POSSIBILITIES TO REDUCE THE HEAD INJURIES OF PEDESTRIANS IN CASE OF TRAFFIC COLLISIONS WITH VEHICLES

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Abstract

In the paper herein we analysed the level of trauma on the head of the pedestrian during collisions with a touring car. The goal is to present some different solutions aiming at reducing the trauma suffered by pedestrians behind the contact with the frontal area of vehicle.

1. GENERALITIES

Traffic safety and vehicle have long been two partners difficult to adjust. In early ages of motorcars development, the designers and engineers paid little attention to dangers occurred together with the new “adventure”. The steering, braking and suspension systems have developed and became of great efficacy; however, these progresses were mainly due to the need to improve the new and revolutionary mean of transport, without taking into account any safety principle in the real sense of the word.

In 1930 the statistics regarding the victims of the “deadly weapon” were without any doubt unfavorable. The number of victims recorded at 100.000 miles covered by motorcars reached in USA 15.6 person as compared to 3.5 in 1980 and 1.8 at present. The figures are decreasing constantly but they should reach lower values so that the society should look at the road transport as a safe mean of transport.

The best and safest mean to survive an accident is very simple, that is not to have that accident. Despite the fact that the driver’s training and instruction are the cheapest and most ideal ways to increase the road safety, unfortunately none of them is really efficient and the objective to create a safer road system stands in the hands of technology.

2. MEASURES AIMING AT REDUCING THE PEDESTRIAN HEAD INJURY

Modifying the frontal part of the vehicle so as to reduce the seriousness of pedestrians’ injuries was not considered as being practical by many specialists. The observations upon the components tested at impact have suggested that there can be made some constructive changes with significant effect on reducing the head injuries.

The hood-fender area generates most of the serious injuries, among all part components tested. Recent demonstrations have showed that this region may be “softened” and made to absorb more energy by reducing the local rigidity of the fender and by providing a distance between the fender surface and apron structure. Some modifications at the fender’s structure have reduced the maximum impact force with 30% below the value measured at a similar vehicle that was not modified.

The fender's rigidity was diminished by combining the interior surface of the perforated fender and by using a Z profile. The distance under the fender's surface was made by replacing the flange from the hood edge and from the apron's upper part. The interior surface was perforated to soften the rigidity. Reducing the injury potential and obtaining HIC values lower than 1000, at 35 kph impact speed of the head, both can be achieved by improving the perforations and by easing the superior apron.

At the rear part of the hood, there was reduced the value of the impact force with 20% by designing a hood that offers a supplementary space of 10 mm between the windscreen cleaners hub and the reinforcement of the traverse at the windshield edge. Figures 1 and 2 shows the head acceleration and the HIC for the impact, with the rear part of the hood. The results show that HIC values below 1000 at 35 kph impact speed are likely to be obtained in the rear part of the hood and for series-manufactured motor vehicles.

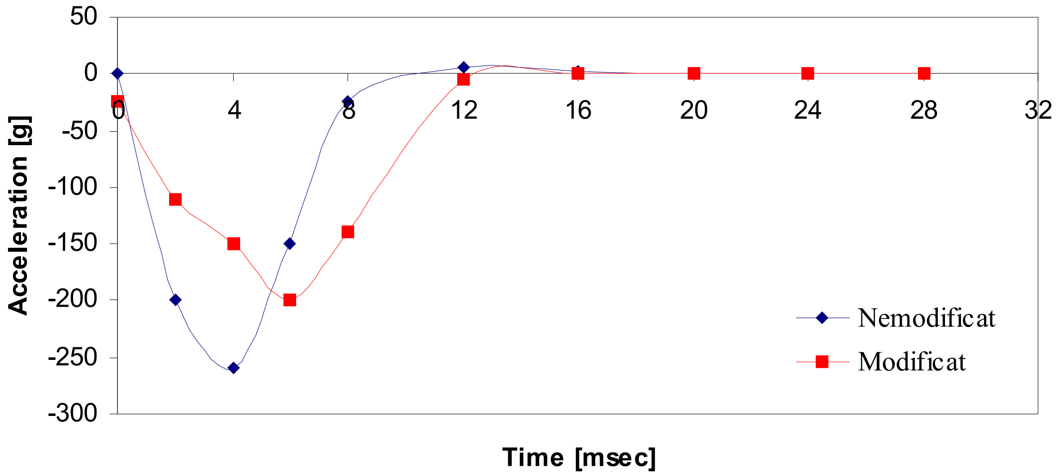

Figure 1. Effect of hood-fender area modification upon the acceleration value at impact

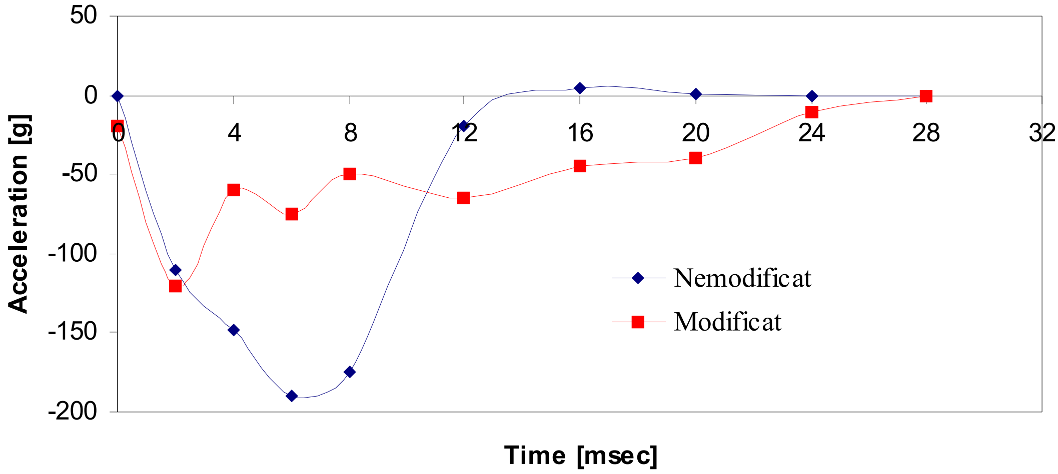

Figure 2. Effect of hood modification upon acceleration at impact

The characteristic areas of the vehicle that affect the impact seriousness comprise the distance between the hood surface and the components in the engine compartment, the material used for hood manufacturing and the reinforcing structure of the hood.

The experimental results suggest that for impact speeds ranging from 35 to 45 km/h, the head must determine dynamic deformations ranging from 58 to 76 mm of the hood surface, in order to maintain the HIC values below 1000. The dynamic deformations may exceed the spaces available under the hood if the engine compartment components are not rigidly mounted. In most cases, these components are rigid and massive as compared to the pedestrian's head and the plate the hood is made of. These observations suggest that the impact of the pedestrian's head with the external frame, that assures a larger distance of 58 mm to the nearest component in the engine compartment, may produce only potential minor injuries.

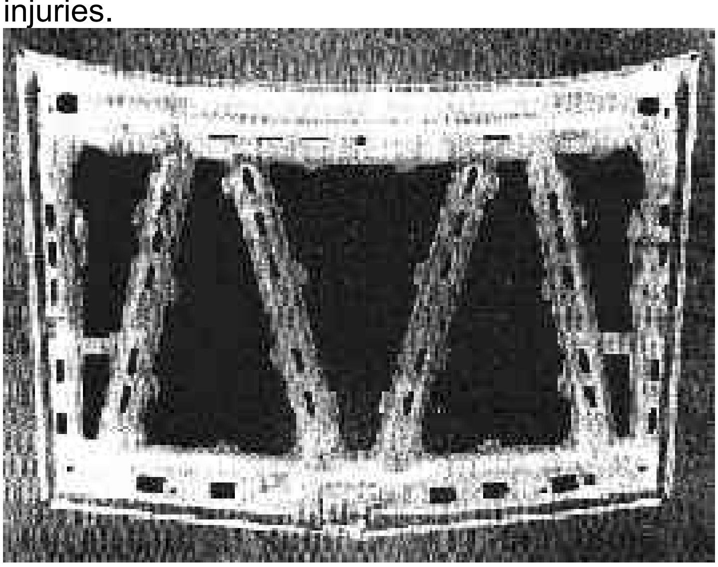

Figure 3. Hood with smooth reinforcing structure

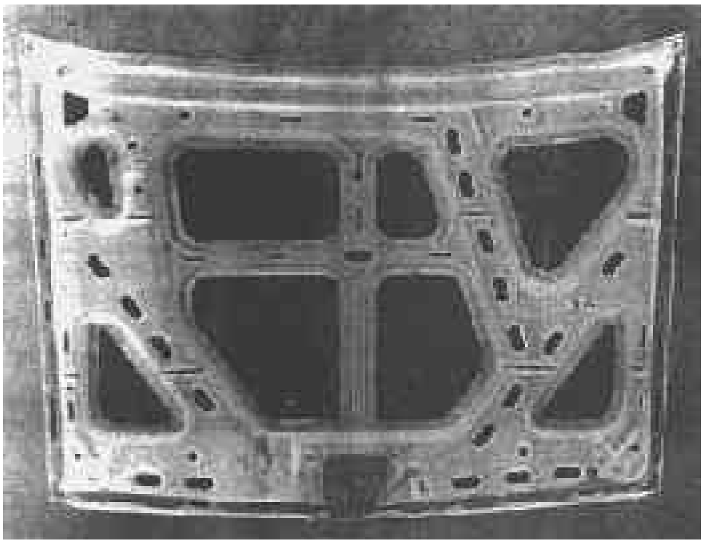

Figure 4. Hood with rigid reinforcing structure

The reinforcing structure of the hood affects, at its turn, the seriousness of the head injury at impact with the hood. The test conducted with two vehicles with almost identical aspect from geometrical point of view and with different reinforcing structures showed that the vehicle with the “strongest” reinforcing structure, Figure 4, caused more serious injuries than the vehicle with the “lightest” reinforcing structure of the hood, Figure 3. Even if the distance under the hood is different at the two vehicles, the performance difference was mainly given to the different reinforcing structure of the hood.

During the last years it was forwarded a new concept aiming at reducing the injuries suffered by pedestrians, especially by diminishing the HIC level. The nowadays motorcars present a dense grouping of components under the hood. Certain rigid parts such as the upper anchorage points of the suspension and the cylinder head are very close positioned to the hood. The consequences are most of the times serious or even fatal.

Starting from these aspects there was developed a protection system in order to reduce the seriousness of head-hood impacts. The system is activated, at the moment of impact, by a sensor placed inside the bumper, at speeds exceeding 20 km/h. The sensor is able to make distinction between objects with different geometries (i.e. another vehicle and the pedestrian’s leg), as well as between objects with different rigidities (i.e. a pole and a leg). Two sensors lift the rear part of the hood with about 100 mm. The transducers were adjusted so as to lift the hood at 60…70 milliseconds after the leg-hood collision, but before producing the impact with the pedestrian’s head. The lifting elements were also conceived to be maintained in the lifted position, during the collision with the body upper part and, at the same time, to absorb the energy so as to unload the head if the impact is produced at the level of the lifting elements.

The system was tested with a dummy head by hitting the hood in different positions at speed up to 50 km/h, but also by the intermediary of a complete frontal part of the vehicle, mounted on a skid, hitting a dummy-pedestrian, Figure 5.

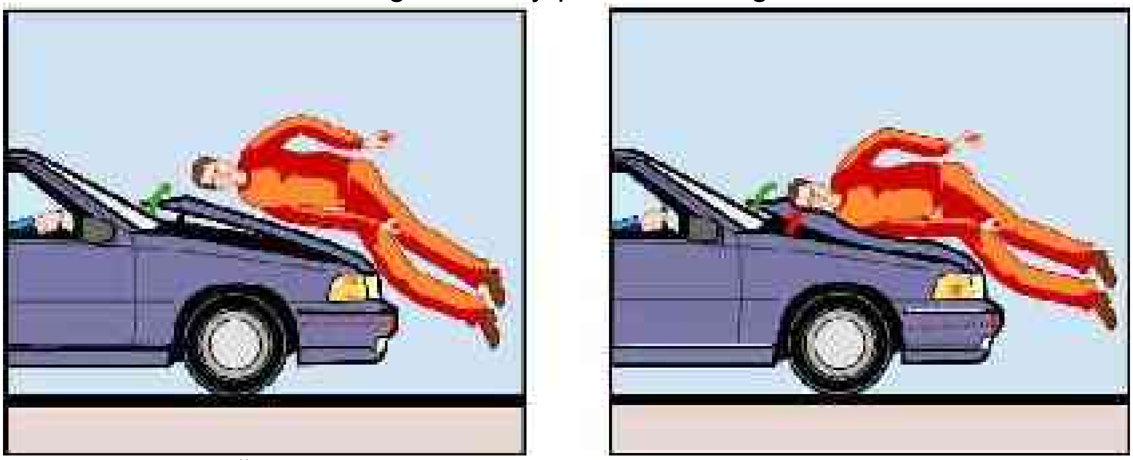

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Figure 5. EuroNCAP test with active hood system

The tests were made in order to test the system’s response time, but also to check if the lifting elements are solid enough to maintain the hood lifted during the collision with the body upper part, till the head hits the hood. The protection system, the active hood, includes two lifting elements that lift up the rear corners of the hood. The lifting elements are made up of pressed metal pleated tubes that are filled up with gas by some micro-generators, in case on an impact.

The advantages are numerous:

The construction does not require consolidations to prevent the gas escapes. Therefore, it is easy to maintain the pressure inside the bellows for a long period of time. This is very important because there can be recorded large variations of impact durations with the head, this depending on the person's size and on the impact speed.

The bellows is insensitive to the collision angle (some lifting devices can absorb energy only if the impact in produced under a perfectly determined angle).

The transducers dimensions may be very undersized. The device height may be shorter than the lifting height, which is impossible in case of a piston device.

Due to the hood limiting form, one of the six points of the Euro-NCAP test was not assessed. It already had a HIC lower value, that is 877. The other five points of the test emphasized lower values of the HIC for the active good, compared with the standard hood, Table 1 and Figure 6.

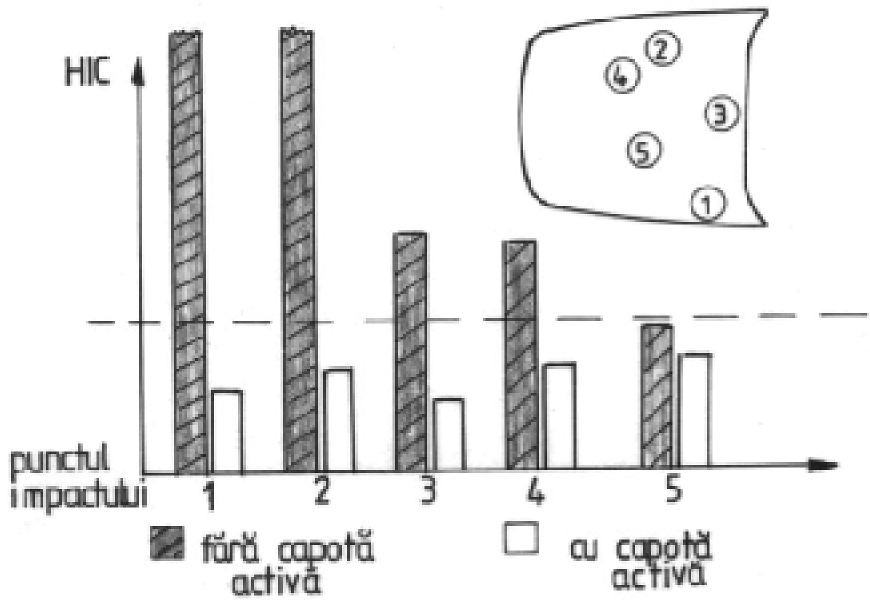

Figure 6. EuroNCAP test to test the active hood at impact with the pedestrian's head

Table 1. tests with the dummy's head; comparison between the active hood and the standard hood (40 km/h).

Punct	**HIC** **Standard**	**Activă**	**Reducerea**
1	3257	648	-80 %
2	7056	735	-90 %
3	1486	525	-65 %
4	1438	753	-48 %
5	953	778	-18 %

In all tests conducted with the active hood, the values of the HIC coefficient were recorded within the threshold value of 1000. HIC highest value for the active hood was of 778, as compared to the standard hood, were the HIC values ranged within the interval (953, 7056). Reducing the HIC values oscillated from 18% to 90%, where he highest values for the standard hood were mostly reduced. At the same time the test conducted in the lifting point obtained HIC values under the threshold of 1000, that is 774.

The reference tests with the dummy cranium, conducted at 50 km/h, emphasized the HIC extremely high value for the standard hood, that is 16497. This value should have been the highest, because the acceleration in one direction exceeded the accelerometer's maximum indication. In exchange, for the active hood there was obtained a HIC value of 1213, which represents less than a tenth of the value obtained with the standard hood.

3. CONCLUSIONS

The head may be protected if there are followed two general conditions:
- The kinetic energy of the head is to be reduced during the impact;
- The force developed is to be less than the one necessary to produce relative motions between the head component parts.

These conditions may be reached by:
- Increasing the contact surface between the pedestrian head and the parts of the vehicle it comes into contact with;
- Equalizing the contact force;
- Minimizing the head hitting force with the vehicle.

The protection system addressing pedestrians proved to be efficient for an adult. The active hood was able to activate fast and to maintain the HIC at values below 1000 at all test points at a speed of 40 km/h. at the same time, at 50 km/h, there was obtained an important HIC decrease.

The dummies test showed that the active system developed well under various conditions similar to real life (the shoulder has the impact time lower that the head's).

REFERENCES

1. Nahum, A.M., Melvin, J.W., Accidental Injury, ed. Springer – Verlag, 1996.
2. Neathery, R. F., Lobdell, T. E., Mechanical Simulation of human Thorax Under Impact, SAE – Technical Paper No 730982, 1973.
3. Şoica, A., Cercetări privind modelarea impactului autoturism – pieton, Teza de doctorat, Braşov, 2002.
4. Şoica, A., Florea, D.: Measures undertaken in order to reduce injuries at touring car – pedestrians collisions, The 10th International Congress, CONAT 2004, Automotive and future technologies, Brasov, 20-22 october, 2004.
5. Tănase, Gh., Cercetări teoretice şi experimentale privind optimizarea structurii față în ceea ce priveşte siguranța pasivă a automobilului, teza de doctorat, Braşov, 2003.
6. www.autoliv.com