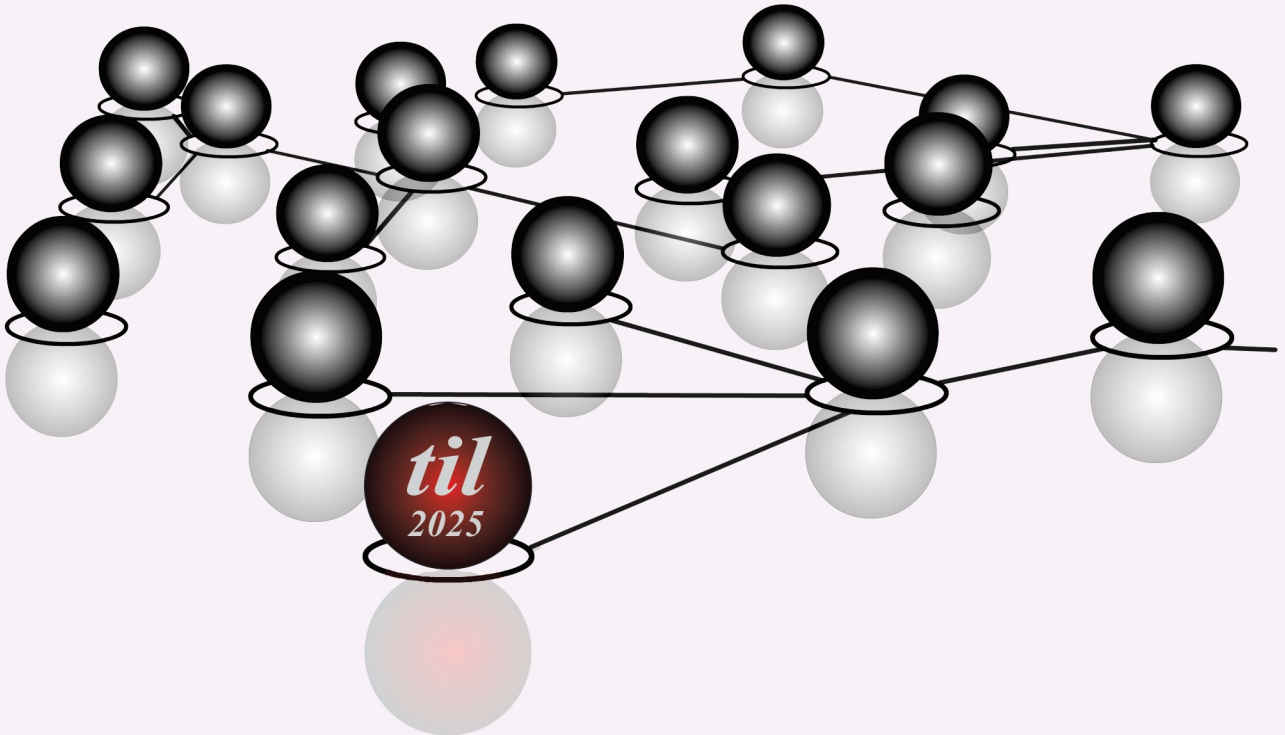
UNIVERSITY OF NIS
FACULTY OF MECHANICAL ENGINEERING
Department of Transport Engineering and Logistics

10th INTERNATIONAL CONFERENCE

TRANSPORT & LOGISTICS

PROCEEDINGS



Niš, Serbia 5 December 2025

THE TENTH INTERNATIONAL CONFERENCE

TRANSPORT AND LOGISTICS

Niš, Serbia 5 December 2025

PROCEEDINGS

Edited by

Assoc. Prof. Dr. Predrag Milić

Design

Dr. Aleksandar Stanković
Dr. Jovan Pavlović
Jelena Mihajlović

Publisher

University of Niš
Faculty of mechanical engineering
Department of Transport Engineering and Logistics

Under the auspices of
Serbian Ministry of Education, Science and Technological Development

Scientific *committee*

Chairman of the Scientific Committee:

***Assoc. Prof. Dr. Predrag Milić**, Faculty of Mechanical Engineering, University of Niš, SRB*

***Prof Dr. Aleksandr Rakhmangulov**, Department of Logistics and Transportation Systems Management, Nosov Magnitogorsk State Technical University, RUS*

***Assoc. Prof. Dr. Aleksandra Anđelković**, Faculty of Economics, University of Niš, SRB*

***Assoc. Prof. Dr. Alptekin Ulutas**,Department of International Trade and Logistics, Sivas Cumhuriyet University, TUR*

***Assoc. Prof. Dr. Beti Angelevska**, Faculty of Technical Sciences, "St. Kliment Ohridski" University, Bitola, MKD*

***Asst. Prof. Dr. Boban Nikolić**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Assoc. Prof. Dr. Caglar Karamasa**, Faculty of Business Administration, Anadolu University, TUR*

***Assoc. Prof. Dr. Danijel Marković**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Assoc. Prof. Dr. Dillip Kumar Das**, The Discipline of Civil Engineering, University of KwaZulu- Natal, Durban, RSA*

***Prof. Dr. Đorđe Nikolić**, Technical Faculty in Bor, University of Belgrade, SRB*

***Dr. Dragan Marinković**, Institute of Mechanics, TU Berlin, GER*

***Prof. Dr. Dragan Pamučar**, Faculty of Organizational Sciences, University of Belgrade, SRB*

***Prof. Dr. Dragan Peraković**, Faculty of Transport and Traffic Sciences, University of Zagreb, CRO*

***Assoc. Prof. Dr. Golam Kabir**, Faculty of Engineering and Applied Science, University of Regina, Canada, CAN*

***Prof. Dr. Goran Marković**, Faculty of mechanical and civil engineering Kraljevo, University of Kragujevac, SRB*

***Prof. Dr. Goran Milovanović**, Faculty of Economics, University of Niš, SRB*

***Prof. Dr. Goran Petrović**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Gordana Stefanović**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Assoc. Prof. Dr. Ibrahim Badi**, Mechanical Engineering department, Misurata University, LIB*

***Prof. Dr. Jelena Stefanović Marinović**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Kristina Jakimovska**, Faculty of Mechanical Engineering, Ss. Cyril and Methodius University in Skopje, MKD*

***Assoc. Prof. Dr. Kristina Marković**, Faculty of Engineering, University of Rijeka, Croatia, CRO*

***Prof. Dr. Ljiljana Radović**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Ljubiša Vasov**, Faculty of Transport and Traffic Engineering, University of Belgrade, SRB*

***Prof. Dr. Marijana Petrović**, Faculty of Transport and Traffic Engineering, University of Belgrade, SRB*

***Assoc. Prof. Dr. Marko Periša**, Faculty of Transport and Traffic Sciences, University of Zagreb, CRO*

***Prof. Dr. Marko Petković**, Faculty of Sciences and Mathematics, University of Niš, SRB*

***Prof. Dr. Mile Savković**, Faculty of mechanical and civil engineering Kraljevo, University of Kragujevac, SRB*

***Asst. Prof. Dr. Miloš Madić**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Miloš Milošević**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Assoc. Prof. Dr. Miloš Simonović**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Nenad T. Pavlović**, Faculty of Mechanical Engineering, University of Niš, SRB*

***Assoc. Prof. Dr. Nikola Petrović**, Faculty of Mechanical Engineering, University of Niš, SRB*

***Prof. Dr. Olegas Prentkovskis**, Faculty of Transport Engineering, Vilnius Gediminas TU, LIT*

***Prof. Dr. Peđa Milosavljević**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Assoc. Prof. Dr. Prasenjit Chatterjee**, Department of Mechanical Engineering, MCKV Institute of Engineering, IND*

***Prof. Dr. Predrag Rajković**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Rosen Mitrev**, Faculty of Mechanical Engineering, Technical University of Sofia, BGR*

***Assoc. Prof. Dr. Sarfaraz Hashemkhani Zolfani**, School of Engineering Universidad Catolica del Norte, Chile, CHI*

***Assoc. Prof. Dr. Selçuk Korucuk**, Department of International Trade and Logistics, Giresun University, TUR*

***Assoc. Prof. Dr. Sanjin Troha**, Faculty of engineering, University of Rijeka, CRO*

***Prof. Dr. Slađana Marinković**, Faculty of Elecronic Engineering, University of Niš, SRB*

***Prof. Dr. Thorsten Schmidt**, Faculty of Mechanical Science and Engineering, TU Dresden, GER*

***Assoc. Prof. Dr. Vesna Jovanović**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Vladislav Blagojević**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Prof. Dr. Žarko Ćojbašić**, Faculty of Mechanical Engineering in Niš, University of Niš, SRB*

***Assoc. Prof. Dr. Željko Stević**, Faculty of Transport and Traffic Engineering Doboj, University of East Sarajevo, BiH*

***Assoc. Prof. Dr. Željko Vrcan**, Faculty of Engineering, University of Rijeka, Croatia, CRO*

Organising committee

Chairman of the Organizing Committee:

***Dr. Aleksandar Stanković**, Faculty of Mechanical Engineering, University of Niš, SRB*

***Dr. Jovan Pavlović**, Faculty of Mechanical Engineering, University of Niš, SRB,*

***Jelena Mihajlović**, Faculty of Mechanical Engineering, University of Niš, SRB.*

***Mr Saša Marković**, Faculty of Mechanical Engineering, University of Niš, SRB,*

The conference is supported by:

Republic of Serbia

MINISTRY OF SCIENCE,
TECHNOLOGICAL DEVELOPMENT AND INNOVATION

Companies that supported the conference:

NIS

PHILIP MORRIS INTERNATIONAL

LEONI

TOYOTA
Raavex-Group

BYD

ZUMTOBEL Group
TRIDONIC

ZF

MILSPED

АЕРОДРОМ НИШ
AIRPORT NIŠ

lagerton
www.lagerton.com

diligent
SOFTWARE

TIGAR

CONTENTS

FOREWORD

The *International Conference on Transport and Logistics (TIL 2025)* marks a significant milestone, celebrating its tenth edition. The origins of this conference date back to 2004, when the first Serbian Seminar on Transport and Logistics (TIL 2004) was organized within the framework of a TEMPUS project funded by the European Commission. The project aimed to support the transfer of knowledge in the field of logistics from European universities to the Faculty of Mechanical Engineering in Niš, where the first generation of students had enrolled a year earlier in the newly established study profile Transport and Logistics.

The members of the Department of Transport Engineering and Logistics express their special gratitude to the former Head of the Department, Prof. Dr. Vinko Jevtić, whose visionary insight made it possible to bring together leading experts in logistics from across the European Union. His efforts played a crucial role in the establishment of a new academic orientation that, at that time, had not been taught at mechanical engineering faculties in Serbia.

Since 2004, the conference has undergone continuous development, evolving from an academic seminar and a national conference with international participation into the *International Conference on Transport and Logistics*. This evolution reflects both the growing scientific maturity of the event and the increasing importance of transport and logistics as key disciplines in modern engineering, economics, and society.

The Proceedings of the *International Conference on Transport and Logistics* include a total of **40 peer-reviewed papers**, authored by researchers from **Bosnia and Herzegovina, China, Croatia, Germany, Greece, Italy, Lithuania, Poland, Serbia, Slovenia, and Turkey**. The conference serves as an international forum for researchers, academics, and practitioners to exchange knowledge, experiences, and recent advances in the broad field of transport and logistics.

The conference focuses on contemporary challenges and emerging trends in transport systems, logistics, mobility, traffic engineering, vehicle technology, and related interdisciplinary areas. Particular emphasis is placed on sustainable transport solutions, intelligent transportation systems, logistics optimization, and the interaction between academia and industry.

We would like to thank all authors for their valuable contributions, as well as the members of the Organizing and Scientific Committees for their dedication and efforts in ensuring the successful realization of the conference. Special thanks are extended to the supporting institutions and partners whose cooperation made this event possible.

We hope that this volume will serve as a useful reference for future research and professional practice and will stimulate further discussion and collaboration in the field of transport and logistics.

Chair of the Scientific Committee
Assoc. Prof. Dr. Predrag Milić

.

UNIVERSITY OF NIS
FACULTY OF MECHANICAL ENGINEERING
Department of Transport Engineering and Logistics

UNIVERSITY OF NIS FACULTY OF MECHANICAL ENGINEERING

THE TENTH INTERNATIONAL CONFERENCE
TRANSPORT AND LOGISTICS
https://doi.org/10.46793/TIL2025.145S

til 2025

COMPUTATIONAL ANALYSIS OF THE VEHICLES COLLISION

***Nadica STOJANOVIĆ*[1], *Ivan GRUJIĆ*[1], *Željko ĐURIĆ*[2], *Bojana BOŠKOVIĆ*[3]**

[1)]*University of Kragujevac, Faculty of Engineering, Sestre Janjic 6, 34000 Kragujevac, Serbia*
[2)]*Faculty of mechanical engineering, University of Banja Luka, Banja Luka, BiH*
[3)]*Academy of professional studies Šumadija, Department in Trstenik, Trstenik, Serbia*

ORCID iDs: Nadica STOJANOVIĆ https://orcid.org/0000-0002-4199-0587
Ivan GRUJIĆ https://orcid.org/0000-0003-0572-1205
Željko ĐURIĆ https://orcid.org/0009-0001-8573-6038
Bojana BOŠKOVIĆ https://orcid.org/0000-0001-8622-9874

Abstract

During the transport, many factors can lead to the traffic accident. The highest number of accidents on the Republic of Serbia, where two vehicles participated are frontal collisions. In the paper are conducted two computational simulations of vehicles frontal collision, where in the first case, the vehicle one had speed of 90 km/h, and the second vehicle had the speed of 60 km/h, while in the second case, the speed of the vehicle 1 was 60 km/h, while the speed of the vehicle 2 was 90 km/h. both simulations were conducted in PC-Crash software package, which represent the special software for traffic accidents simulation. After the simulations, in the paper are presented the propositions and measurements for the reduction of the number of traffic accidents. On the basis of the conducted research, were drawn conclusions what should take into the consideration during the production of new vehicles.

Keywords*: traffic accident, frontal collision, PC-Crash, measurements for reduction.*

1 INTRODUCTION

According to the data from the Road Traffic Safety Agency, the most often type of the traffic accident for the year 2024., from the group of accident where participated at least two vehicles, was the frontal collision[1].The greatest number of traffic accidents in the Republic of Serbia was caused by human error. The frontal collision, Figure 1, represents the collision of frontal parts of two vehicles, which are driven in opposite directions. This kind of collision causes the deformation of the frontal part of the vehicle, while the speed of the vehicle before the collision, contributes to the deformations size, as well as to the damages level. The causes which lead to the frontal collision are [2]:

- Sleepiness,
- High speed driving,
- Driving under the influence of alcohol or narcotics,
- The weather conditions and similar.

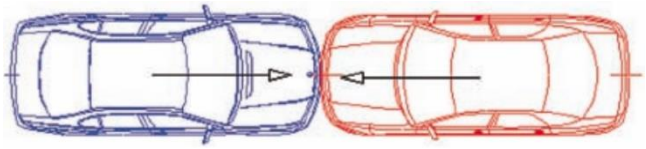


Fig. 1*Frontal collision [3]*

In the case of the frontal collision, it can come to the fatal outcome, or to the injury of the driver and passenger, as well as to the damage of the vehicle. When it comes to the traffic accident, it is necessary to determine who have contributed to the traffic accident occurrence, and which speeds vehicles had before the accident. Today, exists a great number of software's which make more easier the determination of the vehicles speed before the collision. The speeds can be determined by application of specialized software's such are the PC-Crash, or by software's which use the finite elements methods such is the LS Dyna [4-6]. Besides the great number of software's, the specialized software's have found the greatest application. The amplification of the level of the traffic safety, is the significant subject. The amplification of the safety will lead to the decrement of the number of injured as well as the number of fatal outcomes, and this can be accomplished by analysis which type of accident is most often, and how to avoid it. The main aims placed in front of this research are next:

- To give the review which types of traffic accidents are the most often.
- To give the methods which are in use for the analysis of traffic accidents, as well as which method have found the greatest application.
- To present on characteristic traffic accident which occurs quite frequently.
- To presents the measures for the reduction of number of traffic accidents, as well as measures for the reduction of consequences of traffic accidents.

In the introduction is presented which is the most dominant type of traffic accident, where participated two vehicles. After that are presented the methods which are in use for the presentation and analysis of two vehicle collision. How the specialized software's found the greatest application, in this paper will be applied the PC-Crash. In the third part of the paper is presented a characteristic case of the example of frontal collision of two vehicles. The fourth chapter of the paper presents the measures and proposals for the reduction of the number of traffic accidents, as well as for the reduction of consequences of traffic accidents.

2 THE METHOD AND SUBJECT OF RESEARCH

In this study it is applied the PC-Crash software package for the analysis of mechanics of the two-vehicle collision.

The analyzed vehicles are considered as linear, while the data about their mass, inertial moments and similar, were taken from the data base of the used software. Before the simulation, the distance between the center of gravity of vehicle 1 and center of gravity of vehicle 2 was 44 m. the vehicles moved straight ahead (Figure 2) on the dry road, where the friction coefficient was 0.7. before the collision, the speed of the vehicle 1 was 90 km/h while the speed of the vehicle 2 was 60 km/h. the restitution coefficient amounted 0.2. the basic characteristics of vehicles are presented in the Table 1. The collision type was frontal. After the collision, both drivers were braking, the driver's reaction time was 0.96 s, the time of the braking system response was 0.2 s. the deceleration for both vehicles was 0.6 m/s^2.

Fig. 2*Defining of the vehicles position and driving direction*

Table 1 Vehicles characteristics

	Vehicle 1	Vehicle 2
Manufacturer	AUDI	FIAT
Name	A3	Brava 1.4 12V
Type	8L	182
Weight, kg	1220	1040
Lenght, m	4.15	4.19
Drive mode	Front	Front
Distance C.G. - front axle, m	1.0	0.94
Roll moment of inertia, kg·m^2	483.8	421.37
Pitch moment of inertia, kg·m^2	1612.66	1404.57
Yaw moment of inertia, kg·m^2	1612.66	1404.57
Stiffness, front axle, N/m	23999.98	21422.36
Stiffness, rear axle, N/m	15894.02	12585.64
Damping, front axle, N·s/m	2700.00	2410.02
Damping, rear axle, N·s/m	1788.08	1415.88
ABS	No	

3 RESULTS AND DISCUSION

In this chapter of the paper is presented the collision of two vehicles which are moving in opposite directions. It is given the presentation in which direction will vehicles continue to move after the collision. Besides that, are presented the speeds before and after the collision, as well as the speeds difference. Also are presented the total deformation energy and impulse.

In the first case, the vehicle 1 which has greater mass than the vehicle 2, also had the greater speed than the vehicle 2. On the Figure 3 is given the position of the vehicles after the collision. Vehicle 1 after the collision continued to move in the same direction, while the vehicle 2, have changed the direction, Figure 3.

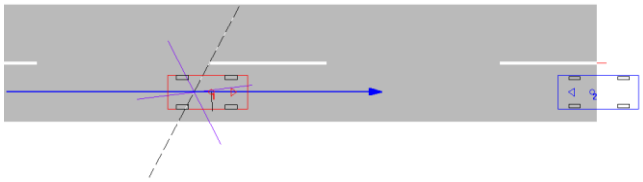


Fig. 3*Vehicles position after the collision – case 1*

The graph on the Figure 4 represents the speeds change, as well as the entire road, which the vehicles passed during the simulation. The red line represents the speed of the vehicle 1, while the blue line represents the speed of the vehicle 2. Before the collision, both vehicles had a constant speed, what is presented with the lines parallel to the horizontal axis. After the constant speed, it is recorded the sudden fall of the speeds, what actually represents the moment of the collision. After the collision both vehicles continued to move. However, the vehicle speed had the greater speed after the collision, compare to the vehicle 1. The happened because the vehicle 1 had greater kinetic energy due to the greater mass and greater speed before the collision. Quick after the collision, the drivers started to brake, and vehicles stopped.

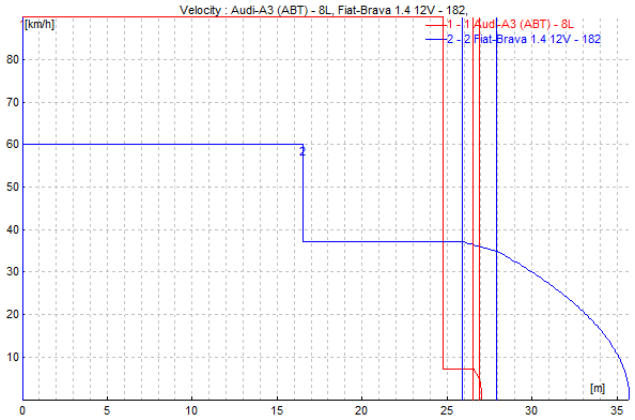


Fig. 4 *Simulation of a collision of motor vehicles running in the same direction and their speed–distance diagram – case 1*

The detail data about vehicle speeds before and after the collision are given in Table 2. From the beginning of the simulation until the collision, passed 0.99 s. the deformation of the vehicle 1 amounted the 0.46 m, while the deformation of the vehicle 2 amounted the 0.47 m, where the energy consumed by vehicles deformations was 467846.61 J.

Different from the first case, for the second case, that is, for the second simulation, the speed before the collision, of the vehicle 1, was 60 km/h, while the speed of the vehicle 2 was 90 km/h. In this case, the vehicles literately bounced one from another, that is, continued to move in opposite directions, Figure 5. The change of the moving direction can be seen in respect to the plane of collision. The collision plane, on the Figure 5 is presented with dashed line.

The graphic representation of speeds change is presented with Figure 6. After the collision, the vehicle which had

greater speed before the collision, it has lower speed, what can be seen in the Table 3.

Table 2 Report case 1

	Возило 1	Возило 2
Time, s	0.99	
Pre impact velocity, km/h	90	60
Post impact velocity, km/h	7.17	37.17
Velocity change (dV), km/h	82.83	97.17
Deformation depth, m	0.46	0.47
EES (Equivalent Eergy Speed), km/h	70.12	76.76
dV/EES, -	1.18	1.27
Total deformation energy, J	467846.61	
Impulse, Ns	28070.80	

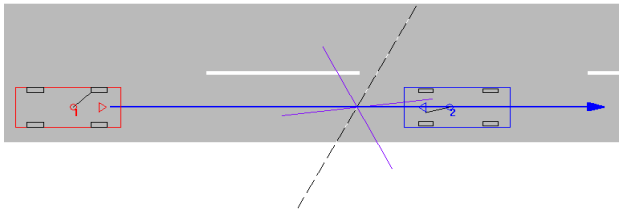


Fig. 5 *Vehicles position after the collision – case 2*

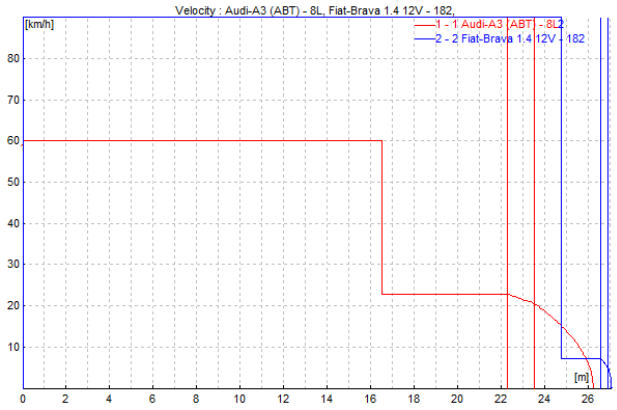


Fig. 4 *Simulation of a collision of motor vehicles running in the same direction and their speed–distance diagram – case 2*

By observing simultaneously Table 2 and Table 3, it can notice that the speeds change in both cases is the same, as well as the deformation depth, total deformation energy and impulse. Only what is different are the speeds after the collision.

Table 3 Report case 2

	Возило 1	Возило 2
Time, s	0.99	
Pre impact velocity, km/h	60	90
Post impact velocity, km/h	22.83	7.17
Velocity change (dV), km/h	82.83	97.17
Deformation depth, m	0.46	0.47
EES (Equivalent Eergy Speed), km/h	69.92	76.97
dV/EES, -	1.18	1.26
Total deformation energy, J	467846.61	
Impulse, Ns	28070.80	

4 MEASUREMENTS AND PROPOSALS FOR THE REDUCTION OF NUMBER AND CONSEQUENCES OF TRAFFIC ACCIDENTS

Today, with the development of the intelligent vehicles, the systems for the collisions avoidance have drawn a great attention. One of the ways to reduce the consequences of the traffic accidents is the application of collision mitigation systems. Collision mitigation systems is the part of the group of advanced driver assistance systems, which use systems such is the radar, cameras (Figure 6) and lasers for the environment following. Thanks to this, this system prevents the traffic accidents, or at least it reduces the consequences. This system warns the driver on the potential accidental situations, and when is necessary it takes control under some vehicles controls such is the braking, or direction management.

Fig. 6 *Advanced driver assistance systems (ADAS)[7]*

The advanced driver assistance systems include prediction and detection of protentional danger, as well as decision making [8]. On such system which is in use at vehicles, and which task is to prevent accidents, is the multi-agent coordinated control system. This system consists a great number of agents, such are agents for lane tracking, agents for global planning and agents for actuators control[9].

Besides the use of intelligent systems on vehicles, the consequences of traffic accidents can be reduced and by vehicle redesign[10].

By vehicle redesign, its meant on the optimization of size and layout of frames, all with aim to provide as great as possible absorption of the impact energy[11].Besides the redesign, also the materials have important role in the reduction of traffic accidents consequences[12].

5 CONCLUSSION

Nowadays, the traffic safety is quite actual subject. Traffic accidents with injuries and fatal outcomes, are also and economic lost how for the family also and for the country. The research conducted in this paper, indicates on the next conclusions:

- In Republic of Serbia, for the year 2024., the dominant traffic accident type wherehave participated two vehicles, was frontal collision.
- The specialized software's have found a great application for the expertise of traffic accident.
- The vehicles speed influences on the vehicle's direction after the collision.

- The total deformation energy was the same for both cases of simulation.
- The advantage systems can reduce the number of traffic accidents.
- The vehicle redesign can reduce the consequences of traffic accidents.

In the future researches it should conduct the reconstruction of the traffic accident, in order to avoid traffic accident, or to reduce the consequence of the traffic accident. Also, in the future researches, it should conduct the survey on drivers, in order to determine their habits.

REFERENCES

1. Road Traffic Safety Agency, Available: https://www.abs.gov.rs/static/uploads/18593_Statisticki_2024_web.pdf, Accessed 29.10.2025.
2. Guptaa, R., 2024,*Distracted driving: its Causes and Effects*, International Journal for Research Publication and Seminar, 15(2), pp. 117-129, 2024.
3. Prentkovskis,O., Sokolovskij,E., Bartulis, V.,2010, *Investigating traffic accidents: a collision of two motor vehicles*, TRANSPORT, 25(2), pp. 105-115.
4. Jerzy,K., Jaroslaw, Z., 2013,*Analysis of the selected aspects of a crash between two vehicles*, in Proceedings of the 2nd International Conference on Advances in Computer Science and Engineering (CSE 2013), Los Angeles.
5. Cao, Y.,Ye,X., Han, G., *A method for calculating the velocity of corner-to-corner rear-end collisions of vehicles based on collision deformation analysis*, Applied Sciences, 11(22), p. 10964, 2021.
6. Zhang,X., Jin, X.,Qi,W.,Guo, Y., 2008,*Vehicle crash accident reconstruction based on the analysis 3D deformation of the auto-body*, Advances in Engineering Software, 39(6), pp. 459-465.
7. Tacttile mobility, Available: https://tactilemobility.com/when-smart-cameras-arent-enough-the-need-for-multisensory-vehicle-data/, Accessed 29.10.2025.
8. Dahl, J.,de Campos, G.R.,Olsson,C., Fredriksson, J., 2019,*Collision avoidance: a literature review on Threat-Assessment Techniques*, IEEE Transactions on Intelligent Vehicles, 4(1), pp. 101-113.
9. Yuan, C.,Lin, Y.,Shen, J.,Chen, L.,Cai, Y.,He, Y.,Weng, S., Wu, X., Yuan, Y.,Gong,Y.,Yu, Q., 2023,*Research on active collision avoidance and hysteresis reduction of intelligent vehicle based on multi-agent coordinated control system*, World Electric Vehicle Journal, 14(1), p. 16.
10. Watanabe, T.,Onaga, M.,Hirayama, S.,Obayashi,K.,Okabe, T.,*Research on vehicle-to-MDB impact test for frontal impact compatibility*, SAE Technical Paper, pp. 2006-01-1136, 2006.
11. Luu N.P.T., Anh, L.H., 2024,*Analysis SUV vehicle structure in car to car frontal impact*, in Proceedings of the 3rd Annual International Conference on Material, Machines and Methods for Sustainable Development (MMMS2022), Cham.
12. Bahatmaka, A., Maulana, A.Y.,Amin, M.,Pratama, F.R.S.,Prabowo, A.R.,Fitriyana, D.F.,Seo, H.A.,Ju,H., Cho, J.H.,2025, *Material performance analysis in frontal collision simulation of electric vehicle frames using explicit dynamic finite element analysis method*, Results in Engineering, 28, p. 107130.

Contact address:
Ivan Grujić
University of Kragujevac
Faculty of Engineering
34000 Kragujevac
Sestre Janjić 6
E-mail: ivan.grujic@kg.ac.rs