COMEC

The 10th International Conference on COMPUTATIONAL MECHANICS AND VIRTUAL ENGINEERING

Transilvania University of Brasov
FACULTY OF MECHANICAL ENGINEERING

25-27 October 2023

ANALYSIS AND SIMULATION OF REAR COLLISION BETWEEN TWO VEHICLES

Zoltan Ș.*1, **Munteanu A.***2, **Beșliu D.***3 , **Bobeș I.***4 , **Trușcă D.***5

1. Transilvania University of Brașov, Romania, stefan.zoltan@student.unitbv.ro
2. Transilvania University of Brașov, Romania, alexandru-ioan.munteanu@student.unitbv.ro
3. Transilvania University of Brașov, Romania, abel.besliu@student.unitbv.ro
4. Transilvania University of Brașov, Romania, iulia.bobes@student.unitbv.ro
5. Transilvania University of Brașov, Romania, d.trusca@unitbv.ro

*Corresponding author: stefan.zoltan@student.unitbv.ro

Abstract: *This paper will highlight deformations suffered from vehicles suffered from sliding impact on a lane change maneuver or from a rear-end collision; it will furthermore determine the parameters of acceleration of both vehicles before, in time and after the collision. The analysis of accident is performed mainly by using PC-Crash software. The deformation energy resulted can offer important data when performing an accident reconstruction. At the end of the paper the severity of the crash can be evaluated based on accelerations obtained.*

Keywords: *crash, deformation, barrier, sliding-impacts, rear-end*

1. INTRODUCTION

Nowadays, vehicles became the main transport device for everyone. Even if you travel for work or in a vacation, you use a transportation device. Therefore, globally, the traffic intensity increases more by year, overcrowding every city. In our country, one of the reasons for overcrowding the cities is that we get more and more driving licenses at the maturity age. And the other reason is that, after almost 35 years apart from communism and with a substantial number of vehicles sold during the years, everyone with a good salary or with some sacrifices can buy a car.[9]

Since 2007, when Romania joined the European Union, the Romanian car park increases by year with approximately 15%, most of the vehicles coming from Eastern Europe, being second hand.

Statistics says that, worldwide, vehicles are the most dangerous transportation devices, being one of the common causes of death, due to a high number of victims resulted from accidents. Unfortunately, in Romania,

everyday dies 5 people on the roads, resulted of car accidents, which put us on the number 1 spot of the rankings for most deaths from car accidents. These are the consequences that comes from the lack of highways, speeding, or reckless driving.[9]

Against human survival, there are natural and artificial dangers, on the last place being categorized the vehicle. It provokes over 80% of the accidents that lead to invalidity. On a scale made by European Union, road accidents are the first cause of registered deaths between the ages from 6 to 30. Therefore, for example, in Romania the insurance companies charge three times more a price for an insurance to a person aged up to 30 years old, compared to those aged over 30 years old for a standard insurance.

2. TECHNICAL RESEARCH

The term of collision of vehicles depends on a variety of factors associated with the construction of motor vehicles, but also the conditions of the event. In this case, the study of vehicle kinematics and dynamics on the other hand, requires the use of experimental research results and theoretical models associated with the collision.

2.1. Objectives

The main objective of this paper represents the simulation and analysis based on an experimental test of a frontal impact between a motor vehicle and a stationary vehicle. The location of experimental test is the parking lot belonging to the Research Institute of Transylvania University of Brasov. In order to achieve the purpose of the research next objectives should be stated as follows:

- Performing the frontal type collision, vehicle - vehicle;
- Determination of the body deformations;
- Determination of deformation energy;
- Collision speed determination;
- Accelerations measurement of the vehicle during the impact.

2.2. Methodology

The methodology used for this research consists in the frontal collision test with a stationary vehicle at 60 km/h speed. For this experimental test were used a towed vehicle and a damaged vehicle. The test scenario is presented in Figure 1. The collision test was filmed using a high speed camera Fastec HI spec 5 capable to film up to 1000 FPS. In addition to perform the study were needed following technical items:

- Test polygon;
- Opel Vectra B Caravan vehicle damaged;
- Fiat Bravo vehicle for impact;
- Mercedes GLK220d towing vehicle;
- Quick release hook;
- Metal plate with rollers to guide the tow rope;
- Cable with 85 m length;
- GPS system;
- PIC DAQ device;
- Brake pedal actuator working at a pressure of 8 bar that allows the

vehicle to be stopped safely;
- Remote-controlled steering system via a radio remote control module.

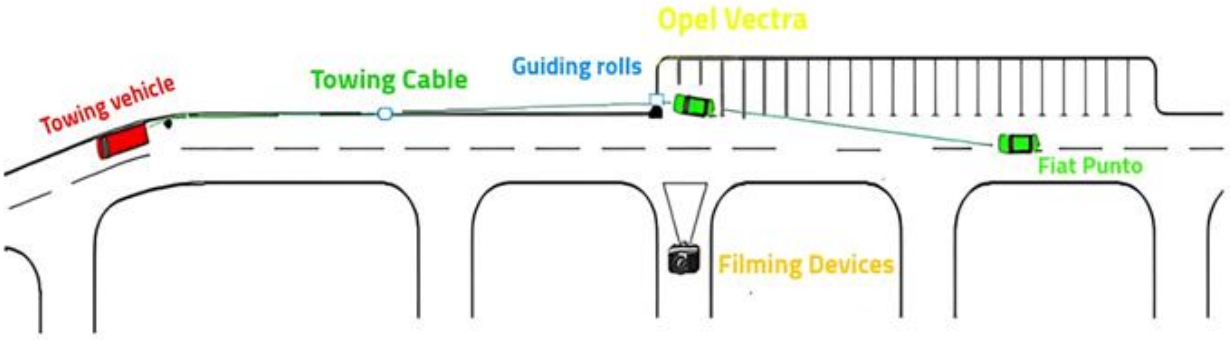

Figure 1: Test scenario

3. RESULTS

For a better analysis of this case, the collision between the vehicles was modeled and reproduced in the specialized soft for accident reconstruction. For a better simulation and a proper data analysis, both vehicles were put in the same point of the collision.

.

Figure 2: Post-collision vehicle positions

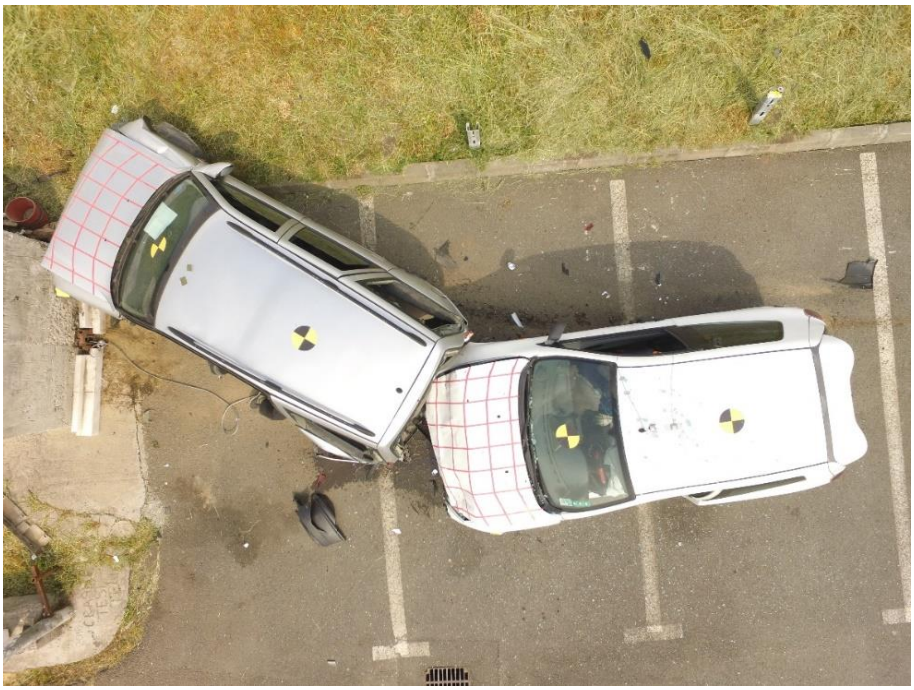

Figure 3: Post-collision vehicle positions in the test range

Figure 4: Post-collision vehicle positions in the test range

	1 Fiat-Brav	2 Opel-Vect	3 Wall
Time [s]:	1.975	1.975	0.220
Distance [m]:	6.10	6.39	0.00
Velocity [km/h]:	0.51	0.46	0.02

Characters: 175

Figure 5: Final values of the vehicles

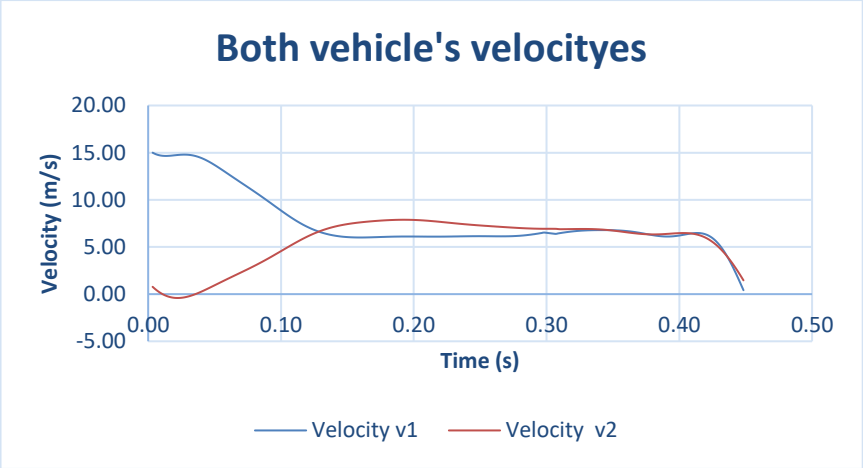

Figure 6: Post-collision combined velocity of the vehicles

The relevant data have been provided by cameras and with the help of Tracker, Origin Pro and Microsoft Excel software, the accelerations obtained after vehicle velocities differentiation were processed. Using the given methods, a variation of acceleration during the impact is shown in Figure 7.

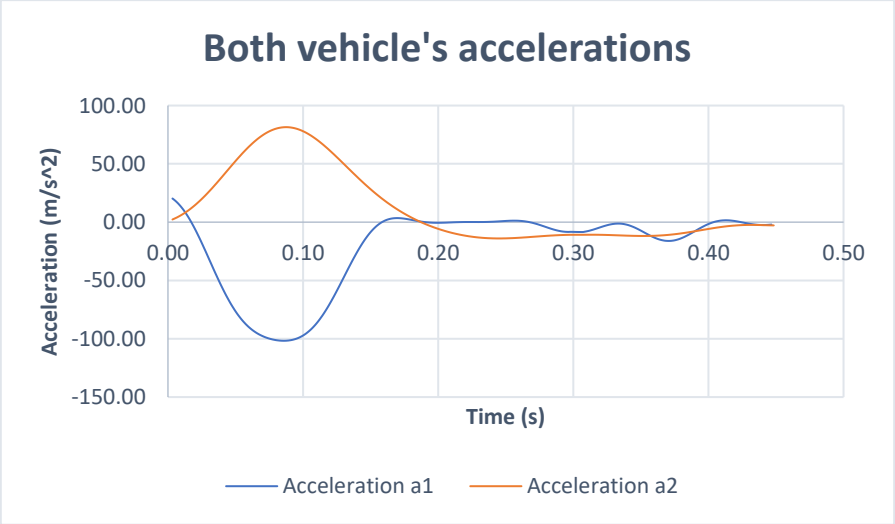

Figure 7: Acceleration change of the vehicles during the impact

As you can see in the graphics shown above, the maximum deceleration

from the forces exchange is in the interval of time of 0.00s and 0.09s is -101.71 m/s^2. From the moment of contact until the separation time, the stationary vehicle changes it's velocity from 0.00m/s to 7.885 m/s in a time of 0.20s. By the end of the process where both vehicles arrive in the rest positions it takes 0.45 s to reach back to velocity and acceleration 0.

4. CONCLUSIONS

The experimental research was performed by creating simulations of the scenario where you can see in the graphics represented in the previous chapter, in the moment of the collision, the stationary vehicle receives a velocity from the vehicle who hits. The main difference of the velocities and accelerations of both vehicles in the contact moment is the deformation where both vehicles are submitted.
Both vehicles are made to absorb a quantity of shock in the body in order to protect the passengers. The stationary vehicle absorbs some velocity from the running vehicles and then it begins to move, being submitted to a velocity change.

REFERENCES

[1] V. Campian, V. Vulpe, " Automobile", Ed. Universitatea din Brasov, 1989
[2] M. Unitaru, V. Campian, " Dinamica autovehiculelor", Ed. Universitatea din Brasov, 1988.
[3] Lazăr Cârjan – Tratat de criminalistică, editura Pinguin Book, București 2005
[4] Oţăt V, Bolcu , D., Thierheimer W. , Simniceanu L., Dinamica autovehiculelor, Editura Universitatea Craiova, 2005, ISBN 973-742-023-3
[5] Seitz Nicolae, Aspecte privind reconstituirea accidentelor rutiere. Universitatea Transilvania din Brasov, 1993
[6] Collins, James C. 1979. Accident Reconstruction.
[7] Searle, John A. . 1993. "The physics of throw distance in accident reconstruction. No. 930659." SAE Technical Paper No. 930659.
[8] https://en.wikipedia.org/wiki/Traffic_collision
[9] https://www.kraftlaw.com/car-accidents/types-of-car-accidents/