NUMERICAL AND EXPERIMENTAL TESTING OF SELECTED CRASH CUSHION AND ROAD BARRIER

Tadeusz Niezgoda\(^1\), Pawel Dziewulski\(^1\), Wieslaw Barnat\(^1\), Andrzej Kiczko\(^1\), Grzegorz Slawinski\(^1\), Slawomir Dzienis\(^2\)

\(^1\)Department of Mechanics and Applied Computer Science, Military University of Technology, Warsaw, Poland
\(^2\)The Road and Bridge Research Institute, Warsaw, Poland

\(^*\)Email: tniezgoda@wat.edu.pl

ABSTRACT
The paper presents the numerical and experimental results of road crash tests based on the selected crash cushion and the road barrier. The results include behaviour and deformation of the active device serving for road safety and the hitting vehicle, the ASI index. The simulations were performed using the nonlinear explicit FE code LS-DYNA v971. In the article, the problem of numerical modelling of an impact with an active device serving for road safety are considered. The results of numerical analysis have been compared with the experimental results which were carried out at the stand designed for impact tests.

Keywords: crash, crash cushion, road barrier, energy, LS-DYNA.

INTRODUCTION
A crash cushion, as well as a road barrier, is an active device serving for road safety, with which a car has a contact during unintended occurrences in road traffic, e.g., collisions or road accidents. These devices are constructively adapted to the immediate contact with a vehicle, moreover, special attention is paid to the minimization of direct impacts and their consequences for people in a vehicle. The basis of the statements on the quality of barriers and crash cushions is a crash test conducted according to a harmonized European standard PN-EN 1317. This standard includes all information required to conduct a crash test, namely:
- technical details of vehicles,
- criteria of tests,
- requirements established for a research area, a vehicle and a barrier,
- indicators determining the investigated product for human safety (THIV, ASI),
- requirements established for barriers and crash cushions after the test.

RESULTS AND CONCLUSIONS
A numerical model of a road barrier and a crash cushion has been self-produced with the performed geometry of the CATIA V5 system. The division into finite elements and preparation of a numerical model have been executed in the HYPERMESH system and dynamics calculations in the LS-DYNA system, which is an advanced implementation of the finite elements method for quickly changing phenomena. Tests for a vehicle- active device serving for a road safety system include carrying out experimental identification tests for numerical modelling of materials and a crash test, experimental validation of a numerical model, numerical modelling and simulations of the process of crash of vehicles and protective road barriers and crash cushions. The results from the crash tests of a vehicle - protective road barrier test system are shown in Fig. 1. The numerical simulation of stages of the process...
were the same as in the experimental test, the car drives into the lane barriers, deformation of the front part of the car and the barrier, raise of the rear of the car, the fall of the rear wheels on the surface.

![Fig. 1 - Comparison of deformation and accelerations acting on the center of gravity of the vehicle for a fragment of the road barrier](image)

The model of a crash cushion is characterized by the construction segment. The crash cushion was loaded with a susceptible vehicle of 1300 kg mass moving at the initial speed of 100 km/h. In Fig. 2, there are shown deformations of the vehicle and the crash cushion, and ASI course.

![Fig. 2 - Form of deformations of a vehicle and a crash cushion, and ASI course.](image)

Numerical investigations of energy absorbing shields can help not only at the design stage (because of speed, easiness of introducing changes, costs of tests, possibilities of simultaneous testing many variants or testing not-yet-existing solutions) but also can serve to conduct reliable, numerical (virtual) impact tests. The two presented cases showed a good agreement of the experimental and numerical results.

REFERENCES
