

# The course of the process of a motor car frontal impact against various places of the second vehicle's body side and its results

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**Abstract:** The aim of the study is to determine the influence of the impact place on the side of passenger car body on the course of the front-to-side vehicles' collision process. The study combines experimental research and mathematical modelling. In experimental research six crash tests taking into account different mutual positions of the vehicles at initial collision time were carried out. In mathematical modeling a simple collision model (2D) and the results of experimental tests have been used. This allowed to determine the courses of important quantities for the road accidents reconstruction. They were, among others forces of interaction between vehicles, displacements and vehicle velocities, characteristics of deformation of the front and side of the vehicle's body, components of energy lost during a collision. The results are shown in the 0-0.2 s time interval. After this time the cars separate and continue to move based on their kinetic energy of translational and rotary motion.

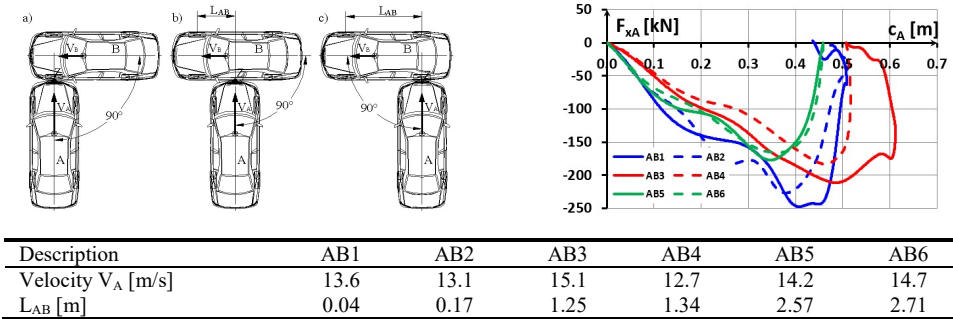
**Keywords:** road traffic safety, front-to-side vehicles' collision, road accidents reconstruction

## 1. Introduction

Front-to-side vehicles' collisions are a very common type of road accident. In 2020, they accounted for 31.5% of all road accidents in Poland. They often have a complicated and unpredictable course. Changes in vehicle motion parameters during and after a collision depend on many factors that have been poorly defined so far. The reconstruction of this type of accidents is very difficult and requires the use of the experimental studies results [1, 2]. In order to improve the road accidents reconstruction methods, six crash tests were carried out at the Łukasiewicz Research Network – Automotive Industry Institute (Łukasiewicz-PIMOT) with the use of 12 passenger cars of the same manufacturer and model. In each test, car A hit in the left side of car B head-on. The velocity of car A immediately before the collision was approx. 50 km/h and was twice as high as the car B velocity. In subsequent crash tests, the relative initial positions of cars A and B were changed (Fig. 1). The presented work summarizes the results of the crash tests carried out. Considerations introducing the analysis of the front-to-side vehicles' collision process have already been presented by the authors in previous works [3,4,5].

## 2. Results and Discussion

A planar model of the dynamics of the vehicles' collision was developed. Using the developed model and the accelerations and angular velocities of the cars measured during the crash tests, the courses of important quantities for the road accidents reconstruction were determined. They were, among others forces of interaction between vehicles, displacements and vehicle ve-locities (translational and rotating), characteristics of deformation of the front and side of the vehicle's body, components of energy lost during a collision. Figure 1 shows the deformation characteristics of the front of car A and of the side of car B obtained in six crash tests as the example result of the calculations.



**Fig. 1.** Relative positions of cars A and B during the crash tests and combined deformation of the front of car A and the side of car B

## 3. Concluding Remarks

Considering the results of the experimental and mathematical modeling results together, it was possible to describe the course of the front-to-side vehicles' collision depending on the impact place of the vehicle's body side. The place of an impact by a vehicle on the another car's body side significantly influences the course and consequences of the collision. It determines the values of parameters that have a significant impact on the vehicles movement trajectories after a collision and their final positions after an accident. The obtained results can be used to improve the methods of reconstruction of this type of road accidents.

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