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Impact energy versus the hazards for the occupants during a front-to-side vehicles' collision

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Abstract: The deformation process of the side part of the vehicle body in the culminating phase of the front-to-side vehicles' collision is considered. This is the basis for modeling the risk development process for occupants during a road accident. The danger and injuries to the occupants arise as a result of short-term dynamic loads in the culminating phase of vehicles deformation process. As a measure of these hazards, biodynamic indicators calculated from the course of acceleration and the forces acting on the occupant were adopted. During the collision, the occupant is being hit by the deforming structure of the vehicle body frequently . This phenomena significantly increases the risk of injury as a consequence of a road accident. The aim of the work is to analyse the influence of the impact energy on the occupants load in the struck vehicle during front-to-side collision. The results of inertial interactions and the vehicle body structure deformation forces were considered. The realization of the aim of the work was based on numerical research with usage of the developed front-to-side vehicles' collision model. The partial model of the interaction of the dummy with the vehicle body structure was taken into account. The performed numerical research allowed for the analysis of the relationship between the energy of a vehicle lateral impact and the dynamic loads to which the occupant is subjected.

Keywords: vehicles' collision, vehicle body deformation model, occupants injuries and safety

1. Introduction

The issue of the front-to-side vehicles' collision is being considered. In the culminating phase of the collision, hazards and injuries to the occupants arise as a result of short-term dynamic loads. The analysis of the emergence of these dynamic loads and their effects requires prior knowledge of many other processes, including the kinematics of vehicles in the collision phase and the velocity of the vehicle bodies deformation in the collision contact area. The authors of the study undertook considerations in this respect, f.e. in [1] and [2]. Particular attention was paid to model validation. Based on numerical studies, the kinematics of the side part of the vehicle body deformation process in the front-to-side vehciles' collision was determined. Dynamic deformation of the lateral part of the vehicle body is the main component of the hazard occuring process. A frequent phenomenon accompanying this deformation is the impact of the occupant by the deforming structure of vehicle body (Fig. 1).

The aim of the study is to analyze the influence of the lateral vehicle impact energy on the occupant's load. This influence is assessed, among others, by on the basis of biomechanical indicators, which are the basis for an inference about the risk of human injury as a result of a road accident.

Fig. 1. Occupant's impact by side structure of the vehicle body deforming during the front-to-side cars crash test; frames every 0.02 s from the beginning of the collision contact [3]

2. Research methods and results

The numerical research were carried out with the usage of the developed model of the front-to-side vehicles' collision. The model was presented in [1] and in [2]. The interaction of the dummy with the deforming structure of vehicle body was included. The model of dynamic interaction between dummy and the vehicle is shown in Figure 2.

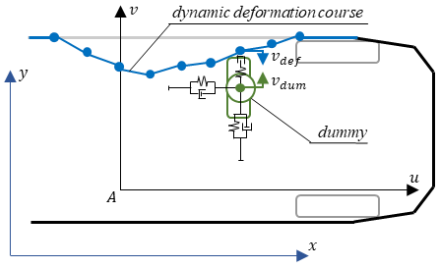

Fig. 2. Model of the interaction between the vehicle and the dummy

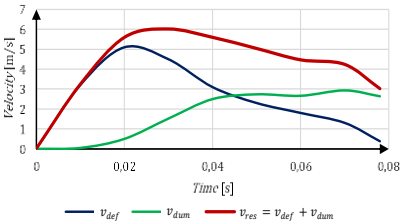

Fig. 3. Research results as velocity courses: the vehicle body deformation in the occupant's seat area v_{def}, the dummy v_{dum} and the dummy's impact in the deforming structure of the vehicle body v_{res}

Figure 3 shows an example of the numerical research results as the course of the vehicle body deformation velocity and the velocity of the dummy's movement towards the deforming structure of the vehicle body. This reveals the resultant velocity at which the dummy strikes by the vehicle body. In the event of the vehicle lateral impact with a velocity of approx. 13 m/s, the dummy collides with the deforming vehicle body structure with a velocity of approx. 6 m/s. On this basis, the occupant impact energy in relation to the initial velocity of the front-to-side vehicles' collision was concluded and the occupant risk of injury was predicted.

References

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