

road traffic safety, duty vehicles, technical conditions

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## **FAULTS OF DUTY VEHICLES IN THE ASPECTS OF SECURING SAFETY**

**Summary.** This paper presents the results of examinations of 500 duty vehicles. Tests were carried out in scope of securing safety in road traffic. The methodology of compulsory periodical inspections was applied during initial tests. Vehicles were examined on typical control stands and in road tests. A special methodology for road tests for heavy duty vehicles with anti-lock systems was elaborated. Additional checks were carried out in cases when the results of basic tests were dissatisfying. Above 280 vehicles of the total number of examined vehicles were faulty.

## **NIEDOMAGANIA SAMOCHODÓW CIĘŻAROWYCH W ASPEKCIE ZAPEWNIENIA BEZPIECZEŃSTWA**

**Streszczenie.** W pracy przedstawiono wyniki badań 500 samochodów użytkowych w aspekcie bezpieczeństwa użytkowania w ruchu drogowym. W badaniach wstępnych wykorzystano metodykę obowiązkowych okresowych badań kontrolnych. Badania prowadzono na stanowiskach kontrolnych oraz podczas prób drogowych. Dla samochodów wyposażonych w układy ABS pracowano specjalną metodykę badania. W przypadku stwierdzenia nieodpowiedniego stanu technicznego przeprowadzono dodatkowe badania w celu określenia przyczyn niesprawności. Ponad 280 pojazdów z grupy którą poddano kontroli było niesprawne.

### **1. INTRODUCTION**

The analysis of the results of investigations which were carried out in scope of securing safety in road traffic allowed to find an assessment of technical stand of duty vehicles as a very important problem [1-3]. The safety of duty 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 a crash effects. The technical state of all vehicles has been examined during required periodical inspections, but in spite of this, the technical conditions of large number vehicles have been poor [4, 5].

The range of inspections and their frequency have been determined according to the law of each country. The methodology and frequency has been determined in accordance with domestic legislation. The methodology of technical inspections concerns only some important systems of vehicles but not all. For example, anti-lock systems, retarders, adaptive cruise control systems, speed limitation devices etc. have not been examined.

The check methodology of many vehicle systems which are important for traffic safety in duty vehicles has not been worked out yet.

The examinations of 500 duty vehicles in scope of securing safety have been carried out to determine the causes of vehicle disabilities which are important in road traffic. Duty vehicles N1, N2, N3 categories including semitrailers were examined as well. Specification of vehicle types and examined car age has been presented in Table 1.

Table 1

Specification of the examined vehicle age

Vehicle category	Percentage of vehicles in age group					Total number of vehicles
	2 – 3 years	4 – 5 years	6 – 7 years	8 – 9 years	10 years and more	
N1	15	50	45	18	22	150
N2	20	45	45	45	15	170
N3	15	20	20	45	20	120
Semitrailers	5	25	10	18	2	60

## 2. METHODS OF VEHICLE EXAMINATIONS

The investigations were carried out in two stages. The initial tests were based on typical periodical inspections. The vehicles were examined in order to define technical states and typical faults significant for assuring safety in road traffic. The analysis concentrated on the feasibility of detecting faults, which can be determined using conventional diagnosing methods. The way of fixing the fault was also defined. During the examination, organoleptic methods, road and stand tests were applied. The vehicles were examined in order to define technical conditions and typical faults regarding traffic safety. The analyses concentrated on the possibilities of diagnosing any faults which can be determined using conventional diagnosing methods.

For each category of vehicles suitable tests according to binding rules of periodic vehicle inspections were carried out. For faulty vehicles, different diagnostic methods such as diagnosing through on-board diagnostic systems using diagnostic connectors, the measurements of electrical values while testing, additional road tests were conducted.

The examinations of brake systems were carried out in the course of road and stand tests, according to domestic and ECE regulations. The types of tests have been presented in Table 2 and algorithm of vehicle examinations has been presented in Fig. 1.

Table 2

Tests which were applied during examinations of vehicles

Test / Way of examination	Vehicle category			
	N1	N2	N3	Semitrailers
Braking test on a roller stand	x	x	x	x
Road braking test	x	x	x	x
Boge / Eusama test	x			
Examination of steering system	x	x	x	x
Anti-lock system test			x	x
On-board diagnostic test	x	x	x	x
Detailed diagnostic tests	x	x	x	x

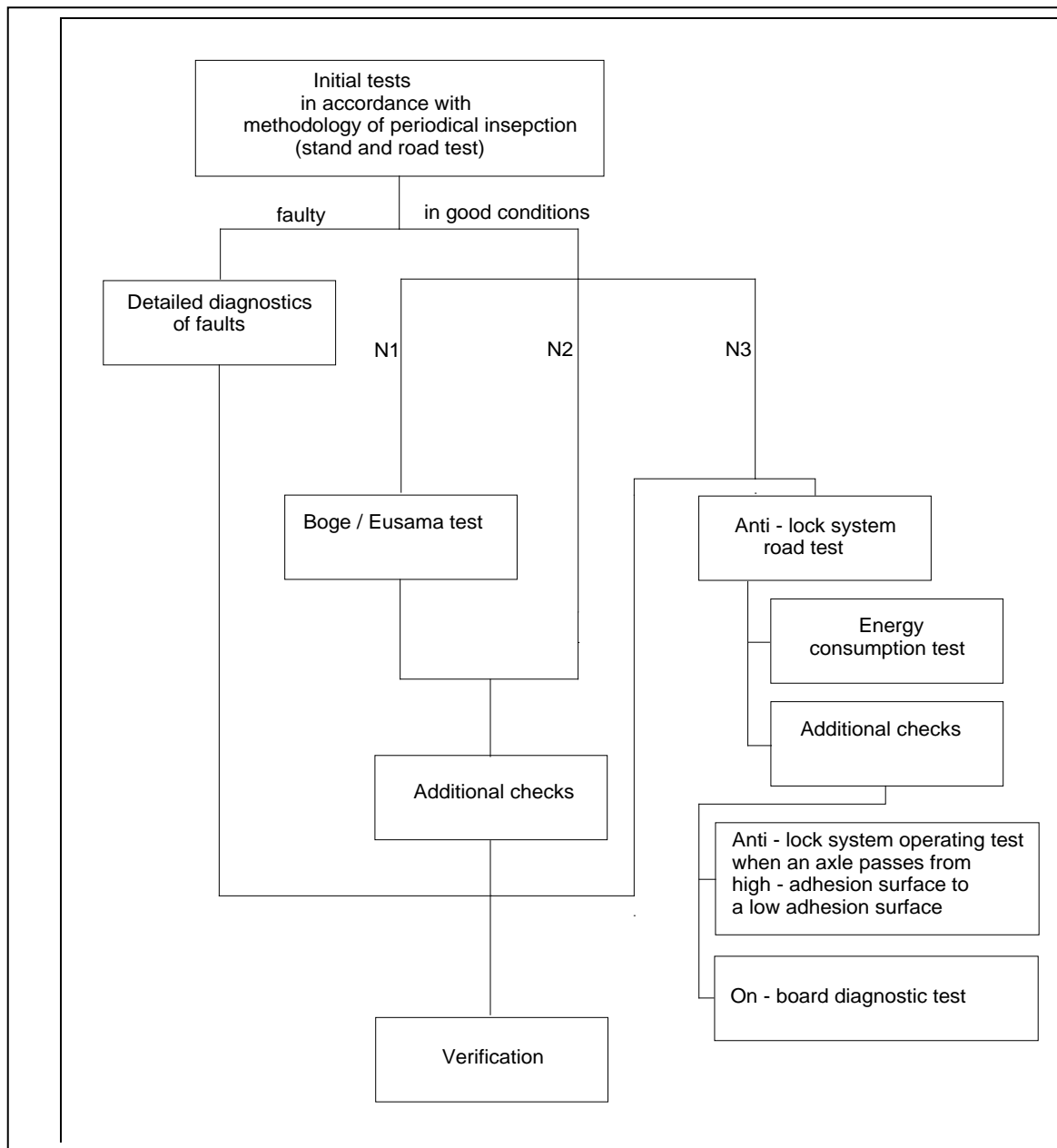


Fig. 1. Algorithm of vehicle examinations  
 Rys. 1. Algorytm badania samochodów

All semitrailers with tractors N3 category, which were examined, had pneumatic brake systems with anti-lock system category 1, according to ECE Regulation No. 13. Requirements of ECE regulations formed the basis of elaborating a new road tests for these vehicles. During the examinations for vehicles with pneumatic anti-lock system, the energy consumption test, and operating test when an axle passes from a high-adhesion surface to a low-adhesion surface were carried out. The initial speed for all the tests was between 50 – 60 km/h. Additionally, for all vehicles, when it was possible, on-board diagnostic test was made.

For N1 vehicle category suspension systems were examined during Boge and Eussama tests. Additional detailed diagnostic tests for all faulty vehicles were also carried out.

### 3. EXEMINATION RESULTS

Taking into consideration the securing safety aspects, for 283 examined vehicles the initial test results showed that the technical conditions were poor. The additional diagnostic tests allowed to recognize faulty systems and the elements of vehicles, the kind and causes of damages. But in many cases faults were not recognized using common diagnostic methods.

The analysis of faults for each category of the examined vehicles can be classified into the following groups: faults of systems which have direct impact on driving safety like brake system, steering system, suspension system, indicators and lights, chassis system and faults which diminishes the comfort of driving and the safety of freight. Examination results for all vehicles have been shown in Fig. 2. The results for each category of vehicles have been presented in Table 3. There have been far more faults of brake system in each category. Forty four per cent out of total number of faults were connected with brake system including anti-lock system. It is probably the result of insufficient quality maintenance.

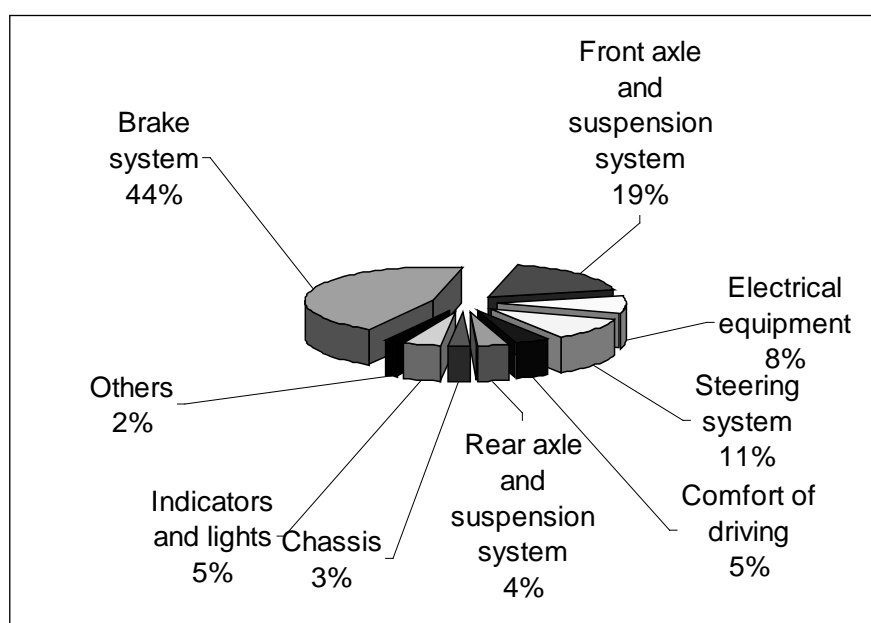


Fig. 2 Structure of vehicle faults

Rys. 2. Struktura uszkodzeń w samochodach

Table 3

Structure of vehicle faults for particular vehicle categories (number of faults)

Faulty system	Vehicle category				Total number of faults
	N1	N2	N3	Semitrailer	
Brake system	64	48	52	42	206
Front axle and suspension system	28	18	34	-	80
Electrical equipment	16	8	2	12	38
Steering system	34	13	3	-	50
Comfort of driving	20	1		-	21
Rear axle and suspension system	5	6	4	2	17
Chassis	12	1			13
Indicators and lights	2	2	1	16	21
Others	1	3	2	2	8
Total number of faults					454

Taking into consideration the feasibility of fault diagnosis and the technology of repairs it is possible to distinguish the following aspects: normal wear during operation, abnormal mechanical faults, faults which are connected with engine control unit and electrical system, dynamic and corrosion fatigue.

The number of vehicles with faults for each examined vehicle category, including vehicles which technical condition posed a threat to traffic safety, has been presented in Table 4.

Table 4

The number of vehicles with faults in the examined categories

Faulty system	Vehicle category				Total number of faults
	N1	N2	N3	Semitrailer	
Number of faults	96	70	69	48	283

A majority of vehicles with pneumatic anti-lock systems were faulty. The damages have had big negative effects on air consumption while using brake system on low-adhesion surface. Such cases are particularly dangerous. In many cases the causes of faults were not recognized. The common brake stand tests were insufficient.

The results of investigations showed that to describe the technical condition of brake systems, the calculation of braking rate is unreliable. The calculation results depend on the total mass of vehicle. The examinations of N3 category vehicles during road tests are difficult because of a large total mass of vehicle, the difference between maximum mass and real mass of a vehicle and lack of specific test road section for this kind of vehicles. Measuring the deceleration is difficult because of the relationship between the measured deceleration value and the initial speed of a vehicle. That kind of difficulty does not appear during tests of lighter N1 vehicles categories.

The analysis of detailed diagnostics results and verifications during repairs allowed to identify faulty parts for each category of the examined vehicles. The demonstration results of verifications have been shown in Fig 3. For brake pneumatic systems with anti-lock system, apart from normal wear, most faults concern modulators and compressors.

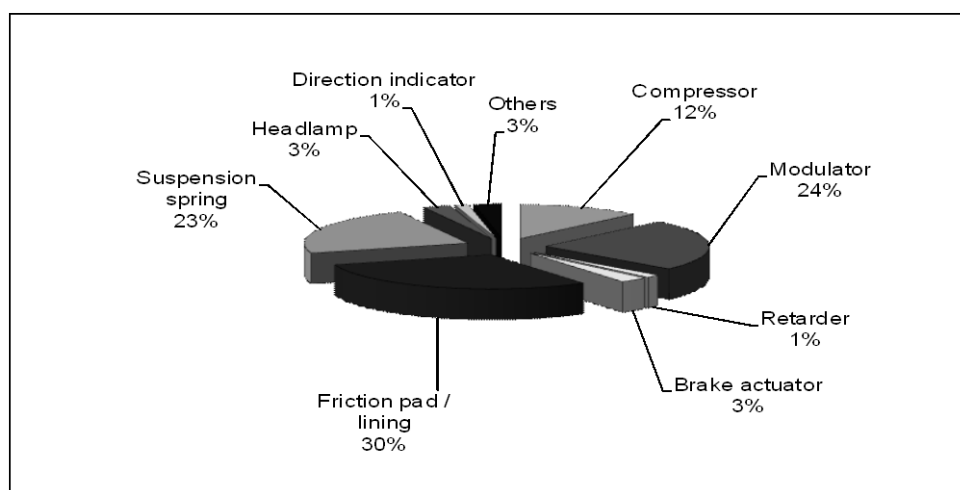


Fig. 3. Structure of faults of parts for N3 category vehicles

Rys. 3. Struktura uszkodzeń części dla samochodów kategorii N3

#### 4. CONCLUSIONS

The results of investigations revealed that there is a possibility to improve the methodology of inspection of vehicles. A large number of faulty vehicles was the result of more restrictive criteria which were used in examination tests. The increased number of tests and the kinds of tests which were applied during the examinations, allowed to detect much more types of faults compared to the results of common inspections. Anti-lock road test provided satisfying results of the examination, however this is difficult to apply in service stations.

The test results have shown that there is a strong need for elaborating the methodology of inspections for some vehicle systems which are crucial for road safety such as anti-lock systems in heavy vehicles, retarders, speed limitation devices etc.

The inspections of duty vehicles should be carried out far more frequently, than it is required by low regulations. All examined vehicles have been used in traffic but only half on the total number of these vehicles were in good conditions.

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