PEDESTRIAN PROTECTION SYSTEMS

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Abstract: *Pedestrians are the most vulnerable group of participants in traffic, who, in collision with motor vehicles, most often suffer severe bodily injuries, and sometimes even fatal. The contemporary automobile industry is making great efforts to develop active and passive protection systems for all participants in traffic, including pedestrians. Protection of pedestrians is attempted to be achieved by modifying shapes of front parts of vehicles, as well as by using plastic materials with higher deformation potential that would, when impacting the body of a pedestrian, expend most of the impact energy on their energy on its deformation and by that spare the gentle biological tissue of pedestrians in the maximum possible way. Instead of protruding, rigid metal structures of insignificant elasticity and potential for deformation, cars today have suitable shaped bodies, have highly elastic material with contact surfaces are capable of high deformity, specially shaped and integrated fenders, elastic and raised motor bonnets, headlights integrated into the contour of the front end of the vehicle, capable of absorbing a part of impact energy, as well as other details. Contemporary researches show some efficiency of these improvements on modern cars. Most of these studies are experimental in strictly controlled conditions, on mannequins, often ordered and financed by rich automobile corporations, while there is less research in real conditions in the field. Lately there are experiments with testing active bonnets and models of gluing pedestrian's body. headlights integrated into the contour of the front end of the vehicle, capable of absorbing part of the impact energy, as well as other details. Contemporary researches show some efficiency of these improvements on modern cars. Most of these studies are experimental in strictly controlled conditions, on mannequins, often ordered and financed by rich automobile corporations, while there is less research in real conditions in the field. Lately there are experiments with testing active bonnets and models of gluing pedestrian's body. headlights integrated into the contour of the front end of the vehicle, capable of absorbing part of the impact energy, as well as other details. Contemporary researches show some efficiency of these improvements on modern cars. Most of these studies are experimental in strictly controlled conditions, on mannequins, often ordered and financed by rich automobile corporations, while there is less research in real conditions in the field. Lately there are experiments with testing active bonnets and models of gluing pedestrian's body. often ordered and financed by rich automobile corporations, while there is less research in real conditions in the field. Lately there are experiments with testing active bonnets and models of gluing pedestrian's body. often ordered and financed by rich automobile corporations, while there is less research in real conditions in the field. Lately there are experiments with testing active bonnets and models of gluing pedestrian's body.*

Key words: *safety, pedestrian, vehicle, bonnet*

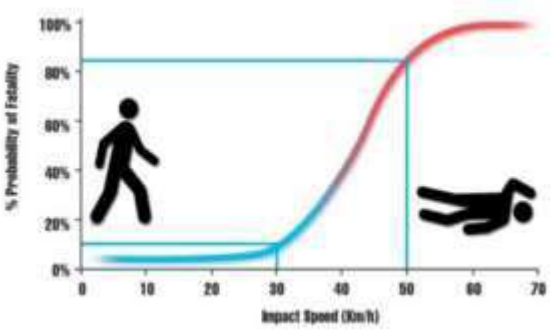
1. INTRODUCTION

How in order to get a clearer insight into the consequences of traffic accidents in which pedestrians are involved, it is useful to observe them according to the consequences that occur in collision processes. Pedestrian injuries are determined in forensic proceedings. The severity of a pedestrian injury depends on several factors, such as the shape of the vehicle with which the pedestrian's body came in contact, vehicle weight and speed at the time of impact, height, weight and position of the pedestrian's center of gravity, characteristics of the pedestrian body. There are three types of vehicle collisions with pedestrians: frontal, which can be complete or partial, lateral skirting and running over the body of a pedestrian.

One of the most important factors is the shape of the vehicle front profile, which can be grouped into three basic shapes[40]: wedge, pontoon and box. It is known that preventive detection of pedestrians can prevent a vehicle from crashing into it. In addition to the listed preventive systems that are active, there are also passive safety systems, which are related to mitigating the consequences of a collision if it occurs.

2. INFLUENCE OF SPEED ON PEDESTRIAN SUFFERING

Traffic science, i.e. the profession in Bosnia and Herzegovina has failed to warn of the harmful consequences of prescribed tolerance and impunity for drivers, for speeding. Due to all the above, it is necessary to change the regulations when necessary, based on the conducted analyzes of the statistical sample. Wrong professional attitudes have always been paid for by increasing the number of traffic accident and consequence. When it turns out that certain attitudes have been overcome, they change very quickly in all national legislations. ZOOBS on the roads in Bosnia and Herzegovina[41] has established tolerance to the measured speed of vehicles, in a way that does not penalize the driver if he exceeded the speed limit by 10 km / h. Research[42] shows the harmful consequences of this legal provision. The error tolerance of the measuring device is very small (3km / h for speeds up to 100km / h and 3% for speeds over 100km / h), compared to the 10 km / h value provided by ZOOBS. If the speed of the impact on a pedestrian is 30 km / h, 10% of pedestrians will die, at a speed of 40 km / h about 20% will die, at 50 km / h about 40% of pedestrians will die, and at 60 km / h about 80% will die. If a pedestrian is hit by a vehicle traveling at 80km / h and above, his chances of survival are negligible.



Picture 1. Influence of collision speed on mortality of participants in a traffic accident

[40] [3] Rotim, F. " Expertise of Traffic Accidents ", FPZ 1986.

[41] *The law on the basics of road traffic in Bosnia and Herzegovina, Sl. Glansik BiH, 6/2006.*

[42] [1] Lipovac, K. Basics of traffic safety, Belgrade 2014

3. PEDESTRIAN PROTECTION SYSTEMS

3.1. Car construction

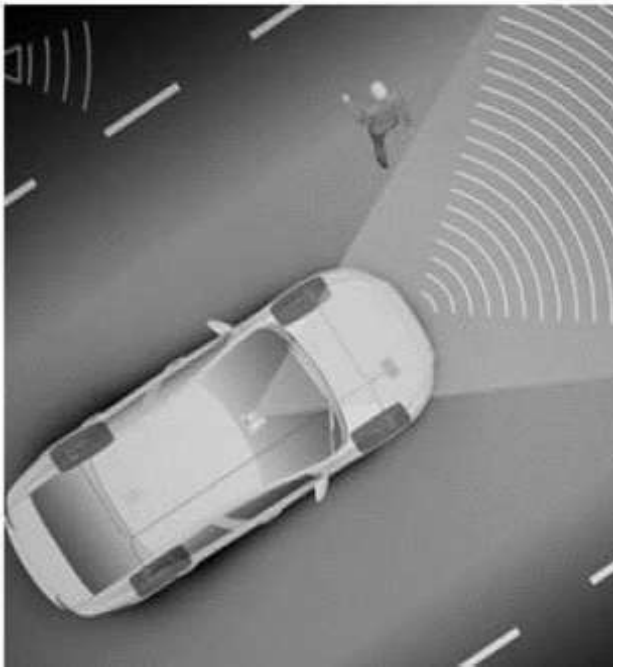
Influence technical improvements of modern cars can affect the reduction of weight to injuries of the lower extremities of pedestrians[43]. Pedestrians collide with motor vehicles in the primary phase usually suffer injuries to the lower extremities. These injuries also have great forensic significance in the process of expertise in a traffic accident in which a pedestrian participated. The modern automotive industry is investing great efforts in the development of active and passive protection systems for all traffic participants, including pedestrians. Pedestrian protection is attempted by changes in the shape of the front parts of the vehicle as well as the use of plastic materials with greater deformation potential that will collide with the body of pedestrians most of the impact energy spent on its deformation and thus save gentle biological tissue of pedestrians. Instead of protruding, rigid metal structures with low elasticity and deformation potential, today's cars are characterized by appropriate body design, use of high elasticity materials and deformation behavior of contact surfaces, specially shaped and integrated bumpers, flexible and raised bonnet, headlights integrated into the contour of the front of the vehicle, capable of absorbing part of the impact energy, as well as other details. These solutions have been serially installed in motor vehicles since the 1990s and are constantly being improved. Contemporary research shows some effectiveness of these improvements on modern cars. Most of these studies are of the experimental type in strictly controlled conditions on puppets, often commissioned and funded by wealthy automobile corporations, while there is less research in real field conditions. The aim is to compare lower extremity injuries in pedestrians injured by modern models compared to pedestrians injured in older car models and to determine whether modern motor vehicles really cause minor trauma to the lower extremities of pedestrians. Observing lower extremity injuries through the prism of the AIS classification, they get a significant difference in lower extremity injuries between the observed groups, to the detriment of injured older car models ($p = 0.034$).

Most of all is an injury that is represented mainly by fractures of the tibia and dislocations of larger joints. The technical improvements of modern cars, which concern changes in the shape and construction of their front parts, really have a protective effect on the lower extremities of pedestrians and reduce their trauma in the event of a car head-on collision with a pedestrian. Confirmation of these results should be sought in future research that would take into account the crash speeds of motor vehicles, but also a more precise description of the appearance of the resulting fractures of the lower extremities. However, these studies are applicable for speeds less than 50km / h.

3.2. Pedestrian detection system

System for pedestrian detection has recently been developed by Volvo. It is based on components of the type: radar, camera, which serve to identify pedestrians when they are in the zone of dangerous traffic situation before the immediate collision of the vehicle (Figure 2).

[43] Nedić, D. '' Influence of technical upgrading modern cars to lower injuries extremities pedestrian '' Institute for Forensic Medicine of the Republic of Srpska, Banja Luka 2014.G.



Picture 2. The principle of operation of the camera and radar in the pedestrian detection system[44]

System operates in several stages and levels, depending on the distance between pedestrians and vehicles at the time of collision. The system identifies the pedestrian in the collision zone, when an audible signal is activated and a red light is reflected in the upper part of the windshield, in order to warn the pedestrian of the occurrence of a dangerous situation. In the event that the driver does not respond to the above warnings, the system will activate the vehicle's brakes, slow down or eventually stop the vehicle. The described pedestrian detection system is able to prevent collisions with pedestrians at speeds less than 40 km / h, while at speeds up to 80 km / h it will reduce the consequences of a traffic accident. The system is set to respond to the response of inappropriate and poor pedestrian detection, and thus strong forced braking, which can cause a new collision, such as a vehicle-to-vehicle collision.

[44] *https: //www.audi-technology-portal.de / de / mobilitaet-der-zukunft / audi-future-lab- mobility / audi-future-engines / praediktiver-effizienzassistent.*

the percentage of pedestrian fatalities caused by frontal collisions by 25% compared to conventional ones.

3.3. Night View - a system for better visibility

System for improved visibility, it is specifically designed for traffic in conditions of poor or night visibility. Statistics show that a significant number of accidents occur in conditions of reduced visibility (night, fog, rain ...). In these conditions, there is an additional danger, since with poor visibility there is a loss or drop in concentration. The lighting system is not efficient enough in the described conditions. The Night View system is functional for traffic conditions in night driving conditions and low visibility conditions.

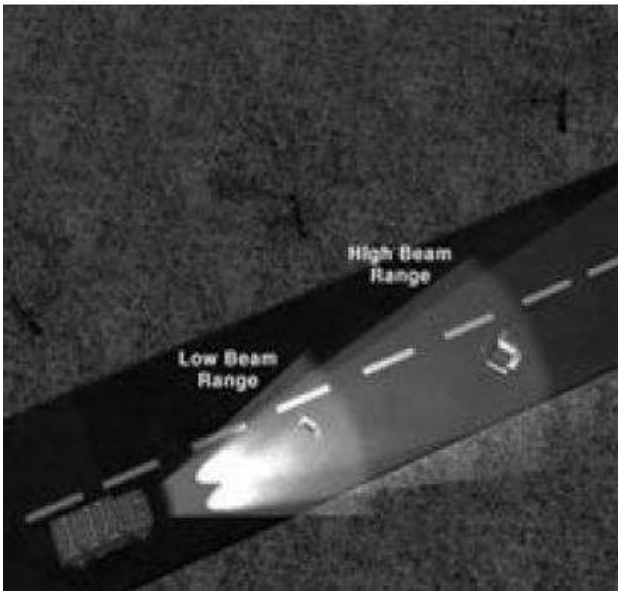
Night system View45 includes two types of equipment:

1. active amplifiers light signal,
2. passive and more complex thermal systems.

Amplifiers light signals belong to the group of active systems, as such functioning as aids such as IR binoculars, cameras and night glasses. They significantly amplify the light with internal optics, in order to amplify the image of the traffic situation in front of the vehicle or driver. Such an amplified light image is reproduced on the LCD in the vehicle itself, so the driver can now see on the display what he had not previously seen clearly in a real situation. The good side of this system is that there must be enough light to get a useful projection. The problem of using this system is related to complete darkness when it becomes completely useless, as well as in conditions of intense fog.

[45] *https: //www.audi-technology-portal.de / de / mobilitaet-der-zukunft / audi-future-lab- mobility / audi-future-engines / praediktiver-effizienzassistent.*

Compared to light amplifiers, thermal analysis systems are more useful and work in the absence of any light. In their work, they use terminal cameras, i.e. they detect IR light emitted by objects that as such can radiate heat. The system consists of a heat detector, an optical component, a screen and a processor. The optical part of the system has the function of collecting IR light at a distance of 300m, which is then analyzed and processed by a heat detector, so that it detects focused wavelength light which is then converted into an image in a specific processor, and finally displayed on the screen. Thermal cameras are located in front of the refrigerator and must be protected from mechanical damage, most often by grilles. This system can function in the dark, but is more expensive than the previously described system (Picture 3).

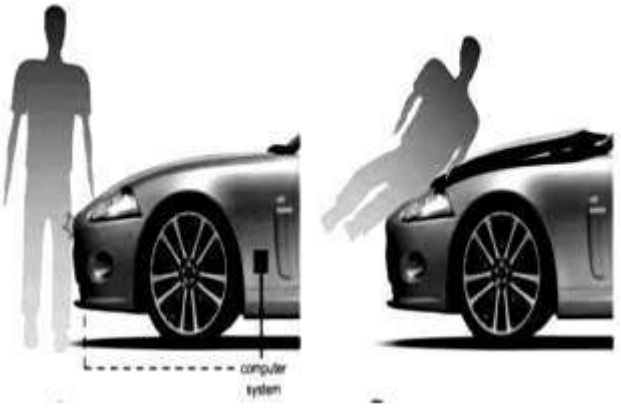


Picture 3. Night View system range[46]

3.4. Active bonnet

The active bonnet belongs to the passive safety systems for the protection of pedestrians only in the case of traffic accidents such as frontal collisions with pedestrians. It works on the principle of automatic and partial lifting of the bonnet, only after the sensor detects a frontal collision with a pedestrian. The system is controlled by sensors built into the front bumper. The cover is raised 65mm to be lifted in 40ms regardless of the strength of the impact.

This one system reduces the risk of injury when in contact with the front of the vehicle. A pedestrian placed on the cover will not come into contact with hard and blunt parts under the cover. The cover is designed to absorb impact energy, so the risk of injury will be reduced, since the pedestrian's head will be protected from contact with the engine. This system is credited to the company Citroen, which presented the innovative active cover technology with its C6 model (Picture 4).



Picture 4. Demonstration of the operation of the active bonnet system in the event of a pedestrian collision[47]

Pedestrian airbag is a very important part of this system (similar to the airbags in a car). They activate in a matter of seconds and open in front of the vehicle's windscreen, closing the pedestrian-airbag contact profile. When activated, the airbag system is filled with gas, then its inflator lifts the bonnet by 10 cm (partially open to keep the front fixed and the rear free). Received distance between the rigid parts in the engine compartment and the bonnet opens a space for the deformation of the bonnet, whose task is to cushion the consequences of the impact on the pedestrian.

[46] *https: //www.audi-technology-portal.de / de / mobilitaet-der-zukunft / audi-future-lab- mobility / audi-future-engines / praediktiver-effizienzassistent.*

[47] *https: //www.audi-technology-portal.de / de / mobilitaet-der-zukunft / audi-future-lab- mobility / audi-future-engines / praediktiver-effizienzassistent.*

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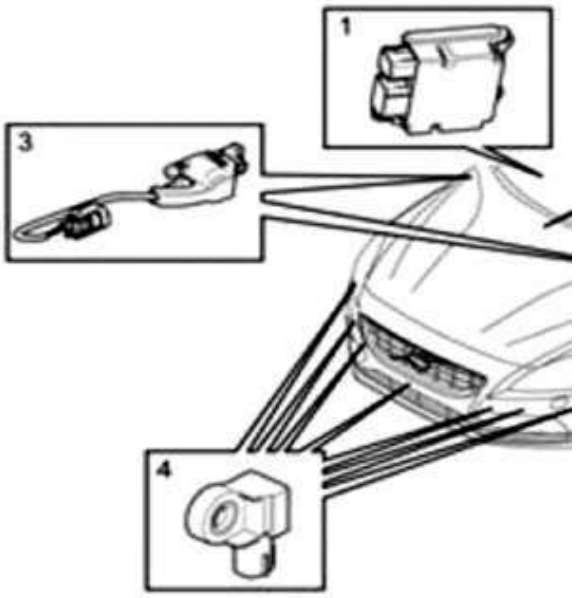
The parts of the pedestrian airbag system are (Picture 5):

1. pedestrian protection module,
2. aerial pedestrian pillow,
3. two discharge drive joints,
4. seven pedestrian sensors.



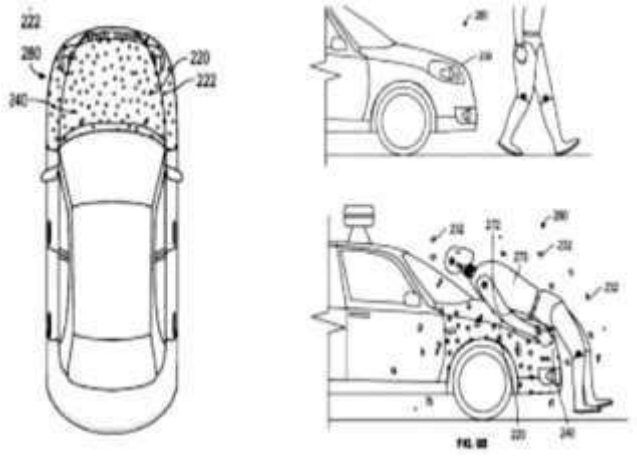
Picture 5. Pedestrian airbag system components[48]

3.5. Google pedestrian gluing patent per vehicle

Previously the described systems have the task of reducing the consequences of the primary impact on pedestrians, but the secondary impact should also be analyzed - into the ground, another vehicle or another pedestrian. Google experts in order to reduce injuries due to the fall of the body of a pedestrian on the road after and due to the reduction of the flight of the body of a pedestrian and the impact on another vehicle, they think on the solution to keep the body of the pedestrian on the vehicle.

In the event of a collision of the pedestrian's body with the vehicle, it is necessary to activate the adhesive coating that should keep the pedestrian's body on the vehicle, then carry it glued to the stopped vehicle. This system needs to be combined with other known pedestrian protection systems. It is designed and programmed as equipment for future smart cars, developed by Google. It should be noted that this system, unlike the previously mentioned, is in an early stage of development, and cannot be developed until Google solves the problem of glue and its current or temporal function and the cessation of the stickiness function of the pedestrian body, which should be separated from the accident. car and give him medical help.

It is an innovation that is based on an adhesive coating whose mass is on the front of the vehicle and which is activated in the event of a collision between a vehicle and a pedestrian or animal. The adhesive coating described by Google vehicles works in the same way as adhesive tapes for catching flies (Picture 6).



Picture 6. Display the adhesive surface on the front of the Google vehicle[49]

[48]*https: //www.audi-technology-portal.de / de / mobilitaet-der-zukunft / audi-future-lab- mobility / audi-future-engines / praediktiver-effizienzassistent.*

[49]*https: //www.audi-technology-portal.de / de / mobilitaet-der-zukunft / audi-future-lab- mobility / audi-future-engines / praediktiver-effizienzassistent.*

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[5] *https://www.audi-technology-portal.de/de/mobilitaet-der-zukunft/audi-future-lab-mobility/audi-future-engines/praediktiver-effizienzassistent*