UDC 629.29.00 DOI: 10.30977/AT.2219-8342.2023.53.0.01

Analysis of the mechanism of side impact of cars

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Annotation. Problem. *Globally, car crashes are the major cause of death, killing 1.2 million people, and despite improvements in car safety, forecasts indicate that car crash deaths will increase significantly by 2030 due to the increase in the number of cars. Such a trend requires an increase in passive safety in the design of cars. It is also necessary to consider with these factors the most popular segments of SUV cars, which during an accident create more dangerous consequences in the event of a side impact, taking into account the mass and dimensions parameters.* ***Goal.*** *The aim is to* ***c****onduct an analysis of the side collision mechanism of cars of different mass and dimensional parameters. Taking into account the trends in the sale of cars, identifying the most popular classes of cars in Ukraine both on the new car market and on the second-hand market, to further identify problems in testing cars according to various certification protocols.* ***Methodology.*** *The approaches to solving the tasks used in the work are based on the use of statistical data and comparative analysis of various methodologies and certification protocols.* ***Results.*** *Considering that scientific studies of frontal impact are presented by the scientific community in the broadest form, the study of the side impact of two cars is currently a relevant direction, taking into account the global trend towards the production of cars in the SUV segment, which exceed passenger cars in terms of mass and dimensions. In a road accident with a side impact of a passenger car and an off-road vehicle of the SUV segment, we will get a large difference in the height of the primary impact, which is 250 millimeters. That is, all the energy of the impact to the side of the passenger car falls not on the safety bar, but 250 millimeters higher, which will inevitably lead to fatal injuries to the driver and passenger. Unfortunately, the European NCAP and the US National Highway Traffic Safety Administration use moving barriers that are similar in terms of mass and dimensions to an average passenger car.* ***Originality.*** *The obtained results of the analysis of the mechanism of the car side collision make it possible to evaluate the current trend of the automobile market in terms of passive safety and, in particular, to conduct certification tests for side impact in a new way.* ***Practical value.*** *The obtained results can be recommended when studying the structural features of preparing and conducting crash tests.*

Key words: *passive safety, road accidents, deformation zone, injuries, road accident statistics, EuroNCAP, NHTSA.*

Introduction

Globally, car crashes are the leading cause of death, killing 1.2 million people, and despite improvements in car safety, projections indicate that road traffic deaths will increase significantly by 2030 due to the increase in the number of cars. 82 million units of automobiles are produced annually in the world. By 2035, the world car fleet will reach 2 billion cars. This trend inevitably leads to an increase in traffic accidents (traffic accidents).

A road accident (a road accident) is an event that occurred during the movement of a vehicle, as a result of which people were killed or injured or material damage was caused.

The system "man - car - environment - environment" is a complex energetic system of interaction of technical means, physiological, psychological and intellectual qualities of a person, which is becoming more and more complex due to the increase in movement speeds and the decrease in the time needed to make a decision. Driving a car requires the driver to take into account a huge number of factors, process significant amounts of information, and analyze patterns of road situations in a short period of time.

Taking into account these factors, car manufacturers improve the safety of the driver and passengers with each update of the model range, reducing the possibility of injury in the event of an

accident. But this is not enough. Car manufacturers have reached the maximum possible changes in the design of the car, which allows absorbing and dissipating the energy of the impact during an accident.

Analysis of publications

Analyzing the rating of European countries, it was found that the highest road death rate in Albania is 12.32 people per 100,000 population, followed by Lithuania with 11.34 people per 100,000 population, and Moldova with 9.9 people per 100,000 population. Not the lowest death rate in road accidents is in Sweden, Great Britain and the Netherlands - less than 3/100 thousand. Ukraine ranks 131st in the overall rating with an indicator of 9.11/100 thousand. At the same time, researchers classified Ukraine as one of the countries with a "low" number of number of deaths in road accidents.

A significant fact is that in EU countries there are 500 registered cars per thousand people, and in Ukraine, according to the Ministry of Infrastructure, 202, which is 2.5 times less. That is, in Ukraine, with a lower level of motorization, the death rate in road accidents per 1 million cars is more than 5 times higher than in EU countries [1-5].

Traffic accident statistics for the period 2011-2020 are presented in Figure 1-2. In general, during this period, 45,376,000 citizens died on the roads of Ukraine and 377,696 were injured. A certain decline in the number of accidents and their consequences, observed from 2014 to the present, is explained by the fact that data on regions not controlled by the Ukrainian authorities (AR Crimea, the city of Se-vastopol, parts of the Donetsk and Luhansk regions) are not taken into account), which in previous years were characterized by a high level of accidents and traffic injuries.

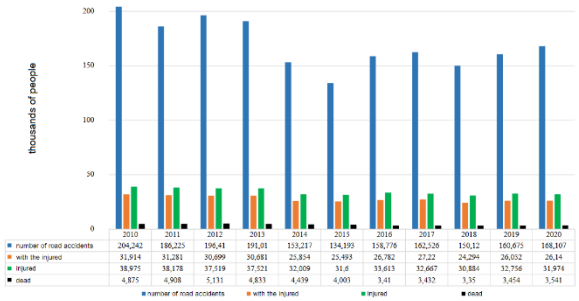

Fig. 1. Traffic accident statistics in Ukraine according to the data of the Patrol Police and the State Statistics Service of Ukraine

One of the reasons for the data discrepancy is that the Ministry of Health of Ukraine keeps statistics of all transport accidents according to the WHO methodology (V01-V99). But not all of them qualify as traffic accidents (data on fatalities and injuries on water and air transport are taken into account). Another fundamental reason for the discrepancy in official statistics is that the Patrol Police records only cases of injuries and deaths at the scene of road accidents and does not take into account those who died in the hospital or on the way to it.

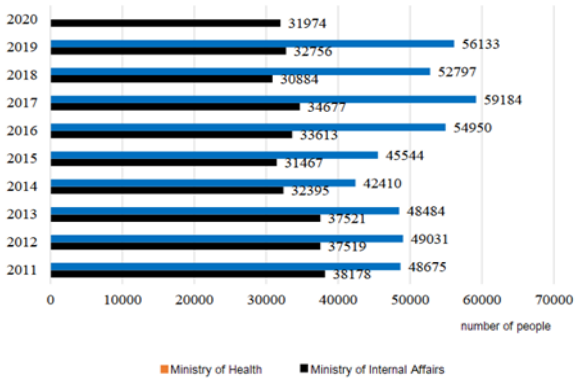

Fig. 2. The number of people injured in road accidents in Ukraine (2011-2020)

Since March 2016, on the basis of Resolution No. 538 of the Cabinet of Ministers of Ukraine in Ukraine, the legal document regulating the procedure for recording road accidents has become invalid. Instead, the new Resolution of the CMU No. 424 "Some issues of keeping records of traffic accidents" was adopted only on 22.05.2019, according to which the Ministry of Internal Affairs, the Ministry of Health, the National Police, Ukravtodor, the Ministry of Infrastructure, Ukrtransbezpeka are obliged to organize and carry out record keeping within their competences, but unfortunately there is a lack of synchronization between these departments, which cannot but be reflected in real statistical data (Fig. 3).

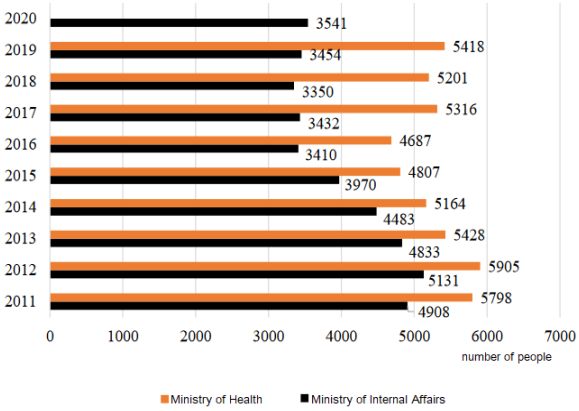

Fig. 3. The number of people killed in road accidents in Ukraine (2011-2020)

According to statistical data, the most common cause of road accidents in Ukraine is exceeding the safe speed of movement - 34% of all accidents. Other frequent causes of accidents are violations of maneuvering rules - more than 22%, violations of crossing rules - almost 8.5%, non-observance of a safe distance - 7.5%, violations of crossing at a pedestrian crossing - 6% , driving under the influence of alcohol - 5% and 17% other types of road accidents (crossing in an unspecified place, crossing into the oncoming lane, unexpectedly entering the carriageway, failure to comply with the requirements of traffic signals). As can be seen from the analysis of statistical data, the accident rate in the world and in Ukraine is at a fairly high level [1-5].

It must be said that among the total number of road accidents, if we make a breakdown by types of accidents, we will find that the first place is occupied by a frontal impact 50%, and the second place is a side impact 44.9%. Also a very important factor is the secondary impact of cars in the process of an accident, in this case the most frequent side impact is 48.4% followed by frontal impact 27.6%. 4.7 million road accidents were analyzed in which 108 thousand passengers and drivers were injured. This study was conducted by the authoritative Association for the Advancement of Automotive Medicine of the USA. From the analysis, it can be seen that the statistical indicators are equal between the frontal and side impact, but if we take into account the secondary impact, then in the lateral direction it is almost twice the value of the frontal impact. Thus, a side impact is the most dangerous in the case of a primary impact and in the case of a secondary impact in a road accident, it is necessary to take into account the deformation zone in the lateral direction, which is minimal for absorbing the kinetic energy of the impact, which leads to more serious injuries. We can see this by analyzing the research of the same Association for promoting the development of automobile medicine. Who developed the injury severity scale, called the "Abbreviated Injury Scale", is an anatomical coding system presented in Table 1. It represents the threat to life associated with the injury, and not a comprehensive assessment of the severity of the injury (Table 1).

Using this scale of injuries, we get the ratio of injuries from a primary collision to a secondary collision as 1 to 4. The study was conducted from a sample of 100 victims of road accidents. Thus, we can see that both primary and secondary side collisions are very dangerous for the driver and passengers [4-5].

Table 1. Severity according to the abbreviated scale of injuries

№	Severity of injuries
1	Insignificant
2	moderate
3	Serious
4	Strong
5	Critical
6	Maximum

As can be seen from Figure 1.4 of the simulation of a side impact by the VAG concern, the diagram of a side collision makes it clear that the deformation zone is very small and the total time during which the collision takes place is 60 milliseconds (Fig.4).

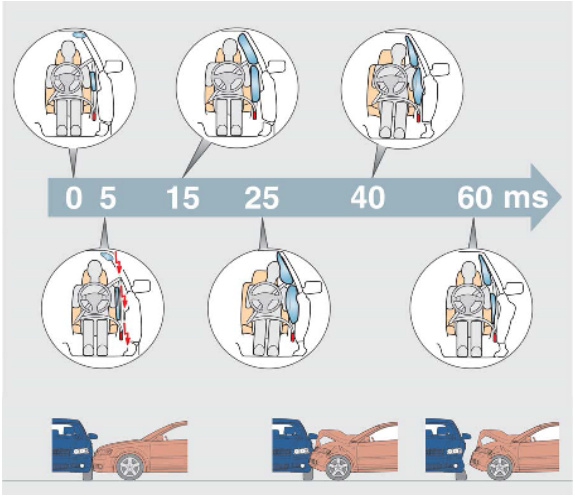

Fig. 4. Diagram of a side collision at a speed of 50 km/h

In contrast to a frontal impact, where at the same speed, the total impact time is 150 milliseconds due to a larger deformation zone [1-5].

Purpose and Tasks

The purpose of this article is the analysis of accidents on the roads to identify the most dangerous types of road accidents and the further study of the influence of the car design on the injuries of the driver and passengers in order to reduce injuries.

Programs for evaluating new cars during crash tests

Since the 1970s, a number of European governments have conducted studies to assess various aspects of car safety in the European Committee for Experimental Transport Vehicles (ECVT). Thanks to these studies, by the beginning of the 1990s, a full-scale procedure for conducting crash tests was developed, which

made it possible to assess the degree of protection of the driver and front passenger in a frontal and side impact, as well as pedestrians who were injured as a result of a car collision .

In June 1994, the Department of Transport of Great Britain approved the creation of the Commonwealth New Car Assessment Program (NCAP), which later spread throughout Europe. The program acquired a comprehensive character on the basis of test procedures developed by the European committee of experimental vehicles. In July 1995, the European Commission discussed the prospects for the development of the program for Europe.

EuroNCAP publishes reports on the safety of new cars, and gives them a rating in the form of stars, a maximum of 5 stars is possible, based on how the car behaved in a series of crash tests, the main studies are:

– Head kick with displacement. Performed at a speed of 64 km/h (40 mph) into a deformable obstacle. Dummies imitating a three-year-old and a one-and-a-half-year-old child are placed on the back seat;

– Side kick. It is performed at a speed of 50 km/h. A platform with a deformed block hits the car, the impact falls on the driver's side;

– Side impact on a pillar. It is performed at a speed of 29 km/h. The car is placed on a cart and hit on a pole, while the situation of loss of control on a slippery road is simulated [6-9];

Based on the statistical analysis, we are interested in the side crash test. The European New Car Assessment Program uses the following parameters for side impact studies [6-9]. The test vehicle is placed on a flat surface statically, a moving trolley is started from the driver's seat at a speed of 50 km/h ± 1 km/h. It is necessary to use a cart with a wheelbase of 3000 ±10 mm and a track of sp-red and rear of 1500 ±10 mm. A deformed barrier is fixed in front so that its lower edge is at a height of 300 mm +/- 5 mm from the ground. The total weight of the carts should be 950 ±20 kg (Fig. 5).

The US National Highway Traffic Safety Administration first conducted crash tests with a safety rating in 1979. Initially, only the frontal impact was evaluated, but over time new tests were introduced, including the side impact test in 1997. Tested cars are awarded ratings from one star to five stars to conveniently illustrate the results for consumers. Assessments consist of four broad areas:

– Protection of adult passengers (for front passengers);

– Assistant systems that help the driver avoid accidents on the road.

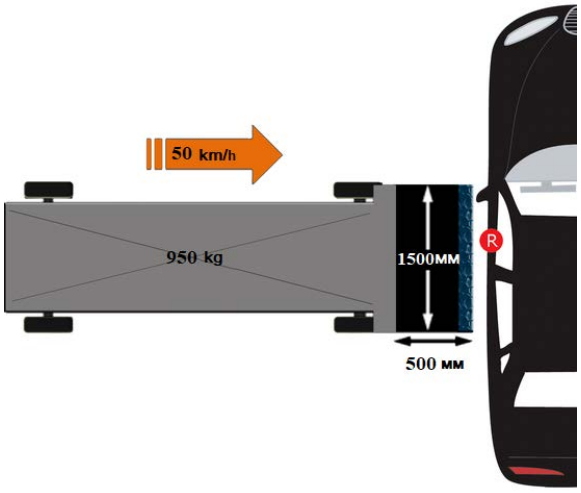

Fig. 5. Conditions for conducting a side crash test according to the EuroNCAP methodology

Our attention will be focused on the protection of the driver and passengers during a side impact. The test vehicle is located on a flat surface statically, a moving cart is launched from the driver's side at a speed of 62 km/h (38.5 mph) at an angle of 27 degrees (Fig. 6). A trolley with a 3632 mm wheelbase and a front and rear track of 1880 mm must be used. A deformed barrier is attached in front so that its lower edge is at a height of 279 mm from the ground. The total weight of the carts must be 1367 kg (3015 lb). The purpose of this test is to assess injuries to the head, abdomen, chest, and pelvis (Fig. 1.6) [6-9].

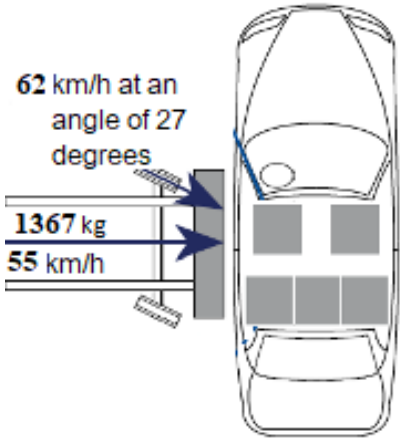

Fig. 6. Conditions for conducting a side crash test according to the USNCAP methodology

We will not cite how crash tests are evaluated in other regions of the world, because they are very similar in terms of their conditions. To understand how crash tests are conducted, it was enough for us to familiarize ourselves with the world's leaders in safety studies, namely the European NCAP and the US National Highway Traffic Safety Administration [7-9].

In both tests, a collision with the side of the car at an angle of 90 degrees is simulated as the main impact. This is due to statistical data (Fig. 7) which show that a side impact at an angle of 90 degrees is two times greater than a side impact at an angle of 45 degrees.

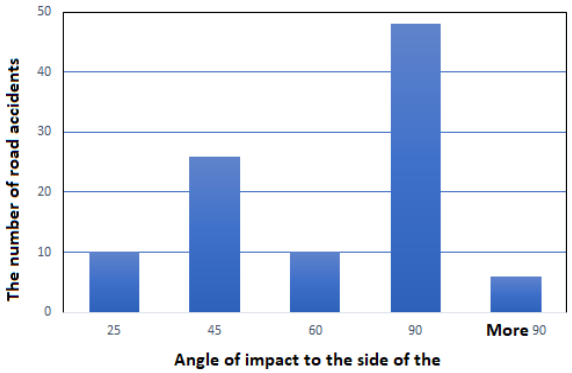

Fig. 7. The dependence of the number of side impacts in a road accident on the angle of the collision direction

This analysis was carried out from a sample of 100 road accidents where a side impact occurred in the middle zone of the car at different angles.

Analysis of the car sales market by their types

In order to fully understand the problem, it is necessary to analyze the car market in order to clearly understand the trends of the types of cars that are currently in trend in the world. In 2022, it was possible to sell 40,000 new passenger cars in Ukraine, which is 61.3% less than in pre-war 2021. The leader of the Ukrainian market in 2022 was Toyota, which managed to sell almost 7,000 new passenger cars. The second place was for Renault, with a result of almost 4 thousand cars per year. But third place was taken by Volkswagen, selling 3,000 cars.

Toyota RAV4 became the most popular model in the car market (Table 2). The most popular model of the premium segment was the BMW X5. In the budget segment, the RENAULT Duster crossover became the most popular.

A very important fact is the type of car itself, 17 models from the TOP-20 sales leaders of the Ukrainian car market are models of the SUV (Sport Utility Vehicle) segment, including only one model of the VW ID.4 electric car. And 3 models of passenger cars with a sedan body [10].

Table 2. Statistics of sold car models in Ukraine for 2022

№	Brand/Model	2022	
		cars	%
1	Toyota RAV4	2538	6,3%
2	Renault Duster	2444	6,1%
3	Toyota LC Prado	1243	3,1%
4	Volkswagen ID.4	1230	3,1%
5	Skoda Kodiaq	1155	2,9%
6	Hyundai Tucson	842	2,1%
7	Mitsubishi Outlander	757	1,9%
8	Chery Tiggo	718	1,8%
9	BMW X5	664	1,7%
10	Toyota Camry	628	1,6%
11	Skoda Karoq	627	1,6%
12	KIA Sportage	622	1,6%
13	Dong Feng X-NV	609	1,5%
14	Toyota Land Cruiser	597	1,5%
15	Mercedes-Benz GLE	595	1,5%
16	Suzuki Vitara	577	1,4%
17	Volkswagen T-Roc	553	1,4%
18	Skoda Octavia	544	1,4%
19	Renault Logan	536	1,3%
20	Toyota Yaris Cross	498	1,2%
Other		22 103	55,2%
All		40 076	100.0%

Analyzing the market of used cars, we can say that the leader of the Ukrainian market in 2022 will be passenger cars, of which 21 are sedan, station wagon, and hatchback body types (Table 3) [10], in contrast to the new car market, where cars took the lead SUV segment.

As can be seen from the two tables, the market of new and used cars is saturated with SUVs, which in terms of mass and dimensions can be compared to SUVs. 15 out of 20 new cars sold are SUVs or, as it is now commonly called, crossovers. Conversely, the situation is opposite in the market of used cars, where out of the 25 most popular models, only 1 SUV occupies a place in the list. Such a situation inevitably leads to dangerous road accidents involving cars and SUVs. Let me remind you that the European NCAP and the US National Highway Traffic Safety Administration, which are currently the benchmark in the world of crash tests, do not conduct comparative crash tests between cars of different classes. Basically, this is a crash test, which is a simulation of a side impact with a cart with a load, with parameters similar to an average passenger car.

Table 3 Statistics of the number of contracts for the purchase and sale of used cars in Ukraine for 2022

№	Brand/Model	Number of contracts purchase and sale
1	Volkswagen Passat	26830
2	ZAZ Lano/Sens	24663
3	Skoda Octavia	22030
4	Volkswagen Golf	20759
5	Renault Megane	12669
6	Ford Focus	11567
7	BA3 2109/99	10715
8	Skoda Fabia	10140
9	Opel Astra	10076
10	BMW 5 Series	9431
11	BMW 3 Series	8930
12	Chevrolet Aveo	8779
13	Audi A6	8746
14	Toyota Camry	8618
15	Audi A4	7754
16	Mercedes-Benz E-Class	7708
17	Renault Scenic	7211
18	BMW X5	7012
19	Volkswagen Jetta	6555
20	Hyundai Sonata	6133
21	Volkswagen Transporter	6083
22	Mitsubishi Lancer	6069
23	Opel Zafira	5871
24	Mazda 6	5862
25	Renault Logan	5842

The problem lies in the different mass and dimensional parameters of a passenger car and an SUV of the SUV segment (Fig. 8).

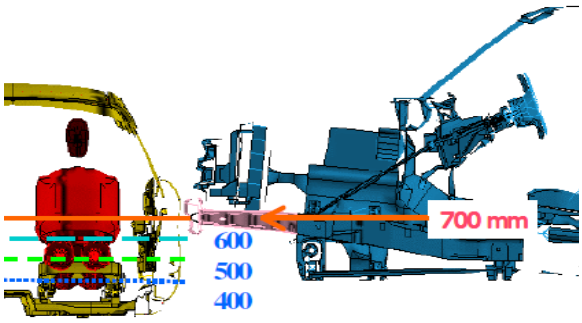

Fig. 8. Comparison of the side impact height of an SUV in the SUV segment with a passive safety system in the doors of a passenger car

In passenger cars, there are safety bars in the doors, which, in the event of a side impact, make it possible to absorb a greater amount of kinetic energy and minimize injury to the driver or passenger. This will be possible in the case of an accident involving cars of the same class or similar mass-dimensional parameters, but in an accident with a side impact of a passenger car and an off-road vehicle of the SUV segment, we will get a big difference in the dimensions of the cars. Figure 1.8 shows us that the difference between the side impact of passenger cars and a passenger car with an SUV segment is 250 millimeters. That is, all the energy of the impact to the side of the passenger car falls not on the safety bar but 250 millimeters higher, which will inevitably lead to fatal injuries to the driver and passenger. Unfortunately, the European NCAP and the US National Highway Traffic Safety Administration use moving barriers that are similar in terms of mass and dimensions to an average passenger car [11-14].

An important aspect that significantly affects the safety of the driver and passengers in a side impact are various passive and active safety systems that allow to partially reduce the consequences of injury to the driver and passengers. We are interested in systems that prevent or partially reduce injury to the driver or passengers in the event of a side impact. A detailed overview of such systems can be found in the article "Analysis of adaptive suspensions and their impact on the passive safety of the car" [11-14]. Such passive safety systems, which are part of the car's suspension, make it possible, as I already said, to reduce the consequences of a side impact in a road accident.

They make it possible to predict and react to a side impact and prepare the car for the impact. Two systems are the most advanced: adaptive air suspension with electromechanical roll stabilization and hydropneumatic suspension with electronic control. These systems make it possible to influence passive safety characteristics by improving the absorption of kinetic energy by 50% by raising the body by 80 millimeters. As for the serial production of these systems and their integration into serial cars, at the moment it is possible because they are not serial, but only prototypes that we can see only on test grounds.

Conclusion

Given that scientific research on frontal impact is presented by the scientific community in the broadest form. The study of the side impact of two cars is currently a relevant direction, taking into account the global trend towards the production of cars in the SUV segment, which

exceed passenger cars in terms of mass and dimensions.

In a road accident with a side impact of a passenger car and an off-road vehicle of the SUV segment, we will get a large difference in the height of the primary impact, which is 250 millimeters. That is, all the energy of the impact to the side of the passenger car falls not on the safety bar, but 250 millimeters higher, which will inevitably lead to fatal injuries to the driver and passenger. Unfortunately, the European NCAP and the US National Highway Traffic Safety Administration use moving barriers that are similar in terms of mass and dimensions to an average passenger car.

Conflict of interest

The author declares no conflict of interest regarding the publication of this article.

Gratitude

This article was written thanks to the consulting advice of Ivan Volodymyrovych Lukashov, head of the Laboratory of High-Speed Cars of the National Academy of Sciences of the Russian Academy of Sciences.

References

1. Національна поліція. / [Електроний ресурс]. — Режим доступу: https://www.npu.gov.ua/. Natsionalna politsiia [National police]. / [Elektronyi resurs]. Rezhym dostupu: https://www.npu.gov.ua/;
2. Державне агенство відновлення та розвитку інфраструктури України. / [Електроний ресурс]. — Режим доступу: https://restoration.gov.ua. Derzhavne ahenstvo vidnovlennia ta rozvytku infrastruktury Ukrainy [State Agency for Reconstruction and Development of Infrastructure of Ukraine]. / [Elektronyi resurs]. — Rezhym dostupu: https://restoration.gov.ua;
3. Міністерство розвитку громад, територій та інфраструктури України. / [Електроний ресурс]. — Режим доступу: https://mtu.gov.ua/. Ministerstvo rozvytku hromad, terytorii ta infrastruktury Ukrainy [Ministry of Development of Communities, Territories and Infrastructure of Ukraine]. / [Elektronyi resurs]. — Rezhym dostupu: https://mtu.gov.ua/;
4. Державна службу України з безпеки на транспорті. / [Електроний ресурс]. — Режим доступу: https://dsbt.gov.ua/ Derzhavna sluzhbu Ukrainy z bezpeky na transporti [The State Service of Ukraine for Transport Safety]. / [Elektronyi resurs]. — Rezhym dostupu: https://dsbt.gov.ua/;
5. National Highway Traffic Safety Administration. / [Електроний ресурс]. — Режим доступу: https://www.nhtsa.gov/;
6. Department for Transport (2021), Reported road casualties Great Britain, provisional results: 2020, Department for Transport, United Kingdom, https://www.gov.uk/government/statistics/reported-road-casualties-great-britain provisional-results-2020/reported-road casualties-great-britain-provisional-results-2020 (accessed 5 December 2021);
7. NHTSA (2021), "Early Estimate of Motor Vehicle Traffic Fatalities in 2020", *Traffic Safety Facts: Crash Stats*, National Highway Traffic Safety Administration, U.S. Department of Transportation, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813115;
8. Qureshi, A. I. et al. (2020), "Mandated societal lockdown and road traffic accidents", Accident Analysis and Prevention, Vol. 146, 105747, https://doi.org/10.1016/j.aap.2020.105747;
9. Vandoros, S. and F. Papailias (2021), "Empty Streets, Speeding and Motor Vehicle Collisions during Covid-19 Lockdowns: Evidence from Northern Ireland" MedRxiv, https://doi.org/10.1101/2021.01.03.21249173;
10. Autoconsulting. / [Електроний ресурс]. — Режим доступа: https://autoconsulting.ua/news;
11. R. Ibanez, E. Abisset-Chavanne, A. Ammar, D. Gonzalez, E. Cueto, A. Huerta, J.L. Duval, F. Chinesta, (2018) A multidimensional data-driven sparse identification technique: the sparse proper generalized decomposition, Complexity, 5608286;
12. Safety Wissen, February 2019, European Car Assessment Programme (EuroNCAP), available https://www.safetywissen.com/#/requirement/ ;
13. Александров Є. Є., Александрова Т. Є., Моргун Я. Ю., Холодов, М. П., Ярита, О. О., Шаповаленко В. О. (2023). До питання декомпозиції математичних моделей збуреного руху складних дискретно – континуальних динамічних систем. Автомобільний транспорт, (52), 41–53. https://doi.org/10.30977/AT.2219-8342.2023.52.0.05. Aleksandrov E., Aleksandrova T., Morgun Ya., Kholodov, M., Yaryta, O., Shapovalenko V. (2023) Do pytannia dekompozytsii matematychnykh modelei zburenoho rukhu skladnykh dyskretno – kontynualnykh dynamichnykh system. [To the issue of decomposition of mathematical models of disturbed motion of complex discrete-continuous dynamic systems] Automobile Transport, (52), 41–53.;
14. Ярита О.О., Шаповаленко В.О. (2022). Аналіз адаптивних підвісок та їх вплив на пасивну безпеку автомобіля НТУ ХПІ. Iaryta O.O., Shapovalenko V.O. (2022). Analiz adaptyvnykh pidvisok ta yikh vplyv na pasyvnu bezpeku avtomobilia NTU KhPI. [Analysis of adaptive suspensions and their impact on the passive safety of a car] Bulletin of the National Technical University "KhPI". Series: Automobile and tractor construction No. 2 (2022).

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Аналіз механізму бокового зіткнення автомобілів

Анотація. Проблема. *У всьому світі автомобільні аварії є основною причиною смерті, в них гине 1,2 млн людей, незважаючи на покращення автомобільної безпеки, прогнози вказують на те, що смертність від ДТП значно зросте до 2030 року через збільшення кількості автомобілів. Така тенденція вимагає підвищення пасивної безпеки в конструкції автомобілів. Також потрібно з цими факторами розглядати найпопулярніші сегменти автомобілів SUV, які під час ДТП створюють більш небезпечні наслідки при боковому ударі враховуючи масово-габаритних параметрів.* ***Мета.*** *Проведення аналізу механізму бокового зіткнення автомобілів різних масово-габаритних параметрів. Враховуючи тенденції продажу автомобілів, виявлення найпопулярніших класів автомобілів в Україні як на ринку нових автомобілів так і на вторинному ринку, для подальшого виявлення проблем у тестуванні автомобілів за різними сертифікаційними протоколами.* ***Методологія.*** *Застосовані в роботі підходи до вирішення поставлених задач базуються на використані статистичних даних та порівняльному аналізу різних методологій, сертифікаційних протоколів.* ***Результати.*** *Враховуючи, що наукові дослідження фронтального удару представлені науковою спільнотою в найширшому вигляді. Дослідження бокового удару двох автомобілів являється на даний момент актуальним напрямком враховуючи світову тенденцію направлену на випуск автомобілів сегменту SUV, які масово-габаритними параметрами перевершують легкові автомобілі. В ДТП з боковим ударом легкового автомобіля і позашляховика сегменту SUV ми отримаємо велику різницю в висоті первинного удару, яка складає 250 міліметрів. Тобто вся енергія удару в бокову час-тину легкового автомобіля приходиться не в брус безпеки, а вище на 250 міліметрів, що неминуче призведе до смертельного травмування водія та пасажира. Нажаль Європейський NCAP та Національне управління безпеки дорожнього руху США використовують рухомі бар'єри які схожі за масово-габаритними параметрами з середньостатистичним легковим автомобілем.* ***Оригінальність.*** *Отримані результати аналізу механізму бокового зіткнення автомобілів дають змогу по новому оцінити сучасну тенденцію автомобільного ринку з точки зору пасивної безпеки та зокрема проведення сертифікаційних тестів на боковий удар.* ***Практична цінність.*** *Отримані результати можна рекомендувати при вивченні конструктивних особливостей підготовки та проведення краш тестів.*

Ключові слова: *пасивна безпека, ДТП, зона деформації, травматизм, статистика ДТП, EuroNCAP, NHTSA.*

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