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REVIEW

Telematics of new vehicles for the purpose of pedestrian safety

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Abstract: Pedestrians are a vulnerable group of traffic users who most often suffer serious physical injuries in collisions with motor vehicles, which very often have a fatal outcome.
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 tried to be achieved by changing the shape of the front parts of the vehicle, by using plastic materials with higher deformation potential which, in collision with the body of the pedestrian, will spend most of the impact energy on its own deformation and thus maximally spare the delicate biological tissue of the pedestrian.
Instead of protruding, rigid metal structures of insignificant elasticity and deformation potential, today's cars are characterized by appropriate body design, use of high elasticity materials and deformation of contact surfaces, specially shaped and integrated bumpers, elastic and raised bonnet, headlights integrated into the contour of the vehicle front which are capable of absorbing part of the impact energy.
Modern research shows a certain efficiency of these improvements on modern cars. Most of these studies are of the experimental type and are done in strictly controlled conditions on dolls, often commissioned and funded by wealthy automobile corporations, while there is less research in real field conditions.
Recently, experiments have been made with testing the active bonnet, the airbag under the bonnet, and the google model of gluing the pedestrian body.

Keywords: safety, pedestrian, vehicle, bonnet.

INTRODUCTION

In order to obtain a clearer insight into the consequences of traffic accidents involving pedestrians, it is necessary to observe them according to the consequences that occur in collision processes. Pedestrian injuries are determined in a forensic procedure. The severity of the pedestrian injury depends on several factors, such as the shape of the vehicle with which the pedestrian's body came into contact, the mass and speed of the vehicle at the time of impact, the height, weight, and position of the pedestrian's center of gravity, the characteristics of the ground on which the body of the pedestrian was thrown after the collision, and the like.

There are three types of vehicle collisions with pedestrians: frontal, which can be complete or partial, lateral impact, and running over the body of a pedestrian.

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

In this paper, we will show the importance of researching new standards of car equipment and its efficiency in the area of speed range in settlements, in the zone of upper limits of maximum allowed speeds in settlements.

THE IMPACT OF SPEED ON PEDESTRIAN CASUALTIES

Traffic science, i.e. the traffic profession in Bosnia and Herzegovina, failed to warn the population of the harmful consequences of the legally prescribed tolerance and impunity for drivers in the event of such speeding. Wrong expert attitudes have always resulted in an increase in the number of traffic accidents and consequences.

When it turns out that certain attitudes have been overcome, they change very quickly in all national legislations.

The Law on Basics of Road Traffic in Bosnia and Herzegovina (ZOOBS)[4] has established tolerance for the measured speed of vehicles by not punishing the driver if he exceeds the speed limit by 10 km/h. Research[2] proves the harmful consequences of this legal provision. The error tolerance of the measuring device is very small (3 km/h for speeds up to 100 km/h and 3% for speeds over 100 km/h) compared to the tolerance of 10 km/h predicted by the ZOOBS.

Research dealing with the speed of cars hitting pedestrians shows[1] that:

- at a speed of 30 km/h, 10% of pedestrians die;
- at a speed of 40 km/h, 20% of pedestrians die;
- at a speed of 50 km/h, 40% of pedestrians die;
- at a speed of 60km/h, about 80% of pedestrians die.

Especially significant is the research of pedestrian casualties in settlements at speeds less than 60 km/h, in frontal collisions, in circumstances related both to active and passive safety systems of new generations of vehicles.

If a pedestrian is hit by a vehicle moving at 80 km/h or more, his chances of survival are negligible.

High collision speeds diminish the benefits of the protection system.

ACTIVE PEDESTRIAN PROTECTION SYSTEMS

Pedestrian detection system

The pedestrian detection system has been well developed by Volvo. It is based on components such as radar and cameras, which serve to identify pedestrians when they are in the zone of dangerous traffic situations before the immediate collision of the vehicle (Figure 1).

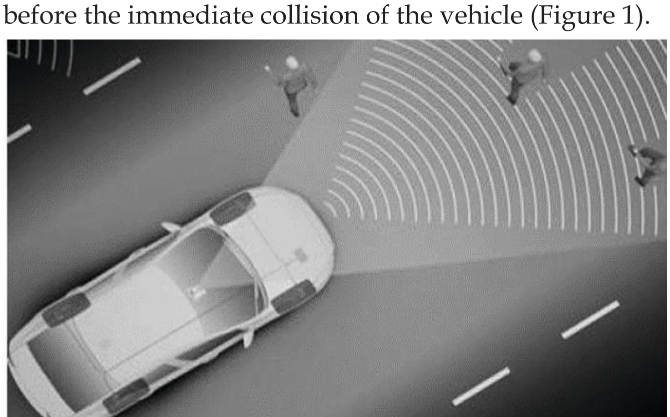

Figure 1. The mode of operation of the camera and radar in the pedestrian detection system[5]

The system operates in several stages and levels depending on the distance between pedestrians and vehicles at the moment of collision. After having identified a pedestrian in the collision zone, an audible signal is activated and a red light is reflected in the upper part of the windscreen in order to warn the pedestrian of a dangerous situation. In the event that the driver does not respond to the above warnings, the system activates the vehicle's brakes, slows down or ultimately stops the vehicle.

The described pedestrian detection system is capable of preventively avoiding a collision with a pedestrian at speeds less than 40 km/h, while at speeds up to 80 km/h it will reduce the consequences of a traffic accident.

If this system were to be part of the equipment in the new vehicles, Volvo estimates that the percentage of pedestrian fatalities caused by a frontal collision could be reduced by 25% compared to conventional ones.

Night View - a system for better visibility

This system for better visibility is specifically designed for traffic in low visibility conditions. In these conditions, there is an additional risk, given that with poor visibility, there may be a loss or drop in concentration. The lighting system is not efficient enough in the described conditions. The Night View system is functional in night driving conditions i.e. in conditions of poor visibility.

The Night View system[5] includes two types of equipment:

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

Light signal amplifiers function 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 sufficiently. Such an amplified light image is reproduced on the LCD in the vehicle itself, so the driver now sees on the display what he did not see clearly before in a real situation. This system works well when there is enough light to obtain 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.

Unlike light amplifiers, thermal analysis systems operate in the absence of any light. In their system, they use thermal 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 300 m, which is then analyzed and processed by a heat detector, so that it detects light of focused wavelength 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 car's radiator and must be protected from mechanical damage, most often by grilles. This system can function in the dark, but it is more expensive than the previously described system (Figure 2).

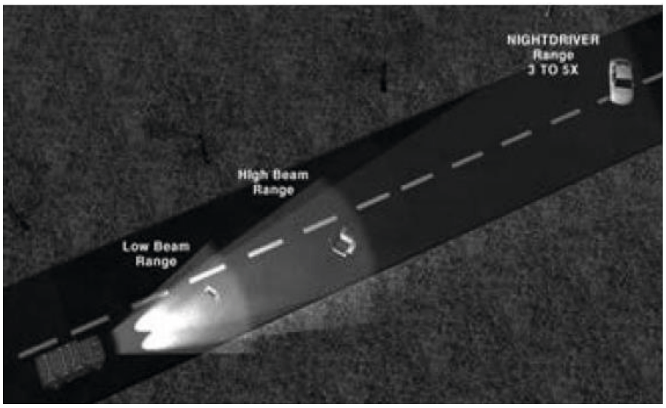

Figure 2. Night View system range [5]

PASSIVE PEDESTRIAN PROTECTION SYSTEMS

Car construction

The impact of technical improvements of modern cars can reduce the severity of injuries to the lower extremities of pedestrians.[3] In collisions with motor vehicles, pedestrians in the first place usually suffer injuries to the lower extremities. 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 tried to be achieved by changing the shape of the front parts of the vehicle, by using plastic materials with higher deformation potential which, in collision with the body of the pedestrian, will spend most of the impact energy on its own deformation and thus maximally spare the delicate biological tissue of the pedestrian. Instead of protruding, rigid metal structures of insignificant elasticity and deformation potential, today's cars are characterized by appropriate body design, use of high elasticity materials and deformation of contact surfaces, specially shaped and integrated bumpers, elastic and raised bonnet, headlights integrated into the contour of the vehicle front which are 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.

Modern research shows a certain efficiency of these improvements on modern cars. Most of these studies are of the experimental type and are done in strictly controlled conditions on dolls, 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 car models compared to pedestrians injured by older car models and to determine whether modern motor vehicles really cause less lower extremity trauma to pedestrians. Observing the injuries of the lower extremities through the prism of the AIS classification, a significant difference was obtained in the injuries of the lower extremities between the observed groups, to the detriment of the injured by older car models (p = 0.034). The most common injuries are fractures of the lower leg bones and dislocations of larger joints.

The technical improvements of modern cars concerning 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 frontal collision with a pedestrian. Confirmation of these results should be sought in future research that would take into account the speed of motor vehicles, but also a more precise description of the resulting fractures of the lower extremities. However, these studies are applicable for speeds less than 50 km/h.

Active bonnet

The active bonnet belongs to the systems of passive pedestrian protection, especially in the case of traffic accidents of a frontal collision with a pedestrian. It works by lifting the bonnet automatically or partially after the sensor detects a frontal collision with a pedestrian. The system is controlled by sensors built into the front bumper. The bonnet is lifted 65 mm in a time of 40 ms regardless of the strength of the impact.

This system reduces the risk of injury when in contact with the frontal part of the vehicle. A pedestrian thrown on the bonnet will not come into contact with hard and blunt parts under the bonnet. The bonnet is designed to absorb impact energy, so the risk of injury will be less since the pedestrian's head will be protected from contact with the engine. This system is credited to the company Citroën, which presented the innovative active bonnet technology with its C6 model (Figure 3).

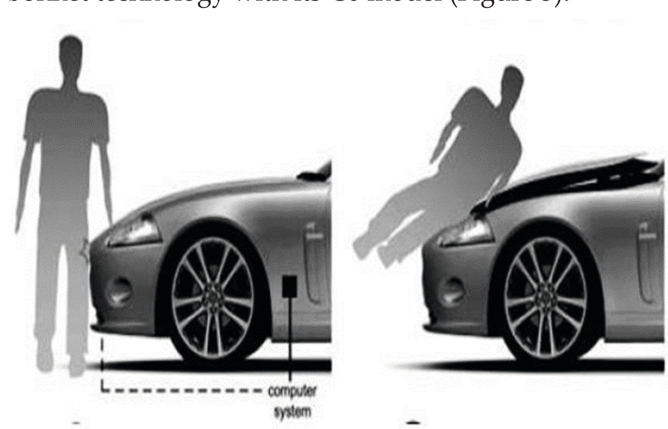

Figure 3. Demonstration of the operation of the active bonnet system in the event of a collision with a pedestrian [5]

Pedestrian airbag

The pedestrian airbag is similar to the airbags found in a car. They are activated in milliseconds and opened in front of the vehicle's windscreen, closing the pedestrian-airbag contact profile. When activated, the airbag system is filled with gas, its inflation raises the bonnet by a height of 10 cm (it is partially opened in order to keep the front fixed and the rear free). The obtained distance between the rigid parts in the engine compartment and the bonnet opens the space for the deformation of the bonnet, whose task is to amortize the consequences of the impact on the pedestrian.

The parts of the pedestrian airbag system are (Figure 4):

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

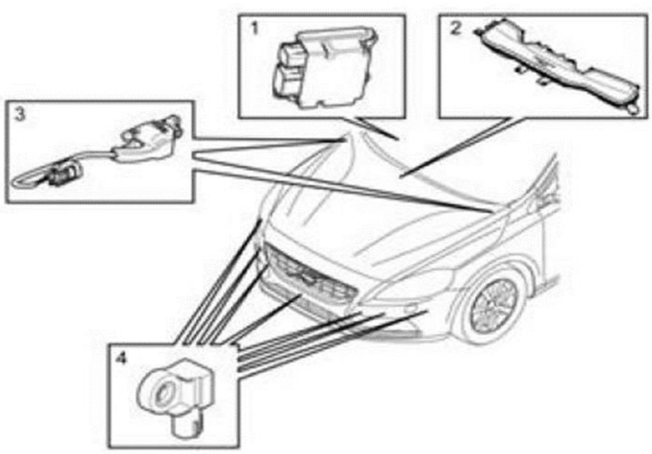

Figure 4. The parts of a pedestrian airbag system[5]

Google patent of gluing pedestrians to a vehicle

The systems described above have the task of reducing the consequences of a primary impact on pedestrians, but a secondary impact to the ground, another vehicle, or another pedestrian should also be analyzed. Google experts are considering a solution to keep the pedestrian's body on the vehicle in order to reduce the injury caused by the pedestrian's body falling to the ground.

In the event of a collision of the pedestrian's body with the vehicle, it is necessary to activate the adhesive coating which should keep the pedestrian's body on the vehicle and continue to carry it glued until the vehicle stops. This system needs to be combined with other known pedestrian protection systems. It is designed 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 i.e. temporal function, as well as the termination of the gluing function, after which the body of the pedestrian should be separated from the car after the accident and given medical assistance [1] .

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. Google's described adhesive coating of the vehicle works in the same way as adhesive tapes for catching flies (Figure 5).

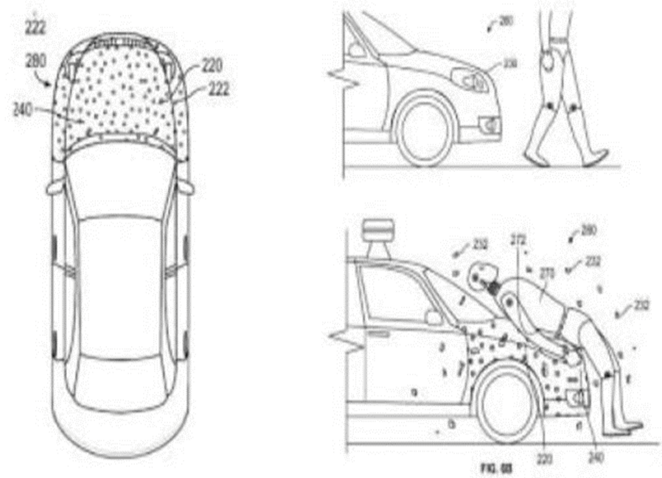

Figure 5. Sticky surface on the front of a Google vehicle [5]

CONCLUSION

Designers of new generations of cars are trying to make effective pedestrian protection systems in traffic where there are the most of them, i.e. in settlements, in zones of speeds less than 60 km/h. The presented active pedestrian safety systems in the form of equipment for pedestrian detection and automatic braking enable the avoidance of collisions with pedestrians at speeds of 40 km/h, and the reduction of consequences at speeds up to 80 km/h.

Night View systems that provide better visibility at night and in reduced visibility conditions also have significant security risk reduction effects. The constructive design of the bumper and the front profile of the vehicle reduces the consequences of collisions of vehicles with pedestrians in the first contact phase of the body with the front part of the vehicle.

Some of the automotive industries are conducting experiments with vehicles colliding with pedestrians.

Experiments with an active bonnet or pedestrian airbag work effectively in the second phase of a vehicle collision with a pedestrian, while the Google patent for gluing pedestrians to a vehicle prevents the consequences of the third phase, prevents the consequences of the third phase, i.e. bouncing the body off the vehicle and falling to and sliding on the ground.

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