Statistical analysis of road accidents associated with technical condition of brake systems

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Abstract: The results of experimental studies aimed at improving road safety in the operation of vehicles are presented. Revealed faults can be detected using the latest methods and tools for instrumental diagnostics.

Qualitative analysis of accidents is used to establish cause-effect factors and the degree of their influence on the occurrence of accidents. In most countries, public opinion and official statistics of traffic management bodies most often see the main cause of accidents in negligence, errors of road users or car malfunctions. When analyzing an accident, it is easier to attribute its cause to the driver, who is believed to be obliged to react to the road traffic situation change and compensate for the imperfection of the “Driver - Car - Road - Environment” system with the necessary controls to ensure safe driving conditions.

According to the world statistics, the distribution of the causes of accidents is approximately the following:
- due to improper human actions 60 - 70%;
- due to the unsatisfactory condition of the road and the inconsistency of the road conditions with the traffic characteristics 20 - 30%;
- due to technical malfunction of the car 10 - 20%.

Analysis of the accidents causes shows that part of them occur due to the poor technical condition of motor vehicles. According to the data of special researches of the Ministry of Internal Affairs of Russia, the share of accidents caused by the poor technical condition of motor vehicles amounts to 15% of their total number. The table shows the number of accidents in percentages due to malfunction of individual elements of the car, affecting traffic safety, graphically displayed in Figure 1.

The most common causes of accidents are: in brake systems - leakage of brake fluid or air from the line, rupture of hoses and diaphragms of brake chambers wear or oiling of friction linings, uneven braking forces, excessive response time of the brake actuator; in steering - increased free travel of the steering wheel, loosening of fastened parts, jamming of the steering mechanism, separation of the steering gear rods due to ball pins; in the lighting and alarm system - blown lamps, improper installation of headlight; in the chassis - punctures and tire cuts, excessive wear of the tread, studs cutting.
Figure 1. Distribution of accidents’ causes
60% - wrong actions of drivers, pedestrians, passengers;
25% - unsatisfactory road conditions, poor traffic management;
15% - unsatisfactory technical condition of the car.

The distribution of accidents for reasons related to the technical condition of vehicles is presented in Table 1 and Figure 2.

Table 1. Distribution of accidents for reasons related to the technical condition of vehicles

| Cause                                           | Amount of accidents, % |
|-------------------------------------------------|------------------------|
| Damage to brake hoses, pipelines                 | 5.7                    |
| Breakdown of the brake actuator parts            | 3.3                    |
| Other brake faults                               | 27.0                   |
| Breakdown of steering gear parts                 | 4.8                    |
| Disengagement of steering gear                   | 3.7                    |
| Increased backlash of the steering wheel         | 3.0                    |
| Other steering problems                          | 5.7                    |
| Breakage of the chassis parts                    | 7.2                    |
| Faulty headlights                                | 0.6                    |
| Faulty brake lights, direction indicators         | 0.4                    |
| Missing or faulty wiper                          | 0.5                    |
| Missing or malfunctioning of rearview mirror     | 0.6                    |
| Limited visibility for the driver due to glass defects | 0.4                |
| Missing or faulty wiper                          | 0.5                    |
| Worn tread                                       | 5.3                    |
| Tirebreak                                        | 8.2                    |
| Faulty hitch                                     | 2.2                    |
| Other malfunctions of the vehicle                | 15.2                   |
Figure 2. Distribution of accidents due to technical failure of the vehicle

17.40% - Brake system malfunction;
13.50% - Malfunction of the steering;
7.20% - Breakage of the chassis parts;
7.20% - Malfunction of the lighting and alarm systems;
17.20% - Tread wear, tire break;
36% - Other faults

As follows from the table, the share of brake systems accounts for an average of 36% of accidents total number due to a malfunction of the PBX. The table shows the indicators characterizing the significance of certain faults (in% of the total number of incidents related to the technical condition of vehicles) for some models of domestic cars.

The relative difference between the braking forces of the axle wheels is one of the standards for the effectiveness of braking and stability of motor vehicles in accordance with GOST R 51709-2001. For motor vehicles category M1, it should be not more than 25%. As can be seen from the statistical data, a significant part of the tested on the line “data obtained on the line of instrumental control “Bilanmatik” GOST AVTO-2 of Vladimir” motor vehicles (46% - domestic cars, 54% - foreign cars) does not meet the requirements of GOST the coefficient of non-uniformity of the braking forces of the axle wheels. So, if we calculate these coefficients according to the method described in GOST R 51709-2001, about 28% of the examined cars have uneven braking forces on the wheels of the front axle above the allowable one. For the rear axle, the permissible parameter exceeds 40% of tested vehicles. This implies the following conclusions: first, the calculation of the unevenness of the braking forces should be carried out according to the recommendations of GOST R 51709-2001, using the algorithm, and secondly, it is necessary to develop a technique for in-depth diagnosis of the braking mechanisms in order to identify the cause of the large unevenness of the braking forces on the wheels.

The total specific braking force is another parameter, normalized by GOST R 51709-2001 - its value must be at least 0.53 for category M1.

Figure 3 shows the histograms of the distribution of specific braking forces from the same sample size as in the previous case. The following statistics were obtained: 44% of all tested vehicles have a value of specific braking force of the front axle less than the allowable value, 60% of cars have an underestimated value of the specific braking force of the rear axle and, finally, 58% of cars have an
unacceptably low total specific braking force. As you can see, only by these two controlled parameters a large percentage of cars are operated with unsatisfactory technical condition. In this regard, it is extremely important to develop technique for in-depth diagnosis of brake systems of ATS, the introduction of which into production significantly increases the active safety of cars.

Figure 3. Histograms of the distribution of specific braking forces:
- a) front axle specific braking force
- b) rear axle specific braking force
- c) total specific braking force
As can be seen, a large number of faulty vehicles that threaten safety are involved in road traffic. Thus, a survey of 900 passenger cars revealed a significant number of faulty ones, and some of them had not one, but several faults at once (Table 1).

Therefore, the most significant reduction in accidents due to poor technical condition of the motor vehicles can be achieved by improving the operational reliability of the brake system.

According to statistics, the number of accidents caused by faults in the brake systems of the car is 30 ÷ 40% of all accidents that have occurred for technical reasons. Modern identification of these faults should be diagnosed using the latest methods and tools for instrumental diagnostics.

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