Bachelor thesis

The analysis of car improvement – comparison between car accidents statistics and the results of laboratory tests

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1. Introduction

The main purpose of the thesis is to analyze the results of measurements made during crash tests in order to assess the improvement in the level of protection of car passengers during road traffic accidents and compatibility of these results with data on the effects of real road accidents. The results of the crash tests from the NHTSA (National Highway Traffic Safety Administration) database were used to perform the work.

To asses the improvement in the level of protection of vehicle passengers injury criteria were used. Injury criteria allow to estimate the scale of injuries caused by loads impacted on the body during a road accident. They associate relevant physical quantities, such as accelerations or forces, with the risk of injury to individual areas of passenger body.

In the analysis were used injury criteria defined for head injuries (such as Head Injury Criterion, a3ms criterion), for chest injuries (a3ms criterion, Compression Criterion, Viscous Criterion, Combined Thoracic Index (CTI)), for neck injuries (N_{ij} criterion) and lower limb injuries (Tibia Index (TI), maximum femur force value).

2. Results

Two cases were considered. In the first of these, the general case of frontal collisions of passenger cars was examined without distinction between body type and dimensions. In the second case, collisions of similar type cars, i.e. of the same type of body (four-door sedan), similar weight and dimensions were considered. The speed of the car was 35 mph. In the first case, 63 crash tests of cars manufactured in 1998-2018 were selected for analysis, while in the second case – 42 crash tests of cars produced in the same period. In order to calculate the values of selected injury criteria, measurements of forces and accelerations acting on the body of the test dummy were used. Measurement data was filtered using 4-pole phaseless Butterworth digital filter. The criteria values were calculated using a script prepared for this purpose in MATLAB.
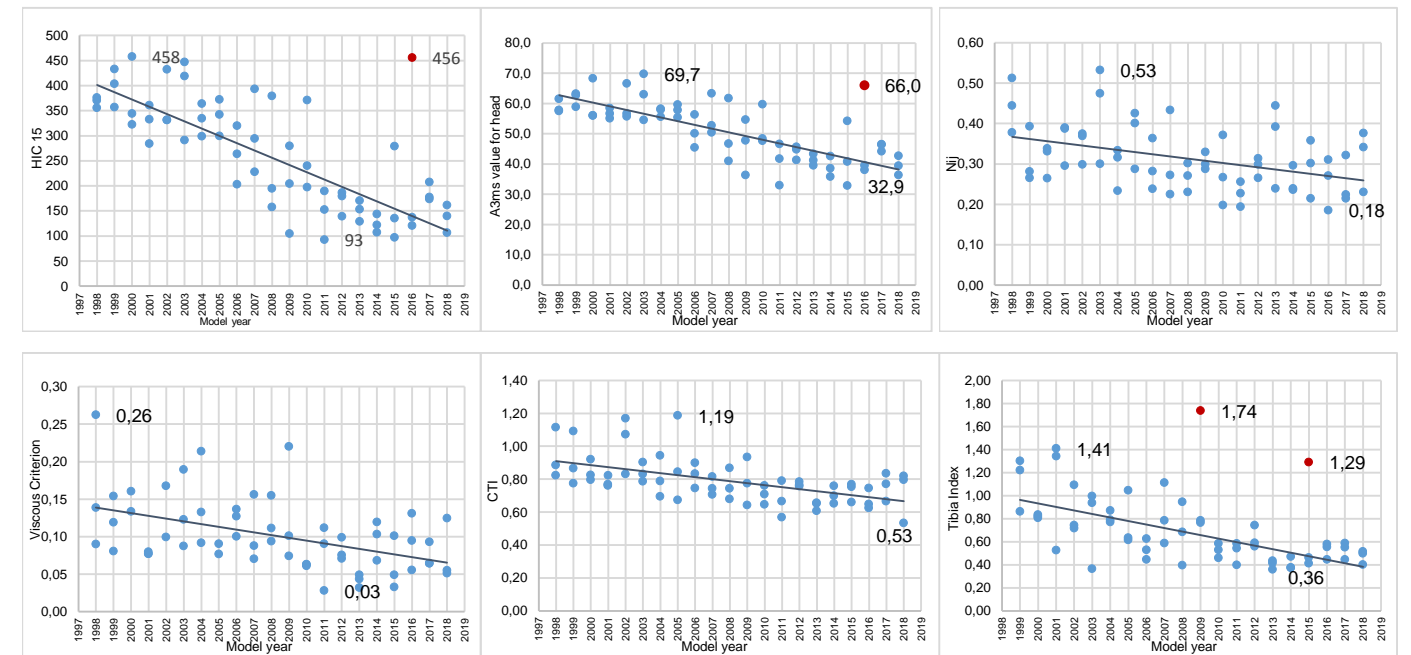

Figure: Injury criteria values (HIC15, a3ms value for head, Nij, Viscous Criterion, CTI and Tibia Index) for crash tests from general case (cars manufactured in 1998-2018).
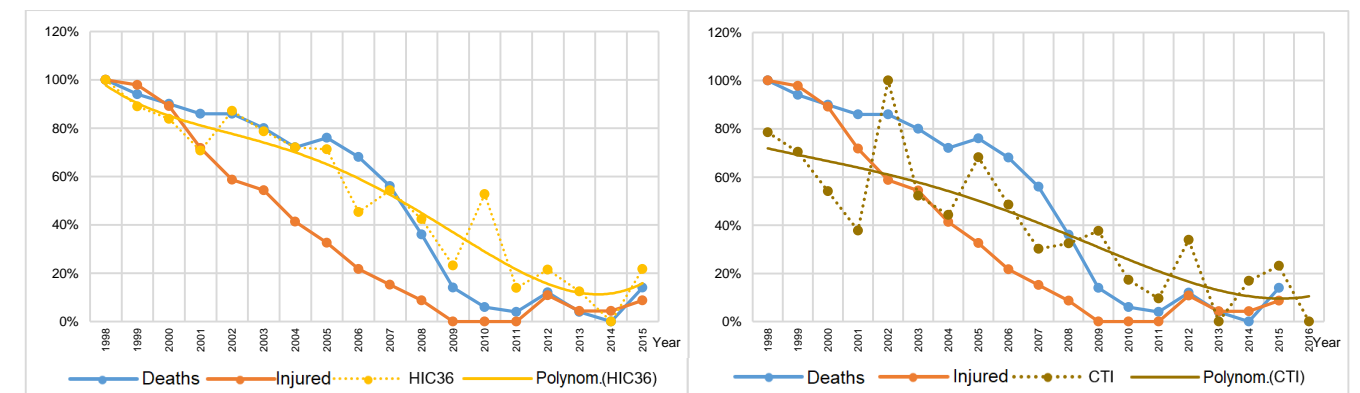

Figure: Comparison of normalised statistics of traffic accidents and normalised mean values of injury criteria (HIC36, CTI) in 1998-2015.

3. Conclusions

- In the general case, a significant decrease of value of loads acting on passengers of vehicles during road accidents was demonstrated. The most visible decrease is in the values of the HIC15 and HIC36 criteria, which means a significant improvement in head protection. This improvement significantly translates into a reduction in the number of fatalities.
- The improvement in vehicle safety in terms of chest protection is significant, though less than for the head.
- There is a slight improvement in protecting the neck against injuries, but the Nij criterion is significantly below the limit value.
- Good compatibility was reached on the assessment of the increase in the level of car passenger safety resulting from performed crash tests with statistical data on the effects of real accidents.