 93-633; 49 U.S.C. 1901).

In 1967, equipment specifications by such major fleet purchasers as the City and County of Los Angeles, California encouraged the voluntary installation in most new cars sold in the US of safety devices, systems, and design features including:

- Elimination of protruding knobs and controls in passenger compartment
- Additional padding on the instrument panel and other interior surfaces
- Mounting points for front outboard shoulder belts
- Four-way hazard flashers
- A uniform P-R-N-D-L gear sequence for automatic transmission gear selectors
- Dual-circuit brake hydraulic systems

In 1968, the precursor agency to the US National Highway Traffic Safety Administration's first Federal Motor Vehicle Safety Standards took effect. These required shoulder belts for left and right front-seat vehicle occupants, side marker lights, collapsible steering columns, and other safety features. 1969 saw the addition of head restraints for front outboard passengers, addressing the problem of whiplash in rear-end collisions. These safety requirements did not apply to vehicles classified as "commercial," such as light-duty pickup trucks. Thus, manufacturers did not always include such hardware in these vehicles, even though many did passenger-car duty.

Volvo developed the first rear-facing child seat in 1964 and introduced its own booster seat in 1978.

In 1974, GM offered driver and passenger airbags as optional equipment on large Cadillacs, Buicks, and Oldsmobile.

In 1979 NHTSA began crash-testing popular cars and publishing the results, to inform consumers and encourage manufacturers to improve the safety of their vehicles. Initially, the US NCAP (New Car Assessment Program) crash tests examined compliance with the occupant-protection provisions of FMVSS 208. Over the subsequent years, this NHTSA program was gradually expanded in scope. In 1997, the European New Car Assessment Program (Euro NCAP) was established to test new vehicles' safety performance and publish the results for vehicle shoppers' information. The NHTSA crash tests are presently operated and published as the U.S. branch of the international NCAP program.

In 1984 New York State passed the first US law requiring seat belt use in passenger cars. Seat belt laws have since been adopted by all 50 states, except for New Hampshire. and NHTSA estimates increased seat belt use as a result save 10,000 per year in the USA.

In 1986 the central 3rd brake light was mandated in North America with most of the world following with similar standards in automotive lighting.

In 1989, companies in Israel implemented Advanced Brake Warning systems, where the driver would be alerted as to how hard the driver in front of them was pressing on their brakes. This has yet to be implemented into mainstream America.

In 1995 the Insurance Institute for Highway Safety (IIHS) began frontal offset crash tests.

In 1997 EuroNCAP was founded.

In 2003 the IIHS began conducting side impact crash tests.

In 2004 NHTSA released new tests designed to test the rollover risk of new cars and SUVs. Only the Mazda RX-8 got a 5-star rating.

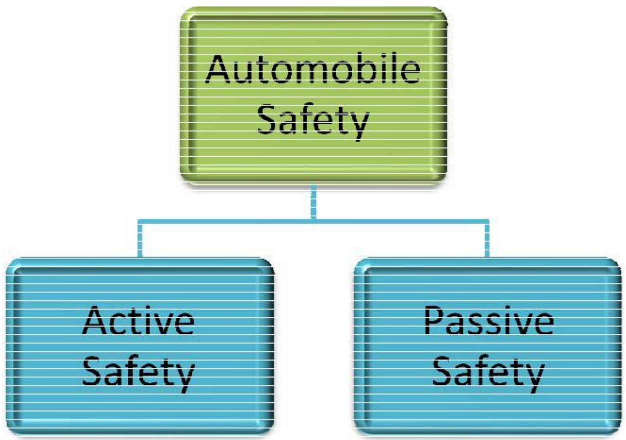
In 2009 Citroën became the first manufacturer to feature "Snow motion", an Intelligent Anti-Skid system developed in conjunction with Bosch, which gives drivers a level of control in extreme ice or snow conditions similar to a 4x4.

In 2009 NHTSA upgraded its roof-crush standard for vehicles weighing 6000 pounds or less. The new standard increased the crush load requirement from 1.5 to 3 times the vehicle's curb weight.

CHAPTER 2

ACTIVE SAFETY AND PASSIVE SAFETY

Based on their use before or after a crash, safety systems in automobiles can be classified into two parts – Active Safety and Passive Safety. Active safety is the concept of helping to prevent accidents from occurring while passive safety is the concept of helping to protect occupants in the event of a collision.



Active Safety

The basic principle of active safety is to assure that a vehicle will always perform its basic functions of "moving, turning and stopping." Many automobile manufacturers endeavor to improve these basic functions by consistently incorporating state-of-the-art technologies. New technologies are being developed that will actively support driving safety using today's advanced electronics. As a result, new systems have been developed such as "VSC," "ABS," and "Brake Assist" which are now used in many cars.

Main Active Safety Systems:

- Electronic Stability Control

- Antilock Braking System
- Traction Control System
- Emergency Brake Assist
- Roll Stability Control
- Night Vision
- Adaptive Cruise Control
- Tyre Pressure Monitoring Systems
- Blind-spot detection/side assist/collision warning
- Adaptive headlights

2.1 Electronic Stability Control

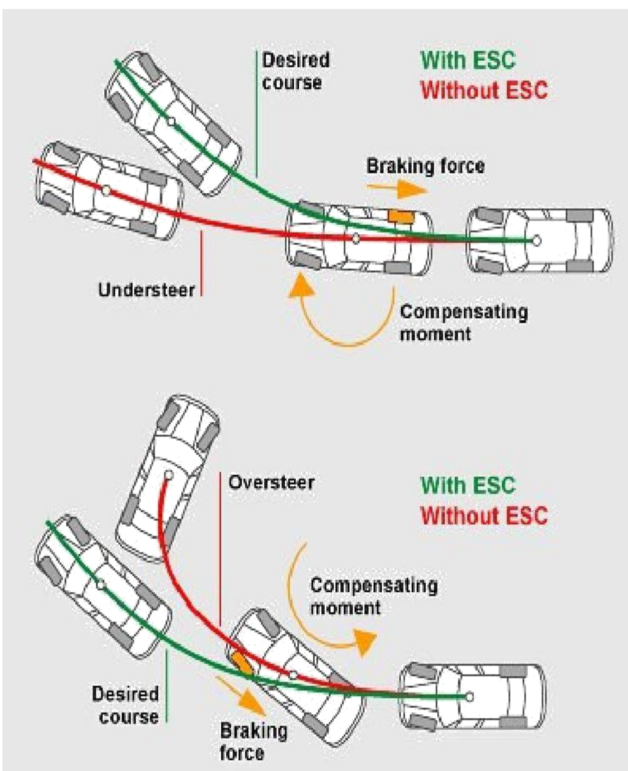
An Electronic Stability Control coordinates the ABS, Traction Control, and the "yaw" of the vehicle (how much a car rocks side-to-side). The individual systems are combined in an effort to reduce tire spinning, skidding, and traction-less cornering, keeping the tires in maximum contact with the road. Found mostly on luxury models, stability systems are slowly working their way into more vehicles.

Electronic Stability Control often referred to as antiskid, goes by many names: GM calls it Stabil Track, Ford dubs it AdvanceTrac, and Chrysler names it Electronic Stability Program (ESP). Other names include Vehicle Dynamics Control (Subaru), Dynamic Stability Control

(Volvo), Vehicle Stability Assist (Honda), and Vehicle Stability Control (Toyota).

An electronic stability control system uses several sensors to detect a loss of traction in your vehicle, and then works with the antilock brake system to apply individual brakes to help keep the vehicle on its intended path.[2] In some cases, an antiskid system also reduces engine power.

Much like antilock brakes work to allow the driver to steer while braking on slippery surfaces, stability control works to help the vehicle stay on its driver-intended path in turns. Sometimes a driver will enter a curve too quickly and exceed the tire's ability to hold the road through the turn. When this happens, the vehicle begins to spin or skid. ESC pulsates the brakes of individual wheels to help "rotate" the vehicle to the driver's intended path. If a vehicle approaches a corner too rapidly and it begins to plow straight ahead, an antiskid system will detect that the vehicle is not on its intended path and intervene by applying the inside brakes. This will rotate the vehicle through the turn and, hopefully, save it from going off the road.



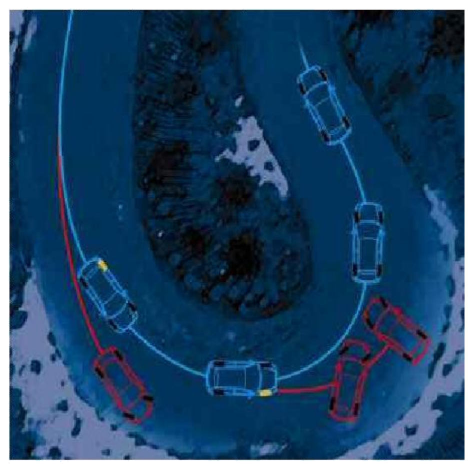


Figure 2.1: Ford's ESC. Stability-control systems utilize several sensors and a computer to determine the driver-intended path for a vehicle. The system will attempt to prevent a skid by applying individual wheel brakes.

2.2 Anti-lock Braking System (ABS)

2.2.1 How do antilock brakes work?

When a driver hits regular brakes hard, the wheels may lock and the vehicle may skid. Wheel lockup can result in longer stopping distances, loss of steering control and, when road friction is uneven, loss of stability if the vehicle begins to spin. The main advantage of antilock is that they can reduce these problems on wet and slippery roads. Antilock work with a vehicle's normal service brakes to decrease stopping distance and increase the control and stability of the vehicle during hard braking.[4] Vehicles equipped with antilock have speed sensors mounted at each wheel and a secondary electro-hydraulic braking circuit. The principle behind antilock is that a skidding wheel provides less stopping force and control than a wheel that is rotating. Antilock prevent wheels from skidding by monitoring the speed of each wheel and automatically pulsing the brake pressure on any wheels where skidding is detected. Antilock should not make much difference in stopping distances on dry roads, although they can enhance vehicle stability and allow drivers to maintain steering control during emergency stops when conventional brakes might allow wheel lockup and skidding. Antilock Braking Systems eliminate the need to "pump the brakes" when one has to stop quickly, preventing him/her from locking the wheels and skidding.

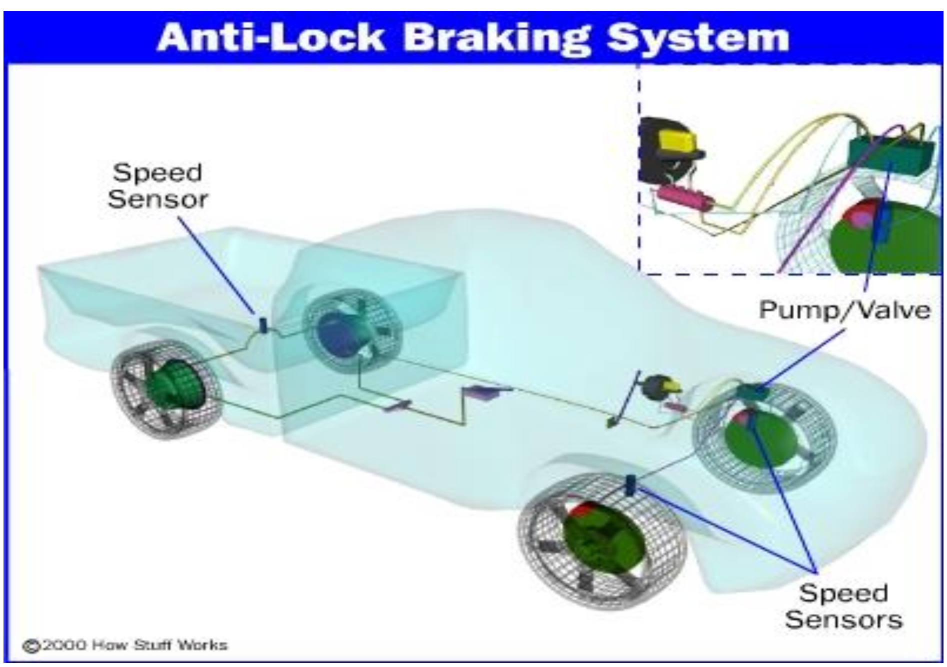


Fig 2.2 Anti-lock Braking system

2.2.2 Why don't antilock reduce stopping distances as much on dry roads as wet ones?

Adequate braking is easy to achieve on dry roads with or without antilock brakes. Even if wheels lock, the coefficient of friction between tires and road surface still is relatively high, so a vehicle stops relatively quickly. It is even possible on some surfaces to stop sooner without antilock than with them, although such instances are rare. They occur, for example, when loosely packed snow or gravel creates a "dam" effect in front of locked wheels, shortening the stopping distance more than antilock could.

Fig. 2.3 Vehicle traction with & without ABS

2.2.3 Should motorcycles be equipped with antilock?

Yes. Motorcycles also are more likely than passenger vehicles to be in crashes involving skids and to lose stability, particularly on wet roads. If a cycle wheel locks during braking, the vehicle is likely to tip over. Test track data show that antilock have substantial benefits on wet road surfaces and exceed the performance of even expert motorcycle test riders with standard brake systems. Antilock can eliminate wheel lockup and allow motorcyclists to maintain steering control, thereby decreasing stopping distances and improving stability. An evaluation of real-world data revealed that motorcycles with antilock had 38 percent fewer fatal crashes per 10,000 registered motorcycles and 19 percent fewer crashes for which insurance claims are filed.

2.3 Traction Control System

Traction control systems prevent wheel spin in slippery conditions when the vehicle needs to be accelerated.

Anti-lock braking systems use wheel speed sensors to identify when a rotating wheel is about to lock up so that the brake pressure can be reduced in order to keep the wheel rotating. Traction control systems use these same wheel sensors to monitor wheel speed during acceleration but now monitor when a drive wheel starts to spin

.

Various strategies can be employed to prevent wheel spin and provide traction. The system can brake a drive wheel that is starting to spin and transfer torque to the opposite drive wheel that still has traction. Some traction control systems will reduce the throttle opening, shift the transmission to a higher gear, retard the ignition timing, or deactivate one or more the fuel injectors to reduce engine power. The control system prevents the drive wheels from spinning and provides the vehicle with maximum traction. Because of the use of common sensing and control systems vehicles equipped with traction control may also feature anti-lock brakes (ABS) and electronic stability control (ESC).

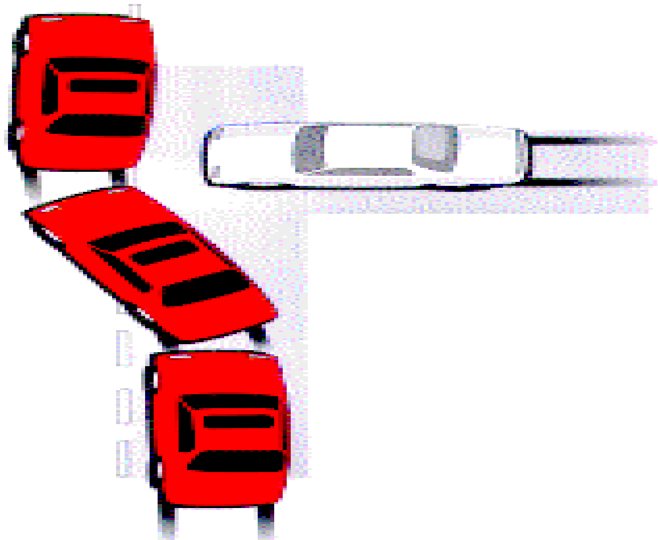


Fig. 2.4 Traction control system

2.4 Emergency Brake Assist

Emergency Brake Assist feature a brake booster system that typically uses either engine vacuum or an electric motor to reduce the force that the driver needs to apply on the brake pedal to generate the desired level of vehicle braking.

In vehicles equipped with brake assist, a sensing system identifies when the driver is pushing on the brake pedal hard and rapidly, with the intention of making an emergency stop. A control system then activates the brake booster system to maximize the braking effort early in the event.[8]

Brake assist provides for a greater degree of braking than in the case of tentative driver action. The system can result in a collision being completely avoided or, at least, it will minimize the severity of a collision that does occur by reducing the vehicle's speed as much as possible.

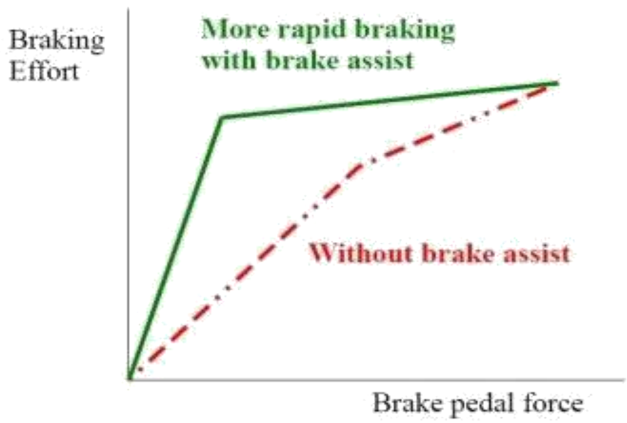


Figure 2.5: Emergency Brake Assist

2.5 Roll Stability Control

Roll stability control works very much like an antiskid system, but uses additional sensors to detect an impending rollover. If the system senses a potential rollover (such as if you whip around a corner too fast or swerve sharply), it will apply the brakes and modulate throttle as needed to help you maintain control. It activates the antiskid system in a manner to prevent a rollover. Roll stability control systems work on flat pavement; they can't prevent rollovers caused by hitting a curb or sliding into a ditch. Also, roll stability control should not be confused with what may be called rollover protection; these systems deploy curtain side airbags when detecting an impending tip.

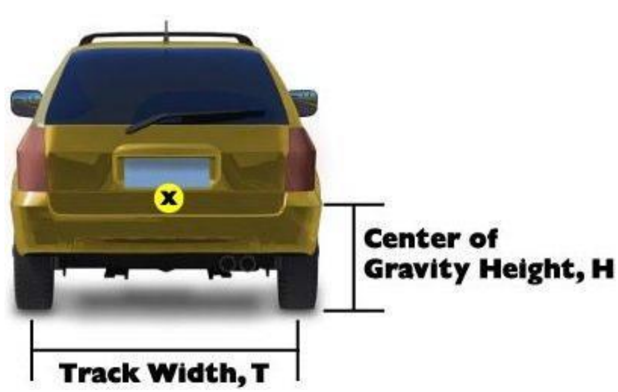


Figure 2.6 Calculation of Static Stability Factor (SSF)

The Static Stability Factor (SSF) of a vehicle is an at-rest calculation of its rollover resistance based on its most important geometric properties. SSF is a measure of how top-heavy a vehicle is. A vehicle's SSF is calculated using the formula SSF=T/2H, where T is the "track width" of the vehicle and H is the "height of the center of gravity" of the vehicle.[9] The track width is the distance between the centers of the right and left tires along the axle. The location of the center of gravity is measured in a laboratory to determine the height above the ground of the vehicle's mass. The lower the SSF number, the more likely the vehicle is to roll over in a single-vehicle crash.

Table 1: Difference between various Control System

Vehicle equipment	Situation
Traction control	This systems prevents wheel spin under acceleration which helps to maintain steerability when accelerating
ABS	ABS helps a driver to prevent skidding during heavy braking. This will help to maintain steering control and achieve shorter braking distances
EBD	helps to balance braking forces between front and rear. In turn this helps to minimise braking distance and keep stability under light axle loads.
ESC	Builds on all the functions above but adds the ability to control skidding during cornering as well.

2.6 Night Vision System

Even with properly adjusted headlights, pedestrians, cyclists, and animals on the road ahead can be difficult to detect in the dark. And, the problem is worse if it's raining or if there is glare from the headlights of oncoming vehicles. Night vision systems use video cameras that are sensitive to infra-red to detect the heat given off by humans and animals against the colder background of the roadway environment. Infra-red emitters may also form part of the vehicle's headlights to help detect objects at greater distances than is possible using only the naked eye with conventional lighting. An in-vehicle display mounted in the instrument panel, or a head-up projection system showing the image on the windshield in the driver's direct field of view, shows the road ahead as a grey-scale image. Potential hazards such as pedestrians walking along the edge of the road, or animals crossing the road directly in the vehicle's path show up as bright objects against a darker background. There is potential for the night vision display to be a distraction, especially when the technology is initially being used. Drivers must make a conscious effort to focus on the regular driving tasks, especially scanning the road ahead, and only take only occasional glances at the night vision display to assimilate the additional information that this can provide.

Figure 2.7: Night Vision allows the driver to see well beyond the reach of the car's headlights. This technology helps drivers detect and avoid potentially dangerous situations.

2.7 Adaptive Cruise Control

Modern cruise control goes beyond just maintaining a constant speed. Because of today's sensors and the use of radar, cruise control can now adjust the throttle and brakes to keep a safe distance from the vehicle in front of it if there are changes in traffic speed or if a slowpoke cuts in. If the system senses a potential collision, it typically will brake hard and tighten the seatbelts. Once it knows the lane is clear or traffic has sped up, it will return the car to its original cruising speed, all without any user input. The user can, of course, override the system by touching the brakes. **12**

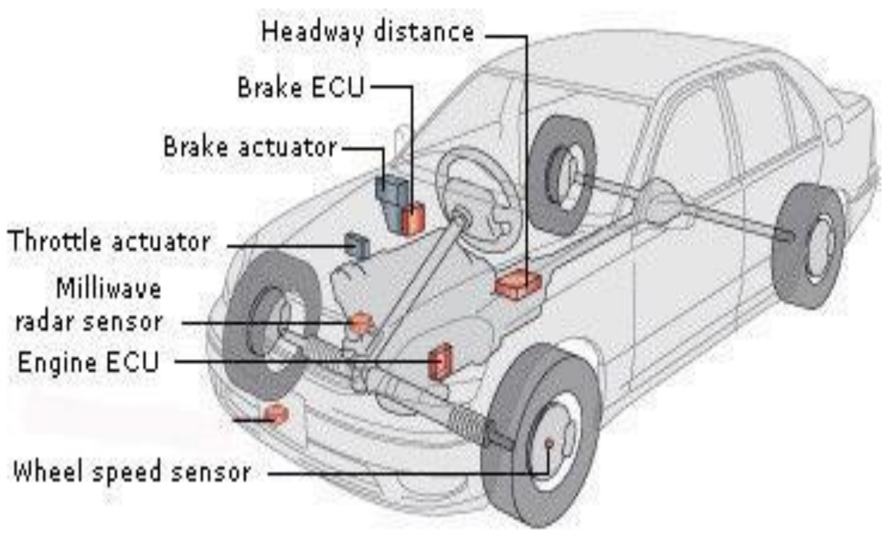


Figure 2.8: Radar System in Cars

2.8 Tyre Pressure Monitoring Systems

Tyre Pressure Monitoring Systems (TPMS) are a way of warning a driver that a tyre is incorrectly inflated, which will decrease the safety and performance of the vehicle, and increase the risk of an accident. It is difficult to spot an under inflated tyre visually, especially without a fully inflated tyre as comparison. Due to the rigidity of current tyre walls, a drop-in pressure will only lead to slight increased flexing of the wall when the tyre is viewed at rest. This is why TPMS can be advantageous, it can warn drivers that their vehicle has an under inflated tyre despite the tyre looking normal.

There are many dangers to having under inflated tyres, because they are designed for use at their recommended pressure. Under inflation can lead to increased deformation in the tyre wall as it concentrates the load upon the tread shoulders, this reduces the amount of surface contact the tyre has with the road. This can have many consequences; such as:

- Increased wear of the tyres treads which will lead to a higher chance of aquaplaning in the wet.

- Reduced handling characteristics and a reduced control of the vehicle.

- Longer stopping distances.

- Higher chance of the tyre delaminating, which could lead to a sudden tyre failure.

There are three types of Tyre Pressure Monitoring Systems:

2.8.1 Direct Tyre Pressure Monitoring Systems

The most accurate and reliable form of TPMS is the direct system; this uses sensors to monitor the tyre's pressure and has the advantage that it can take into account factors, such as the tyres temperature, when calculating the pressure. These systems provide the most accurate feedback to drivers on their tyre's pressure.

2.8.2 Indirect Tyre Pressure Monitoring Systems

Indirect TPMS is an addition to the wheel speed sensors used as a component of the Antilock Brake System (ABS). A decrease in tyre pressure will lead to a decrease in the wheel's radius; this means it will rotate faster compared to the other tyres and the speed sensors detect this change. This system has the major advantage that it is much cheaper to implement and quicker to introduce onto new vehicles, but has major disadvantages due to the fact that it cannot detect a slow and equal decrease in pressure on every tyre. The system also needs to be calibrated more frequently, which could be a difficult for users.

2.8.3 Hybrid Tyre Pressure Monitoring Systems

The concept of a Hybrid TPMS is to combine the advantages of both systems – the accuracy of the direct system and some of the cost savings of the indirect system. The pressure sensors are on two of the vehicles wheels instead of four, and the wheel speed sensors compare the differences in speed to these wheels to detect a dip in pressure.

2.9 Blind-Spot Detection/Side Assist/Collision Warning

This technology is designed to alert the driver to cars or objects in his blind spot during driving or parking, or both. Usually it will respond when the driver puts on your turn signal; if it detects something in the way, it may flash a light in your mirror, cause the seat or steering wheel to vibrate, or sound an alarm. This is more of a short-range detection system.[12] Vehicles in the driver of the green car's (as shown below) blind spot are detected and the driver alerted that it is not safe to change lanes.

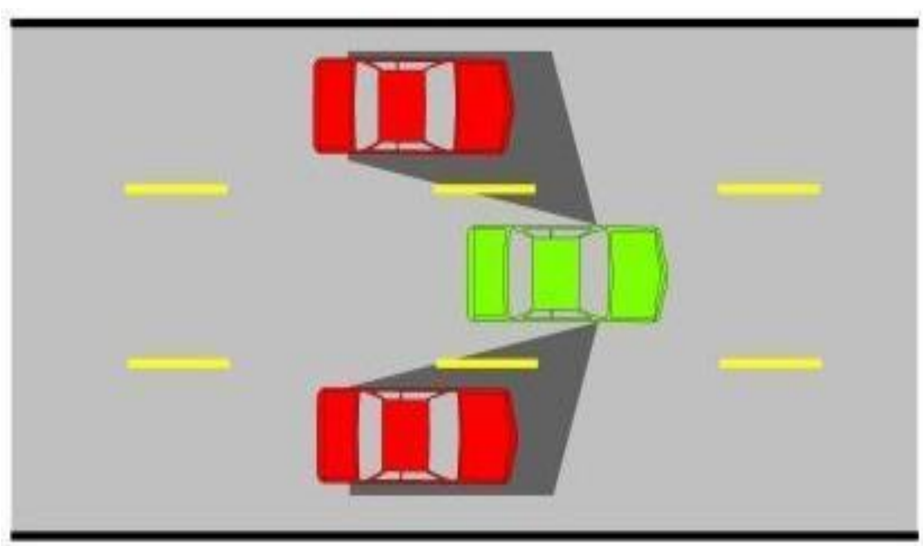


Figure 2.9: Blind-spot detection

CHAPTER 3
PASSIVE SAFETY

With a substantial amount of accident data collected, repeated computer simulated collisions, and crash tests that demolish over thousands of vehicles a year, automobile engineers have been striving to develop safer body structures, new devices to help protect occupants, and other ways to minimize injuries.

Main Passive Safety Systems:

- Active Head Restraint

- Airbags

- Crash Resistant Door Pillars

- Crumple Zones

- Seat Belt Pretensions

3.1 Active Head Restraints

In a rear-end collision an active head restraint system uses mechanical linkages to move the head restraint and/or the seat back to cushion the vehicle occupant and reduce the possibility of neck injury.

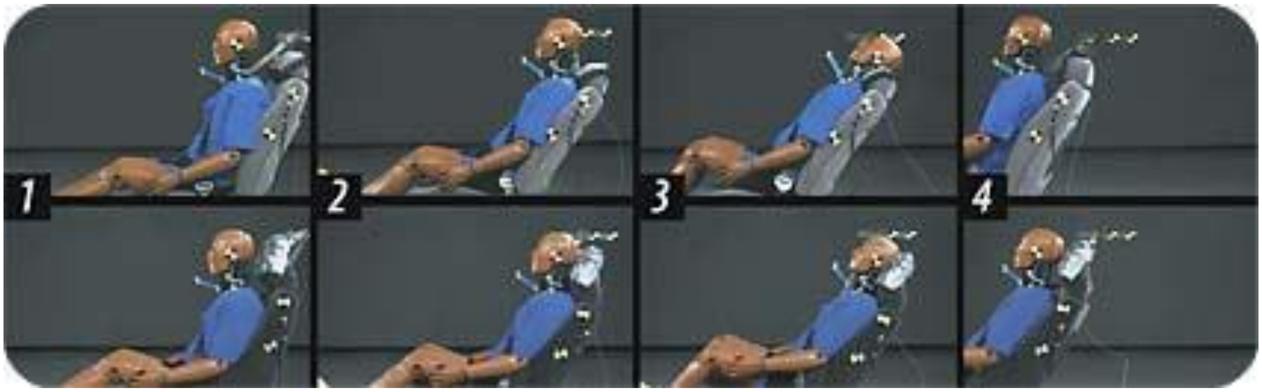


Figure 3.1: Head Restraint - Rear Crash Test. Top: Unsupported Neck

Bottom: Supported Neck

Explanation of Figure 3.1: As the vehicle accelerates forward from the starting position (1), the seatback pushes the occupant forward (2). If the head is unsupported (top sequence), then the neck bends rearward (3). Eventually the seatback springs forward, pushing the body ahead of the neck during rebound (4).

3.1.1 How do they work?

In a rear-end collision the struck vehicle is driven ahead. The seat back pushes against the occupant's back and accelerates the upper torso forward. If the head is unsupported, usually because of an improperly adjusted head restraint, inertia causes the head to remain in place. Due to resulting relative motion of the upper torso and the head, the neck muscles are stretched. This can lead to a hyper-extension condition - and strain to the soft tissue of the neck muscles - the so-called "whiplash" injury. The head restraint should be adjusted vertically so that the top of the headrest is more or less level with the top of the occupant's head. This ensures that the head restraint will make adequate contact with the back of the head in the event of a rear-end impact. Another important dimension is the horizontal setback - the distance between the back of the head and the front surface of the head restraint - since this affects how soon the head restraint engages the head in a crash. Active head restraints use mechanical linkages to move the head restraint into an advantageous position to protect the occupant from whiplash.

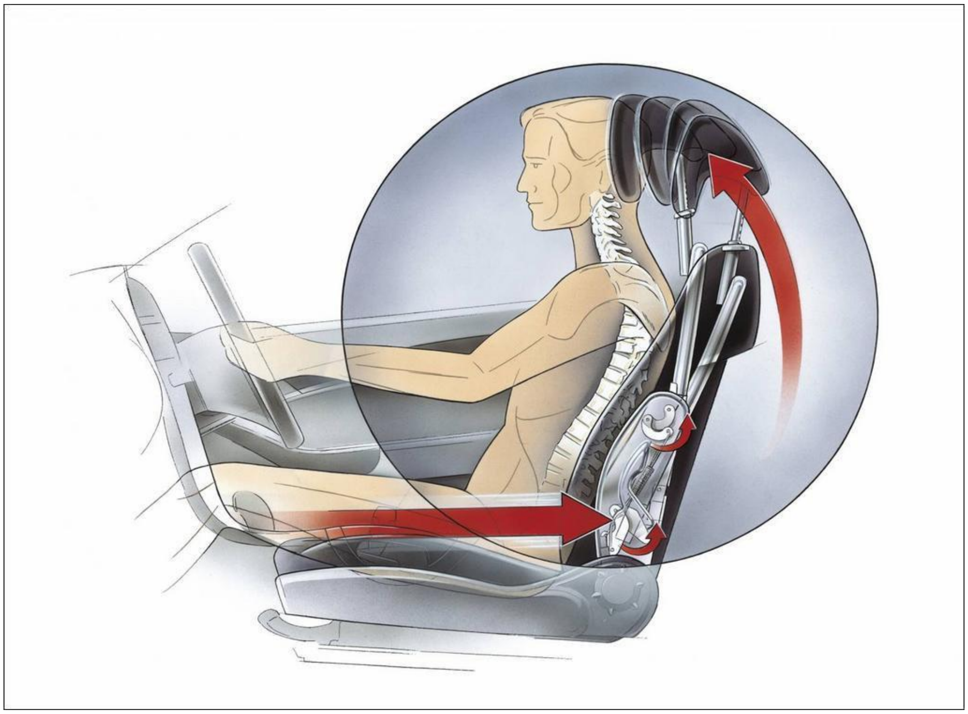


Figure 3.2: Saab Active Head Restraint. Research from the Insurance Institute for Highway Safety (IIHS) has determined that Saab's Active Head Restraint (SAHR) system reduces neck injuries among car occupants by 43 percent.

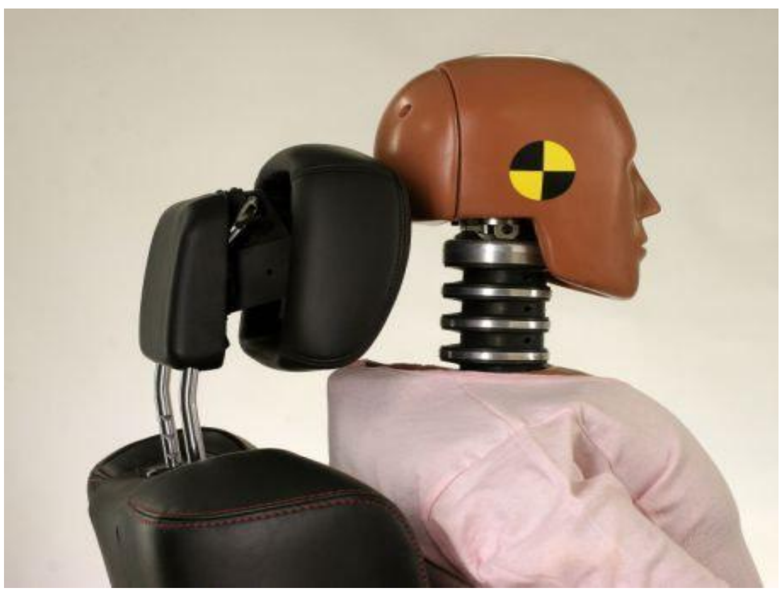


Figure 3.3: TRW Active Head Restraint

TRW's active head restraint triggers in less than 10 ms. It moves forward during accidents to better stabilize the passenger's head. When the head hits the module, and tries to push it back, the mechanism locks into position, much like locking a seatbelt in place.

3.2 Airbags

3.2.1 What are airbags?

Airbags are cushions built into a vehicle that protect occupants from hitting the vehicle interior or objects outside the vehicle (for example, other vehicles or trees) during a collision. The instant a crash begins, sensors start to measure impact severity. If the crash is severe enough (at or above the airbag deployment threshold), the sensors signal inflators to fill the bags with gas. The bags fill in a fraction of a second to cushion occupants. Occupant protection is maximized when safety belts are used in conjunction with airbags. [20]

3.2.2 Frontal airbags

The frontal airbag for the driver is stowed in the steering wheel. The frontal airbag for the front passenger is stored in the instrument panel. In serious frontal crashes, the occupants inside the vehicle do not stop immediately, but continue moving forward. Frontal airbags are designed to work with lap/shoulder belts to protect the heads and chests of occupants from hitting the steering wheel, instrument panel, or windshield. If occupants strike these surfaces hard, they can sustain serious or fatal injuries.

3.2.3 Knee airbags

Some manufacturers provide knee airbags, mounted in the lower instrument panel. Knee airbags distribute impact forces to reduce leg injuries. They also help reduce forces on an occupant's chest and abdomen by controlling occupant movement.

3.2.4 Side airbags

Side airbags are usually smaller than frontal airbags and deploy from the vehicle seatback, door, or roof to protect front- and sometimes rear-seat occupants. Side airbags are important in side impacts where a properly belted occupant can still be struck by an intruding vehicle or object coming from the side. Side airbags that offer head protection are particularly important because they may be the only thing between an occupant's head and the front of a vehicle, a tree or other object, or the ground in the event of a rollover. Airbag systems that protect both the head and torso provide optimal protection.

Head protecting airbags may extend into the rear seating area. Rear seats may also have side airbags separate from those in the front seat.

3.2.5 Advanced Air Bags

Front air bags, for the driver and right-front passenger, mainly provide protection against head contact with the steering wheel and dashboard. They are designed as supplementary restraint systems (SRS), meaning that the protection they provide is in addition to that offered by the use of a regular lap-and-shoulder seat belt. Advanced systems feature sophisticated sensors and multi-stage inflators to better tailor the deployment characteristics to the requirements of specific occupants.

Fig.3.4 (a)Frontal dual airbag system (b)Side airbags to protect the head or head and torso

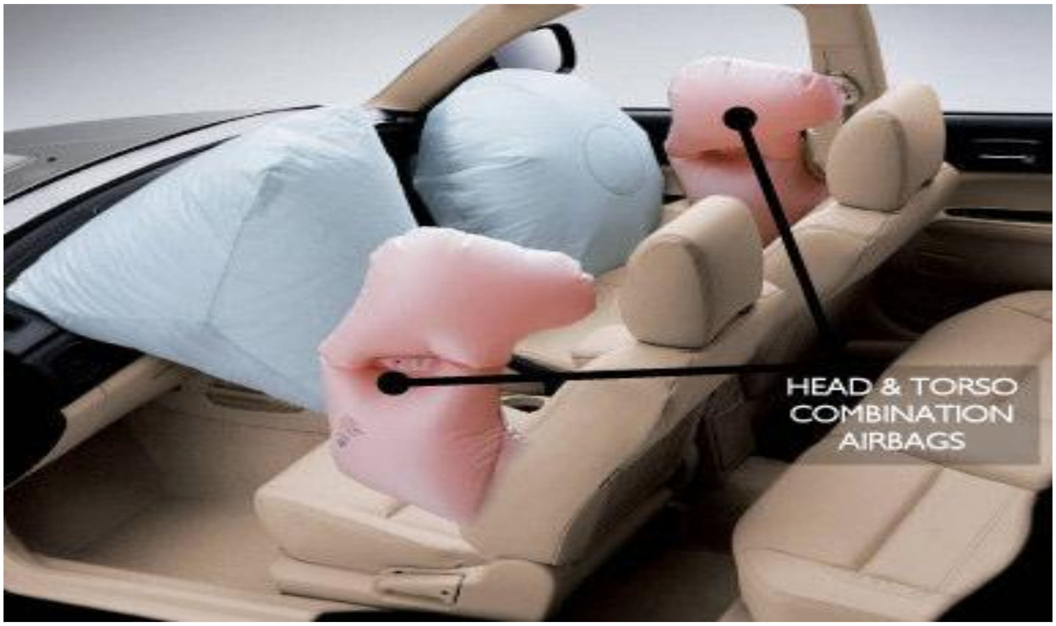


Fig 3.5 Head and torso combination airbag

3.2.6 When do airbags deploy?

Airbags are designed to deploy only when they might be needed to prevent serious injury. In order for airbags to be effective they must deploy early in a crash; in a frontal crash this typically occurs within the first 50 milliseconds (0.05 seconds). A vehicle's airbag control module relies on feedback from crash sensors to predict whether an event is severe enough to warrant an airbag deployment.

Frontal airbags: Frontal airbags are designed to inflate in moderate to severe frontal crashes. One threshold used by airbag designers is "must deploy" which includes a situation such as an impact into a rigid wall of 16-20 kmph for unbelted occupants. The "must deploy" threshold is slightly higher — about 26 kmph — for belted occupants because the belts alone are likely to provide adequate protection up to these moderate speeds. New "advanced" airbags are designed to suppress deployment if weight sensors in the seat detect that a front-seat passenger is small or in a child safety seat. Advanced airbags also can deploy at a lower energy level or pressure when passengers are small or out of position, or if the crash is of very low severity.

Side airbags: Because of the small space between an occupant and the side of the vehicle, side airbags must deploy very quickly to cushion occupants from intruding vehicles or objects. Some airbags typically deploy within the first 10-20 milliseconds of a side crash. "Must deploy" thresholds can be as low as 13 kmph for narrow object crashes (i.e. trees and poles) and 29 kmph for the more distributed side crashes (vehicle-to-vehicle crashes). Several auto manufacturers deploy the side airbags in frontal crashes to help control occupant movement during the rebound phase of a crash. Some curtain side airbags may stay inflated longer to protect occupants in rollover crashes. Allowing the airbags to remain inflated or triggering their deployment during a rollover can help prevent full or partial ejection of occupants.

Figure 3.6: Vehicle Crash Test. Cabin damage resulting from a pole test at 29km/h. (Image supplied by Crash lab.)

3.2.7 Can airbags injure people?

Frontal airbags: Yes. Occasionally, the energy required to quickly inflate frontal airbags can cause injury. Fortunately, most of these injuries are minor scrapes and abrasions. Serious injuries and deaths are relatively rare. To prevent injuries, it is recommended that drivers sit with their chests at least 10 inches away from the center of the steering wheel.

Figure 3.7: Rear-facing child restraints movement during airbag opening.

Rear-facing child restraints SHOULD NOT be used in the front seat with a passenger airbag. The forces of the inflating airbag against the back of the restraint can cause serious, even fatal, head injuries.

Side airbags: Like frontal airbags, side airbags have the potential to cause injury. However, side airbags typically are smaller and deploy with less energy than frontal airbags.

3.3 Crash Resistant Door Pillars

Auto manufacturers have introduced this safety feature to deflect the force of a side-impact collision away from the head area and toward the legs. This is achieved by keeping the top portion of the vehicle's side post more rigid and allowing the lower portion to move inward.

3.4 Crumple Zones

Crumple zones are one of the most underrated safety features in modern vehicles. Automotive Engineers have designed the body parts of a vehicle to crumple in predetermined patterns to absorb the energy from a crash's impact and maintain the integrity of the passenger compartment, keeping the driver and passengers safer.

3.5 Seat Belt Pretensions

A properly used seat belt fits snugly over the pelvis and across the chest. In a crash, the seat belt retractor locks and the webbing prevents the occupant from moving into contact with hard portions of the vehicle's interior, thus reducing the potential for injury. In order to obtain optimal protection, the seat belt needs to firmly engage the occupant's body across strong anatomical structures such as the bony pelvis and the rib cage. This process also needs to occur early in the crash in order to couple the occupant to the decelerating vehicle and provide the greatest amount of ride down. Any slack in the seat belt works against this process and pretensioning systems are used to eliminate small amounts of slack immediately a crash occurs.

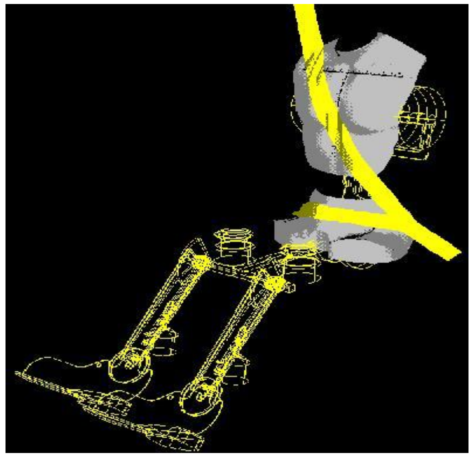


Figure 3.8: The Revolutionary Three Point Seat Belt

3.5.1 How do they work?

Seat belt pretensioners are typically pyrotechnic devices. They are triggered by the same crash sensors that are used to determine the need to deploy the vehicle's air bags. In minor collisions, the seat belt pretensioners may be fired without the air bags being deployed. In more serious crashes both the pretensioners and the air bags will be deployed.

Where pretensioning is applied to the lap belt, the pyrotechnic device usually forms part of the buckle assembly. A steel cable links the seat belt's buckle to a piston that can move along a steel tube. When the pyrotechnic charge is ignited, gas is produced very rapidly and this propels the piston down the tube. The steel cable attached to the piston pulls down on the seat belt buckle and eliminates any slack in the belt system.

The pretensioning forces are not so high as to cause any injury to the belted occupant; however, neither will they remove large amounts of slack. It is important, therefore, that occupants ensure that the lap and shoulder belts are properly position and adjusted so as to be snug.

Figure 3.9: TRW's Active Control Retractor (ACR) unit takes the slack off the seatbelt moving the passenger into a safer crash position (left pic). During the collision or rollover, the ACR unit remains activated, keeping the passenger in a safe position (right pic).

CHAPTER 4
SAFETY TRENDS

Safety trends

Despite technological advances, about 33,000 people die every year in the U.S. Although the fatality rates per vehicle registered and per vehicle distance travelled have steadily decreased since the advent of significant vehicle and driver regulation, the raw number of fatalities generally increases as a function of rising population and more vehicles on the road. However, sharp rises in the price of fuel and related driver behavioral changes are reducing 2007-8 highway fatalities in the U.S. to below the 1961 fatality count. Litigation has been central in the struggle to mandate safer cars.[53]

International comparison

In 1996, the U.S. had about 2 deaths per 10,000 motor vehicles, compared to 1.9 in Germany, 2.6 in France, and 1.5 in the UK. In 1998, there were 3,421 fatal crashes in the UK, the fewest since 1926; in 2010 this number was further reduced to 1,857 and was attributed to the 2009–2010 scrappage scheme.

The sizable traffic safety lead enjoyed by the USA since the 1960s had narrowed significantly by 2002, with the US improvement percentages lagging in 16th place behind thoseof Australia, Austria, Canada, Denmark, Finland, Germany, United Kingdom, Iceland, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Sweden, and Switzerland in terms of deaths per thousand vehicles, while in terms of deaths per 100 million vehicle miles travelled, the USA had dropped from first place to tenth place.

NHTSA has issued relatively few regulations since the mid-1980s; most of the vehicle-based reduction in vehicle fatality rates in the U.S. during the last third of the 20th Century were gained by the initial NHTSA safety standards issued from 1968 to 1984 and subsequent voluntary changes in vehicle design and construction by vehicle manufacturers.

Government-collected data, such as that from the U.S. Fatality Analysis Reporting System, show other countries achieving safety performance improvements over time greater than those achieved in the U.S.:

	1979 Fatalities	2002 Fatalities	Percent Change
United States	51,093	42,815	-16.2%
United Kingdom	6,352	3,431	-46.0%
Canada	5,863	2,936	-49.9%
Australia	3,508	1,715	-51.1%

Research on the trends in use of heavy vehicles indicate that a significant difference between the U.S. and other countries is the relatively high prevalence of pickup trucks and SUVs in the U.S. A 2003 study by the U.S. Transportation Research Board found that SUVs and pickup trucks are significantly less safe than passenger cars, that imported-brand vehicles tend to be safer than American-brand vehicles, and that the size and weight of a vehicle has a significantly smaller effect on safety than the quality of the vehicle's engineering. The level of large commercial truck traffic has substantially increased since the 1960s, while highway capacity has not kept pace with the increase in large commercial truck traffic on U.S. highways. However, other factors exert significant influence; Canada has lower roadway death and injury rates despite a vehicle mix comparable to that of the U.S. Nevertheless, the widespread use of truck-based vehicles as passenger carriers is correlated with roadway deaths and injuries not only directly by dint of vehicular safety performance per se, but also indirectly through the relatively low fuel costs that facilitate the use of such vehicles in North America; motor vehicle fatalities decline as fuel prices increase.

4.1 Issues for particular demographic groups

4.1.1Pregnant women

When pregnant, women should continue to use seatbelts and airbags properly. A University of Michigan study found that "unrestrained or improperly restrained pregnant women are

5.7 times more likely to have an adverse fetal outcome than properly restrained pregnant women". If seatbelts are not long enough, extensions are available from the car manufacturer or an aftermarket supplier then.

4.1.2 Infants and children

Children present significant challenges in engineering and producing safe vehicles, because most children are significantly smaller and lighter than most adults. Safety devices and systems designed and optimized to protect adults — particularly calibration-sensitive devices like airbags and active seat belts — can be ineffective or hazardous to children. In recognition of this, many medical professionals and jurisdictions recommend or require that children under a particular age, height, and/or weight ride in a child seat and or in the back seat, as applicable. In Sweden, for instance, a child or an adult shorter than 140 cm is legally forbidden to ride in a place with an active airbag in front of it.

As another example in Austria the driver of passenger vehicles is responsible for people shorter than 150 cm and below 14 years to be seated in an adequate child safety seat. Moreover, it is not allowed for children below the age of 3 to ride in a passenger vehicle without "security system" (which in practice means the vehicle is not equipped with any seat belts or technical systems like Isofix), whereas children between 3 and 14 years have to ride in the back seat.

Child safety locks and driver-controlled power window lockout controls prevent children from opening doors and windows from inside the vehicle.

4.1.3 Infants left in cars

Very young children can perish from heat or cold if left unattended in a parked car, whether deliberately or through absentmindedness. In 2004 the U.S. NHTSA estimated 25 fatalities per year among children left in hot cars.

4.1.4Teenage drivers

In the UK, a full driving license can be had at age 17, and most areas in the United States will issue a full driver's license at the age of 16, and all within a range between 14 and 18. In addition to being relatively inexperienced, teen drivers are also cognitively immature, compared to other drivers. This combination leads to a relatively high crash rate among this demographic.

In some areas, new drivers' vehicles must bear a warning sign to alert other drivers that the vehicle is being driven by an inexperienced and learning driver, giving them opportunity to be more cautious and to encourage other drivers to give novices more leeway. In the U.S., New Jersey has Kyleigh's Law citing that teen drivers must have a decal on their vehicle.

Some countries, such as Australia, the United States, Canada, Talha town, and New Zealand, have graduated levels of driver's license, with special rules. By 2010, all US states required a graduated driver's license for drivers under age 18. In Italy, the maximum speed and power of vehicles driven by new drivers is restricted. In Romania, the maximum speed of vehicles driven by new drivers (less than one year in experience) is 20 km/h lower than the national standard (except villages, towns and cities). Many U.S. states allow 18-year-olds to skip some requirements that younger drivers would face, which statistics show may be causing higher crash rates among new drivers. New Jersey has the same requirements for new drivers up to the age of 21, which may obviate this problem.

4.1.5Elderly

Insurance statistics in the United States indicate a 30% increase in the number of elderly killed, comparing 1975 to 2000. Several states require additional testing for elderly drivers. The overall trend may be due to greater experience and avoiding driving in adverse conditions. However, on a per-miles-travelled basis, drivers younger than 25-30 and older than 65-70 have significantly higher crash rates.

A common problem for the elderly is the question of when a medical condition or biological aging presents a serious enough problem that one should stop driving. In some cases, this means giving up some personal independence, but in urban areas often means relying more on public transportation. Many transit systems offer discounted fares to seniors, and some local governments run "senior shuttles" specifically targeted at this demographic.

4.2 Vehicle Safety Technology

Vehicle Safety Technology (VST) in the automotive industry refers to special technology (Advanced driver assistance systems) developed to ensure the safety and security of automobiles and passengers. The term encompasses a broad umbrella of projects and devices within the automotive world. Notable examples include car-to-computer communication devices which utilize GPS tracking features, geo-fencing capabilities, remote speed sensing, theft deterrence, damage mitigation, and vehicle-to-vehicle communication.

The field of Road safety is handicapped by the terminology. Words have power to them that conveys impressions as well as meanings, phenomena that in this case results in sub-optimal approaches to prevention, as follows:

4.3 Road safety

The name “Road safety” have conveyed that in this field the activities need to concentrate on items that properly belong to roads and, by extension, to the roads authorities, keeping a reduced scope of activities in a number of different areas, in spite of their potentially significant contributions. For example, in the UK, Burrough, (1991) indicates that only one-third of the target reduction will be delivered by road safety engineering measures while Koornstra (2002) indicates “The contribution of local road engineering to the fatality reductions between 1980 and 2000 are estimated to be 4% for Sweden, 10% for Britain, and 5% for the Netherlands”. Whereas TEC (2003), quotes a research from the Imperial College, London that indicates than the progress in medical technology and care made a significant contribution to the 45% fall of fatalities during the last 20 years, and account for 700 lives saved annually in the UK, and further puts forward that the lack of consideration of the benefits coming from the medical area, suggests that road safety is probably less effective that thought. It is remarkable that implicitly the author of the research doesn't consider medical activities as a component of a road safety management system.

It reflects confusion between the space where this phenomenon occurs (mainly roads) and the design of the Management systems to control it, in what "Roads" is only a 11% of the activities (one area out of nine in previous table).

4.4Accident

the use of the word "accident" with its connotations of being and unavoidable event, weaken the resolve to intervene in order to reduce crashes and the resulting harm. Evans (1991) argues that the word "crash" indicates in a simple factual way what is observed, while "Accident" seems to suggest in addition a general explanation of why it occurred.

4.4.1 Cause of accidents

Road safety recognizes that crashes, and their consequences, are multifactor events, Ogden (1996) indicates: "An approach based in notions of cause and blame is simplistic in the extreme". In short, crashes have **factors** not **causes**.

CONCLUSION

Problem-solving

Old approaches emphasize the concept of **problem-solving** in Road safety, but it is more correct to recognize that Road safety activities doesn’t solve problems. For instance, when a safer road design is implemented, hopefully the number of crashes, or their seriousness, will go down, but they will not disappear. It is more correct to say the implementation of correct policies, programs and measures will reduce numbers or consequences of crashes, but they will not be ´´solved´´.

This realization is important, because it changes the focus from a problem that will go away if we devote enough resources to it, to a situation requiring on-going management. This management in turn requires the development of scientifically based techniques, which will enable us to predict with confidence that safety resources are well-spent and likely to be effective.

REFERENCES

1 Insurance Institute for Highway Safety, 1998. *New Study of Relationships b/w vehicle weight and occupant death rates,*

http://www.iihs.org/news/1998/iihs_news_021098.pdf, accessed on 17 March 2009.

2 How Stuff Works, 2009, *Stability Control*, http://auto.howstuffworks.com/28001-stability-control.htm, accessed on 17 March 2009.

3 Insurance Institute for Highway Safety, 2009. *Electronic Stability Control (ESC)*, http://www.iihs.org/research/qanda/esc.html, accessed on 17 March 2009.

4 Insurance Institute for Highway Safety, 2009. *Antilock Brakes,* http://www.iihs.org/research/qanda/antilock.html, accessed on 17 March 2009.

5 Highway Loss Data Institute, 2008. *Motorcycle antilock braking system (ABS)*, HLDI Bulletin Vol. 25, No. 1. Teoh, Eric R., 2008. *Effectiveness of antilock braking system in reducing fatal motorcycle crashes. Arlington*, VA: Insurance Institute for Highway Safety