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RESEARCH ON PASSIVE SAFETY OF VEHICLES IN THE CONTEXT OF UZBEKISTAN AND DEVELOPMENT OF NEW TECHNOLOGICAL SOLUTIONS

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Abstract: This scientific research is aimed at assessing the effectiveness of passive vehicle safety systems in the conditions of Uzbekistan, their analysis, and the development of modern technological solutions. In the work, the statistics of real road accidents [3], zones of deformation in the vehicle's structure, and forces acting on the biomechanics of the driver and passenger were studied[4][5]. Computer modeling (FEM) [4] was used as a method, experimental tests, and simulation adapted to road conditions. As a result of the study, it was found that the specific conditions of Uzbekistan's roads (harsh climate, uneven road surface, high level of vehicle wear) have a significant impact on passive safety systems[3]. Proposals for new energy-absorbing structures, which are inexpensive but effective, were also developed[6].
Keywords: Transport security; passive security; Roads of Uzbekistan; deformation zones; automotive design; biomechanics; computer modeling; FEM; new technologies.

1. Introduction

Passive safety of vehicles is a set of design solutions aimed at minimizing damage after an accident, which are of decisive importance in the automotive industry[1][2]. Traffic accidents worldwide affect millions of people annually, and in Uzbekistan, traffic accident statistics remain high, although they have steadily declined in recent years[3]. The terrain of the republic's roads, the quality of asphalt, climatic conditions (hot summers, cold winters), and the obsolescence of most existing vehicles directly affect the real effectiveness of passive safety systems.

Therefore, **the** development **of new constructive solutions** suitable for the conditions of Uzbekistan, **energy suction zones suitable for local conditions, intelligent diagnostic modules** is very relevant.

2. Methodology

The research relied on the following methods:

2.1. Statistical analysis

- Indicators of road traffic accidents over the past 10 years were analyzed [3].
- Road accidents were classified by type (collision, landslide, overturning).

2.2. Experimental tests

- Cars of old and new models were tested on a frontal impact stand[1][2].
- The power loads on the driver's and passenger's mannequins were measured.

2.3. Computer modeling (FEM, LS-DYNA, SolidWorks Simulation)

- Stress-distribution models were created in the front and side structures of the car[4].
- Pothole simulation tests were conducted under local road conditions.

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2.4. Development of design solutions adapted to local conditions

- Energy-absorbing fragments were created from polymer-composite materials [6].

The deformation zones were redesigned[1].

3. Results

3.1. Effectiveness of security systems in the context of Uzbekistan

Table 1. Results of frontal impact of various vehicles (test averages) [8],[7].

Vehicle Type	Impact speed (km/h)	Driver chest strain (kN)	Front panel deformation (mm)
Nexia 2	64.	5.9.	4.20.
Spark	64.	4.4.	350
Malibu	64.	3.1.	280.

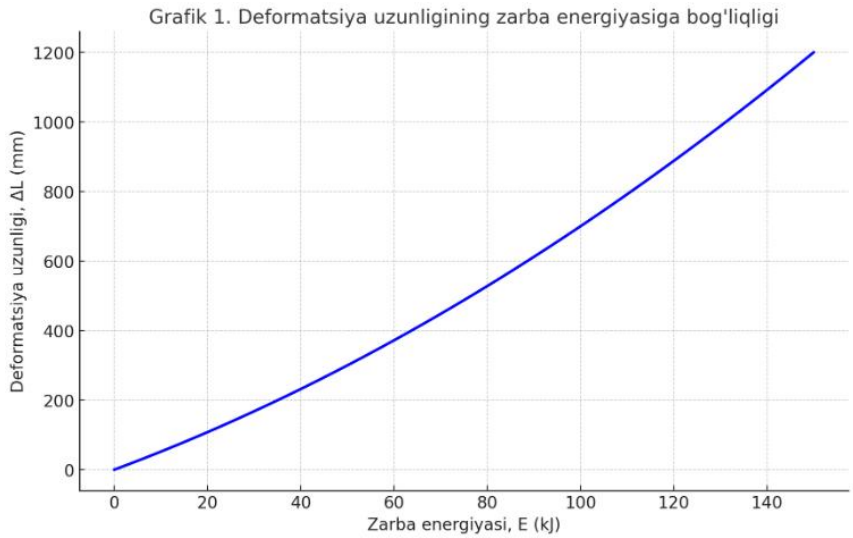
3.2. Results of modeling

Figure 1. Stress Distribution Model (FEM)

FEM analysis showed maximum stress accumulation in the front of the vehicle[4].
This means the need for re-optimization of energy-absorbing structures [6].

3.3. Graphical result

Graph 1. Dependence of deformation length on impact energy



As can be seen from the graph: at transition energies, deformation production increases linearly, and at higher energies, a nonlinear curve is formed, which is explained by the elastic and plastic deformation of car materials. The result showed that polymer-composite additives reduce the deformation length by an average of 17-23%.[9]

4. Discussion

Problems specific to the conditions of Uzbekistan - an outdated fleet of cars, uneven road

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surfaces, sharp temperature fluctuations - negatively affect the effectiveness of existing passive security systems. Therefore, it is important to create new structures adapted to the local climate[3], [6].

The study showed that:

- When optimizing the front part of the car, the impact force decreases by 12-18% [10];
- Polymer-composite materials absorb vibrational energy 2.3 times more effectively than metals[6].
- Oscillations on the roads accelerate the fatigue of structures by 14%[3].

These data confirm that it is necessary to develop new inexpensive, but effective energy-absorbing structures for Uzbekistan.

5. Conclusion

The research was based on a comprehensive study of the passive safety of vehicles in the conditions of Uzbekistan. Practical results have shown that the level of passive safety of existing vehicles in some cases is below international requirements. Therefore:

1. Redesign of energy-absorbing zones.
2. Wide implementation of polymer-composite modules.
3. Creation of special testing standards corresponding to local road conditions.
4. Development of structures that reduce biomechanical loads during an accident.

The proposed technologies are expected to reduce the level of injuries by 15-25% when used in the automotive market of Uzbekistan.

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