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ANALYSIS OF PERIODICAL TECHNICAL INSPECTION SYSTEMS IN AUTOMOTIVE TRANSPORT. THE EXPERIENCES OF POLAND AND RUSSIA

Summary. The increasing number of road accidents nowadays seems to by a global problem. Apart from the obvious causes of accidents, such as violation of road traffic rules by drivers and pedestrians, the drunk driving, poor quality of road infrastructure, the technical faults of vehicles should also be take into account. Reasons of technical failures can be the failure of parts, components and assemblies caused by aging, poor quality or non-observance of technological norms when they are installed. It is possible to prevent the occurrence of faults by applying warning methods, one of which is obligatory periodic technical inspection. The purpose of this article is to analyze the characteristic features of the systems of technical inspections in automotive transport used in Poland and Russia. It makes it possible to identify common features and distinctive features of systems in both countries.

ANALIZA FUNKCJONOWANIA SYSTEMU OKRESOWYCH BADAŃ KONTROLNYCH W TRANSPORCIE SAMOCHODOWYM. DOŚWIADCZENIA POLSKI I ROSJI

Streszczenie. Wzrost liczby wypadków drogowym jest obecnie ogólnoświatowym problemem. Razem z głównymi przyczynami wypadków drogowych, tj. naruszanie zasad ruchu drogowego przez kierowców i pieszych, jazdą po spożyciu alkoholu, niedostateczną jakością drogowej infrastruktury technicznej, powinno się także uwzględniać usterki samochodów, jako istotny czynnik pośredni. Przyczynami defektów technicznych samochodów mogą być uszkodzenia części i komponentów spowodowane starzeniem, złą jakością lub nieprzestrzeganiem norm technicznych podczas ich montażu. W celu zapobiegania występowania usterek możliwe jest stosowanie działań zapobiegawczych. Jednym z nich jest okresowe badanie techniczne. Celem niniejszego artykułu jest analiza specyfiki systemów kontroli stanu technicznego samochodów przyjętych w Polsce i Rosji oraz identyfikacja ich cech wspólnych oraz charakterystycznych.

1. INTRODUCTION

The causes of crashes are well known. The crash risk depends on road user, vehicle and infrastructure. The skills and capabilities of road users, and the technical states of vehicles and infrastructure can be improved.

The research results show that the main factors affecting the level of road safety are: people as traffic participants, road and environment, as well as the vehicle - its design features and technical conditions. Road traffic accident (RTA) can be regarded as the result of random or targeted disruption of one of the factors or all factors simultaneously [1 - 4].

Thus, purposefully working on these factors and their interaction it is possible to significantly reduce the risk of RTA and the severity of its consequences.

The results of research in different countries are different, but usually they show the human factor as the cause is present in almost 90% of road accidents. Road and environment give 30-50% and technical fault of the vehicle is seen in 10-25% of all accidents. These factors have a direct influence on the occurrence of accidents or increase the severity of the consequences. Each of them can be the sole cause of an RTA or increase the risk level of its occurrence. Often accidents can be avoided if at least one of the influencing factors is minimized.

Despite a lower percentage of accidents due to technical conditions of the vehicle parts, components and assemblies, this problem should considered [16]. To reduce the number of accidents due to technical conditions in the first place it is necessary to apply warning methods. The most effective of warning methods is to undergo a periodic technical inspection.

Technical inspection of vehicles (TI) - to check technical conditions, including systems, components and additional elements of their equipment [5]. As additional equipment may be considered for example radio-alarm devices about the accident [6].

These are the following tasks of technical inspection:

- examining the technical conditions of the vehicle and its compliance with technical norms, as well as assessment of technical condition of the equipment; checking conformity with standards declared in legislation; TI reveals how the vehicle meets all the requirements for ensuring road safety and emission standards of pollutants in the environment;
- the detection or warning of crimes and administrative offences in the field of vehicle use;
- identification of stolen vehicles;
- transmission of information about the vehicles to organizations which carry out the national registration of road safety;
- transfer of data for papering a common database about the implementation of technical inspection.

Periodical technical inspection of vehicles has a long-standing practice. In some European countries (Finland, Italy) it became obligatory in the 20s of the last century. In other countries the beginning of the modern system of obligatory technical inspection of the vehicles was initiated by the adoption of appropriate legislation in the following years: Belgium - 1933, Austria - 1939, Japan – 1951,
Germany – 1952, Britain – 1960, Poland – 1961, Hungary – 1968, Spain, France – 1985 [7, 8].

The European Directive of 1997 on the implementation of obligatory TI imposed minimal requirements on vehicle (brakes, axles and suspension) in the system of the European Union member countries. Directive of 1997 formed the basis of TI Spain and Portugal, by limiting TI checking of brakes, axles and suspensions, whereas in Germany, Holland or in the Nordic countries, the inspection includes a control of pollution by harmful substances or internal security of the passenger. In addition, countries use various TI technological processes and frequency.

Organization of TI in different countries has its own specifics. In some of them TI is independent in all aspects of this activity, whereas in other countries there is no difference between the service and TI stations. There is a new directive draft of TI in the system of the European Union, which includes the systematization control of harmful emissions from vehicles.

In France, the law obliges the technical inspection centers to be independent in all activities. Similar policies are typical for Germany, Belgium, Luxembourg, Sweden and Denmark. In the

Netherlands, Finland, Ireland, Austria, Italy the examination of vehicles can be carried out both in service or special TI stations [7].

Organizational forms of a periodical technical checks a different in different countries. However, in all countries we can observed withdrawal of government from managing TI sector. The inspection is delegated to commercial firms which are better prepared for this kind of activities.

2. TECHNICAL ASPECTS OF ROAD ACCIDENTS

2.1. Main causes of road accidents

Road safety is one of the most important factors determining the quality of life of people in the industrialized countries. Every year about 1.2 million people are killed in road traffic accidents worldwide. Number of serious road accidents is undoubtedly related to the global traffic volumes increase. However, this trend can be reversed by increasing driving, road and vehicle safety levels. The measure of the level of road safety may be a trend of changes in the number of accidents, especially fatalities.

Statistical data on traffic accidents show that there is no clear relationship between one main factor and the number of average fatalities regarding number of inhabitants or vehicles. The best situation is in the Nordic countries (Tab. 1). Similar values of the indicators occur in Poland and the United States, two countries of different technical states of road facilities and the automotive culture.

Table 1

Road accident statistics in some countries

Country	Road fatalities per 100,000 inhabitants per year	Road fatalities per 100,000 motor vehicle	Total fatalities in 2012 (by WHO report)
Norway	2.9	4.4	145
Sweden	3.0	5.1	285
Denmark	3.0	5.7	167
Germany	4.3	6.9	3,520
Poland	10.9	17.6	4,191
United States	11.6	13.6	36,166
Russia	18.6	55.4	27,991

Accidents can be classified according to the type of vehicle involved in the accident, the type of consequences and the type of the causes. Causes of accidents can be considered in three categories: human factors, technical properties of vehicles, environmental factors. Circumstantial factors of accidents in EU countries have been shown in Fig. 1.

The main causes of the greatest number of accidents is the violation of traffic rules. This happens in almost 90% of all road accidents. The drivers are to blame, of course, most pedestrians: 76,1% against 12.3% in the total count of the accidents caused by violations of traffic rules.

Taking into consideration the consequences of the accident, the same factors should be considered in three categories of the time: before, during and after the accident. Classification of the consequences of accidents should focus on human factors. This should take into account the size of the person's injuries as well as negative consequences for the environment. The injury severity levels are commonly defined as five ordered categories: no injury (property damage only), possible injury, non-incapacitating injury, incapacitating injury, fatality.

Statistics of accidents in Russia by the end of 2014, according to reports by the traffic police, indicates that the situation is getting worse every year. Statistics has two key indicators - the number of accidents and number of fatalities [9]. For 2014 165,2 thousand accidents were registered in Russia,

which led to more than 22 thousand deaths. With injuries of varying severity it come up to 208,6 thousand people.

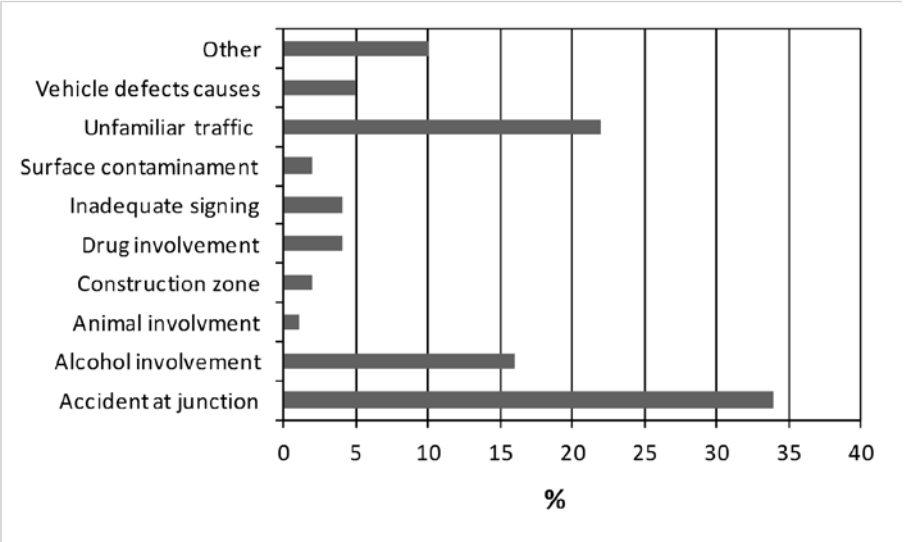

Fig. 1. Circumstantial factors of accidents
Rys. 1. Okoliczności wypadków

The number of vehicles per 1,000 people grow in Russia and it is accompanied by an increase in the number of accidents by a coefficient of 1.2 to 1.3. In Europe and the United States this coefficient is always less than a unity, despite the increase the number of vehicles.

In 2012, there was a reform of the vehicles TI system, which has not yielded positive results yet. In the first five months of 2015 absolute majority of accidents reviewed by the traffic police associated with violations of traffic regulations. The share of such incidents account for up to 87.7% of all accidents. The second most common cause of accidents is the poor state of roads.

The number of accidents involving drunk drivers from January to May reached 4233 cases. It is 2.1% more than in the same period of 2014.

The percentage of accidents caused by vehicle technical failure in 2015 has been growing. In five months the number of such incidents has increased by 44,3%, but against the background of nonconforming technical conditions of vehicles it remains a rare cause of accidents (622 cases). However, the growing dynamics of accidents from year to year has been decreasing. The corresponding dynamics can be linked to the reform of the TI system, after which the control of vehicle technical condition was passed from traffic police to the insurance companies.

2.2. The influence of automotive transport fleet type-age structure on the road accident

The Russian vehicle fleet during the collapse of the USSR was almost entirely made up of Soviet automotive industry products. So, by 1994 11,5 million cars moved on the Russian roads, of which only about 600 thousand (i.e. just over 5%) were foreign vehicle. According to the analytical agency AUTOSTAT [9] in the early 2000s, it was averaging more than 3 million vehicles, and the share of foreign vehicles grew by almost 15%. In the beginning of 2015 in Russia there were 40,85 million passenger cars [10].

If consider the age structure, the third part of the fleet (33.1%) are the vehicles over 15 years old. The fleet of trucks (CV+HCV) in Russia consisted of 3.73 million units. Almost 75% of the fleet is older than 10 years. A dozen of the leading brands occupies almost 85% of the truck fleet (CV+HCV).

The fleet of light commercial vehicles (LCV) in Russia is 3.95 million units. Almost 60% of the fleet is older than 10 years [11].

The analysis showed that the main part of trucks, which present the greatest risk to road safety, is obsolete. Meanwhile, the Ministry of Industry and Trade of the Russian Federation submitted a draft

law to limit the age of trucks and buses. The first bans on the old vehicles are to be introduced from July 2015.

The old vehicles will be withdraw in several stages. From July 2015, should be withdrawn 18 years old busses and older be weighted up to 5 tons with more should be withdrawn. Trucks aged 18 years which weight das not exceeded 3.5 tons (30 thousand vehicles) should go out of operation in January 2016.

Taking in to account the aging, Russia vehicle fleet requires the use of cardinal measures on the organization of road safety. The main measures to be taken in this case are the application of all types of automotive transport TI system.

3. SYSTEMS OF TECHNICAL INSPECTION

3.1. Technical inspection in Poland

In Poland the legal basis for periodic vehicle inspection have been defined in the Act on Freedom of Economic Activity and the Road Traffic Low. Any economic operator who has a station with suitable facilities and employs adequate staff with appropriate privileges can apply for the possibility to carry out technical inspection. Starting from the end of the nineties of the last century most of the stations have been completely modernized as well as numerous new ultra-modern facilities have been developed. At the beginning of this century most of the inspection stations in Poland have been equipped with the latest worldwide equipment.

During the examination, organoleptic methods, road and stand tests were applied. The vehicles are examined in order to define technical conditions and typical faults regarding traffic safety and environmental protection.

ECE Regulation No. 13-H and Regulation No. 13 according to Revision 6, determines the requirements for the braking performance of vehicles. The vehicles braking system properties are defined by the stopping distance and the mean fully developed deceleration.

The performance of a braking system should be determined by measuring the stopping distance in relation to the initial speed of the vehicle or by measuring the mean fully developed deceleration during the test. Vehicles, which are not equipped with an anti-lock system, should meet requirements defining the distribution of braking power between the axles.

The producers of examination equipment determine the testing methodology of suspension systems, chassis and wheel alignment. The suspension systems of category M1 vehicles are examined using one of two methods, the method based on resonance (Boge method) or utilising EUSAMA approach. The suspension test stands measure the ability to absorb shocks. The percentage value is obtained by calculating resistance against the presented weight of the vehicle.

In the resonance (Boge) method, the percentage rate (ability to absorb shocks) is calculated using maximum value of vibration amplitude and normal reaction of plate surface on axle at static conditions.

The performance requirements for steering systems and axle assemblies have not been determined by EEC regulations as yet. Inspection methodology consists of checking the components of systems for compliance with vehicle producer specifications and examining technical states of joints, steering assemblies, bearing slackness in wheels, hub and quality of repairs.

3.2. Reforming the technical inspection system in Russia

With the release of the Russian Federation Government Resolution No. 880 dated 31 July 1998 "On the procedure of state technical inspection of vehicles registered in the State inspection of traffic safety of the Russian Federation Ministry of internal affairs" Russia began to develop a system of vehicles technical conditions control.

The jurisdiction of the executive authorities of the Russian Federation subjects was attributed with mechanism to introduce vehicles technical condition check.

Since the beginning of 2012 control over TI was transferred to the Russian Union of Automotive Insurers (RUAI), which in fact das not bear any responsibility.

The rights to carry out technical control of vehicles was passed to dealer-service centers, service stations and points of state technical inspection, which, from 1 January 2012 were transferred to the RUAI. The main requirement for such organizations is the certificate of the established pattern. This certificate contains a reference to the specific scope of accreditation under which the operator can carry out a diagnosis of transport. Accreditation can be granted only to those organizations that meet the law requirements, namely:

- legitimately have facilities where they can conduct the inspection of vehicles;
- have all equipment and tools required for professional diagnosis;
- the state organization employs at least 1 technical expert;
- have the technical ability to carry out daily data on the results of inspections into a single system;
- have a contract with a car manufacturer on warranty maintenance of such vehicles.

The new law simplifies the lives of the vehicle owners that are regularly maintained at dealer-service centers. In this case, the diagnostic card is issued by the vehicle official dealer, and the owner will not require additional technical control point inspection. Moreover, these dealers having agreements with the manufacturers or distributors of vehicles and received the RUAI obligatory accreditation, will be able to issue a diagnostic card only for the vehicles of the brands that they sell [14].

It should be noted that the used to 2012 TI system allowed to conduct an independent assessment of the dealers quality of work. Now the dealer issues a diagnostic card, and for obvious reasons does not indicate defects made in the process of maintenance or repair. This has led to loss of control over TI in the country and to a sharp rise in accidents linked to technical failure of the vehicle. Diagnostic cards in most cases are given together with the insurance policy without carrying out a real TI, and in fact it takes no more than 20% of personal vehicles.

The frequency of TI has been slightly increased. The increase of TI frequency has a positive effect on the dynamics of reducing the accidents number.

The TI process also underwent changes. The number of required operations and checked settings has decreased since the beginning on 2012 [15].

Technical diagnosis is made by organoleptic control methods and with the use of technical diagnostic means, including mobile equipment. The process of examination consists of the following tests:

- the brake system test; the law does not allow compressed air leaks, mechanical damage, leakage of brake fluid, cracks and corrosion that can cause depressurization of the system;
- steering system test; it is important to avoid damage or missing parts, mounting, steering column, and machinery carter;
- external lighting devices tests;
- the state of the wiper and washer test;
- tires and wheels test; specialists measure the height of the tire tread, determine the suitability of the tire, searches for violations of the shape and size of mounting holes;
- the engine test, which must conform to the standards on the permissible amount of harmful gases released into the atmosphere;
- checking the level of noise during operation of the motor;
- checking of other structural parts of the vehicle, for example, locks, glass, safety switches, safety devices, trailers and towing devices.

4. CONCLUSION

The safety of vehicles in road traffic is very important because of potential hazards of peoples' life and health, damage and loss of freight and high costs of crash effects. The technical state of all

vehicles has been examined during obligatory periodical inspections, but in spite of this, the technical conditions of large number of vehicles has been poor.

In Poland buses are considered to be safer than other motorized modes of transportation. However, there is still a considerable number of crashes involving buses every year. The majority of research works has been concerned with road accidents involving buses at low speed. The road incidents have been classified as active ones and passive ones, depending on the season of the year, the weather conditions, time of the day, the type of a vehicles, skills, age, experience, sex, cultural background of the drivers. The technical state of a vehicle may be less important in the case of crash analysis at low speed, but it is very important at high speed, especially for inter-city buses and coaches.

The structures of faults and the trends of percentage of faults depending on the age of cars in each category of vehicles are similar. But the official data concerning technical causes of accidents are similar to the results of investigations only in the case of passenger cars. The check methodology of many vehicle systems which are important for traffic safety in buses, especially coaches and heavy duty vehicles, has not been worked out yet.

The technical conditions of all systems of vehicles should provide a reduction risk exposure, prevent accidents, reduce the severity of injuries in the crash and reduce the consequences of injuries.

Analysis of the current situation in the field of automotive transport TI on the territory of Russia revealed a number of problems associated with lack of control over the organization and carrying out of the works, lack of availability of the required material-technical base of the operator, the availability of a single database of vehicles in which information about the history of maintenance and repair is stored. In this respect, the authors propose a list of recommendations for improving the system of automotive transport TI on the territory of Russia:

- it is necessary to oblige the state traffic police to control the quality of automotive transport TI by the operators;
- it is necessary to create a unified database of vehicles, combining the data of the traffic police, dealer-service centers and technical inspection stations. The database should also store information about the payment of vehicle taxes and the availability of insurance;
- it the service station should 300-400 parameters should be check, including the use of measuring equipment and on the basis of experts knowledge and experience;
- it is necessary to develop a unified quality system for the organizations that make the automotive transport TI;
- it is necessary to develop uniform criteria for the assessment of defects identified during TI;
- it is also necessary to create and develop a system of personnel training and certification.

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